Today 8.1, 8.2

L24

Today 8.1, 8.2

L24

Momentum &

impulse

ASU

Today 8.1, 8.2

L24

Conservation of momentum

L24

Today 8.1, 8.2

Friday 8.3, 8.4

L24

Today 8.1, 8.2

Friday 8.3, 8.4

Momentum conservation & collisions

Today 8.1, 8.2

L24

Friday 8.3, 8.4

Elastic collisions

Today 8.1, 8.2

L24

Friday 8.3, 8.4

SI Session Today 5-6pm

Today 8.1, 8.2

L24

Friday 8.3, 8.4

SI Session Today 5-6pm

* Conservative & Nonconservative Forces

L24

Today 8.1, 8.2

Friday 8.3, 8.4

SI Session Today 5-6pm

* Conservative & Nonconservative Forces

* Forces & potential energy

ASU

Today 8.1, 8.2

L24

Friday 8.3, 8.4

SI Session Today 5-6pm

* Conservative & Nonconservative forces

* Forces & potential energy

Friday 9-10am

Today 8.1, 8.2

L24

Friday 8.3, 8.4

SI Session Today 5-6pm

* Conservative & Nonconservative Forces

* Forces & potential energy

Friday 9-10am

* momentum & impulse

JOIN THE WAVE

ATTEND OUR 2020-2021
NEW MEMBER MEETING
VIA ZOOM
OCTOBER 21ST
6:00 PM
REGISTER THROUGH THE
QR CODE BELOW

Desert WAVE is a Women in Autonomous Vehicle Engineering team. They compete annually in RoboNation's International RoboSub competition, placing 2nd in the World Overall, 2020!

- Learn about autonomous systems
- Collaborate w/ industry mentors
- Build valuable technical skills
- Work w/ motivated women in STEM

NO EXPERIENCE REQUIRED

Desert WAVE
Women in Autonomous Vehicle Engineering

Si Se Puede

Open to all undergraduate and graduate students of any major across all ASU campuses

ASU

Momentum

Momentum

$$\vec{p} \equiv \text{momentum}$$

Momentum

$\vec{p} \equiv$ momentum

$$\vec{p} \equiv m\vec{v}$$

Momentum

$\vec{p} \equiv$ momentum

$\vec{p} \equiv m\vec{v}$

Note $\frac{d}{dt}\vec{p} = m\vec{a}$

Momentum

$\vec{p} \equiv$ momentum

$$\vec{p} \equiv m\vec{v}$$

Note $\frac{d}{dt}\vec{p} = m\vec{a}$

so $\sum \vec{F} = m\vec{a}$

Momentum

$\vec{p} \equiv$ momentum

$$\vec{p} \equiv m\vec{v}$$

Note $\frac{d}{dt}\vec{p} = m\vec{a}$

so $\sum \vec{F} = m\vec{a} \Rightarrow$

$$\sum \vec{F} = \frac{d\vec{p}}{dt}$$

Momentum

$\vec{p} \equiv$ momentum

$\vec{p} \equiv m\vec{v}$

Note $\frac{d}{dt}\vec{p} = m\vec{a}$

so $\sum \vec{F} = m\vec{a} \Rightarrow$

$\sum \vec{F} = \frac{d\vec{p}}{dt}$ so

$\sum \vec{F} = 0$

Momentum

$\vec{p} \equiv$ momentum

$\vec{p} \equiv m\vec{v}$

Note $\frac{d}{dt}\vec{p} = m\vec{a}$

so $\quad \Sigma\vec{F} = m\vec{a} \Rightarrow$

$\Sigma\vec{F} = \frac{d\vec{p}}{dt}$ so

$\Sigma\vec{F} = 0 \Rightarrow \frac{d\vec{p}}{dt} = 0$

ASU

Impulse

Impulse

$\vec{J} \equiv$ Impulse

Impulse

$\vec{J} \equiv$ Impulse

& $\vec{J} = \left(\sum \vec{F}\right)(\Delta t)$

constant over Δt

ASU

Impulse

$\vec{J} \equiv$ Impulse

$$\vec{J} = \left(\sum \vec{F}\right)(\Delta t) = (F_{AVE})(\Delta t)$$

constant over Δt

Impulse

$\vec{J} \equiv$ Impulse

$\not{c}$ $\vec{J} = \left(\sum \vec{F}\right)(\Delta t) = (F_{AVE})(\Delta t)$

constant over Δt

Also $\vec{J} = \Delta \vec{P}$

Impulse

$$\sum \vec{F} = \frac{d\vec{p}}{dt}$$

Impulse

$$\sum \vec{F} = \frac{d\vec{p}}{dt} \Rightarrow \int \sum \vec{F}\, dt = \int \frac{d\vec{p}}{dt}\, dt$$

ASU

Impulse

$$\sum \vec{F} = \frac{d\vec{p}}{dt} \Rightarrow \int \sum \vec{F}\,dt = \int \frac{d\vec{p}}{dt}\,dt$$

$$\Rightarrow \quad \int \sum \vec{F}\,dt = \Delta \vec{p}$$

ASU

Impulse

$$\sum \vec{F} = \frac{d\vec{p}}{dt} \Rightarrow \int \sum \vec{F}\,dt = \int \frac{d\vec{p}}{dt}\,dt$$

$$\Rightarrow \int \sum \vec{F}\,dt = \Delta \vec{p} \Rightarrow$$

$$\vec{J} = \Delta \vec{p}$$

ASU

Impulse

$$\sum \vec{F} = \frac{d\vec{p}}{dt} \Rightarrow \int \sum \vec{F}\,dt = \int \frac{d\vec{p}}{dt}\,dt$$

$$\Rightarrow \int \sum \vec{F}\,dt = \Delta \vec{P} \Rightarrow$$

$$\vec{J} = \Delta \vec{P}$$, where

$$\vec{J} \equiv \int \sum \vec{F}\,dt$$

ASU

Impulse

$$\sum \vec{F} = \frac{d\vec{p}}{dt} \Rightarrow \int \sum \vec{F}\, dt = \int \frac{d\vec{p}}{dt}\, dt$$

$$\Rightarrow \int \sum \vec{F}\, dt = \Delta \vec{p} \Rightarrow$$

$$\vec{J} = \Delta \vec{p}$$, where

$$\vec{J} \equiv \int \sum \vec{F}\, dt$$ mean value theorem

for integrals $\Rightarrow$ $$\int \sum \vec{F}\, dt = \vec{F}_{AVE} \Delta t$$

Impulse

$$\sum \vec{F} = \frac{d\vec{p}}{dt} \Rightarrow \int \sum \vec{F}\,dt = \int \frac{d\vec{p}}{dt}\,dt$$

$$\Rightarrow \int \sum \vec{F}\,dt = \Delta \vec{p} \Rightarrow$$

$$\vec{J} = \Delta \vec{p}$$, where

$$\vec{J} \equiv \int \sum \vec{F}\,dt$$

mean value theorem for integrals $\Rightarrow$ $\int \sum \vec{F}\,dt = \vec{F}_{AVE}\,\Delta t$

so $\vec{J} = \vec{F}_{AVE}\,\Delta t$

ASU

You throw a ball with a mass of 0.40 kg against a brick wall. It is moving horizontally to the left at $30\ \mathrm{m/s}$ when it hits the wall; it rebounds horizontally to the right at $20\ \mathrm{m/s}$. (a) Find the impulse of the net external force on the ball during its collision with the wall. (b) If the ball is in contact with the wall for 0.010 s, find the average horizontal force that the wall exerts on the ball during the impact.

ASU

You throw a ball with a mass of 0.40 kg against a brick wall. It is moving horizontally to the left at 30 m/s when it hits the wall; it rebounds horizontally to the right at 20 m/s. (a) Find the impulse of the net external force on the ball during its collision with the wall. (b) If the ball is in contact with the wall for 0.010 s, find the average horizontal force that the wall exerts on the ball during the impact.

$m = 0.40 \text{ kg}$

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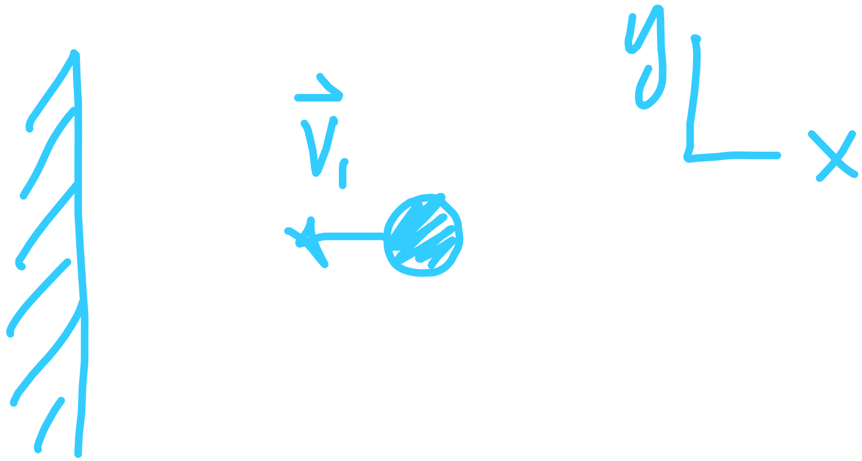
$m = 0.40$ Kg



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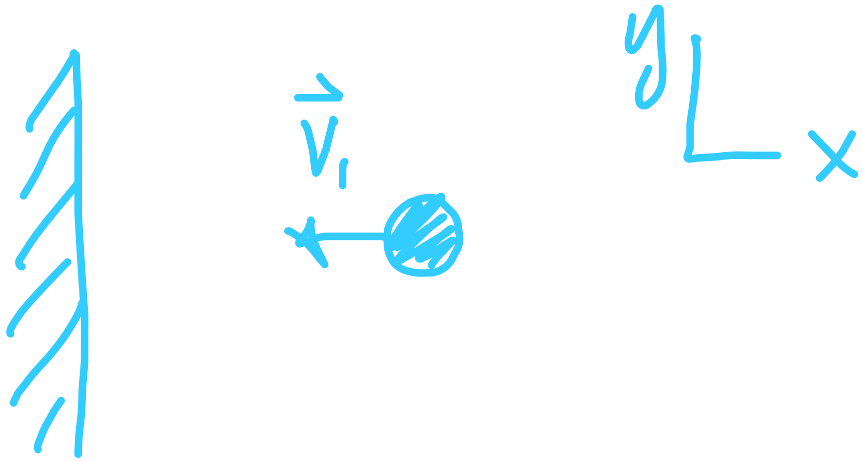
$m = 0.40\ \text{kg}, \ \vec{v}_1 = -30\ \text{m/s}\ \hat{i}$



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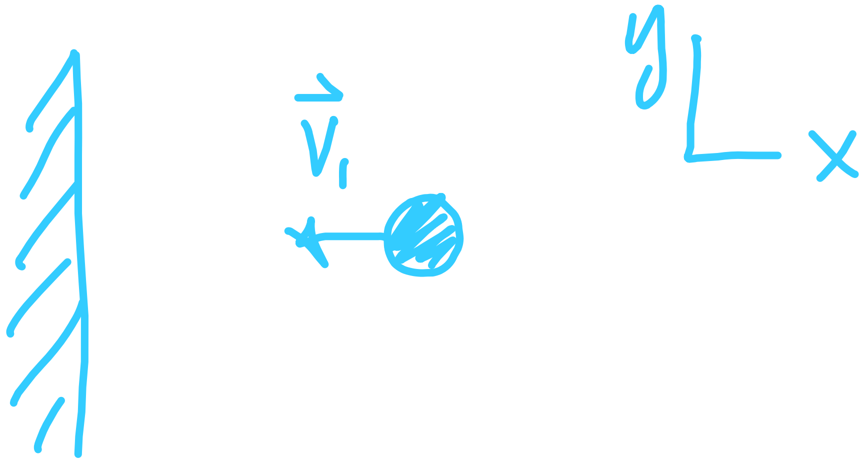
$m = 0.40\ \text{kg}$, $\vec{v}_1 = -30\ \text{m/s}\ \hat{i}$

$\vec{v}_2 = 20\ \text{m/s}\ \hat{i}$



Find $\vec{J}$:

You throw a ball with a mass of 0.40 kg against a brick wall. It is moving horizontally to the left at 30 m/s when it hits the wall; it rebounds horizontally to the right at 20 m/s. (a) Find the impulse of the net external force on the ball during its collision with the wall. (b) If the ball is in contact with the wall for 0.010 s, find the average horizontal force that the wall exerts on the ball during the impact.

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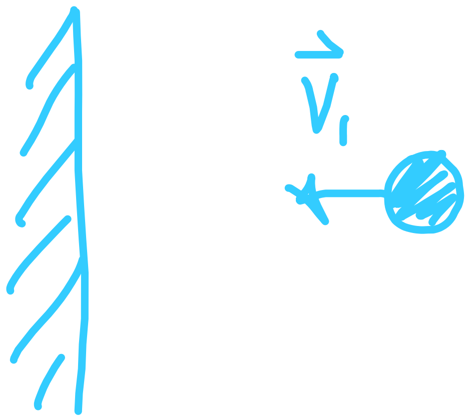

Find $\vec{J}$:

$\vec{J} = \Delta \vec{p}$

You throw a ball with a mass of 0.40 kg against a brick wall. It is moving horizontally to the left at 30 m/s when it hits the wall; it rebounds horizontally to the right at 20 m/s. (a) Find the impulse of the net external force on the ball during its collision with the wall. (b) If the ball is in contact with the wall for 0.010 s, find the average horizontal force that the wall exerts on the ball during the impact.

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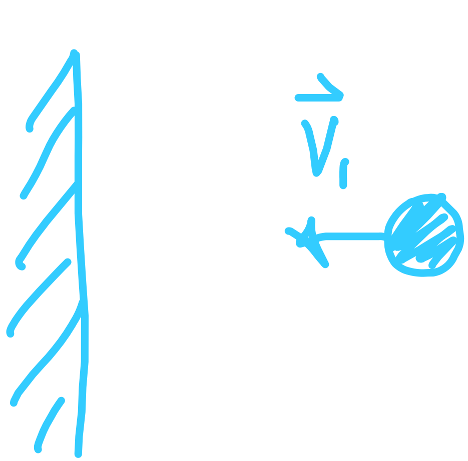
$\vec{v}_2 = 20\,\text{m/s}\,\hat{i}$



Find $\vec{J}$:

$$\vec{J} = \Delta\vec{p} = \vec{p}_2 - \vec{p}_1$$

ASU

You throw a ball with a mass of 0.40 kg against a brick wall. It is moving horizontally to the left at 30 m/s when it hits the wall; it rebounds horizontally to the right at 20 m/s. (a) Find the impulse of the net external force on the ball during its collision with the wall. (b) If the ball is in contact with the wall for 0.010 s, find the average horizontal force that the wall exerts on the ball during the impact.

$m = 0.40\ \text{kg}$, $\vec{v}_1 = -30\ \text{m/s}\ \hat{i}$

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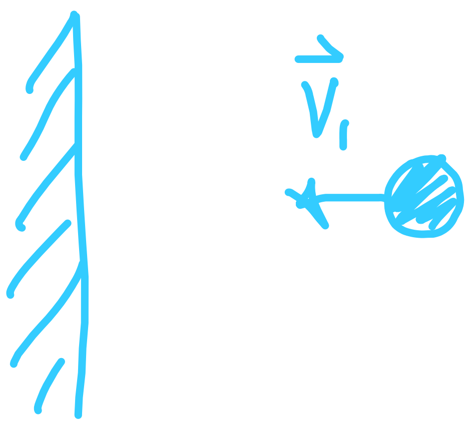


Find $\vec{J}$:

$$\vec{J} = \Delta \vec{p} = \vec{p}_2 - \vec{p}_1 = m\vec{v}_2 - m\vec{v}_1$$

You throw a ball with a mass of 0.40 kg against a brick wall. It is moving horizontally to the left at 30 m/s when it hits the wall; it rebounds horizontally to the right at 20 m/s. (a) Find the impulse of the net external force on the ball during its collision with the wall. (b) If the ball is in contact with the wall for 0.010 s, find the average horizontal force that the wall exerts on the ball during the impact.

$m = 0.40\text{ kg}, \quad \vec{v}_1 = -30\text{ m/s}\ \hat{i}$

$\vec{v}_2 = 20\text{ m/s}\ \hat{i}$

Find $\vec{J}$:

$\vec{J} = \Delta\vec{p} = \vec{p}_2 - \vec{p}_1 = m\vec{v}_2 - m\vec{v}_1$

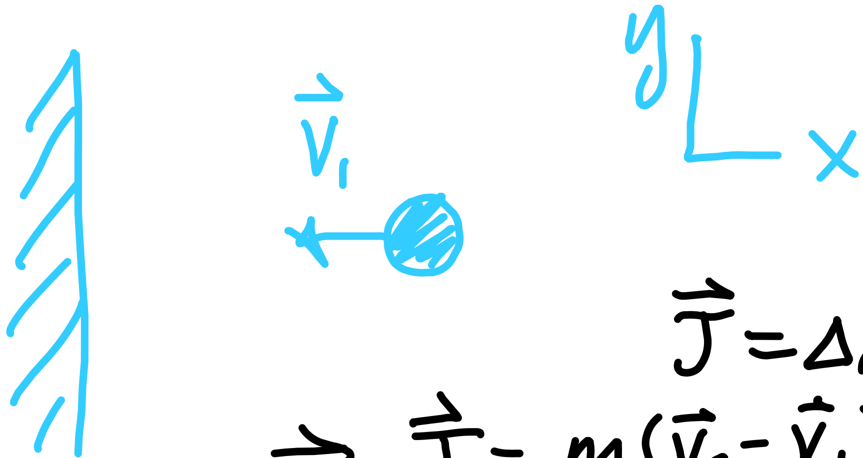
$\Rightarrow \vec{J} = m(\vec{v}_2 - \vec{v}_1) = (0.4\text{ kg})[20 - (-30)]\text{ m/s}\ \hat{i}$

ASU

You throw a ball with a mass of 0.40 kg against a brick wall. It is moving horizontally to the left at 30 m/s when it hits the wall; it rebounds horizontally to the right at 20 m/s. (a) Find the impulse of the net external force on the ball during its collision with the wall. (b) If the ball is in contact with the wall for 0.010 s, find the average horizontal force that the wall exerts on the ball during the impact.

$m = 0.40\,\text{Kg}, \quad \vec{v}_1 = -30\,\text{m/s}\,\hat{i}$

$\vec{v}_2 = 20\,\text{m/s}\,\hat{i}$



Find $\vec{J}$:

$$\vec{J} = \Delta\vec{p} = \vec{p}_2 - \vec{p}_1 = m\vec{v}_2 - m\vec{v}_1$$

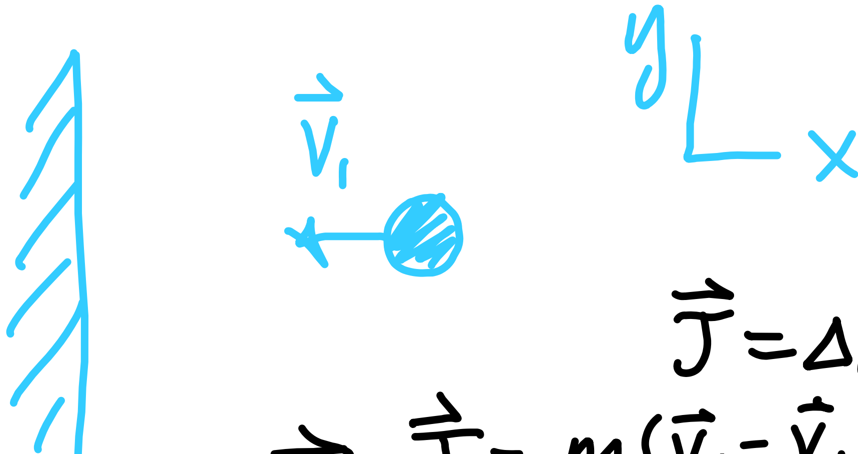
$$\Rightarrow \vec{J} = m(\vec{v}_2 - \vec{v}_1) = (0.4\,\text{Kg})[20-(-30)]\,\text{m/s}\,\hat{i}$$

$$\Rightarrow \vec{J} = (0.4 * 50)\,\frac{\text{Kg}\cdot\text{m}}{\text{s}}\,\hat{i}$$

You throw a ball with a mass of 0.40 kg against a brick wall. It is moving horizontally to the left at 30 m/s when it hits the wall; it rebounds horizontally to the right at 20 m/s. (a) Find the impulse of the net external force on the ball during its collision with the wall. (b) If the ball is in contact with the wall for 0.010 s, find the average horizontal force that the wall exerts on the ball during the impact.

$m = 0.40\,kg$, $\vec{v}_1 = -30\,m/s\,\hat{i}$

$\vec{v}_2 = 20\,m/s\,\hat{i}$



Find $\vec{J}$:

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$$\Rightarrow \vec{J} = (0.4 * 50)\,\frac{kg\cdot m}{s}\,\hat{i} \Rightarrow \boxed{\vec{J} = 20\,N\cdot s\,\hat{i}}$$

You throw a ball with a mass of 0.40 kg against a brick wall. It is moving horizontally to the left at 30 m/s when it hits the wall; it rebounds horizontally to the right at 20 m/s. (a) Find the impulse of the net external force on the ball during its collision with the wall. (b) If the ball is in contact with the wall for 0.010 s, find the average horizontal force that the wall exerts on the ball during the impact.

$m = 0.40\ \text{Kg}$, $\vec{V}_1 = -30\ \text{m/s}\ \hat{i}$

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$$\vec{J} = \Delta\vec{P} = \vec{P}_2 - \vec{P}_1 = m\vec{V}_2 - m\vec{V}_1$$

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Find $\vec{F}_{ave}$:

ASU

You throw a ball with a mass of 0.40 kg against a brick wall. It is moving horizontally to the left at 30 m/s when it hits the wall; it rebounds horizontally to the right at 20 m/s. (a) Find the impulse of the net external force on the ball during its collision with the wall. (b) If the ball is in contact with the wall for 0.010 s, find the average horizontal force that the wall exerts on the ball during the impact.

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$\vec{v}_2 = 20\,\text{m/s}\,\hat{i}$

Find $\vec{J}$:

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$$\Rightarrow \vec{J} = m(\vec{v}_2 - \vec{v}_1) = (0.4\,\text{Kg})[20-(-30)]\,\text{m/s}\,\hat{i}$$

$$\Rightarrow \vec{J} = (0.4 * 50)\frac{\text{Kg}\cdot\text{m}}{\text{s}}\,\hat{i} \Rightarrow \boxed{\vec{J} = 20\,\text{N}\cdot\text{s}\,\hat{i}}$$

Find $\vec{F}_{AVE}$: $\vec{F}_{AVE}\,\Delta t = \vec{J}$

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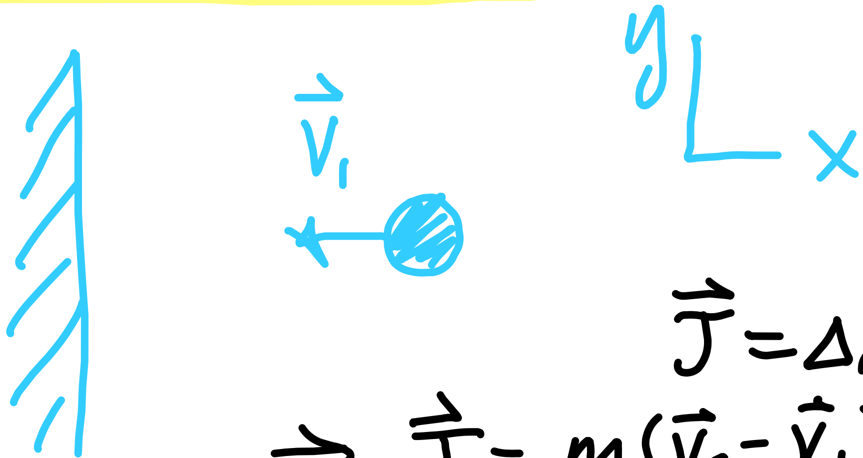
$m = 0.40\ \text{Kg}$, $\vec{v}_1 = -30\ \text{m/s}\ \hat{i}$

$\vec{v}_2 = 20\ \text{m/s}\ \hat{i}$



Find $\vec{J}$:

$$\vec{J} = \Delta\vec{p} = \vec{p}_2 - \vec{p}_1 = m\vec{v}_2 - m\vec{v}_1$$

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$$\Rightarrow \vec{J} = (0.4 * 50)\ \frac{\text{Kg}\cdot\text{m}}{\text{s}}\ \hat{i} \Rightarrow \boxed{\vec{J} = 20\ \text{N}\cdot\text{s}\ \hat{i}}$$

Find $\vec{F}_{ave}$: $\vec{F}_{ave}\,\Delta t = \vec{J} \Rightarrow \vec{F}_{ave} = \dfrac{\vec{J}}{\Delta t}$

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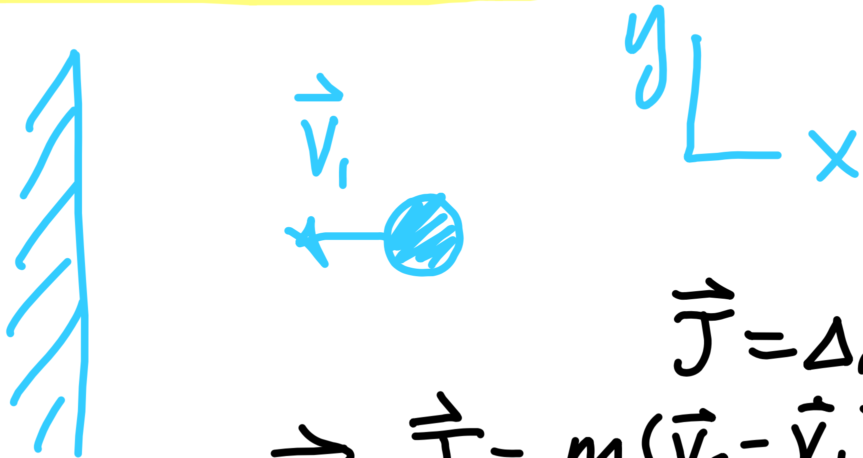

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$$\Rightarrow \vec{J} = m(\vec{v}_2 - \vec{v}_1) = (0.4\,\text{Kg})[20-(-30)]\,\text{m/s}\,\hat{i}$$

$$\Rightarrow \vec{J} = (0.4 * 50)\,\frac{\text{Kg}\cdot\text{m}}{\text{s}}\,\hat{i} \Rightarrow \vec{J} = 20\,\text{N}\cdot\text{s}\,\hat{i}$$

Find $\vec{F}_{ave}$: $\vec{F}_{ave}\,\Delta t = \vec{J} \Rightarrow \vec{F}_{ave} = \dfrac{\vec{J}}{\Delta t}$

$$\Rightarrow \vec{F}_{ave} = \frac{20\,\text{N}\cdot\text{s}\,\hat{i}}{0.01\,\text{s}}$$

ASU

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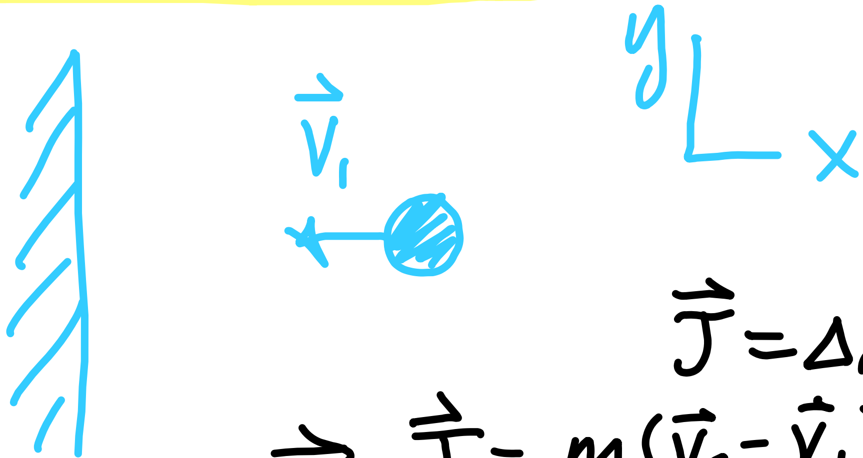
$\vec{v}_2 = 20\,\text{m/s}\,\hat{i}$



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$\vec{J} = \Delta\vec{p} = \vec{p}_2 - \vec{p}_1 = m\vec{v}_2 - m\vec{v}_1$

$\Rightarrow \vec{J} = m(\vec{v}_2 - \vec{v}_1) = (0.4\,\text{Kg})[20-(-30)]\,\text{m/s}\,\hat{i}$

$\Rightarrow \vec{J} = (0.4 * 50)\,\frac{\text{Kg}\cdot\text{m}}{\text{s}}\,\hat{i} \Rightarrow \boxed{\vec{J} = 20\,\text{N}\cdot\text{s}\,\hat{i}}$

Find $\vec{F}_{AVE}$: $\vec{F}_{AVE}\,\Delta t = \vec{J} \Rightarrow \vec{F}_{AVE} = \frac{\vec{J}}{\Delta t}$

$\Rightarrow \boxed{\vec{F}_{AVE} = \frac{20\,\text{N}\cdot\text{s}\,\hat{i}}{0.01\,\text{s}} = 2000\,\text{N}\,\hat{i}}$

ASU

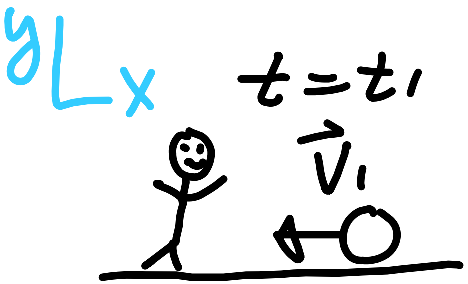
A soccer ball has a mass of 0.40 kg. Initially it is moving to the left at $20 \mathrm{~m/s}$, but then it is kicked. After the kick it is moving at 45° upward and to the right with speed $30 \mathrm{~m/s}$ (Fig. 8.8a). Find the impulse of the net external force and the average net external force, assuming a collision time $\Delta t = 0.010 \mathrm{~s}$.

ASU

A soccer ball has a mass of 0.40 kg. Initially it is moving to the left at $20 \mathrm{~m/s}$, but then it is kicked. After the kick it is moving at 45° upward and to the right with speed $30 \mathrm{~m/s}$ (Fig. 8.8a). Find the impulse of the net external force and the average net external force, assuming a collision time $\Delta t = 0.010 \mathrm{~s}$. $m = 0.4 kg$,

A soccer ball has a mass of 0.40 kg. Initially it is moving to the left at 20 m/s, but then it is kicked. After the kick it is moving at 45° upward and to the right with speed 30 m/s (Fig. 8.8a). Find the impulse of the net external force and the average net external force, assuming a collision time $\Delta t = 0.010$ s.

$m = 0.4\,\text{kg}, \ \vec{v}_1 = 20\,\text{m/s}\,(-\hat{i})$



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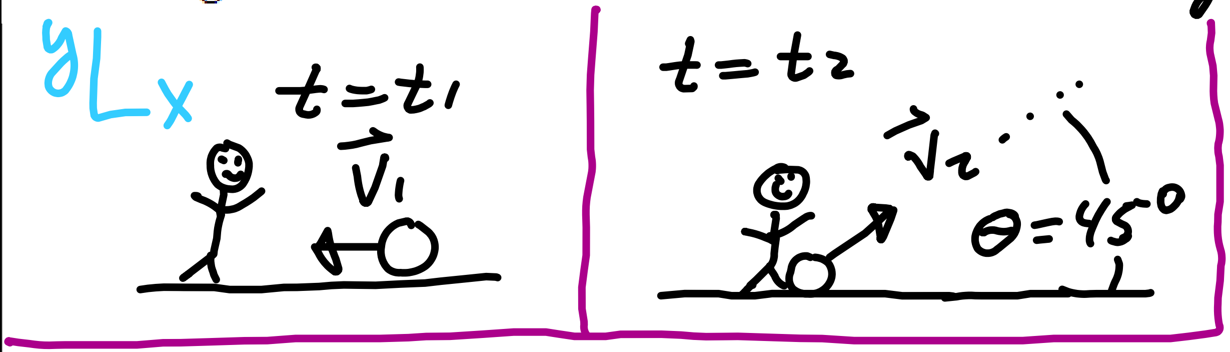
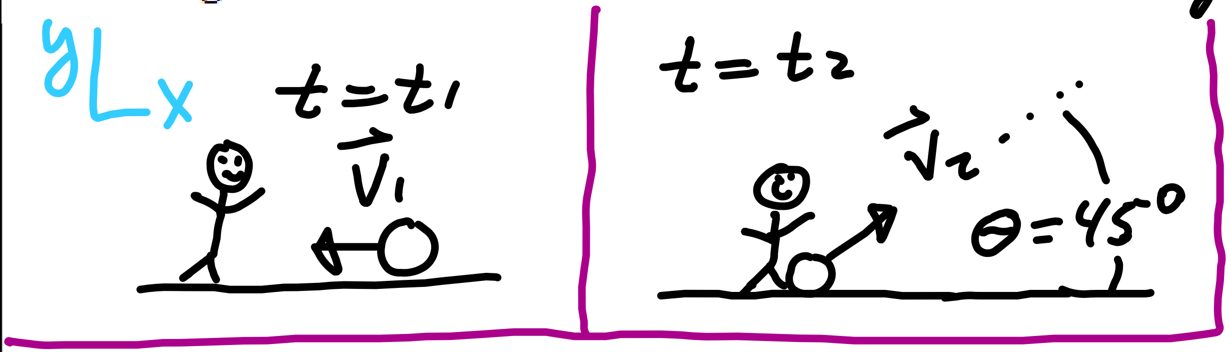
$M = 0.4\,kg$, $\vec{V}_1 = 20\,m/s\,(-\hat{i})$

$\vec{V}_2 = V_{2x}\hat{i} + V_{2y}\hat{j}$



A soccer ball has a mass of 0.40 kg. Initially it is moving to the left at 20 m/s, but then it is kicked. After the kick it is moving at 45° upward and to the right with speed 30 m/s (Fig. 8.8a). Find the impulse of the net external force and the average net external force, assuming a collision time $\Delta t = 0.010$ s.

$m = 0.4\,\text{kg}, \ \vec{v}_1 = 20\,\text{m/s}\,(-\hat{\imath})$



$\vec{V}_2 = V_{2x}\hat{\imath} + V_{2y}\hat{\jmath}$

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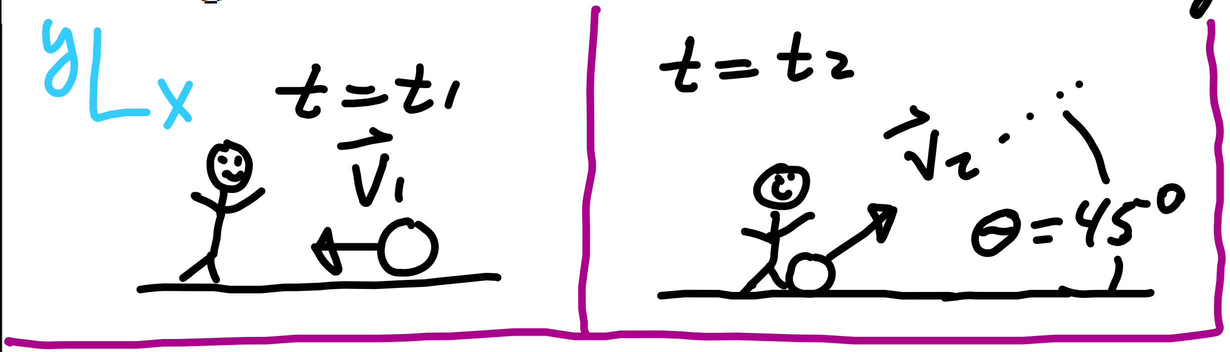

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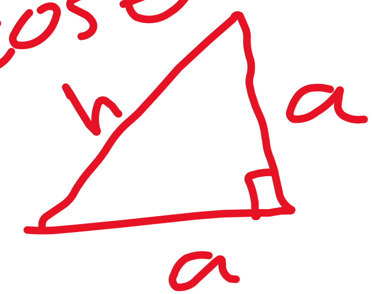
Note: for $\theta = 45°$

$\sin\theta = \cos\theta = \frac{a}{h}$



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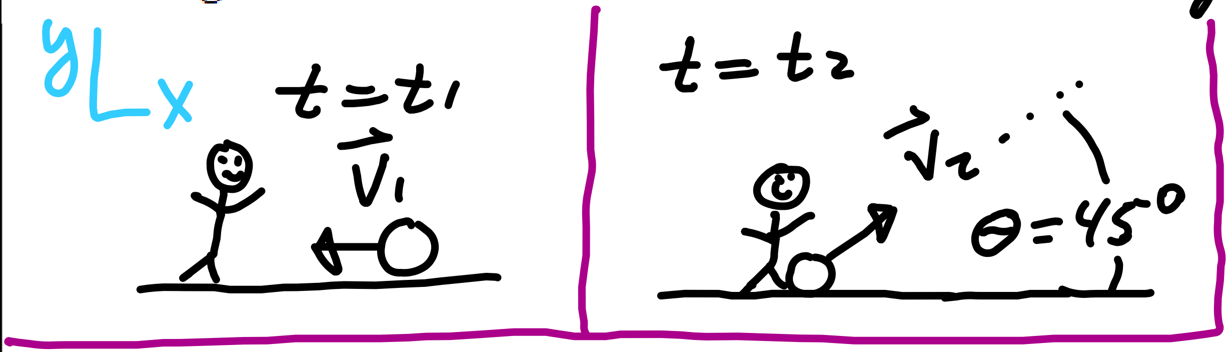

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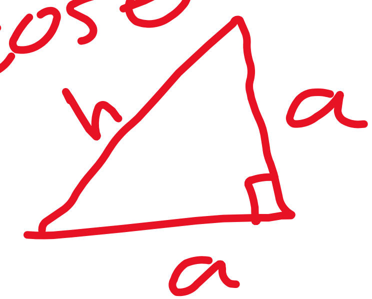

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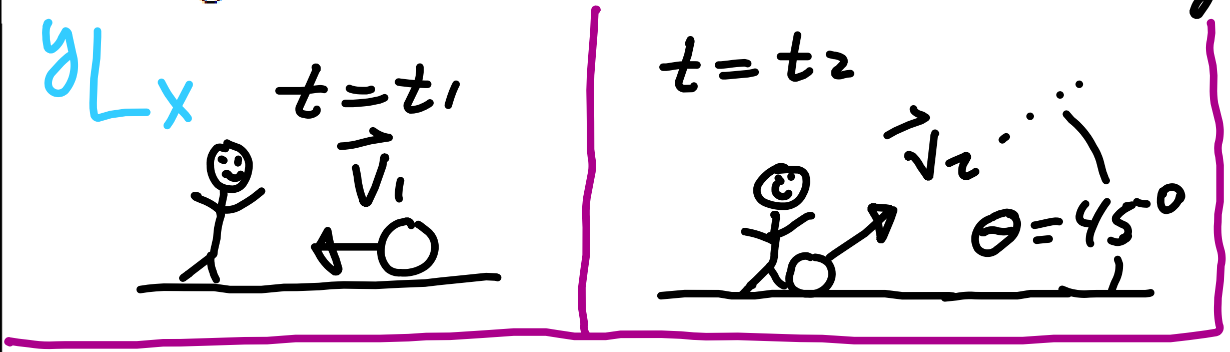

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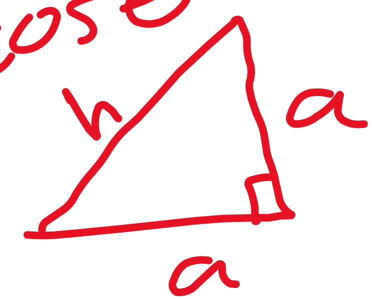

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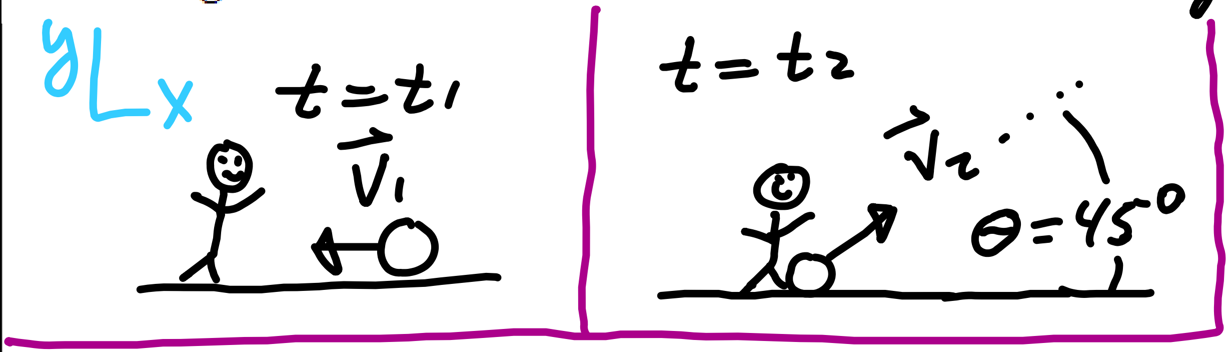

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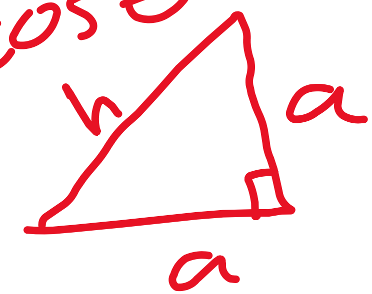

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So

$\cos\theta = \frac{1}{\sqrt{2}}$

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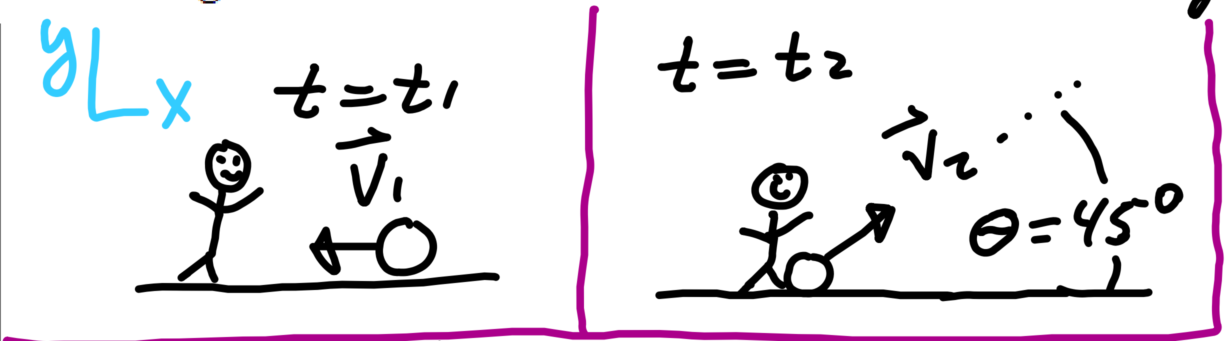

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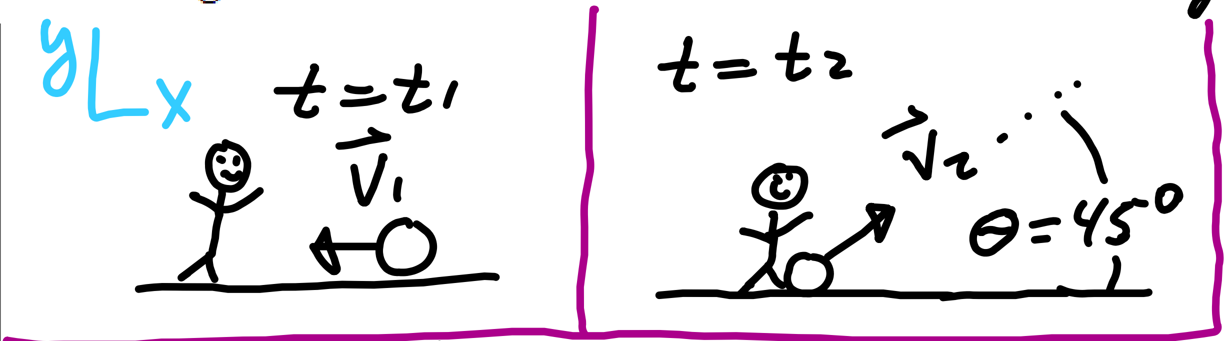

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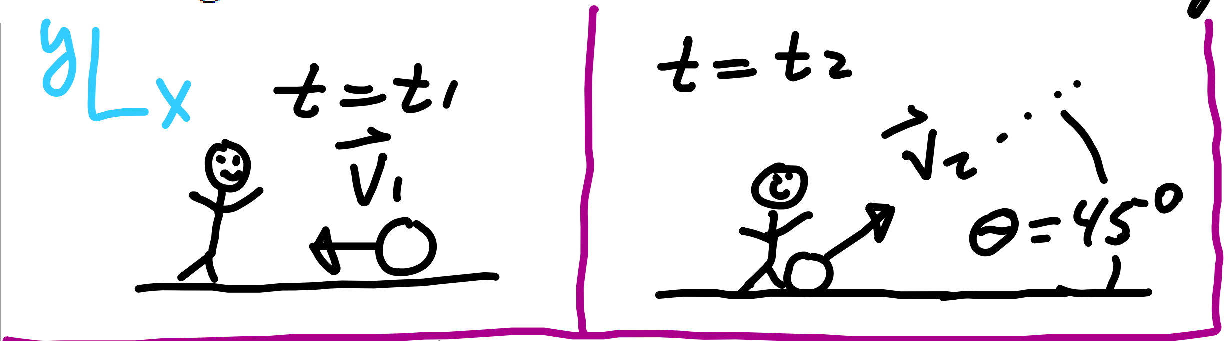

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Find $\vec{J}$:

$\vec{J} = \vec{p}_2 - \vec{p}_1 = m(\vec{V}_2 - \vec{V}_1)$

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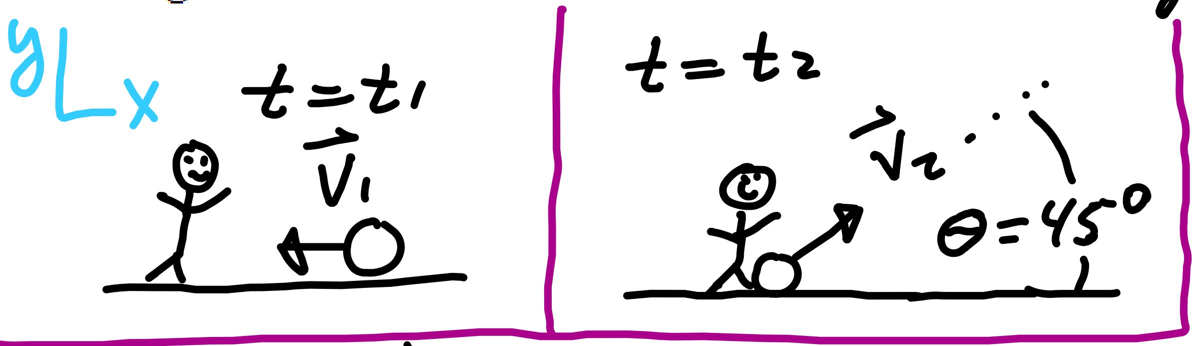

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Find $\vec{J}$: $\vec{J} = \vec{p}_2 - \vec{p}_1 = m(\vec{V}_2 - \vec{V}_1)$

$\Rightarrow \vec{J} = (0.40\,\text{kg})\left(30\,\frac{\text{m}}{\text{s}}\hat{i}/\sqrt{2} + 30\,\frac{\text{m}}{\text{s}}\hat{j}/\sqrt{2} + 20\,\frac{\text{m}}{\text{s}}\hat{i}\right)$

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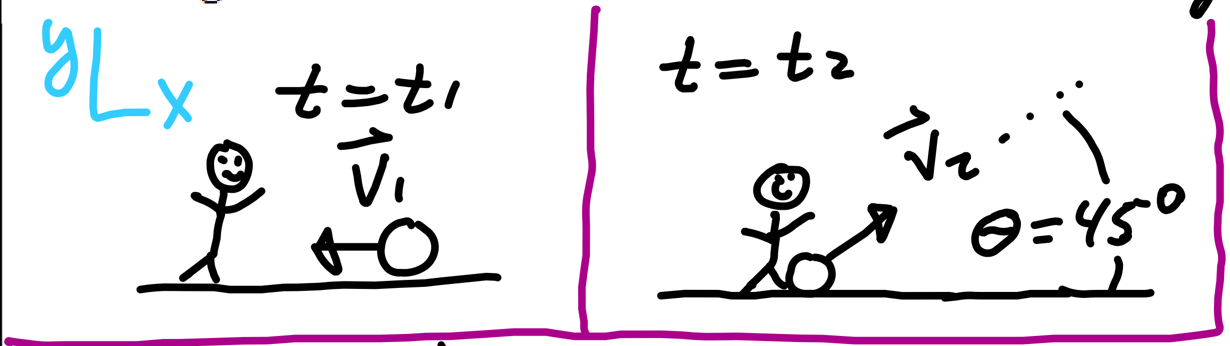

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$\Rightarrow \vec{J} = [16.5\hat{\imath} + 8.49\hat{\jmath}]\,\text{N·s}$

ASU

A soccer ball has a mass of 0.40 kg. Initially it is moving to the left at 20 m/s, but then it is kicked. After the kick it is moving at 45° upward and to the right with speed 30 m/s (Fig. 8.8a). Find the impulse of the net external force and the average net external force, assuming a collision time $\Delta t = 0.010$ s.

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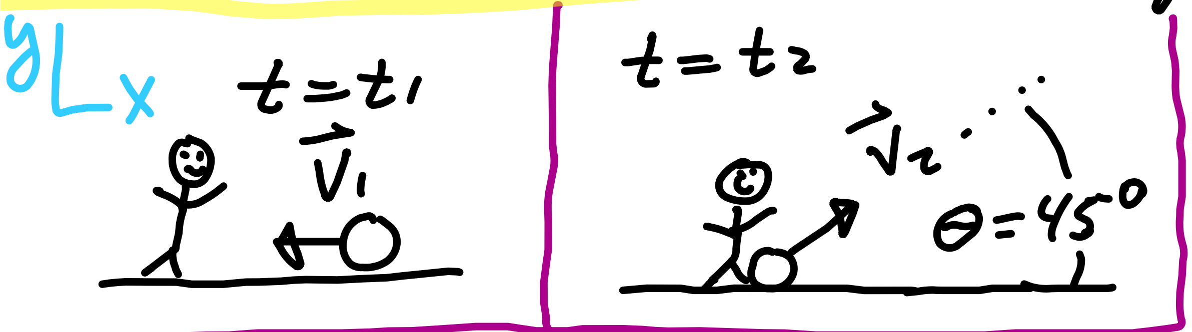

$\vec{V}_2 = V_{2x}\hat{i} + V_{2y}\hat{j}$

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<u>Find $\vec{J}$:</u> $\vec{J} = \vec{p}_2 - \vec{p}_1 = m(\vec{V}_2 - \vec{V}_1)$

$\Rightarrow \vec{J} = (0.40\,\text{kg})\left(30\,\frac{\text{m}}{\text{s}}\hat{i}/\sqrt{2} + 30\,\frac{\text{m}}{\text{s}}\hat{j}/\sqrt{2} + 20\,\text{m/s}\,\hat{i}\right)$

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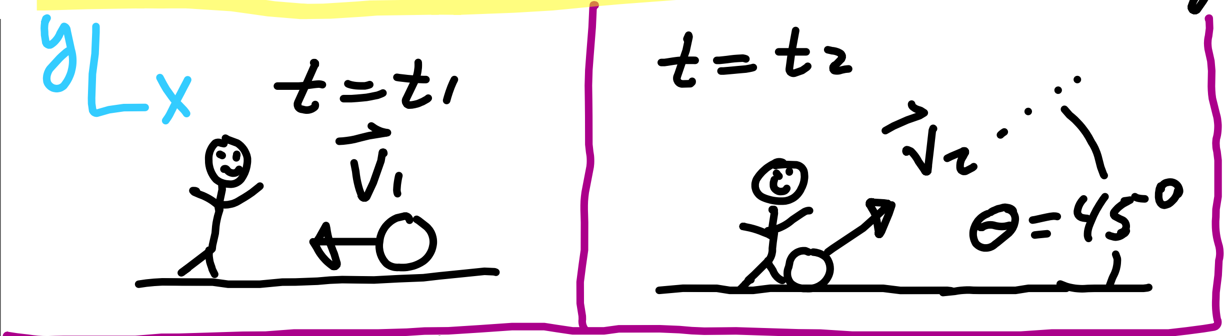
<u>Find F_{ave}:</u>

A soccer ball has a mass of 0.40 kg. Initially it is moving to the left at 20 m/s, but then it is kicked. After the kick it is moving at 45° upward and to the right with speed 30 m/s (Fig. 8.8a). Find the impulse of the net external force and the average net external force, assuming a collision time $\Delta t = 0.010$ s.

$m = 0.4\,kg,\ \vec{v}_1 = 20\,m/s\,(-\hat{i})$



$\vec{v}_2 = v_{2x}\hat{i} + v_{2y}\hat{j}$

where

$v_{2x} = v_{2y} = (30\,m/s)/\sqrt{2}$

Find $\vec{J}$:

$\vec{J} = \vec{p}_2 - \vec{p}_1 = m(\vec{v}_2 - \vec{v}_1)$

$\Rightarrow \vec{J} = (0.40\,kg)\left(30\,\frac{m}{s}\hat{i}/\sqrt{2} + 30\,\frac{m}{s}\hat{j}/\sqrt{2} + 20\,\frac{m}{s}\hat{i}\right)$

$\Rightarrow \vec{J} = [16.5\hat{i} + 8.49\hat{j}]\,N\cdot s$

Find F_{AVE}:

$\vec{F}_{AVE} = \frac{\vec{J}}{\Delta t}$

ASU

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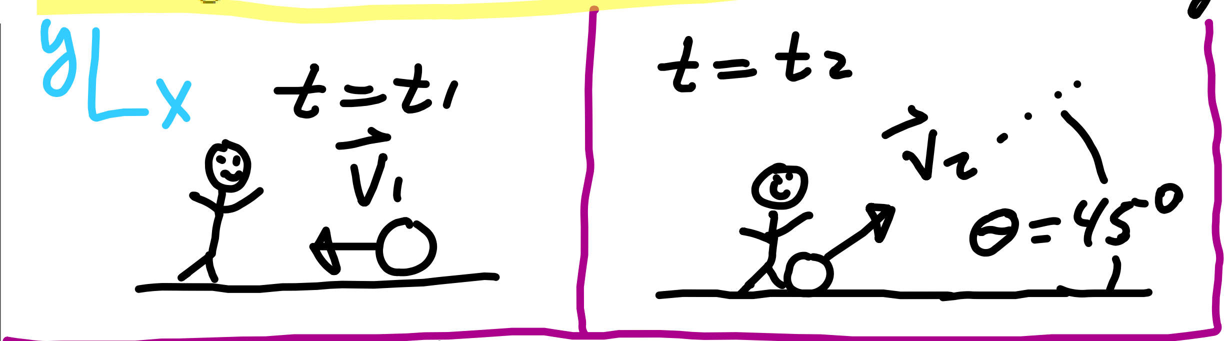

$\vec{V}_2 = V_{2x}\hat{i} + V_{2y}\hat{j}$

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Find $\vec{J}$:

$\vec{J} = \vec{p}_2 - \vec{p}_1 = m(\vec{V}_2 - \vec{V}_1)$

$\Rightarrow \vec{J} = (0.40\,kg)(30\,\frac{m}{s}\hat{i}/\sqrt{2} + 30\,\frac{m}{s}\hat{j}/\sqrt{2} + 20\,m/s\,\hat{i})$

$\Rightarrow \vec{J} = [16.5\hat{i} + 8.49\hat{j}]\,N\cdot s$

Find F_{AVE}:

$\vec{F}_{AVE} = \frac{\vec{J}}{\Delta t} = [1650\hat{i} + 849\hat{j}]\,N$

ASU

Conservation of momentum

Conservation of momentum

No external forces to system

Conservation of momentum

No external forces to system

$\Rightarrow$

Total momentum of system is conserved

Conservation of momentum

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$\Rightarrow$

Total momentum of system is conserved

$$\vec{P}_{TOTAL\,1} = \vec{P}_{TOTAL\,2}$$

A marksman holds a rifle of mass $m_{\mathrm{R}} = 3.00\mathrm{kg}$ loosely, so it can recoil freely. He fires a bullet of mass $m_{\mathrm{B}} = 5.00\mathrm{g}$ horizontally with a velocity relative to the ground of $v_{\mathrm{B}x} = 300\mathrm{m/s}$. What is the recoil velocity $v_{\mathrm{R}x}$ of the rifle? What are the final momentum and kinetic energy of the bullet and rifle?

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$M_R = 3\text{Kg}$, $M_B = 5\text{g}$

ASU

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$M_R = 3\,Kg$, $M_B = 5g$

$\vec{V}_B = 300\,m/s\ \hat{i}$

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$M_R = 3\,Kg$, $M_B = 5\,g$

$\vec{V}_B = 300\,m/s\,\hat{i}$

Find $\vec{V}_B$

$\vec{P}_I = \vec{P}_F$

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$M_R = 3\,\mathrm{Kg}$, $M_B = 5\,\mathrm{g}$

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find $\vec{V}_B$

$\vec{P}_I = \vec{P}_F$

$\vec{P}_I = 0$

A marksman holds a rifle of mass $m_{\rm R} = 3.00{\rm kg}$ loosely, so it can recoil freely. He fires a bullet of mass $m_{\rm B} = 5.00{\rm g}$ horizontally with a velocity relative to the ground of $v_{{\rm B}x} = 300{\rm m/s}$. What is the recoil velocity $v_{{\rm R}x}$ of the rifle? What are the final momentum and kinetic energy of the bullet and rifle?

$M_R = 3Kg$, $M_B = 5g$

$\vec{V}_B = 300 m/s \ \hat{i}$

find $\vec{V}_B$

$\vec{P}_I = \vec{P}_F$

$\vec{P}_I = 0$

$\vec{P}_F = M_R\vec{V}_R + M_B\vec{V}_B$

ASU

A marksman holds a rifle of mass $m_{\mathrm{R}} = 3.00\mathrm{kg}$ loosely, so it can recoil freely. He fires a bullet of mass $m_{\mathrm{B}} = 5.00\mathrm{g}$ horizontally with a velocity relative to the ground of $v_{\mathrm{B}x} = 300\mathrm{m/s}$. What is the recoil velocity $v_{\mathrm{R}x}$ of the rifle? What are the final momentum and kinetic energy of the bullet and rifle?

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$\vec{P}_I = \vec{P}_F$ $\quad$ $\vec{P}_I = 0$

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Find $\vec{V}_B$

$\vec{P}_I = \vec{P}_F$

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$\vec{V}_R = \left(-\frac{M_B}{M_R}\right) \vec{V}_B$

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$M_R = 3\,Kg\,,\ M_B = 5g$

$\vec{V}_B = 300\,\frac{m}{s}\,\hat{i}$

find $\vec{v}_B$

$\vec{P}_I = \vec{P}_F \qquad \vec{P}_I = 0$

$\vec{P}_F = M_R\vec{V}_R + M_B\vec{V}_B \Rightarrow 0 = M_R\vec{V}_R + M_B\vec{V}_B \Rightarrow$

$\vec{V}_R = \left(-\frac{M_B}{M_R}\right)\vec{V}_B = \left(-\frac{5/1000}{3}\right)300\,\frac{m}{s}\,\hat{i}$

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$M_R = 3\text{Kg}$, $M_B = 5\text{g}$

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Find $\vec{v}_B$

$\vec{P}_I = \vec{P}_F$ $\vec{P}_I = 0$

$\vec{P}_F = M_R \vec{V}_R + M_B \vec{V}_B \Rightarrow 0 = M_R \vec{V}_R + M_B \vec{V}_B \Rightarrow$

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$M_R = 3\,Kg \; , \; M_B = 5\,g$

$\vec{V}_B = 300\,\frac{m}{s}\,\hat{i}$

find $\vec{V}_R$

$\vec{P}_I = \vec{P}_F$ $\quad\quad$ $\vec{P}_I = 0$

$$\vec{P}_F = M_R\vec{V}_R + M_B\vec{V}_B \Rightarrow 0 = M_R\vec{V}_R + M_B\vec{V}_B \Rightarrow$$

$$\vec{V}_R = \left(-\frac{M_B}{M_R}\right)\vec{V}_B = \left(-\frac{5/1000}{3}\right)300\,\frac{m}{s}\,\hat{i} = -0.5\,\frac{m}{s}\,\hat{i}$$

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$M_R = 3\,\text{Kg}\ ,\ M_B = 5\,\text{g}$

$\vec{V}_B = 300\,\frac{m}{s}\,\hat{i}$

find $\vec{V}_R$

$\vec{P}_I = \vec{P}_F \qquad \vec{P}_I = 0$

$\vec{P}_F = M_R\vec{V}_R + M_B\vec{V}_B \Rightarrow 0 = M_R\vec{V}_R + M_B\vec{V}_B \Rightarrow$

$\vec{V}_R = \left(-\frac{M_B}{M_R}\right)\vec{V}_B = \left(-\frac{5/1000}{3}\right) 300\,\frac{m}{s}\,\hat{i} = -0.5\,\frac{m}{s}\,\hat{i}$

$\vec{p}_R = M_R\vec{V}_R$

A marksman holds a rifle of mass $m_R = 3.00\text{kg}$ loosely, so it can recoil freely. He fires a bullet of mass $m_B = 5.00\text{g}$ horizontally with a velocity relative to the ground of $v_{Bx} = 300\text{m/s}$. What is the recoil velocity v_{Rx} of the rifle? What are the final momentum and kinetic energy of the bullet and rifle?

$M_R = 3\,\text{Kg}\ ,\ M_B = 5\,\text{g}$

$\vec{V}_B = 300\,\text{m/s}\,\hat{i}$

Find $\vec{V}_B$

$\vec{P}_I = \vec{P}_F \qquad \vec{P}_I = 0$

$\vec{P}_F = M_R\vec{V}_R + M_B\vec{V}_B \Rightarrow 0 = M_R\vec{V}_R + M_B\vec{V}_B \Rightarrow$

$\vec{V}_R = \left(-\frac{M_B}{M_R}\right)\vec{V}_B = \left(-\frac{5/1000}{3}\right)300\,\frac{m}{s}\,\hat{i} = -0.5\,\frac{m}{s}\,\hat{i}$

$\vec{p}_R = M_R\vec{V}_R = (3\,\text{Kg})(-0.5\,\text{m/s}\,\hat{i})$

A marksman holds a rifle of mass $m_{\mathrm{R}} = 3.00\mathrm{kg}$ loosely, so it can recoil freely. He fires a bullet of mass $m_{\mathrm{B}} = 5.00\mathrm{g}$ horizontally with a velocity relative to the ground of $v_{\mathrm{B}x} = 300\mathrm{m/s}$. What is the recoil velocity $v_{\mathrm{R}x}$ of the rifle? What are the final momentum and kinetic energy of the bullet and rifle?

$M_R = 3\,\mathrm{Kg}$, $M_B = 5\,\mathrm{g}$

$\vec{V}_B = 300\,\mathrm{m/s}\,\hat{i}$

Find $\vec{v}_R$ $\quad \vec{P}_I = \vec{P}_F \quad \vec{P}_I = 0$

$$\vec{P}_F = M_R\vec{V}_R + M_B\vec{V}_B \Rightarrow 0 = M_R\vec{V}_R + M_B\vec{V}_B \Rightarrow$$

$$\vec{V}_R = \left(-\frac{M_B}{M_R}\right)\vec{V}_B = \left(-\frac{5/1000}{3}\right) 300\,\frac{\mathrm{m}}{\mathrm{s}}\,\hat{i} = -0.5\,\frac{\mathrm{m}}{\mathrm{s}}\,\hat{i}$$

$$\vec{p}_R = M_R\vec{V}_R = (3\,\mathrm{Kg})(-0.5\,\mathrm{m/s}\,\hat{i}) = -1.5\,\frac{\mathrm{Kg\cdot m}}{\mathrm{s}}\,\hat{i}$$

ASU

A marksman holds a rifle of mass $m_R = 3.00\text{kg}$ loosely, so it can recoil freely. He fires a bullet of mass $m_B = 5.00\text{g}$ horizontally with a velocity relative to the ground of $v_{Bx} = 300\text{m/s}$. What is the recoil velocity v_{Rx} of the rifle? What are the final momentum and kinetic energy of the bullet and rifle?

$M_R = 3\,\text{Kg}\ ,\ M_B = 5\,\text{g}$

$\vec{V}_B = 300\,\frac{m}{s}\,\hat{i}$

find $\vec{v}_B$

$\vec{P}_I = \vec{P}_F \qquad \vec{P}_I = 0$

$\vec{P}_F = M_R\vec{V}_R + M_B\vec{V}_B \Rightarrow 0 = M_R\vec{V}_R + M_B\vec{V}_B \Rightarrow$

$\vec{V}_R = \left(-\frac{M_B}{M_R}\right)\vec{V}_B = \left(-\frac{5/1000}{3}\right)300\,\frac{m}{s}\,\hat{i} = -0.5\,\frac{m}{s}\,\hat{i}$

$\vec{p}_R = M_R\vec{V}_R = (3\,\text{Kg})(-0.5\,\text{m/s}\,\hat{i}) = -1.5\,\frac{\text{Kg}\cdot\text{m}}{s}\,\hat{i}$

$\vec{P}_B = M_B\vec{V}_B$

ASU

A marksman holds a rifle of mass $m_R = 3.00\text{kg}$ loosely, so it can recoil freely. He fires a bullet of mass $m_B = 5.00\text{g}$ horizontally with a velocity relative to the ground of $v_{Bx} = 300\text{m/s}$. What is the recoil velocity v_{Rx} of the rifle? What are the final momentum and kinetic energy of the bullet and rifle?

$M_R = 3\,\text{Kg}$, $M_B = 5\,\text{g}$

$\vec{V}_B = 300\,\text{m/s}\,\hat{i}$

find $\vec{V}_B$

$\vec{P}_I = \vec{P}_F$ $\quad\vec{P}_I = 0$

$\vec{P}_F = M_R\vec{V}_R + M_B\vec{V}_B \Rightarrow 0 = M_R\vec{V}_R + M_B\vec{V}_B \Rightarrow$

$$\vec{V}_R = \left(-\frac{M_B}{M_R}\right)\vec{V}_B = \left(-\frac{5/1000}{3}\right)300\,\frac{m}{s}\,\hat{i} = -0.5\,\frac{m}{s}\,\hat{i}$$

$\vec{P}_R = M_R\vec{V}_R = (3\,\text{Kg})(-0.5\,\text{m/s}\,\hat{i}) = -1.5\,\frac{\text{Kg}\cdot\text{m}}{\text{s}}\,\hat{i}$

$\vec{P}_B = M_B\vec{V}_B = (5\,\text{Kg}/1000)(300\,\text{m/s})$

ASU

A marksman holds a rifle of mass $m_R = 3.00\text{kg}$ loosely, so it can recoil freely. He fires a bullet of mass $m_B = 5.00\text{g}$ horizontally with a velocity relative to the ground of $v_{Bx} = 300\text{m/s}$. What is the recoil velocity v_{Rx} of the rifle? What are the final momentum and kinetic energy of the bullet and rifle?

$M_R = 3\,\text{Kg}\ ,\ M_B = 5\,\text{g}$

$\vec{V}_B = 300\,\text{m/s}\,\hat{i}$

find $\vec{V}_B$

$\vec{P}_I = \vec{P}_F \qquad \vec{P}_I = 0$

$\vec{P}_F = M_R\vec{V}_R + M_B\vec{V}_B \Rightarrow 0 = M_R\vec{V}_R + M_B\vec{V}_B \Rightarrow$

$$\vec{V}_R = \left(-\frac{M_B}{M_R}\right)\vec{V}_B = \left(-\frac{5/1000}{3}\right)300\,\frac{m}{s}\,\hat{i} = -0.5\,\frac{m}{s}\,\hat{i}$$

$$\vec{P}_R = M_R\vec{V}_R = (3\,\text{Kg})(-0.5\,\text{m/s}\,\hat{i}) = -1.5\,\frac{\text{Kg}\cdot\text{m}}{s}\,\hat{i}$$

$$\vec{P}_B = M_B\vec{V}_B = (5\,\text{Kg}/1000)(300\,\text{m/s}) = 1.5\,\frac{\text{Kg}\cdot\text{m}}{s}\,\hat{i}$$

ASU

A marksman holds a rifle of mass $m_R = 3.00$kg loosely, so it can recoil freely. He fires a bullet of mass $m_B = 5.00$g horizontally with a velocity relative to the ground of $v_{Bx} = 300$m/s. What is the recoil velocity v_{Rx} of the rifle? What are the final momentum and kinetic energy of the bullet and rifle?

$M_R = 3\,\text{Kg}, \quad M_B = 5\,\text{g}$

$\vec{V}_B = 300\,\text{m/s}\,\hat{i}$

Find $\vec{V}_B$

$\vec{P}_I = \vec{P}_F \qquad \vec{P}_I = 0$

$\vec{P}_F = M_R\vec{V}_R + M_B\vec{V}_B \Rightarrow 0 = M_R\vec{V}_R + M_B\vec{V}_B \Rightarrow$

$\vec{V}_R = \left(-\frac{M_B}{M_R}\right)\vec{V}_B = \left(-\frac{5/1000}{3}\right)300\,\frac{m}{s}\,\hat{i} = -0.5\,\frac{m}{s}\,\hat{i}$

$\vec{P}_R = M_R\vec{V}_R = (3\,\text{Kg})(-0.5\,\text{m/s}\,\hat{i}) = -1.5\,\frac{\text{Kg}\cdot m}{s}\,\hat{i}$

$\vec{P}_B = M_B\vec{V}_B = (5\,\text{Kg}/1000)(300\,\text{m/s}) = 1.5\,\frac{\text{Kg}\cdot m}{s}\,\hat{i}$

$K_R = P_R^2/2M_R$

ASU

A marksman holds a rifle of mass $m_R = 3.00\text{kg}$ loosely, so it can recoil freely. He fires a bullet of mass $m_B = 5.00\text{g}$ horizontally with a velocity relative to the ground of $v_{Bx} = 300\text{m/s}$. What is the recoil velocity v_{Rx} of the rifle? What are the final momentum and kinetic energy of the bullet and rifle?

$M_R = 3\,\text{Kg}, \quad M_B = 5\,\text{g}$

$\vec{V}_B = 300\,\text{m/s}\,\hat{i}$

Find $\vec{V}_B$ $\qquad \vec{P}_I = \vec{P}_F \qquad \vec{P}_I = 0$

$\vec{P}_F = M_R\vec{V}_R + M_B\vec{V}_B \Rightarrow 0 = M_R\vec{V}_R + M_B\vec{V}_B \Rightarrow$

$$\vec{V}_R = \left(-\frac{M_B}{M_R}\right)\vec{V}_B = \left(-\frac{5/1000}{3}\right)300\,\frac{m}{s}\,\hat{i} = -0.5\,\frac{m}{s}\,\hat{i}$$

$\vec{P}_R = M_R\vec{V}_R = (3\,\text{Kg})(-0.5\,\text{m/s}\,\hat{i}) = -1.5\,\frac{\text{Kg}\cdot\text{m}}{s}\,\hat{i}$

$\vec{P}_B = M_B\vec{V}_B = (5\,\text{Kg}/1000)(300\,\text{m/s}) = 1.5\,\frac{\text{Kg}\cdot\text{m}}{s}\,\hat{i}$

$K_R = P_R^2/2M_R = \left[(1.5)^2/(6)\right]\text{J}$

ASU

A marksman holds a rifle of mass $m_R = 3.00\text{kg}$ loosely, so it can recoil freely. He fires a bullet of mass $m_B = 5.00\text{g}$ horizontally with a velocity relative to the ground of $v_{Bx} = 300\text{m/s}$. What is the recoil velocity v_{Rx} of the rifle? What are the final momentum and kinetic energy of the bullet and rifle?

$M_R = 3\,\text{Kg}, \; M_B = 5\,\text{g}$

$\vec{V}_B = 300\,\text{m/s}\,\hat{i}$

find $\vec{v}_B$

$\vec{P}_I = \vec{P}_F \qquad \vec{P}_I = 0$

$\vec{P}_F = M_R\vec{V}_R + M_B\vec{V}_B \Rightarrow 0 = M_R\vec{V}_R + M_B\vec{V}_B \Rightarrow$

$\vec{V}_R = \left(-\frac{M_B}{M_R}\right)\vec{V}_B = \left(-\frac{5/1000}{3}\right)300\,\frac{m}{s}\hat{i} = -0.5\,\frac{m}{s}\hat{i}$

$\vec{P}_R = M_R\vec{V}_R = (3\,\text{Kg})(-0.5\,\text{m/s}\,\hat{i}) = -1.5\,\frac{\text{Kg}\cdot m}{s}\hat{i}$

$\vec{P}_B = M_B\vec{V}_B = (5\,\text{Kg}/1000)(300\,\text{m/s}) = 1.5\,\frac{\text{Kg}\cdot m}{s}\hat{i}$

$K_R = P_R^2/2M_R = [(1.5)^2/(6)]\,J = 0.375\,J$

ASU

A marksman holds a rifle of mass $m_R = 3.00\text{kg}$ loosely, so it can recoil freely. He fires a bullet of mass $m_B = 5.00\text{g}$ horizontally with a velocity relative to the ground of $v_{Bx} = 300\text{m/s}$. What is the recoil velocity v_{Rx} of the rifle? What are the final momentum and kinetic energy of the bullet and rifle?

$M_R = 3\,\text{Kg}$, $M_B = 5\,\text{g}$

$\vec{V}_B = 300\,\text{m/s}\,\hat{i}$

find $\vec{V}_R$

$\vec{P}_I = \vec{P}_F$ $\vec{P}_I = 0$

$\vec{P}_F = M_R\vec{V}_R + M_B\vec{V}_B \Rightarrow 0 = M_R\vec{V}_R + M_B\vec{V}_B \Rightarrow$

$$\vec{V}_R = \left(-\frac{M_B}{M_R}\right)\vec{V}_B = \left(-\frac{5/1000}{3}\right)300\,\frac{m}{s}\,\hat{i} = -0.5\,\frac{m}{s}\,\hat{i}$$

$$\vec{P}_R = M_R\vec{V}_R = (3\,\text{Kg})(-0.5\,\text{m/s}\,\hat{i}) = -1.5\,\frac{\text{Kg}\cdot\text{m}}{s}\,\hat{i}$$

$$\vec{P}_B = M_B\vec{V}_B = (5\,\text{Kg}/1000)(300\,\text{m/s}) = 1.5\,\frac{\text{Kg}\cdot\text{m}}{s}\,\hat{i}$$

$$K_R = P_R^2/2M_R = [(1.5)^2/(6)]\,J = 0.375\,J$$

$$K_B = \frac{P_B^2}{2M_B}$$

ASU

A marksman holds a rifle of mass $m_R = 3.00\text{kg}$ loosely, so it can recoil freely. He fires a bullet of mass $m_B = 5.00\text{g}$ horizontally with a velocity relative to the ground of $v_{Bx} = 300\text{m/s}$. What is the recoil velocity v_{Rx} of the rifle? What are the final momentum and kinetic energy of the bullet and rifle?

$M_R = 3\text{ Kg}, \; M_B = 5\text{ g}$

$\vec{V}_B = 300 \text{ m/s } \hat{i}$

Find $\vec{V}_B$

$\vec{P}_I = \vec{P}_F \qquad \vec{P}_I = 0$

$\vec{P}_F = M_R\vec{V}_R + M_B\vec{V}_B \Rightarrow 0 = M_R\vec{V}_R + M_B\vec{V}_B \Rightarrow$

$\vec{V}_R = \left(-\frac{M_B}{M_R}\right)\vec{V}_B = \left(-\frac{5/1000}{3}\right) 300 \frac{m}{s}\hat{i} = -0.5 \frac{m}{s}\hat{i}$

$\vec{p}_R = M_R\vec{V}_R = (3\text{ Kg})(-0.5 \text{ m/s } \hat{i}) = -1.5 \frac{\text{Kg}\cdot\text{m}}{s}\hat{i}$

$\vec{P}_B = M_B\vec{V}_B = (5\text{ Kg}/1000)(300\text{ m/s}) = 1.5 \frac{\text{Kg}\cdot\text{m}}{s}\hat{i}$

$K_R = P_R^2/2M_R = \left[(1.5)^2/(6)\right]\text{J} = 0.375\text{ J}$

$K_B = \frac{P_B^2}{2M_B} = \left[\frac{1.5^2}{(10/1000)}\right]\text{J} = (1.5^2)(100)\text{J}$

A marksman holds a rifle of mass $m_R = 3.00\text{kg}$ loosely, so it can recoil freely. He fires a bullet of mass $m_B = 5.00\text{g}$ horizontally with a velocity relative to the ground of $v_{Bx} = 300\text{m/s}$. What is the recoil velocity v_{Rx} of the rifle? What are the final momentum and kinetic energy of the bullet and rifle?

$M_R = 3\,\text{Kg}, \quad M_B = 5\,\text{g}$

$\vec{V}_B = 300\,\text{m/s}\,\hat{i}$

Find $\vec{V}_B$

$\vec{P}_I = \vec{P}_F \qquad \vec{P}_I = 0$

$\vec{P}_F = M_R\vec{V}_R + M_B\vec{V}_B \Rightarrow 0 = M_R\vec{V}_R + M_B\vec{V}_B \Rightarrow$

$\vec{V}_R = \left(-\frac{M_B}{M_R}\right)\vec{V}_B = \left(\frac{-5/1000}{3}\right) 300\,\frac{\text{m}}{\text{s}}\,\hat{i} = -0.5\,\frac{\text{m}}{\text{s}}\,\hat{i}$

$\vec{P}_R = M_R\vec{V}_R = (3\,\text{Kg})(-0.5\,\text{m/s}\,\hat{i}) = -1.5\,\frac{\text{Kg}\cdot\text{m}}{\text{s}}\,\hat{i}$

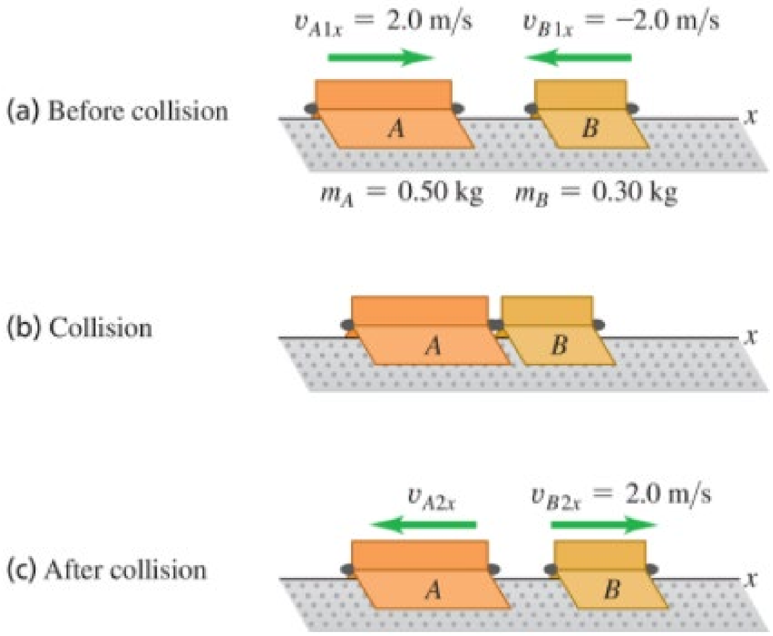
$\vec{P}_B = M_B\vec{V}_B = (5\,\text{Kg}/1000)(300\,\text{m/s}) = 1.5\,\frac{\text{Kg}\cdot\text{m}}{\text{s}}\,\hat{i}$

$K_R = P_R^2/2M_R = \left[(1.5)^2/(6)\right]\text{J} = 0.375\,\text{J}$

$K_B = \frac{P_B^2}{2M_B} = \left[\frac{1.5^2}{(10/1000)}\right]\text{J} = (1.5^2)(100)\,\text{J} = 225\,\text{J}$

ASU

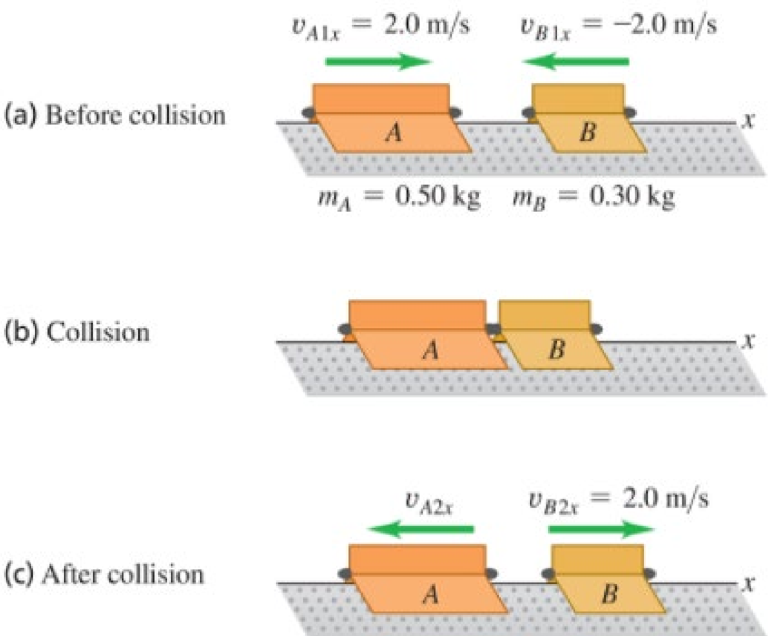
Two gliders with different masses move toward each other on a frictionless air track (Fig. 8.13a). After they collide (Fig. 8.13b), glider B has a final velocity of $+2.0\text{m/s}$ (Fig. 8.13c). What is the final velocity of glider A? How do the changes in momentum and in velocity compare?



ASU

Two gliders with different masses move toward each other on a frictionless air track (Fig. 8.13a). After they collide (Fig. 8.13b), glider B has a final velocity of $+2.0 \mathrm{m/s}$ (Fig. 8.13c). What is the final velocity of glider A? How do the changes in momentum and in velocity compare?

$\vec{p}_{1A} = m_A \vec{v}_{A1}$

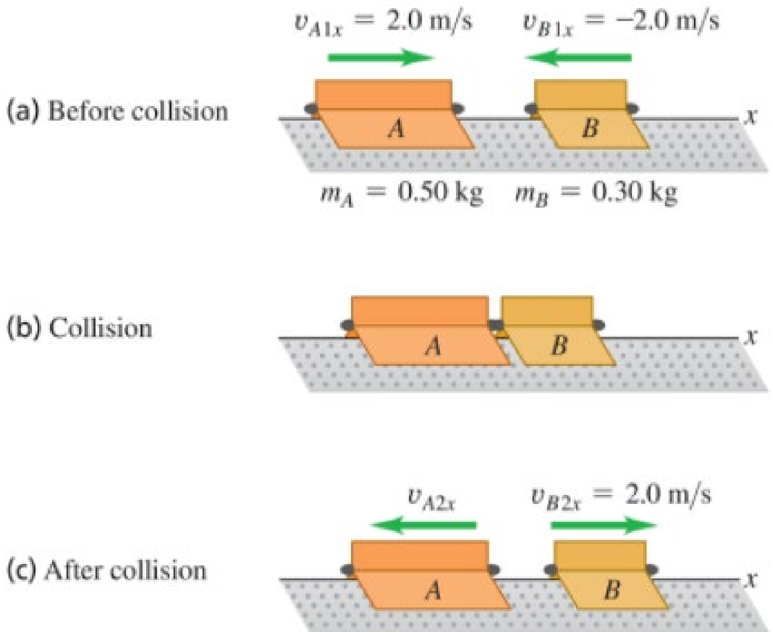


Two gliders with different masses move toward each other on a frictionless air track (Fig. 8.13a). After they collide (Fig. 8.13b), glider B has a final velocity of $+2.0 \mathrm{m/s}$ (Fig. 8.13c). What is the final velocity of glider A? How do the changes in momentum and in velocity compare?

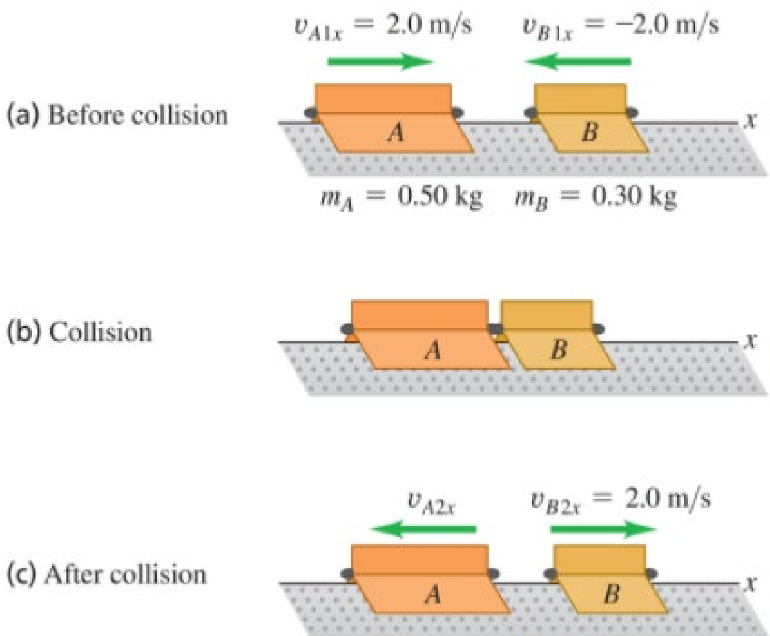
$\vec{P}_{1A} = m_A \vec{V}_{A1}$

$m_A = 0.5 \text{ kg}$

$\vec{V}_{A1} = 2 \text{ m/s } \hat{i}$



Two gliders with different masses move toward each other on a frictionless air track (Fig. 8.13a). After they collide (Fig. 8.13b), glider B has a final velocity of $+2.0\text{m/s}$ (Fig. 8.13c). What is the final velocity of glider A? How do the changes in momentum and in velocity compare?



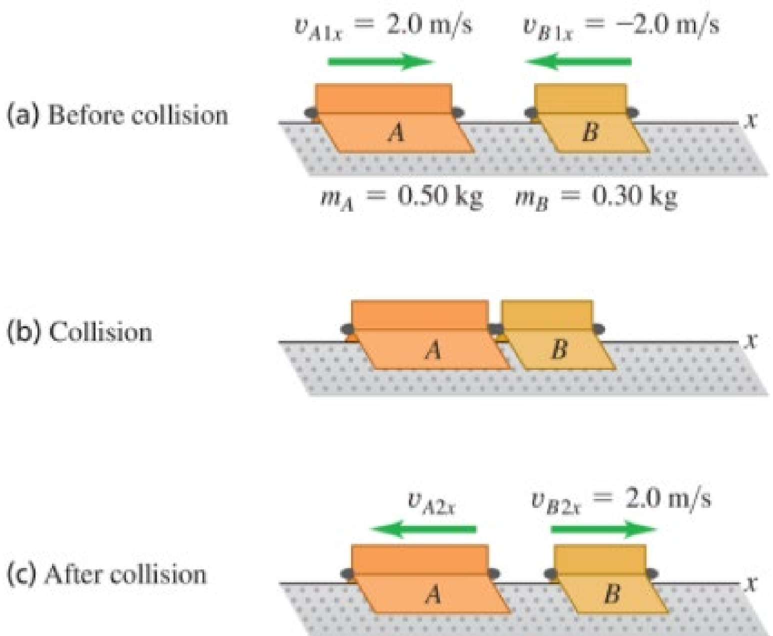
$\vec{P}_{1A} = M_A \vec{V}_{A1}$

$M_A = 0.5\,kg$

$\vec{V}_{A1} = 2\,m/s\,\hat{i}$

$\vec{P}_{1B} = M_B \vec{V}_{B1}$

Two gliders with different masses move toward each other on a frictionless air track (Fig. 8.13a). After they collide (Fig. 8.13b), glider B has a final velocity of $+2.0 \text{m/s}$ (Fig. 8.13c). What is the final velocity of glider A? How do the changes in momentum and in velocity compare?



$\vec{P}_{1A} = m_A \vec{V}_{A1}$

$\vec{P}_{1B} = m_B \vec{V}_{B1}$

$m_A = 0.5 \text{ kg}$

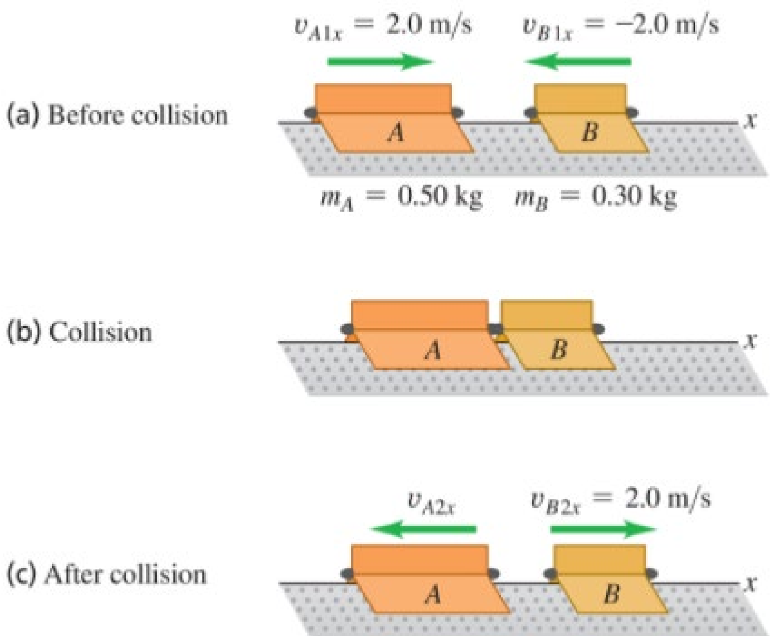
$\vec{V}_{A1} = 2 \text{ m/s } \hat{i}$

$m_B = 0.3 \text{ kg}$

$\vec{V}_{B1} = -2 \text{ m/s } \hat{i}$

ASU

Two gliders with different masses move toward each other on a frictionless air track (Fig. 8.13a). After they collide (Fig. 8.13b), glider B has a final velocity of $+2.0\text{m/s}$ (Fig. 8.13c). What is the final velocity of glider A? How do the changes in momentum and in velocity compare?



$\vec{P}_{1A} = M_A \vec{V}_{A1}$

$M_A = 0.5\,kg$

$\vec{V}_{A1} = 2\,m/s\,\hat{i}$

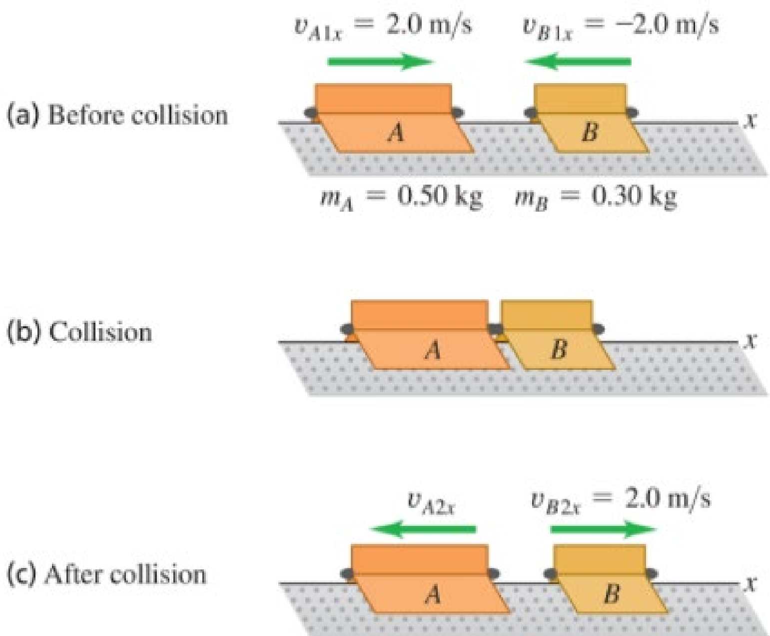
$\vec{P}_{1B} = M_B \vec{V}_{B1}$

$M_B = 0.3\,kg$

$\vec{V}_{B1} = -2\,m/s\,\hat{i}$

$\vec{V}_{B2} = 2\,m/s\,\hat{i}$

Two gliders with different masses move toward each other on a frictionless air track (Fig. 8.13a). After they collide (Fig. 8.13b), glider B has a final velocity of $+2.0\,\mathrm{m/s}$ (Fig. 8.13c). What is the final velocity of glider A? How do the changes in momentum and in velocity compare?



$\vec{P}_{1A} = m_A \vec{V}_{A1}$

$m_A = 0.5\,\mathrm{kg}$

$\vec{V}_{A1} = 2\,\mathrm{m/s}\,\hat{i}$

$\vec{P}_{1B} = m_B \vec{V}_{B1}$

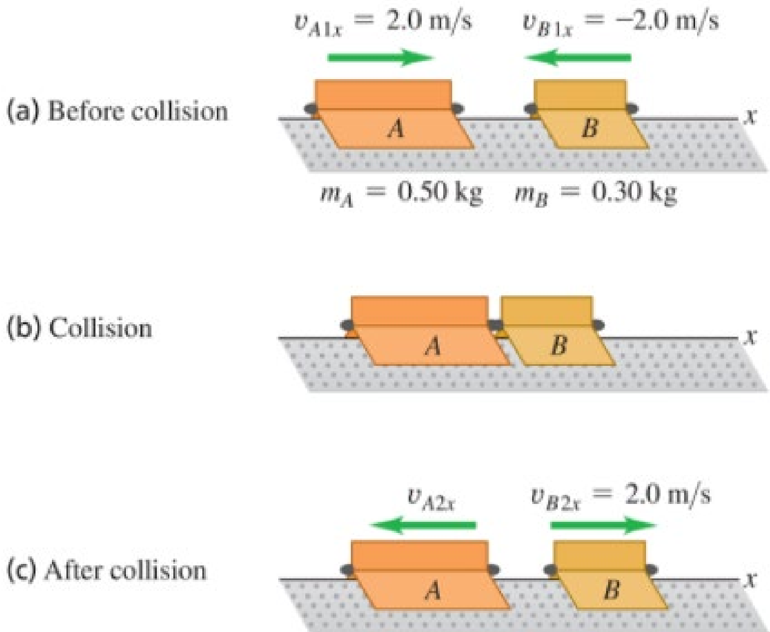
$m_B = 0.3\,\mathrm{kg}$

$\vec{V}_{B1} = -2\,\mathrm{m/s}\,\hat{i}$

$\vec{V}_{B2} = 2\,\mathrm{m/s}\,\hat{i}$

$\vec{P}_{1A} + \vec{P}_{1B} = \vec{P}_{2A} + \vec{P}_{2B}$

Two gliders with different masses move toward each other on a frictionless air track (Fig. 8.13a). After they collide (Fig. 8.13b), glider B has a final velocity of $+2.0\text{m/s}$ (Fig. 8.13c). What is the final velocity of glider A? How do the changes in momentum and in velocity compare?



$$\vec{P}_{1A} = m_A \vec{V}_{A1} \qquad m_A = 0.5\,\text{kg} \qquad \vec{V}_{A1} = 2\,\text{m/s}\,\hat{i}$$

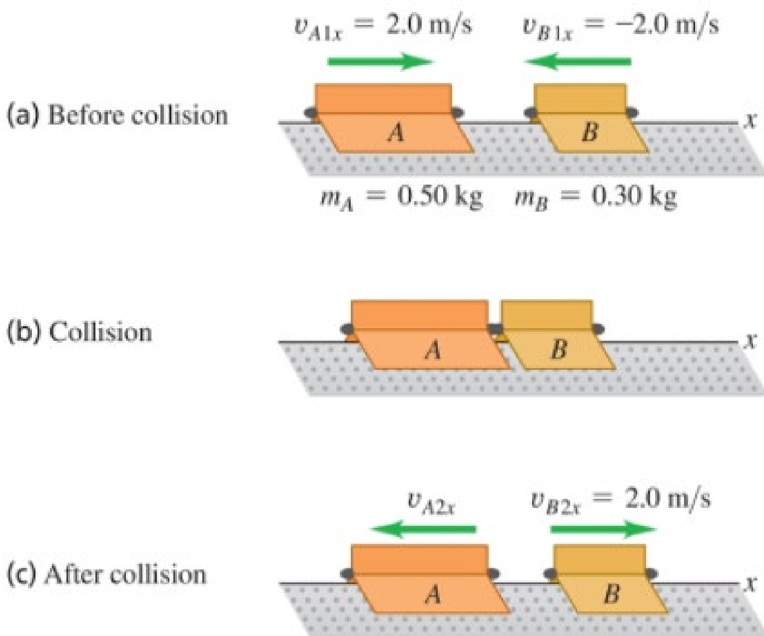
$$\vec{P}_{1B} = m_B \vec{V}_{B1} \qquad m_B = 0.3\,\text{kg} \qquad \vec{V}_{B1} = -2\,\text{m/s}\,\hat{i}$$

$$\vec{V}_{B2} = 2\,\text{m/s}\,\hat{i}$$

$$\vec{P}_{1A} + \vec{P}_{1B} = \vec{P}_{2A} + \vec{P}_{2B}$$

$$\Rightarrow \quad \vec{P}_{2A} = \vec{P}_{1A} + \vec{P}_{1B} - \vec{P}_{2B}$$

Two gliders with different masses move toward each other on a frictionless air track (Fig. 8.13a). After they collide (Fig. 8.13b), glider B has a final velocity of $+2.0 \mathrm{m/s}$ (Fig. 8.13c). What is the final velocity of glider A? How do the changes in momentum and in velocity compare?



$\vec{P}_{1A} = m_A \vec{V}_{A1}$ $\quad m_A = 0.5\,kg$, $\vec{V}_{A1} = 2\,m/s\,\hat{i}$

$\vec{P}_{1B} = m_B \vec{V}_{B1}$ $\quad m_B = 0.3\,kg$, $\vec{V}_{B1} = -2\,m/s\,\hat{i}$

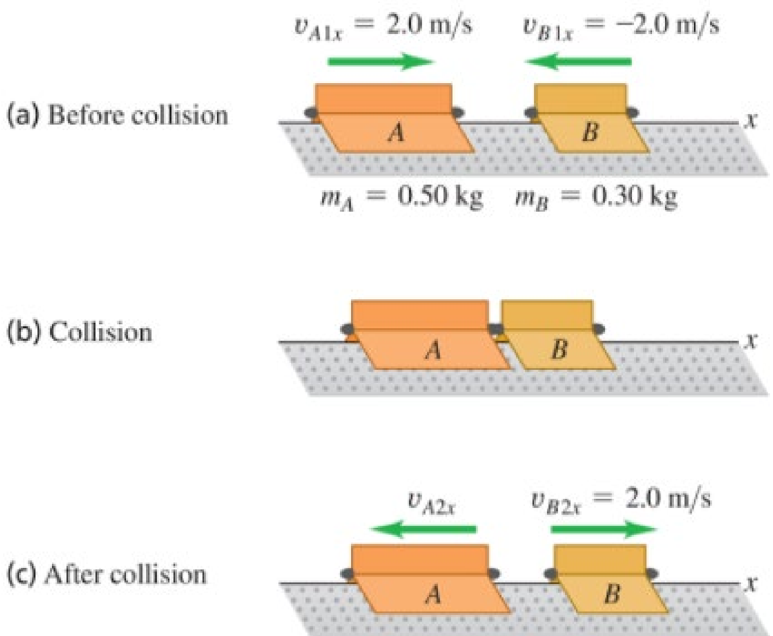
$\vec{V}_{B2} = 2\,m/s\,\hat{i}$

$$\vec{P}_{1A} + \vec{P}_{1B} = \vec{P}_{2A} + \vec{P}_{2B}$$

$$\Rightarrow \vec{P}_{2A} = \vec{P}_{1A} + \vec{P}_{1B} - \vec{P}_{2B} \Rightarrow m_A \vec{V}_{A2} = m_A \vec{V}_{A1} + m_B \vec{V}_{B1} - m_B \vec{V}_{B2}$$

ASU

Two gliders with different masses move toward each other on a frictionless air track (Fig. 8.13a). After they collide (Fig. 8.13b), glider B has a final velocity of $+2.0\,\mathrm{m/s}$ (Fig. 8.13c). What is the final velocity of glider A? How do the changes in momentum and in velocity compare?



$\vec{P}_{1A} = m_A \vec{V}_{A1}$ $\quad m_A = 0.5\,\text{kg}$, $\vec{V}_{A1} = 2\,\text{m/s}\,\hat{i}$

$\vec{P}_{1B} = m_B \vec{V}_{B1}$ $\quad m_B = 0.3\,\text{kg}$, $\vec{V}_{B1} = -2\,\text{m/s}\,\hat{i}$

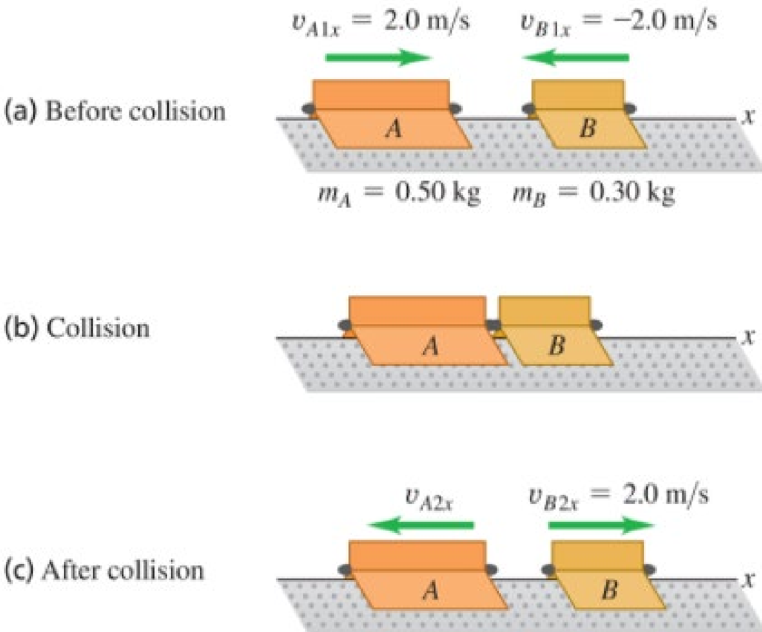
$\vec{V}_{B2} = 2\,\text{m/s}\,\hat{i}$

$$\vec{P}_{1A} + \vec{P}_{1B} = \vec{P}_{2A} + \vec{P}_{2B}$$

$$\Rightarrow \quad \vec{P}_{2A} = \vec{P}_{1A} + \vec{P}_{1B} - \vec{P}_{2B} \Rightarrow m_A \vec{V}_{A2} = m_A \vec{V}_{A1} + m_B \vec{V}_{B1} - m_B \vec{V}_{B2}$$

ASU

Two gliders with different masses move toward each other on a frictionless air track (Fig. 8.13a). After they collide (Fig. 8.13b), glider B has a final velocity of $+2.0\,\mathrm{m/s}$ (Fig. 8.13c). What is the final velocity of glider A? How do the changes in momentum and in velocity compare?



$\vec{P}_{1A} = m_A \vec{V}_{A1}$ $\quad m_A = 0.5\,\mathrm{kg}$, $\vec{V}_{A1} = 2\,\mathrm{m/s}\,\hat{i}$

$\vec{P}_{1B} = m_B \vec{V}_{B1}$ $\quad m_B = 0.3\,\mathrm{kg}$, $\vec{V}_{B1} = -2\,\mathrm{m/s}\,\hat{i}$

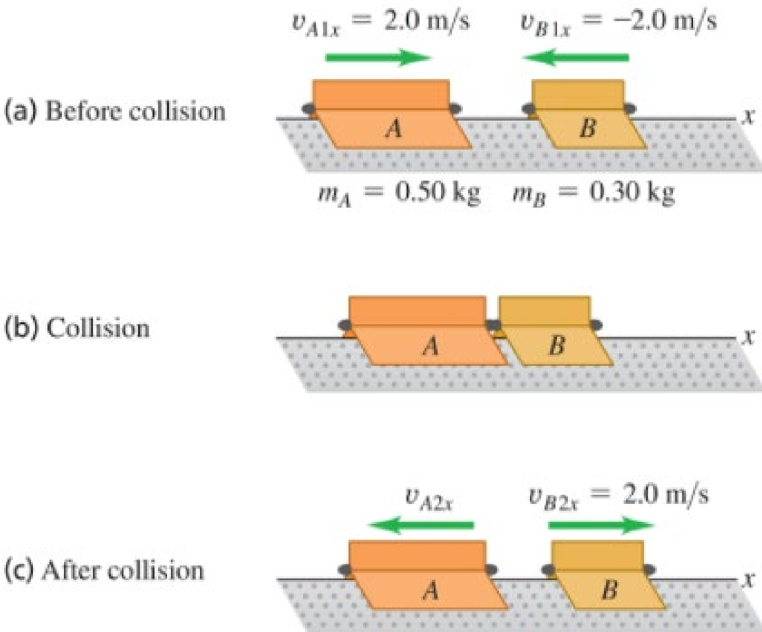
$\vec{V}_{B2} = 2\,\mathrm{m/s}\,\hat{i}$

$$\vec{P}_{1A} + \vec{P}_{1B} = \vec{P}_{2A} + \vec{P}_{2B}$$

$$\Rightarrow \quad \vec{P}_{2A} = \vec{P}_{1A} + \vec{P}_{1B} - \vec{P}_{2B} \Rightarrow \vec{V}_{A2} = \frac{1}{m_A}\left(m_A \vec{V}_{A1} + m_B \vec{V}_{B1} - m_B \vec{V}_{B2}\right)$$

ASU

Two gliders with different masses move toward each other on a frictionless air track (Fig. 8.13a). After they collide (Fig. 8.13b), glider B has a final velocity of $+2.0\,\mathrm{m/s}$ (Fig. 8.13c). What is the final velocity of glider A? How do the changes in momentum and in velocity compare?



$\vec{P}_{1A} = m_A \vec{V}_{A1}$

$m_A = 0.5\,\mathrm{kg}$

$\vec{V}_{A1} = 2\,\mathrm{m/s}\,\hat{i}$

$\vec{P}_{1B} = m_B \vec{V}_{B1}$

$m_B = 0.3\,\mathrm{kg}$

$\vec{V}_{B1} = -2\,\mathrm{m/s}\,\hat{i}$

$\vec{V}_{B2} = 2\,\mathrm{m/s}\,\hat{i}$

$$\vec{P}_{1A} + \vec{P}_{1B} = \vec{P}_{2A} + \vec{P}_{2B}$$

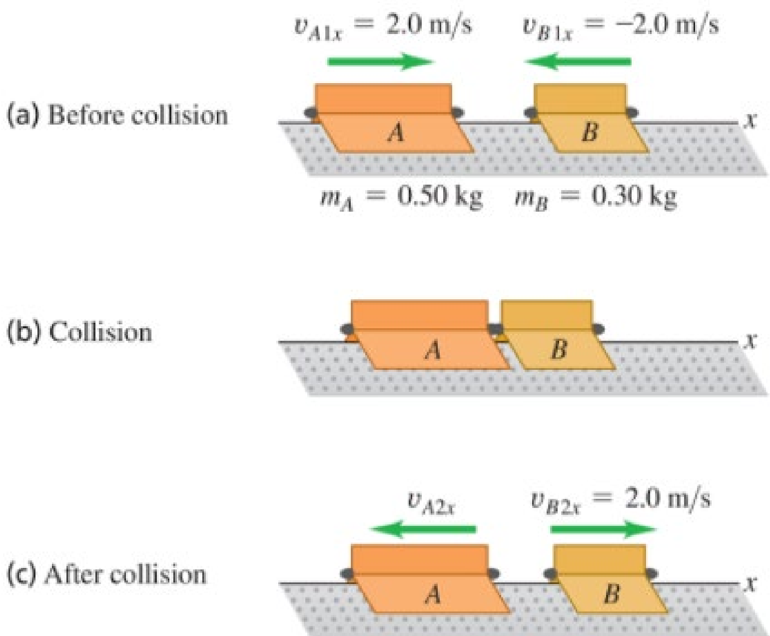
$$\Rightarrow \vec{P}_{2A} = \vec{P}_{1A} + \vec{P}_{1B} - \vec{P}_{2B} \Rightarrow \vec{V}_{A2} = \frac{1}{m_A}\left(m_A \vec{V}_{A1} + m_B \vec{V}_{B1} - m_B \vec{V}_{B2}\right)$$

$$\Rightarrow \vec{V}_{A2} = \left(\frac{1}{0.5}\right)\left[0.5 * 2\hat{i} + 0.3 * (-2\hat{i}) - 0.3 * (2\hat{i})\right]\frac{m}{s}$$

$$\Rightarrow \vec{V}_{A2} = -0.4\,\mathrm{m/s}$$

ASU

Two gliders with different masses move toward each other on a frictionless air track (Fig. 8.13a). After they collide (Fig. 8.13b), glider B has a final velocity of $+2.0 \text{m/s}$ (Fig. 8.13c). What is the final velocity of glider A? How do the changes in momentum and in velocity compare?



$\vec{P}_{1A} = m_A \vec{V}_{A1}$ $\quad m_A = 0.5\,\text{kg}$, $\vec{V}_{A1} = 2\,\text{m/s}\,\hat{i}$

$\vec{P}_{1B} = m_B \vec{V}_{B1}$ $\quad m_B = 0.3\,\text{kg}$, $\vec{V}_{B1} = -2\,\text{m/s}\,\hat{i}$

$\vec{V}_{A2} = -0.4\,\text{m/s}\,\hat{i}$

$\vec{V}_{B2} = 2\,\text{m/s}\,\hat{i}$

$$\vec{P}_{1A} + \vec{P}_{1B} = \vec{P}_{2A} + \vec{P}_{2B}$$

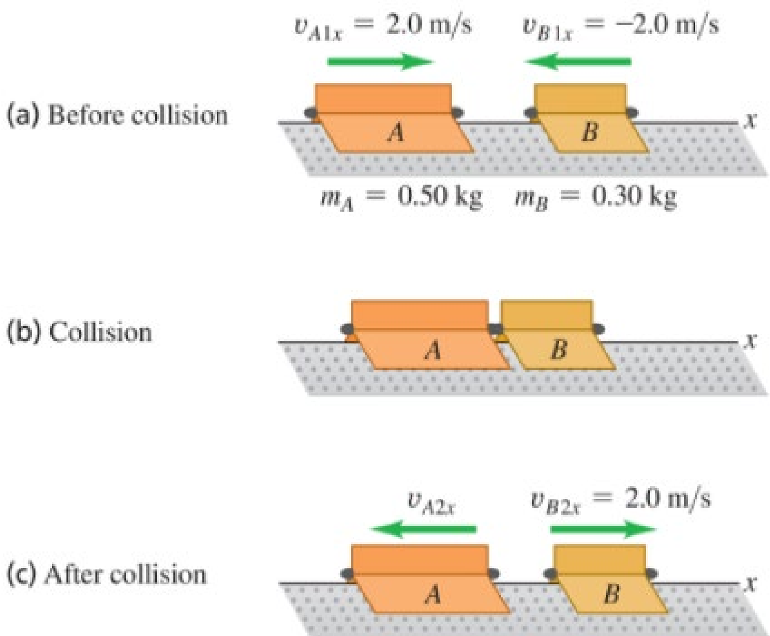
$$\Rightarrow \vec{P}_{2A} = \vec{P}_{1A} + \vec{P}_{1B} - \vec{P}_{2B} \Rightarrow \vec{V}_{A2} = \frac{1}{m_A}\left(m_A\vec{V}_{A1} + m_B\vec{V}_{B1} - m_B\vec{V}_{B2}\right)$$

$$\Rightarrow \vec{V}_{A2} = \left(\frac{1}{0.5}\right)\left[0.5 * 2\hat{i} + 0.3 * (-2\hat{i}) - 0.3 * (2\hat{i})\right]\frac{m}{s}$$

$$\Rightarrow \boxed{\vec{V}_{A2} = -0.4\,\text{m/s}}$$

ASU

Two gliders with different masses move toward each other on a frictionless air track (Fig. 8.13a). After they collide (Fig. 8.13b), glider B has a final velocity of $+2.0\text{m/s}$ (Fig. 8.13c). What is the final velocity of glider A? How do the changes in momentum and in velocity compare?



$\vec{P}_{1A} = m_A \vec{V}_{A1}$

$m_A = 0.5\text{ kg}$

$\vec{V}_{A1} = 2\text{ m/s}\ \hat{i}$

$\vec{P}_{1B} = m_B \vec{V}_{B1}$

$m_B = 0.3\text{ kg}$

$\vec{V}_{B1} = -2\text{ m/s}\ \hat{i}$

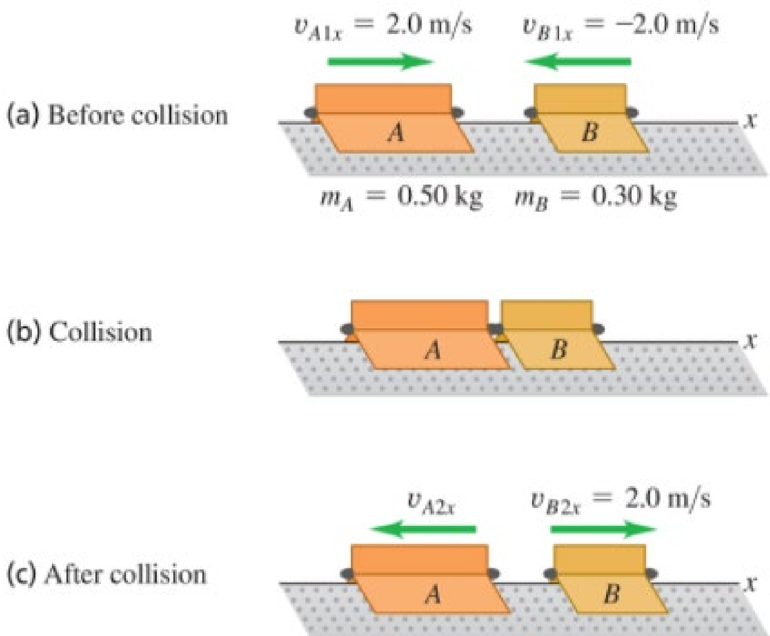
$\vec{V}_{A2} = -0.4\text{ m/s}\ \hat{i}$

$\vec{V}_{B2} = 2\text{ m/s}\ \hat{i}$

$\Delta\vec{P}_A = \vec{P}_{A2} - \vec{P}_{A1}$

ASU

Two gliders with different masses move toward each other on a frictionless air track (Fig. 8.13a). After they collide (Fig. 8.13b), glider B has a final velocity of $+2.0\text{m/s}$ (Fig. 8.13c). What is the final velocity of glider A? How do the changes in momentum and in velocity compare?



$\vec{P}_{1A} = m_A \vec{V}_{A1}$

$m_A = 0.5\,kg$

$\vec{V}_{A1} = 2\,m/s\,\hat{i}$

$\vec{P}_{1B} = m_B \vec{V}_{B1}$

$m_B = 0.3\,kg$

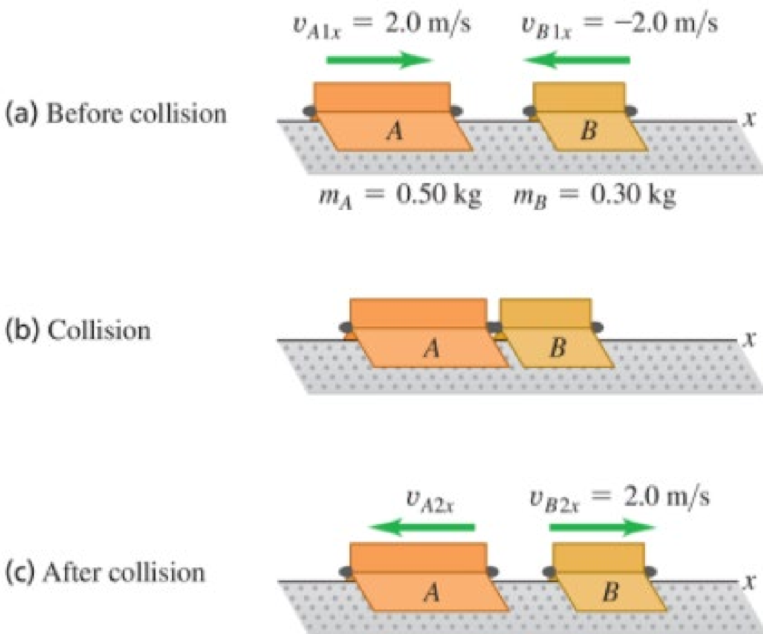
$\vec{V}_{B1} = -2\,m/s\,\hat{i}$

$\vec{V}_{A2} = -0.4\,m/s\,\hat{i}$

$\vec{V}_{B2} = 2\,m/s\,\hat{i}$

$\Delta\vec{P}_A = \vec{P}_{A2} - \vec{P}_{A1} = \frac{kg}{2}(-0.4-2)\,m/s\,\hat{i}$

Two gliders with different masses move toward each other on a frictionless air track (Fig. 8.13a). After they collide (Fig. 8.13b), glider B has a final velocity of $+2.0\,\mathrm{m/s}$ (Fig. 8.13c). What is the final velocity of glider A? How do the changes in momentum and in velocity compare?



$\vec{P}_{1A} = m_A \vec{V}_{A1}$ $\quad m_A = 0.5\,\mathrm{kg}$ $\quad \vec{V}_{A1} = 2\,\mathrm{m/s}\,\hat{i}$

$\vec{P}_{1B} = m_B \vec{V}_{B1}$ $\quad m_B = 0.3\,\mathrm{kg}$ $\quad \vec{V}_{B1} = -2\,\mathrm{m/s}\,\hat{i}$

$\vec{V}_{A2} = -0.4\,\mathrm{m/s}\,\hat{i}$

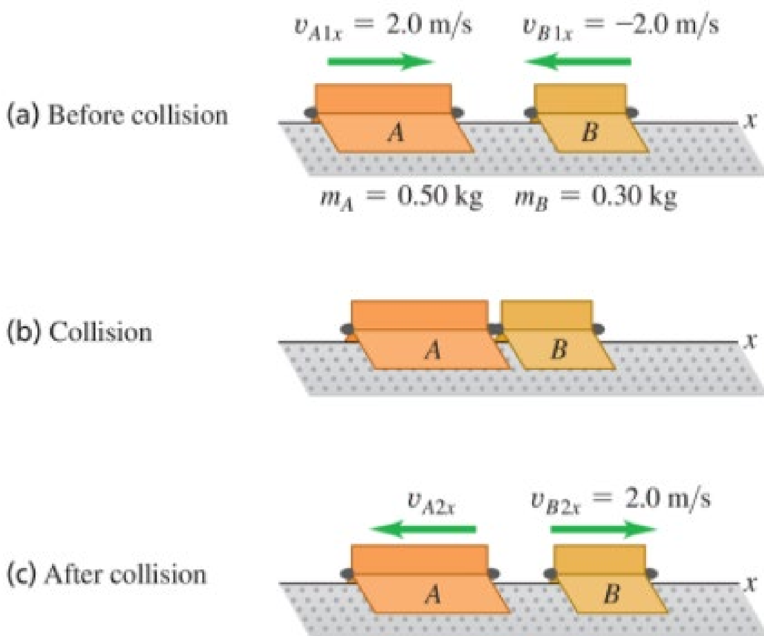
$\vec{V}_{B2} = 2\,\mathrm{m/s}\,\hat{i}$

$$\Delta\vec{P}_A = \vec{P}_{A2} - \vec{P}_{A1} = \frac{\mathrm{kg}}{2}(-0.4-2)\,\mathrm{m/s}\,\hat{i}$$

$$\Rightarrow \quad \Delta\vec{P}_A = -1.2\,\mathrm{kg\,\frac{m}{s}}\,\hat{i}$$

ASU

Two gliders with different masses move toward each other on a frictionless air track (Fig. 8.13a). After they collide (Fig. 8.13b), glider B has a final velocity of $+2.0 \text{m/s}$ (Fig. 8.13c). What is the final velocity of glider A? How do the changes in momentum and in velocity compare?



$\vec{P}_{1A} = m_A \vec{V}_{A1}$

$\vec{P}_{1B} = m_B \vec{V}_{B1}$

$m_A = 0.5\ kg$

$\vec{V}_{A1} = 2\ m/s\ \hat{i}$

$m_B = 0.3\ kg$

$\vec{V}_{B1} = -2\ m/s\ \hat{i}$

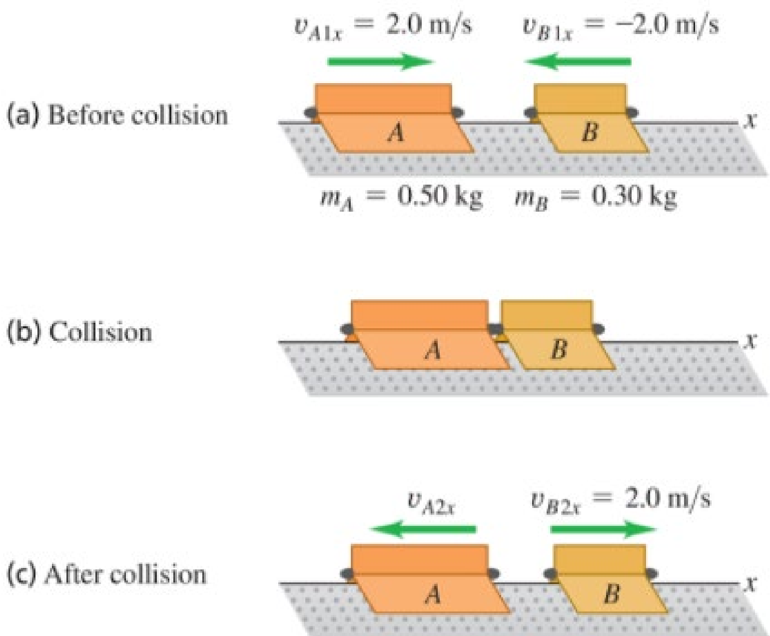
$\vec{V}_{A2} = -0.4\ m/s\ \hat{i}$

$\vec{V}_{B2} = 2\ m/s\ \hat{i}$

$\Delta \vec{P}_A = \vec{P}_{A2} - \vec{P}_{A1} = \frac{kg}{2}(-0.4 - 2)\ m/s\ \hat{i}$

$\Rightarrow \Delta \vec{P}_A = -1.2\ kg\ \frac{m}{s}\ \hat{i}$ $\quad \Delta \vec{P}_B = 0.3\ kg\ (2 - (-2))\ \frac{m}{s}\ \hat{i}$

Two gliders with different masses move toward each other on a frictionless air track (Fig. 8.13a). After they collide (Fig. 8.13b), glider B has a final velocity of $+2.0\,\mathrm{m/s}$ (Fig. 8.13c). What is the final velocity of glider A? How do the changes in momentum and in velocity compare?



$\vec{P}_{1A} = m_A \vec{V}_{A1}$ $\quad m_A = 0.5\,\mathrm{kg}$

$\vec{V}_{A1} = 2\,\mathrm{m/s}\,\hat{i}$

$\vec{P}_{1B} = m_B \vec{V}_{B1}$ $\quad m_B = 0.3\,\mathrm{kg}$

$\vec{V}_{B1} = -2\,\mathrm{m/s}\,\hat{i}$

$\vec{V}_{A2} = -0.4\,\mathrm{m/s}\,\hat{i}$

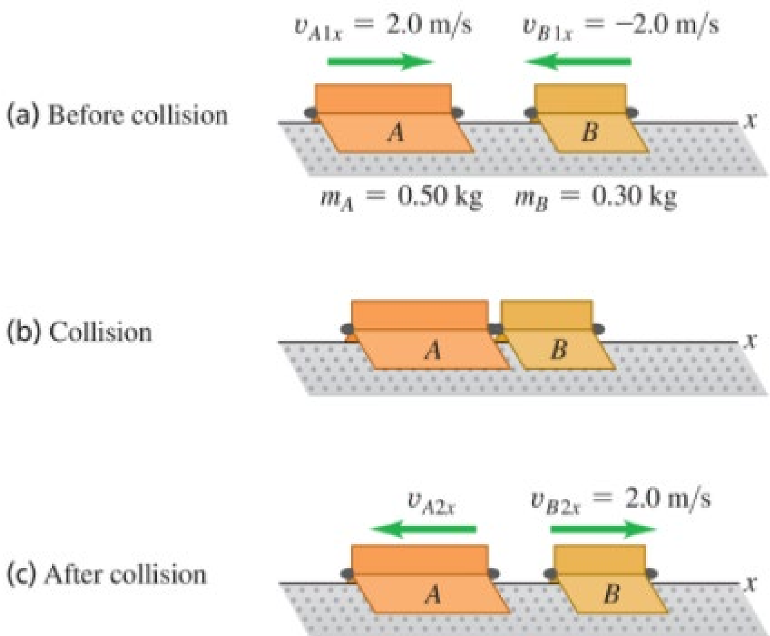
$\vec{V}_{B2} = 2\,\mathrm{m/s}\,\hat{i}$

$\Delta\vec{P}_A = \vec{P}_{A2} - \vec{P}_{A1} = \frac{\mathrm{kg}}{2}(-0.4-2)\,\mathrm{m/s}\,\hat{i}$

$\Rightarrow \quad \Delta\vec{P}_A = -1.2\,\mathrm{kg\,m/s}\,\hat{i}$ $\quad \Delta\vec{P}_B = 0.3\,\mathrm{kg}\,(2-(-2))\,\mathrm{m/s}\,\hat{i}$

$\Rightarrow \quad \Delta\vec{P}_B = 1.2\,\mathrm{kg\,m/s}\,\hat{i}$

Two gliders with different masses move toward each other on a frictionless air track (Fig. 8.13a). After they collide (Fig. 8.13b), glider B has a final velocity of $+2.0\text{m/s}$ (Fig. 8.13c). What is the final velocity of glider A? How do the changes in momentum and in velocity compare?



$\vec{P}_{1A} = m_A \vec{V}_{A1}$ $\quad m_A = 0.5\,\text{kg}$

$\vec{V}_{A1} = 2\,\text{m/s}\,\hat{i}$

$\vec{P}_{1B} = m_B \vec{V}_{B1}$ $\quad m_B = 0.3\,\text{kg}$

$\vec{V}_{B1} = -2\,\text{m/s}\,\hat{i}$

$\vec{V}_{A2} = -0.4\,\text{m/s}\,\hat{i}$

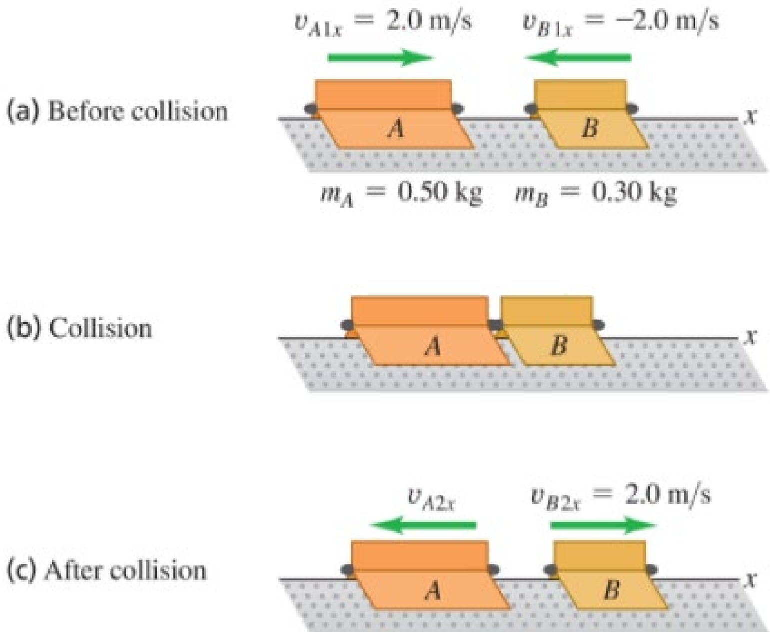
$\vec{V}_{B2} = 2\,\text{m/s}\,\hat{i}$

$\Delta\vec{P}_A = \vec{P}_{A2} - \vec{P}_{A1} = \frac{\text{kg}}{2}(-0.4-2)\,\text{m/s}\,\hat{i}$

$\Rightarrow \Delta\vec{P}_A = -1.2\,\text{kg}\,\frac{\text{m}}{\text{s}}\,\hat{i}$ $\quad \Delta\vec{P}_B = 0.3\,\text{kg}\,(2-(-2))\,\frac{\text{m}}{\text{s}}\,\hat{i}$

$\Rightarrow \Delta\vec{P}_B = 1.2\,\text{kg}\,\frac{\text{m}}{\text{s}}\,\hat{i}$ $\Rightarrow \Delta\vec{P}_A + \Delta\vec{P}_B = 0$

Two gliders with different masses move toward each other on a frictionless air track (Fig. 8.13a). After they collide (Fig. 8.13b), glider B has a final velocity of $+2.0\text{m/s}$ (Fig. 8.13c). What is the final velocity of glider A? How do the changes in momentum and in velocity compare?



$\vec{P}_{1A} = m_A \vec{V}_{A1}$

$m_A = 0.5\text{ kg}$

$\vec{V}_{A1} = 2\text{ m/s}\ \hat{i}$

$\vec{P}_{1B} = m_B \vec{V}_{B1}$

$m_B = 0.3\text{ kg}$

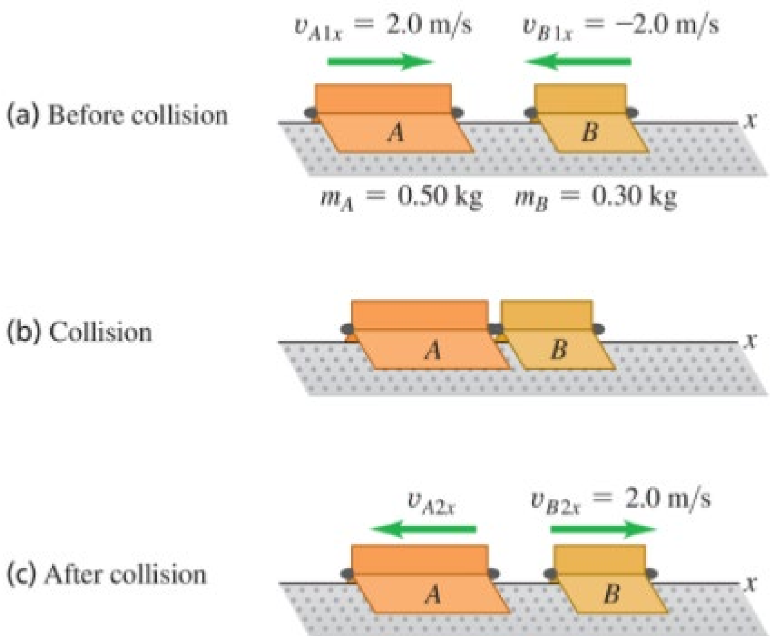
$\vec{V}_{B1} = -2\text{ m/s}\ \hat{i}$

$\vec{V}_{A2} = -0.4\text{ m/s}\ \hat{i}$

$\vec{V}_{B2} = 2\text{ m/s}\ \hat{i}$

$\Delta\vec{V}_A = (-0.4 - 2)\text{ m/s}\ \hat{i}$

Two gliders with different masses move toward each other on a frictionless air track (Fig. 8.13a). After they collide (Fig. 8.13b), glider B has a final velocity of $+2.0\,\text{m/s}$ (Fig. 8.13c). What is the final velocity of glider A? How do the changes in momentum and in velocity compare?



$$\vec{P}_{1A} = M_A \vec{V}_{A1}$$

$M_A = 0.5\,\text{kg}$

$\vec{V}_{A1} = 2\,\text{m/s}\,\hat{i}$

$$\vec{P}_{1B} = M_B \vec{V}_{B1}$$

$M_B = 0.3\,\text{kg}$

$\vec{V}_{B1} = -2\,\text{m/s}\,\hat{i}$

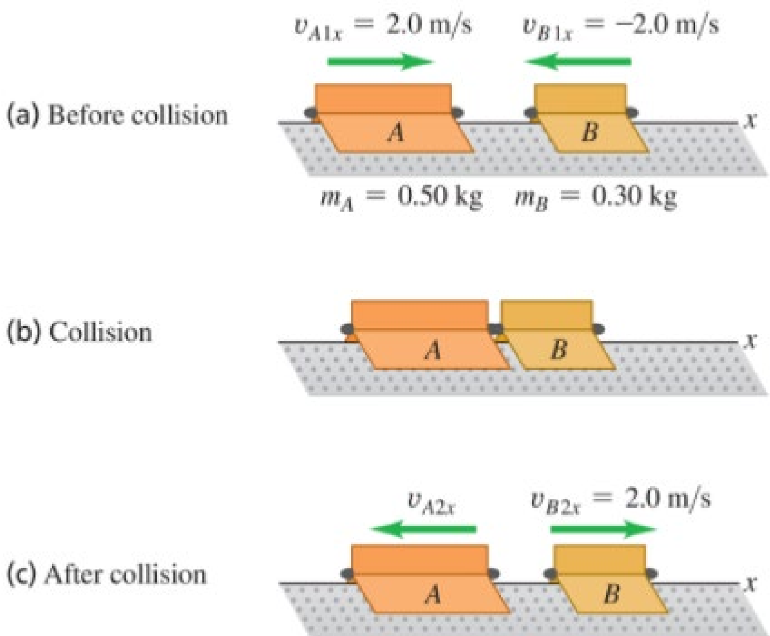
$\vec{V}_{A2} = -0.4\,\text{m/s}\,\hat{i}$

$\vec{V}_{B2} = 2\,\text{m/s}\,\hat{i}$

$$\Delta\vec{V}_A = (-0.4-2)\,\text{m/s}\,\hat{i}$$

$$\Rightarrow \Delta\vec{V}_A = -2.4\,\text{m/s}\,\hat{i}$$

Two gliders with different masses move toward each other on a frictionless air track (Fig. 8.13a). After they collide (Fig. 8.13b), glider B has a final velocity of $+2.0\text{m/s}$ (Fig. 8.13c). What is the final velocity of glider A? How do the changes in momentum and in velocity compare?



$$\vec{P}_{1A} = M_A \vec{V}_{A1} \qquad M_A = 0.5\,kg \qquad \vec{V}_{A1} = 2\,m/s\,\hat{i}$$

$$\vec{P}_{1B} = M_B \vec{V}_{B1} \qquad M_B = 0.3\,kg \qquad \vec{V}_{B1} = -2\,m/s\,\hat{i}$$

$$\vec{V}_{A2} = -0.4\,m/s\,\hat{i}$$

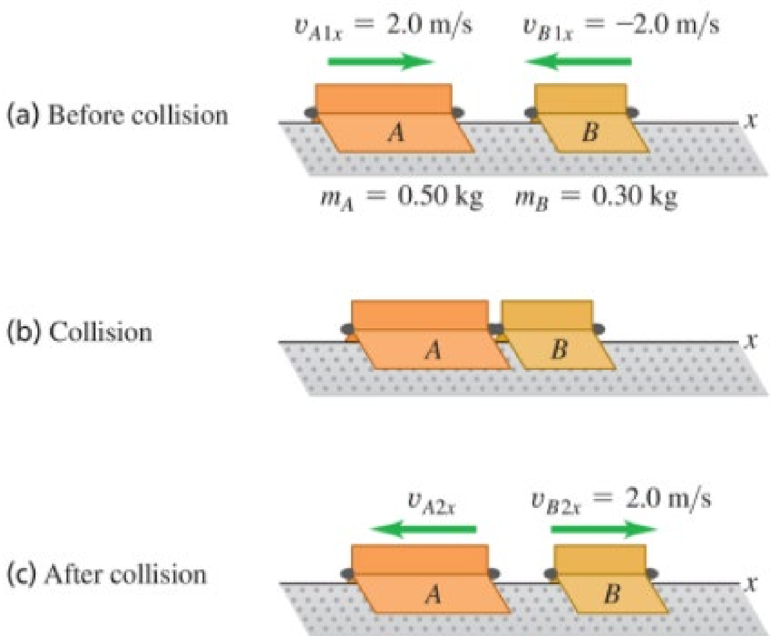
$$\vec{V}_{B2} = 2\,m/s\,\hat{i}$$

$$\Delta\vec{V}_A = (-0.4-2)\,m/s\,\hat{i}$$

$$\Rightarrow \Delta\vec{V}_A = -2.4\,m/s\,\hat{i} \qquad \Delta\vec{V}_B = (2-(-2))\,m/s\,\hat{i}$$

ASU

Two gliders with different masses move toward each other on a frictionless air track (Fig. 8.13a). After they collide (Fig. 8.13b), glider B has a final velocity of $+2.0\text{m/s}$ (Fig. 8.13c). What is the final velocity of glider A? How do the changes in momentum and in velocity compare?



$\vec{P}_{1A} = m_A \vec{V}_{A1}$ $\qquad m_A = 0.5\,kg$, $\vec{V}_{A1} = 2\,m/s\,\hat{i}$

$\vec{P}_{1B} = m_B \vec{V}_{B1}$ $\qquad m_B = 0.3\,kg$, $\vec{V}_{B1} = -2\,m/s\,\hat{i}$

$\vec{V}_{A2} = -0.4\,m/s\,\hat{i}$

$\vec{V}_{B2} = 2\,m/s\,\hat{i}$

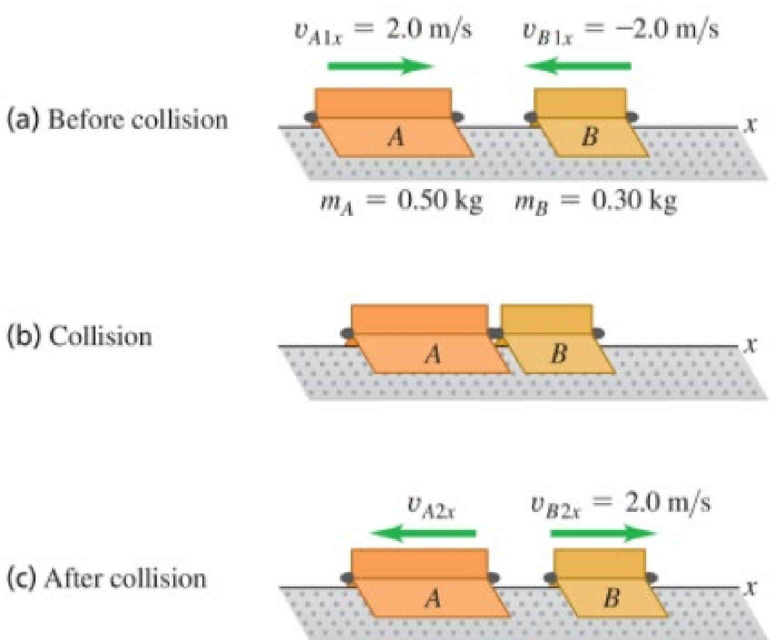
$\Delta\vec{V}_A = (-0.4 - 2)\,m/s\,\hat{i}$

$\Rightarrow \Delta\vec{V}_A = -2.4\,m/s\,\hat{i}$ $\qquad \Delta\vec{V}_B = (2 - (-2))\,m/s\,\hat{i}$

$\Rightarrow \Delta\vec{V}_B = 4\,m/s\,\hat{i}$

ASU

Two gliders with different masses move toward each other on a frictionless air track (Fig. 8.13a). After they collide (Fig. 8.13b), glider B has a final velocity of $+2.0\,\mathrm{m/s}$ (Fig. 8.13c). What is the final velocity of glider A? How do the changes in momentum and in velocity compare?



$\vec{P}_{1A} = m_A \vec{V}_{A1}$

$m_A = 0.5\,\mathrm{kg}$

$\vec{V}_{A1} = 2\,\mathrm{m/s}\,\hat{i}$

$\vec{P}_{1B} = m_B \vec{V}_{B1}$

$m_B = 0.3\,\mathrm{kg}$

$\vec{V}_{B1} = -2\,\mathrm{m/s}\,\hat{i}$

$\vec{V}_{A2} = -0.4\,\mathrm{m/s}\,\hat{i}$

$\vec{V}_{B2} = 2\,\mathrm{m/s}\,\hat{i}$

$\Delta\vec{V}_A = (-0.4 - 2)\,\mathrm{m/s}\,\hat{i}$

$\Rightarrow \Delta\vec{V}_A = -2.4\,\mathrm{m/s}\,\hat{i}$

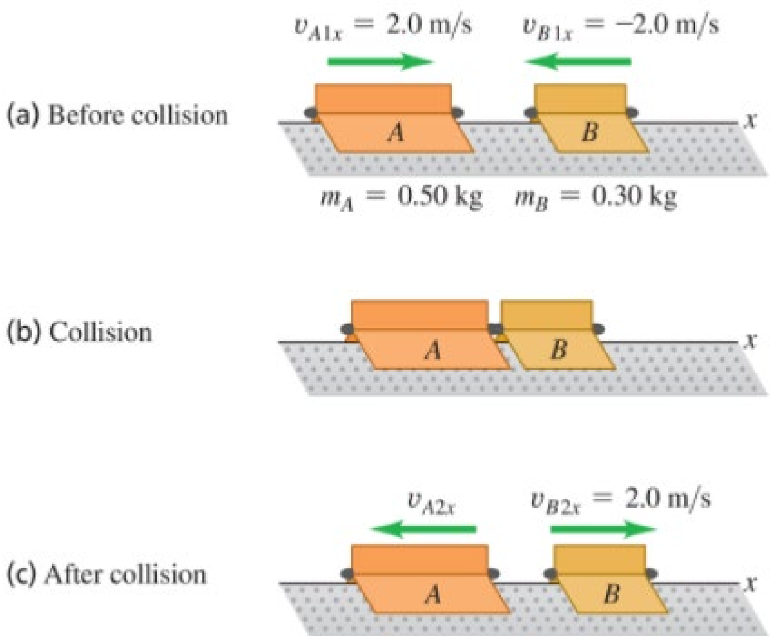
$\Delta\vec{V}_B = (2 - (-2))\,\mathrm{m/s}\,\hat{i}$

$\Rightarrow \Delta\vec{V}_B = 4\,\mathrm{m/s}\,\hat{i}$

$\Delta\vec{V}_A + \Delta\vec{V}_B = 2\,\mathrm{m/s}\,\hat{i}$

ASU

Two gliders with different masses move toward each other on a frictionless air track (Fig. 8.13a). After they collide (Fig. 8.13b), glider B has a final velocity of $+2.0\,\mathrm{m/s}$ (Fig. 8.13c). What is the final velocity of glider A? How do the changes in momentum and in velocity compare?



$\vec{P}_{1A} = m_A \vec{V}_{A1}$

$m_A = 0.5\,\mathrm{kg}$

$\vec{V}_{A1} = 2\,\mathrm{m/s}\,\hat{i}$

$\vec{P}_{1B} = m_B \vec{V}_{B1}$

$m_B = 0.3\,\mathrm{kg}$

$\vec{V}_{B1} = -2\,\mathrm{m/s}\,\hat{i}$

$\vec{V}_{A2} = -0.4\,\mathrm{m/s}\,\hat{i}$

$\vec{V}_{B2} = 2\,\mathrm{m/s}\,\hat{i}$

$\Delta\vec{V}_A = (-0.4-2)\,\mathrm{m/s}\,\hat{i}$

$\Rightarrow \Delta\vec{V}_A = -2.4\,\mathrm{m/s}\,\hat{i}$

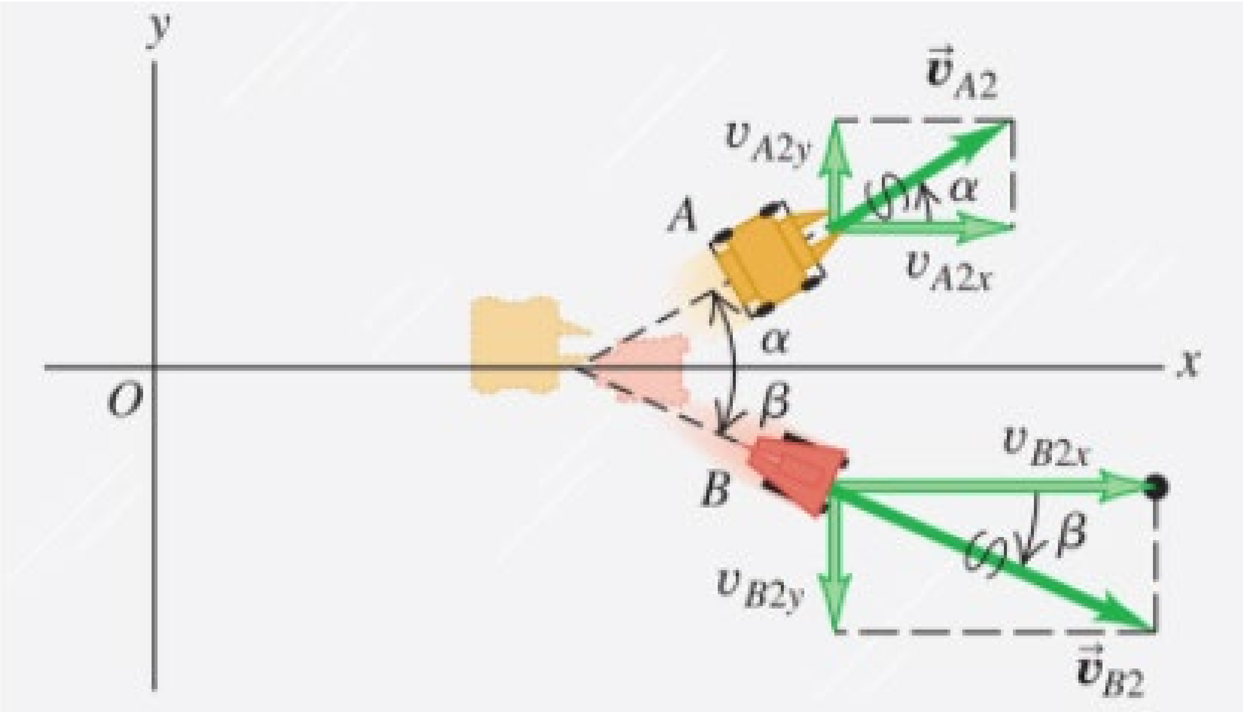
$\Delta\vec{V}_B = (2-(-2))\,\mathrm{m/s}\,\hat{i}$

$\Rightarrow \Delta\vec{V}_B = 4\,\mathrm{m/s}\,\hat{i}$

$\Delta\vec{V}_A + \Delta\vec{V}_B = 2\,\mathrm{m/s}\,\hat{i} \neq 0$

ASU

Figure 8.14a shows two battling robots on a frictionless surface. Robot A, with mass 20 kg, initially moves at $2.0 \mathrm{m/s}$ parallel to the x-axis. It collides with robot B, which has mass 12 kg and is initially at rest. After the collision, robot A moves at $1.0 \mathrm{m/s}$ in a direction that makes an angle $\alpha = 30^\circ$ with its initial direction (Figure 8.14b). What is the final velocity of robot B?



ASU

Figure 8.14a shows two battling robots on a frictionless surface. Robot A, with mass 20 kg, initially moves at $2.0 \mathrm{m/s}$ parallel to the x-axis. It collides with robot B, which has mass 12 kg and is initially at rest. After the collision, robot A moves at $1.0 \mathrm{m/s}$ in a direction that makes an angle $\alpha = 30^\circ$ with its initial direction (Figure 8.14b). What is the final velocity of robot B? $M_A = 20kg$, $\vec{V}_{A1} = 2 \, m/s \, \hat{i}$

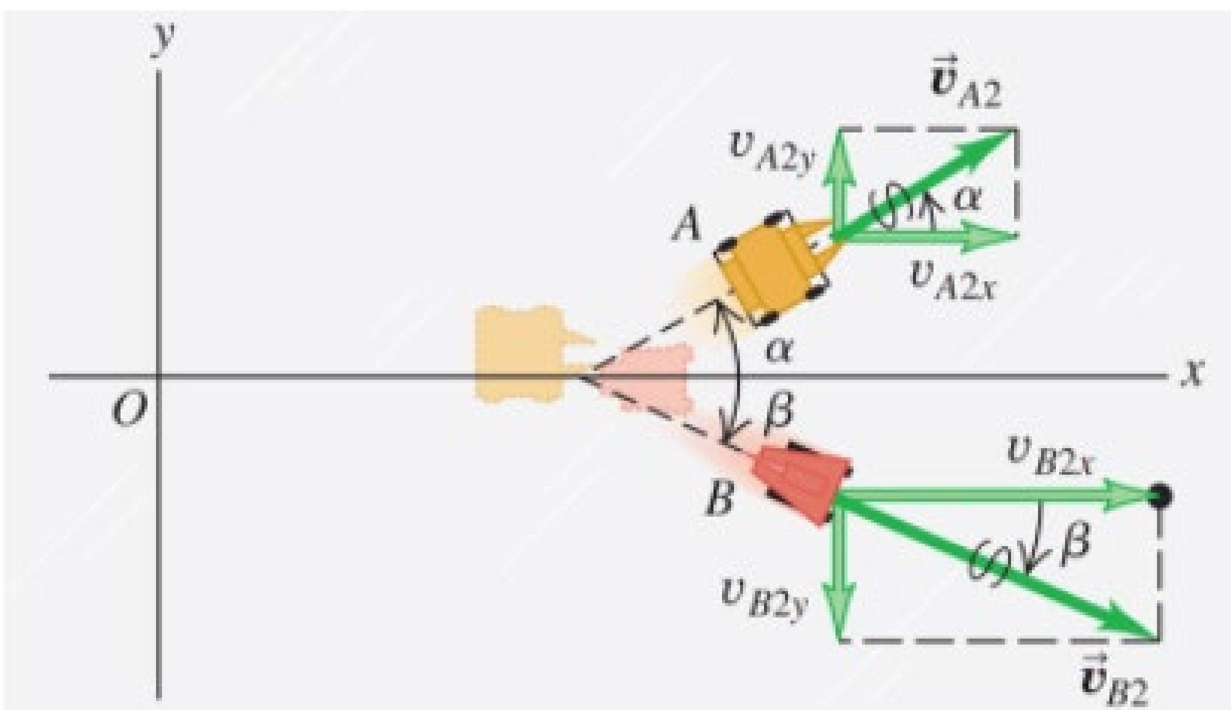
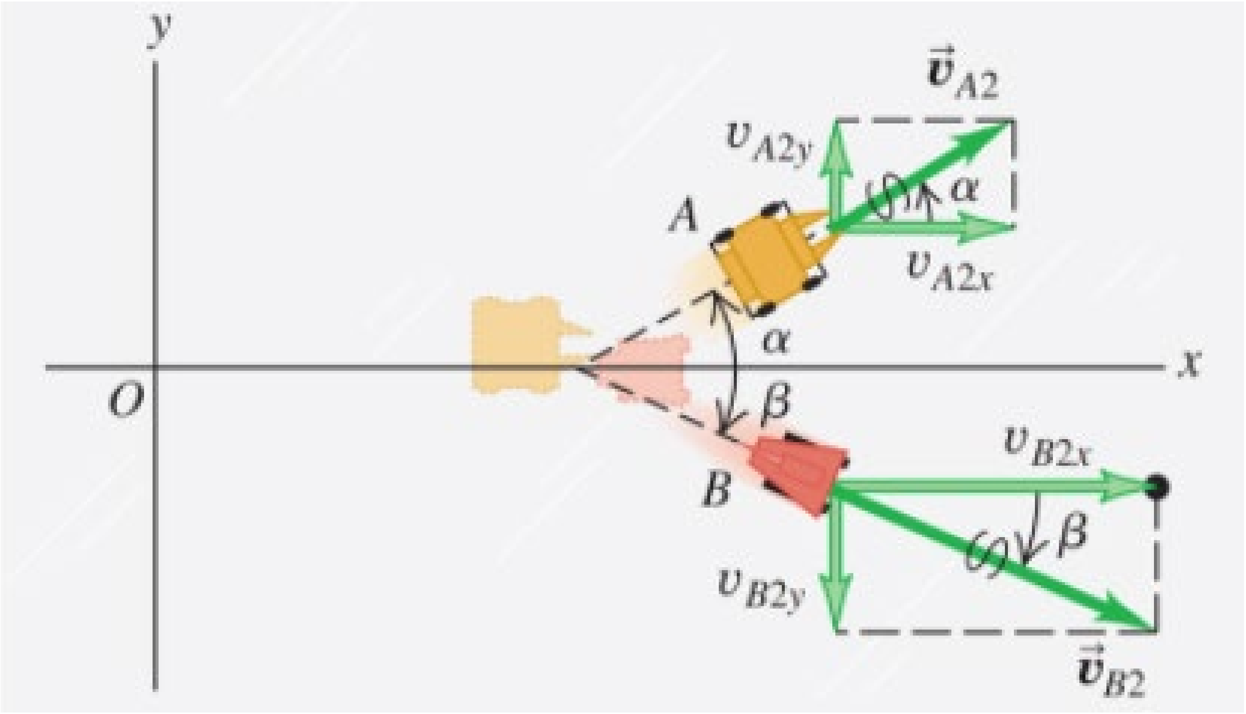


Figure 8.14a shows two battling robots on a frictionless surface. Robot A, with mass 20 kg, initially moves at $2.0 \mathrm{m/s}$ parallel to the x-axis. It collides with robot B, which has mass 12 kg and is initially at rest. After the collision, robot A moves at $1.0 \mathrm{m/s}$ in a direction that makes an angle $\alpha = 30^\circ$ with its initial direction (Figure 8.14b). What is the final velocity of robot B? $M_A = 20 kg$, $\vec{V}_{A1} = 2 m/s\ \hat{i}$, $M_B = 12 kg$, $\vec{V}_{B1} = 0$



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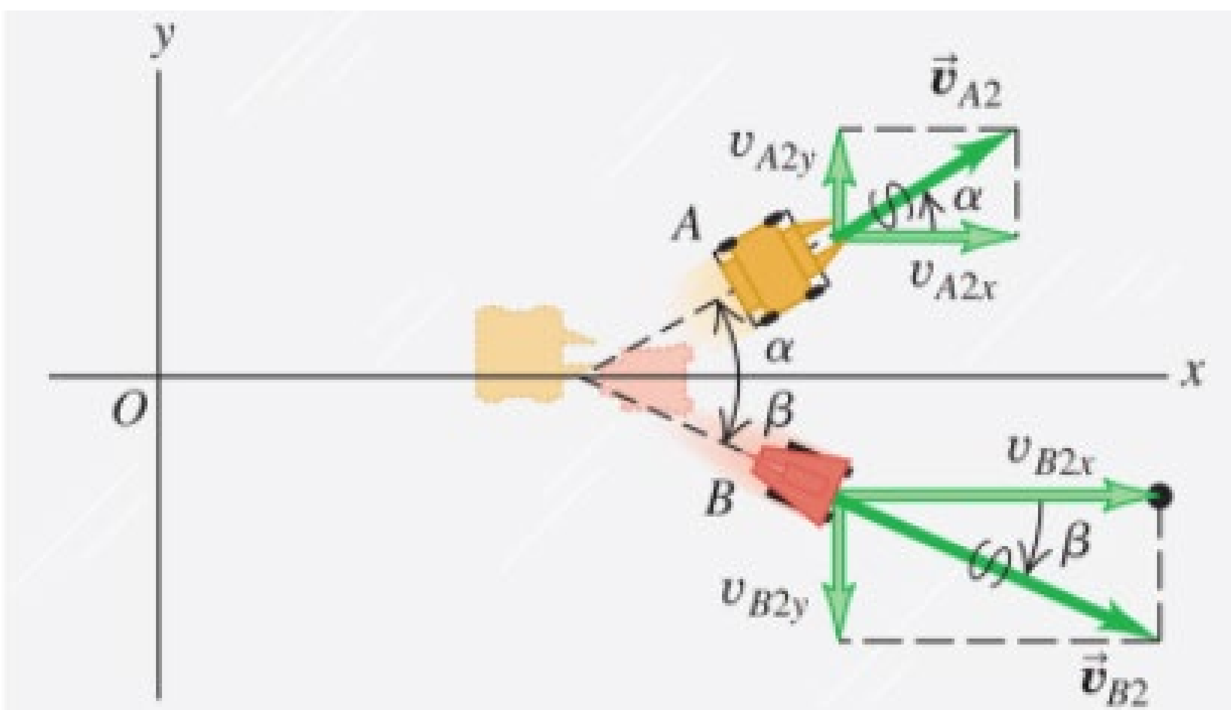

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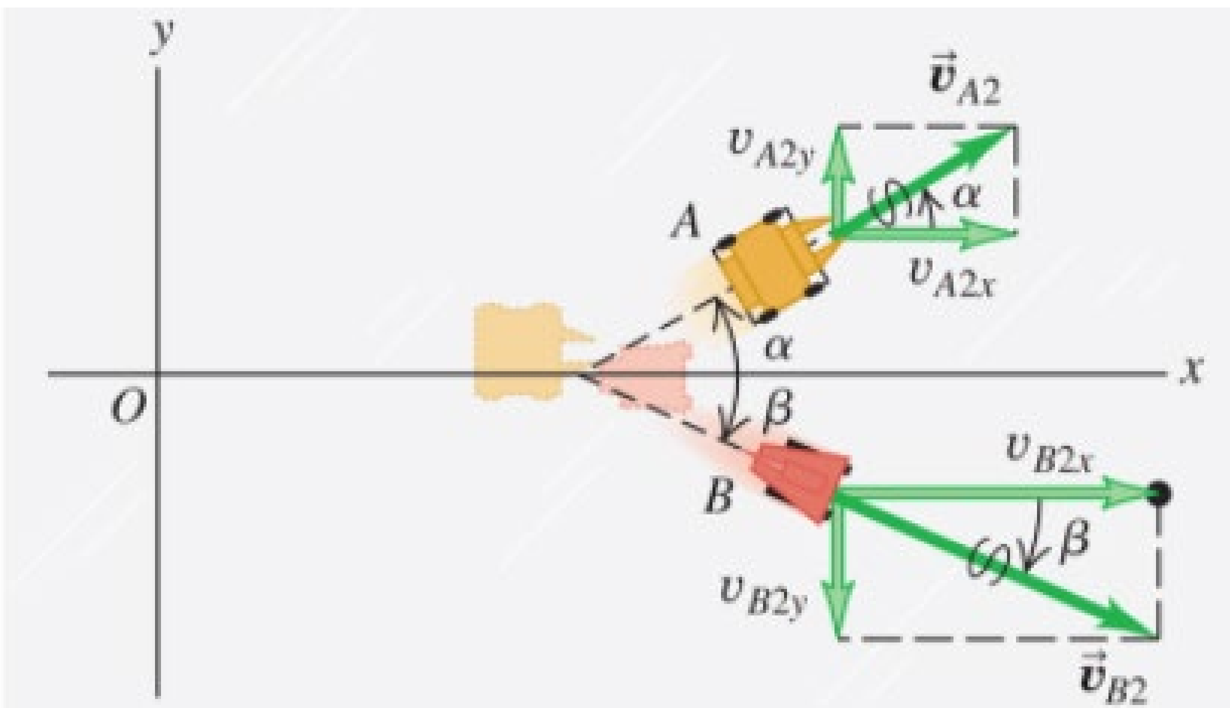

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ASU

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Two equations

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Two equations
1 in y-direction

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Two equations

1 in y-direction & another in x-direction

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$$\Rightarrow \quad P_{B2x} = P_{A1x} - P_{A2x}$$

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($\vec{P}_{B1} = 0$)

$$\Rightarrow P_{B2x} = P_{A1x} - P_{A2x} \ \& \ P_{B2y} = P_{A1y} - P_{A2y}$$

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ASU

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$\Rightarrow P_{B2x} = (20\,kg)(2 - \cos 30^\circ)\,\frac{m}{s} = 22.7\,kg\,\frac{m}{s}$

& $P_{B2y} = (20\,kg)(0 - \sin 30^\circ)\,m/s$

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$$\Rightarrow P_{B2x} = (20\,\text{kg})(2 - \cos 30^\circ)\frac{\text{m}}{\text{s}} = 22.7\,\text{kg}\frac{\text{m}}{\text{s}}$$

$$\& \; P_{B2y} = (20\,\text{kg})(0 - \sin 30^\circ)\text{m/s} = 10\,\text{kg m/s}$$

so $V_{B2} = \dfrac{P_{B2}}{M_B}$

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$$\& \; P_{B2y} = (20\,kg)(0 - \sin 30^\circ)\,m/s = 10\,kg\,m/s$$

so

$$V_{B2} = \frac{P_{B2}}{m_B} = \frac{[22.7^2 + 100]^{1/2}}{12}\left(\frac{m}{s}\right) = 2.07\,m/s$$