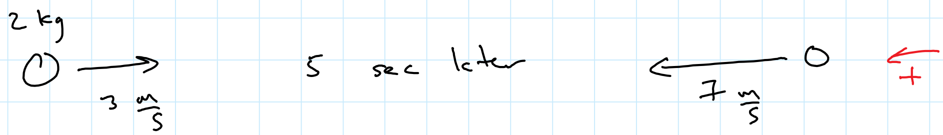
Phy 2A 5/31

Wednesday, May 31, 2017 9:59 AM

Goals for the Lecture:

1) Solve problems requiring both energy and momentum – know how to split the problem and when to use energy and when to use momentum
2) Solve 2-D collision problems using momentum
3) Understand Center of Mass and use it to solve problems

worksheet p. 79



A) $\Delta p = (2)(3+7) = 20 \text{ kg} \frac{m}{s}$ good!

B) $\cancel{\Delta v = 4 \frac{m}{s}}$, so $\Delta p = (2)(4) = 8 \text{ kg} \frac{m}{s}$ $\Delta v = 7-(-3) = 10$

C) $\Delta p = 8 \text{ kg} \frac{m}{s}$ so, $\cancel{I = \frac{\Delta p}{t}} = \frac{8}{5} \text{ kg} \frac{m}{s}$ $\frac{\Delta p}{t} = F_{Ave}$

D) $I = Ft$ yes Need force to find Impulse

No → other ways to find Impulse also

$I = \Delta p$

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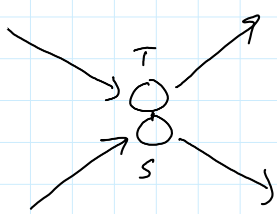
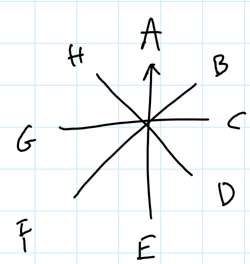
p. 81





Find direction of:

a) $(\vec{P}_i)_T$ D

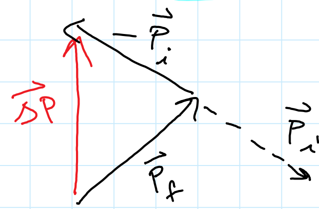
b) $(\vec{P}_f)_T$ B

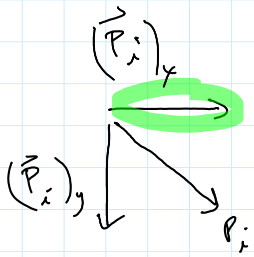
c) $(\Delta\vec{P})_T$ same direction as F on T ↑ A

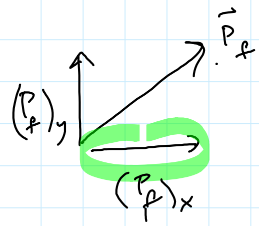
c) $(\Delta\vec{p})_T$ same direction as F on T $\uparrow$ A

or

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







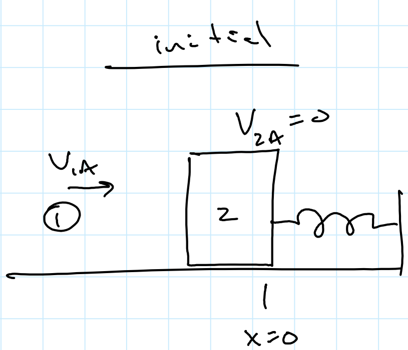
p_x does Not change

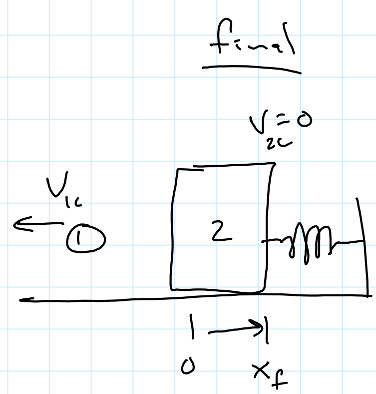
d) $(\Delta\vec{p})_S$ E

e) $\vec{I}_T$ A

f) $\vec{I}_S$ E

Problem





Find: x_f (distance spring is compressed)

given: $m_1 = 0.8$ kg

$M_2 = 1.2$ kg

$V_{1A} = 6 \ \frac{m}{s}$

$V_{2A} = 0$

$V_{1C} = \frac{1}{2} V_{1A}$

$V_{2C} = 0$

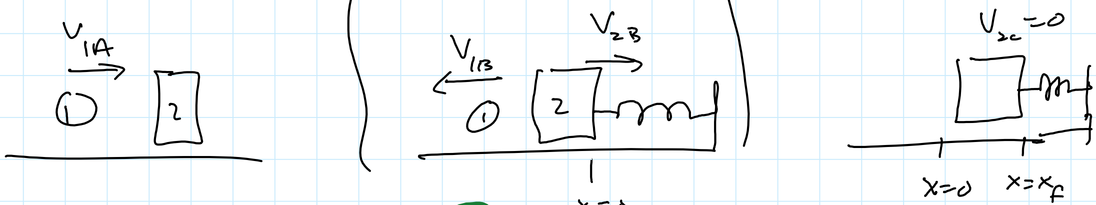
$k = 500 \ \frac{N}{m}$

$\mu_k = 0.2$

can't go from initial to final with Energy or Momentum → so, break it into smaller problems.

Make a timeline:

Just before collision Ⓐ | Just after collision Ⓑ | Later Ⓒ



use momentum

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

use energy

$E_B + W_{friction} = E_C$

$\vec{P}_A = \vec{P}_B \quad \rightarrow +$

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

$m_1 V_{1A} + 0 = m_1 V_{1B} + m_2 V_{2B}$

$(0.8)(6) + 0 = (0.8)(-3) + (1.2)(V_{2B})$

bounces back
Negative Velocity

$$V_{2B} = 6 \ \frac{m}{s}$$

$$E_B + W_{friction} = E_c$$

$$K_B + \cancel{(U_{sp})_B}^{\,0} - \mu_K m g x_f = \cancel{K_c}^{\,0} + (U_{sp})_c$$

$$\frac{1}{2} m_2 V_{2B}^2 + 0 - (0.2)(1.2)(9.8)\, x_f = 0 + \frac{1}{2} k x_f^2$$

$$\frac{1}{2}(1.2)(6)^2 - (0.2)(1.2)(9.8)\, x_f = \frac{1}{2}(500)\, x_f^2$$

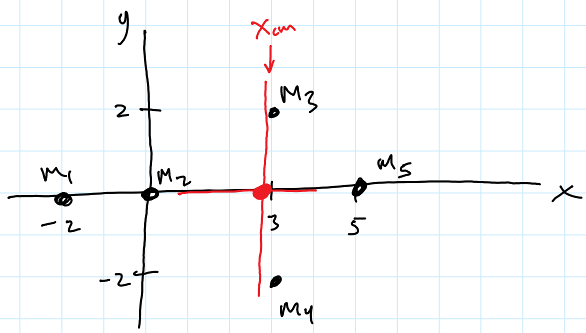
$$250 x_f^2 + 2.35 x_f - 21.6 = 0$$

$$x_f \begin{cases} -0.299 \\ 0.289 \end{cases}$$

$$x_f = 0.289 \ m$$

Center of Mass

Find center of mass of these 5 masses:



$m_1 = 1$ kg

$m_2 = 2$ kg

$m_3 = 3$ kg

$m_4 = 3$ kg

$m_5 = 5$ kg

$$X_{cm} = \frac{\Sigma m_i x_i}{\Sigma m_i} = \frac{m_1 x_1 + m_2 x_2 + m_3 x_3 + m_4 x_4 + m_5 x_5}{m_1 + m_2 + m_3 + m_4 + m_5}$$

$$= \frac{(1\text{ kg})(-2\text{ m}) + (2)(0) + (3)(3) + (3)(3) + (5)(5)}{1 + 2 + 3 + 3 + 5}$$

$$1+2+3+3+5$$

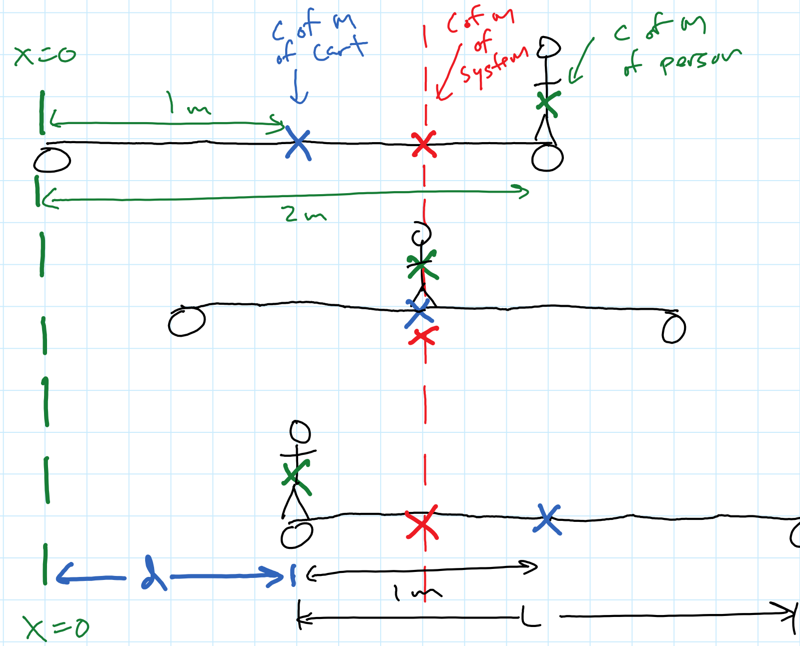
$$= \frac{-2+0+9+9+25}{14}$$

$$= \frac{41}{14} = 2.93 \text{ m}$$

$$y_{cm} = \frac{\sum m_i y_i}{\sum m_i} = \frac{m_1 y_1 + m_2 y_2 + m_3 y_3 + m_4 y_4 + m_5 y_5}{m_1 + m_2 + m_3 + m_4 + m_5}$$

$$= \frac{(1\text{ kg})(0) + (2)(0) + (3)(+2) + (3)(-2) + (5)(0)}{1+2+3+3+5}$$

$$= 0$$



if person and cart are about the same mass

How much does the cart move to the right when the person walks across it? (Find d)

$L = 2$ m

$m_c = 75$ kg

$m_p = 60$ kg

$m_p = 60 \text{ kg}$

Find $(X_{cm})_{initial}$ and $(X_{cm})_{final}$ and set them equal to each other $(X_{cm})_i = (X_{cm})_f$

because c of m of system did not move.

$$(X_{cm})_i = \frac{\Sigma m_i x_i}{\Sigma m_i} = \frac{m_{person} X_{person} + m_{cart} X_{cart}}{m_p + m_c}$$

$$= \frac{(60)(2 \text{ m}) + (75)(1 \text{ m})}{60 + 75}$$

$$= \frac{120 + 75}{135} = 1.44 \text{ m}$$

$$(X_{cm})_f = \frac{m_p X_p + m_c X_c}{m_p + m_c} = \frac{(60)(d) + (75)(d+1)}{60 + 75}$$

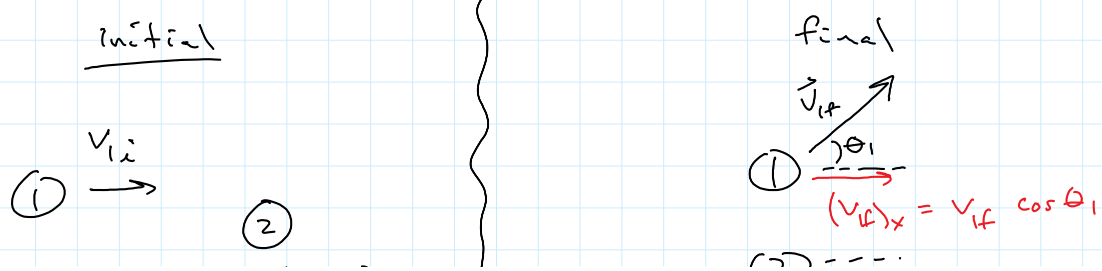
$$(X_{cm})_i = (X_{cm})_f$$

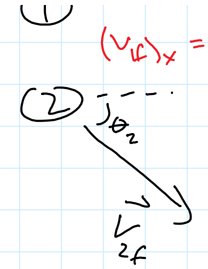
$$1.44 = \frac{60 d + 75 d + 75}{135}$$

$$119.4 = 135 d$$

$$d = 0.88 \text{ m}$$

2-D momentum





$(v_{1f})_x = v_{1f} \cos\theta_1$

$$\vec{P}_i = \vec{P}_f \quad \text{use components!}$$

$P_{ix} = P_{fx} \quad \rightarrow +$

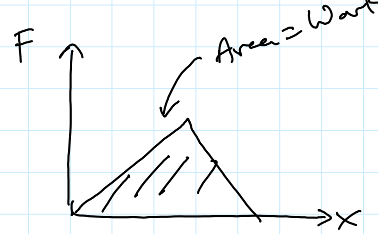
$P_{iy} = P_{fy} \quad \uparrow +$

Like 2 1-D momentum problems

$$m_1 (v_{1i})_x + m_2 (v_{2i})_x = m_1 \underbrace{(v_{1f})_x}_{(v_{1f})\cos\theta_1} + m_2 \underbrace{(v_{2f})_x}_{(v_{2f})\cos\theta_2}$$

Work - KE

$W = \vec{F} \cdot \Delta\vec{x} = \Delta K$



Impulse - P

$\vec{I} = \vec{F}_{ave}\, t = \Delta\vec{P}$

$$E_i + W_{friction} + W_{ext} = E_f$$

E_i: K, U_g, U_{sp}