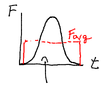
Collision

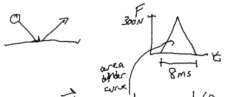


"Impulse J = area under that curve

$\vec{J} = \vec{F}_{avg}\,\Delta t$ units $\boxed{N \cdot s}$

$\frac{kg\,m}{s^2} \cdot s$

$\boxed{kg\,\frac{m}{s}}$



$\vec{J}_{on\ ball} = \frac{1}{2} b h = \frac{1}{2}(8 \times 10^{-3}\,s)(300\,N)$

$= 1.2\,Ns$

direction of $\vec{J}_{on\ ball}$

A) ↑ B) → C) ↓ D) ←

normal force

Which is larger?

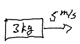
A) impulse on ball

B) impulse on table

$\boxed{\text{C) both the same}}$ $\vec{J}_{A\,on\,B} = -\vec{J}_{B\,on\,A}$

Momentum

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



$\vec{p} = 15\,\frac{kg\,m}{s}$ →

same velocity

truck has more momentum

$\vec{a}_{avg} = \frac{\vec{F}_{avg}}{m}$

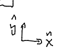
$\vec{a}_{avg} = \frac{\Delta\vec{v}}{\Delta t} = \frac{\vec{v}_f - \vec{v}_i}{\Delta t}$

$\cancel{m}\Delta t\,\frac{\vec{F}_{avg}}{\cancel{m}} = m\cancel{\Delta t}\,\frac{\vec{v}_f - \vec{v}_i}{\cancel{\Delta t}}$

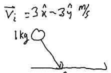
$\vec{F}_{avg}\,\Delta t = m\vec{v}_f - m\vec{v}_i$

$\vec{J} = \vec{p}_f - \vec{p}_i$

$\boxed{\vec{J} = \Delta\vec{p}}$ $\boxed{\vec{p}_i + \vec{J} = \vec{p}_f}$



$\vec{v}_i = 3\hat{x} - 3\hat{y}\ m/s$



$\uparrow \vec{J} = 4Ns\,\hat{y}$

$\vec{p}_i = 3\hat{x} - 3\hat{y}\ \frac{kg\,m}{s}$

$\vec{p}_f =$

A) $3\hat{x} + 4\hat{y}$

B) $3\hat{x} + \hat{y}$

C) $7\hat{x} + \hat{y}$

D) $3\hat{x} - 7\hat{y}$

E) $7\hat{x} + 4\hat{y}$

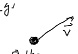
F) $7\hat{x} - 3\hat{y}$

$\vec{p}_f = \vec{p}_i + \vec{J}$

$3\hat{x} + \hat{y} = (3\hat{x} - 3\hat{y}) + (4\hat{y})$

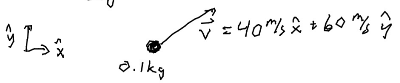
Components of momentum parallel to surface of collision remain the same.

e.g.



$\vec{v} = 40\,m/s\,\hat{x} + 60\,m/s\,\hat{y}$

e.g.



What is $\vec{v}$ 2 seconds later?

$\vec{J} = \vec{F}_{avg}\,\Delta t = (0.1\,kg)(9.8\,m/s^2)(2s) \approx 2\,Ns \downarrow$

$$\begin{aligned} \vec{p}_i &= 4\hat{x} + 6\hat{y} \ kg\,m/s \\ + \vec{J} &= \quad\ -2\hat{y} \ kg\,m/s \\ \hline \vec{p}_f &= 4\hat{x} + 4\hat{y} \ kg\,m/s \end{aligned}$$

$\vec{v}_f = 40\hat{x} + 40\hat{y}\ m/s$

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e.g. Bat hits a 0.2kg ball

$\Delta\vec{p} =$ A) -18 B) -2 C) 2 D) 18 $\frac{kg\,m}{s}$?

E) I am completely lost.

F) I am actually asleep. Shh!

$\vec{p}_i = -10\ kg\,m/s\ \hat{x}$

$\vec{p}_f = (40\hat{x})(0.2) = +8\ \frac{kg\,m}{s}\hat{x}$

$\vec{p}_f - \vec{p}_i = 8\frac{kg\,m}{s}\hat{x} - (-10\frac{kg\,m}{s}\hat{x})$

$= 18\frac{kg\,m}{s}\hat{x}$

$J = F_{avg}\,\Delta t$

$\vec{J} = 18\frac{kg\,m}{s}\hat{x}$

if $\Delta t = 10^{-3}s$, $\vec{F}_{avg} = \dfrac{18\frac{kg\,m}{s}\hat{x}}{10^{-3}s}$

$= +18{,}000\,N\,\hat{x}$

$\vec{p}_f = 0$
Δt small

$\vec{p}_f = 0$
Δt big

$\Delta\vec{p} = -\vec{p}_i$

$\vec{F}_{avg} = \dfrac{\vec{J}}{\Delta t} = \dfrac{\Delta\vec{p}}{\Delta t}$

larger Δt is, smaller F_{avg} is