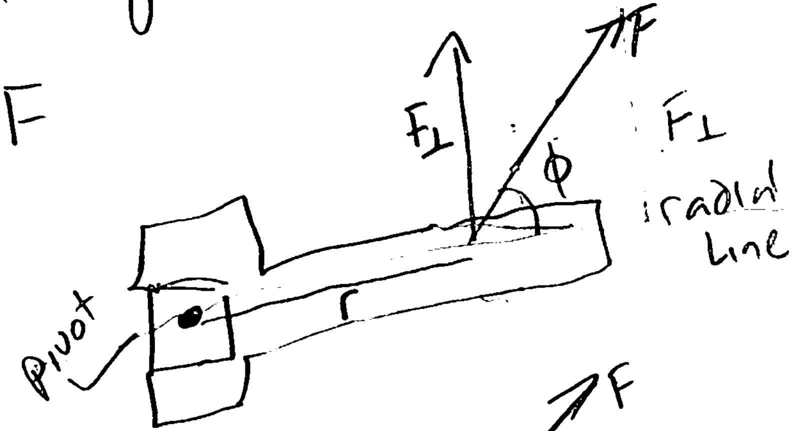
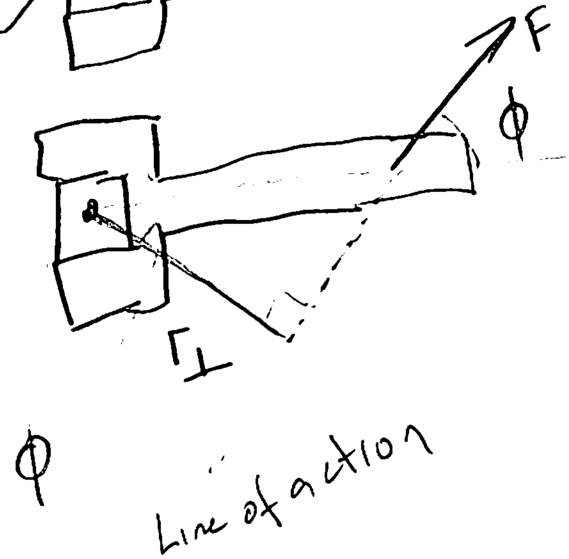
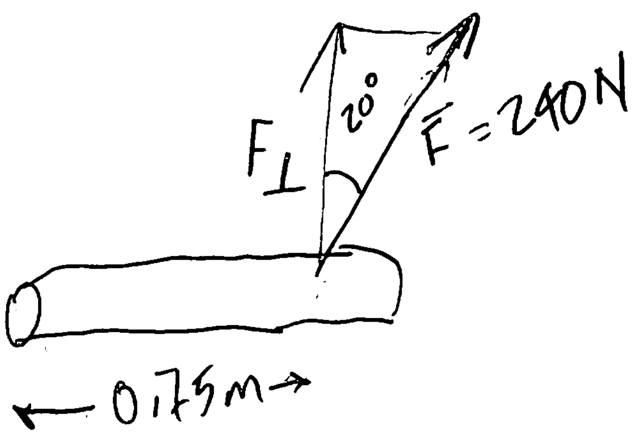
7/28/17 Phys 224 ch9 momentum

Torque is the rotational Equivalent to Force

$\tau = r F_\perp = r_\perp F$







Find the torque

$\tau = r F_\perp = 0.75m \cdot F \cdot \cos 20°\ N$

$\tau = 170\ Nm$

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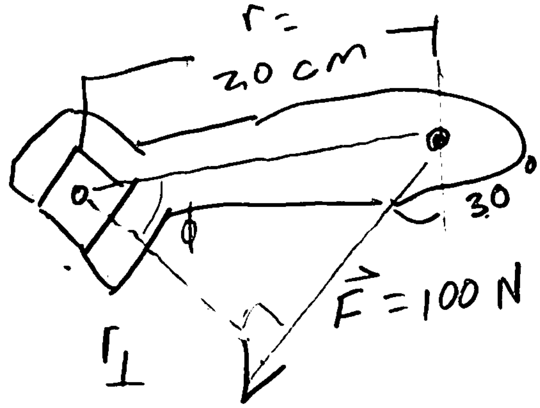
Find the torque

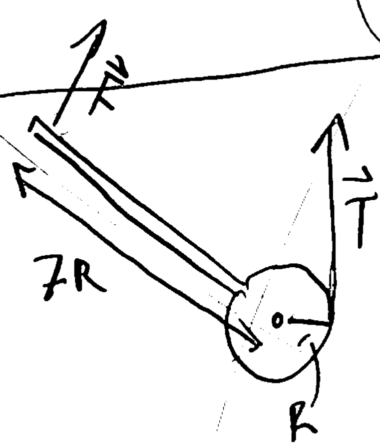


$\tau = r\cos 30 \cdot 100\,N$

$= (0.2)\cos 30(-100\,N)$

$\tau = -17\,Nm$

(The negative means clockwise)



$\vec{T} = 1500\,N$; the line tension from the anchor

How hard to push to balance the tension?

$\tau_T = RT\sin 90 = RT$

$\tau_{Sailor} = -7RF\sin 90 = -7RF$ (clockwise)

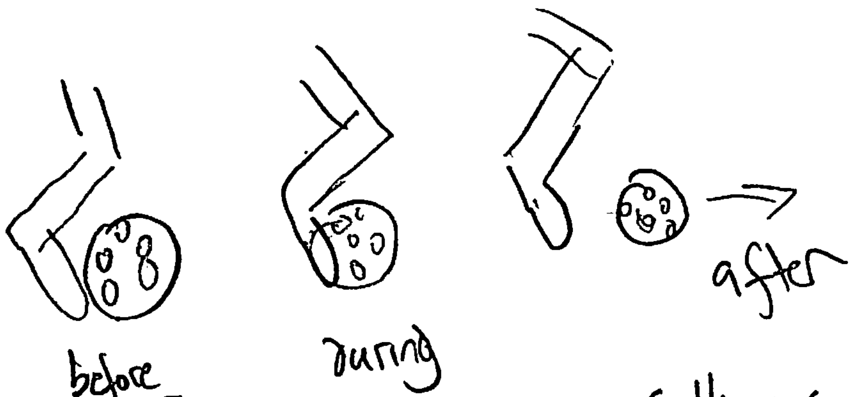
$\tau_{Net} = \emptyset = RT - 7RF =$

$7\cancel{R}F = \cancel{R}T$

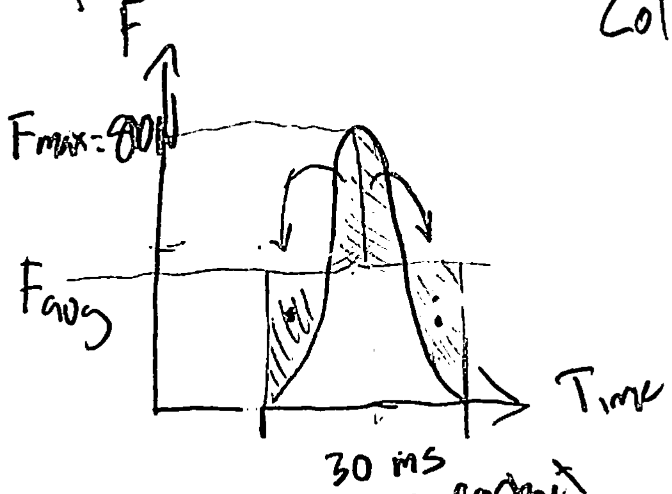
$F = \frac{T}{7} = \frac{1500}{7} = 210\,N$

Midterm

Ch9 Momentum Phys 214

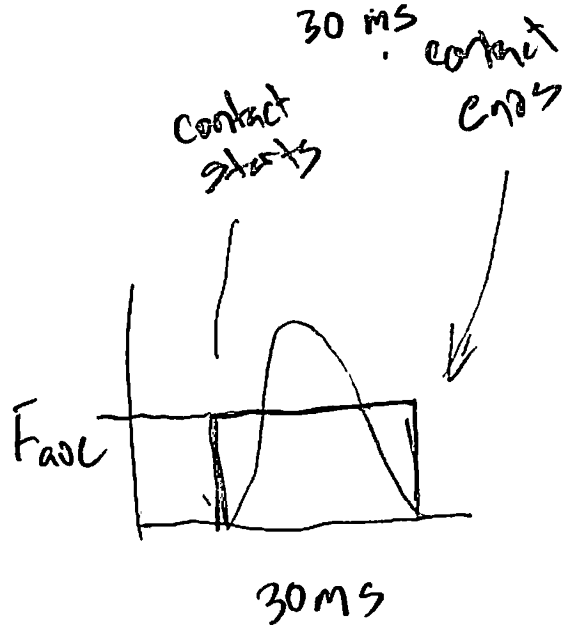


Collisions – impulse



Area under curve = J

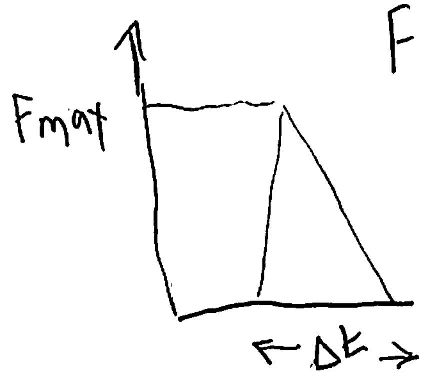
J = Impulse



J = Area under a force curve

$= F_{avg} \Delta t$

$[N \cdot s] = kg\, m/s$



$F_{max} = 800\,N$

$\Delta t = 6\,ms$

What is the impulse?

What is the F_{ave}?

$J = A_{triangle} = \frac{1}{2} bh = \frac{1}{2} \Delta t \cdot F_{max}$

$= \frac{1}{2}\, 8\,mS \cdot 300\,N$

$= 4 \cdot 10^{-3}\,sec \cdot 3 \times 10^{2}\,N$

$= 12 \times 10^{-1}\,Ns$

$J = F_{ave} \Delta t \qquad = 1.2\,Ns$

$F_{ave} = \frac{J}{\Delta t} = \frac{1.2\,Nsec}{8\,msec} \left| \frac{1000\,msec}{sec} \right| = \frac{0.3 \times 10^{3}}{2}$

$= 0.15 \times 10^{3}\,N$

$= 150\,N$

Impulse Momentum Theorum

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

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

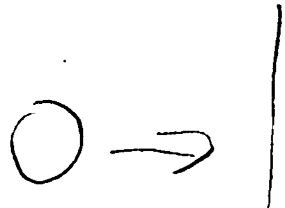
$\vec{J} = \vec{F}_{avg} \Delta t = m\vec{v}_f - m\vec{v}_i$

(Final momentum - Initial momentum)

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

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

Phys 214 momentum

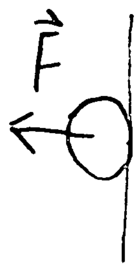


$m = 0.25\,kg$

$v_i = 1.3\,m/s$

$$\vec{P}_i = m\vec{v}_i = 0.25\,kg \cdot 1.3\,m/s$$
$$= 0.325\,kg\,m/s$$

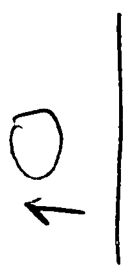
$$\vec{P}_f = 0.25\,kg \cdot -1.1\,m/s$$
$$= -0.275\,kg\,m/s$$



During

$$\Delta P = -0.275 - 0.325$$
$$= -0.6\,kg\,m/s$$

$$F_{ave}\Delta t = J = \Delta P = -0.6\,kg\,m/s$$
$$= -0.6\,N \cdot s$$



$v_f = 1.1\,m/s$

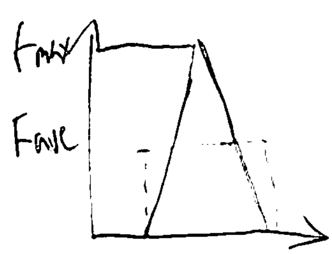
Find Avg F & max F the bat exerts on the ball

Baseball

$m = 150\,g$

$v_i = 20\,m/s$

$v_f = -40\,m/s$



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

$mv_f - mv_i$ = Area under the force curve $= \frac{1}{2}bh = \frac{1}{2}\Delta t\,F_{max} = \frac{1}{2}(0.6sec)F$

$0.15\,kg \cdot -40\,m/s - (0.15\,kg \cdot 20\,m/s) =$

$-6 + -3\,kg\,m/s = 0.3\,msec\,F_{max} = 3\times10^{-4}\,sec\,F_{max}$

$$-9\,kg\,m/s = 3\times10^{-4}\,sec \cdot F_{max}$$

$$\frac{-9\,kg\,m/sec}{3\times10^{-4}\,sec} = F_{max}$$

$$-3\times10^{4}\,N = F_{max}$$

$$-30{,}000\,N = F_{max}$$

$$F_{ave} = \frac{J}{\Delta t} = \frac{-9\,kg\,m/sec}{6\times10^{-4}\,sec}$$

$$F_{avg} = -1.5\times10^{4}\,N$$

$$F_{avg} = -15{,}000\,N$$

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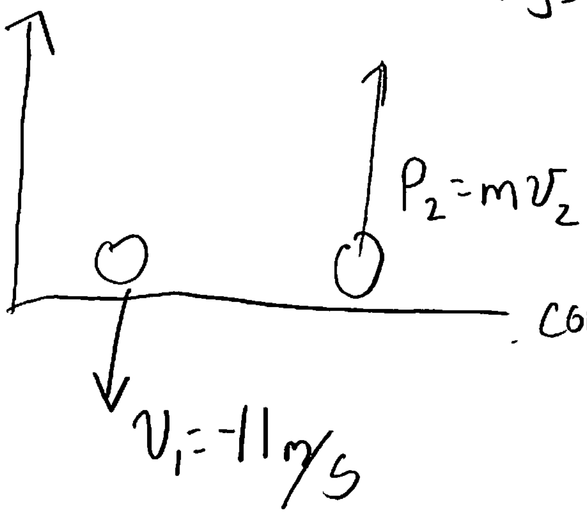
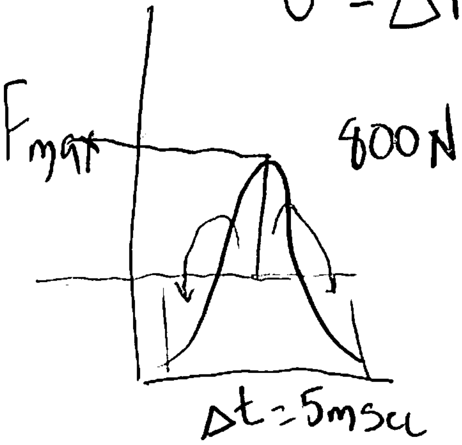
momentum

Ball w/ $m = 0.1\,Kg$

Find height when $\vec{v} = \emptyset$ or max height



$$J = \Delta P = P_2 - P_1 \Rightarrow P_2 = J + P_1$$



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

$$J \simeq 400\,N \cdot 5\times10^{-3}\,sec$$

$$J = 2\,N\,sec$$

$$P_2 = 2\,N\,sec + 0.1\,Kg(-11\,m/s)$$

$$= 2\,Kg\,m/s - 1.1\,Kg\,m/s$$

$$P_2 = 0.9\,Kg\,m/s$$

$$P_2 = v m \Rightarrow v_2 = \frac{P_2}{m} = \frac{0.9\,Kg\,m/s}{0.1\,Kg}$$

$$v_2 = 9\,m/s$$

$$v_f^2 = v_i^2 - 2g\Delta y$$

$$\emptyset = (9\,m/s)^2 - 2(9.81)\Delta y$$

$$\emptyset = 81\,m^2/s^2 - 19.62\,\frac{m}{sec^2}\Delta y$$

$\underline{\Delta y = 4\,m}$

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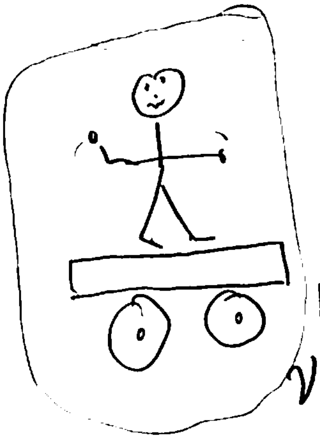
For Isolated System
momentum is conserved

$$\vec{P}_f = \vec{P}_i$$

Dylan mass = 75 kg
$v_i = 4$ m/s



m = 25 kg
$v_i = 0$ m/s

Does Dylan get away by jumping on the cart?

$$\vec{P}_f = \vec{P}_i = 75\,\text{kg} \cdot 4\,\text{m/s} + 25\,\text{kg} \cdot 0\,\text{m/s}$$

$$\vec{P}_f = 300\,\text{kg m/s}$$

$$P_f = m v_f$$

$$v_f = \frac{P_f}{m} = \frac{300\,\text{kg m/s}}{100\,\text{kg}}$$

$$\underline{\underline{v_f = 3\,\text{m/s}}}$$

$$4.5 \times 10^4 \, kg \frac{m}{s} = 4 \times 10^4 \, kg \cdot v$$

$$\frac{4.5}{4} \, m/s = v$$

$$\underline{1.1 \, m/s = v} \text{ to the Left}$$

Momentum is conserved
is an alternative way
to describe Newtons first law
Objects in motion ....
unless ...

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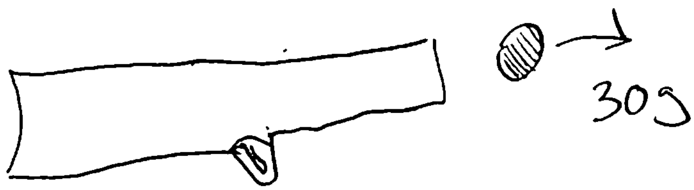
$v = 15\ m/s$



1.2 kg toy rifle

$P_{rifle} = P_{ball}$

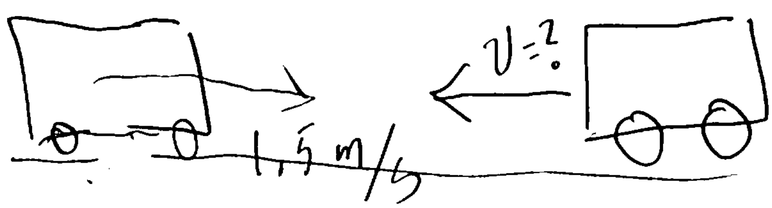
$\leftarrow v_{recoil} = ?$

$1200g\, v_{recoil} = 30g\ 15\ m/s$

$v_{recoil} = \frac{30 \cdot 15}{1200}$

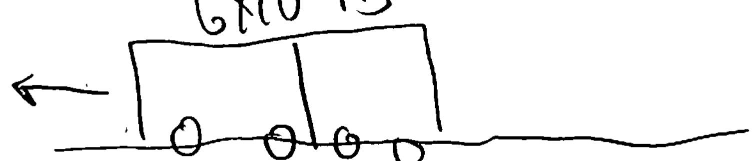
$$\underline{\underline{v_{recoil} = 0.38\ m/s}}$$

$2 \times 10^4\ kg$ $\qquad$ $4 \times 10^4\ kg$



Before

$6 \times 10^4\ kg$



$-0.25\ m/s$

Find v_i heavy car

$\vec{P_f} = P_i$

$-0.25\ m/s \cdot 6 \times 10^4\ kg = 2 \times 10^4\ kg \cdot 1.5\ m/s - v \cdot 4 \times 10^4\ kg$

$-1.5 \times 10^4\ kg\, m/s = 3 \times 10^4\ kg\, m/s - 4 \times 10^4\ kg\, v$