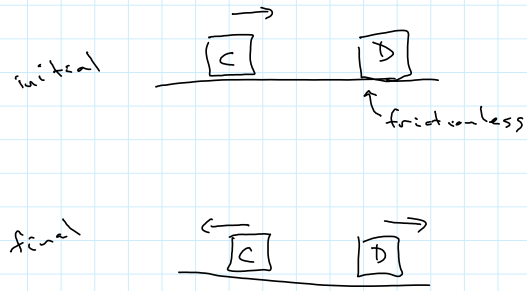
Phy 4A 11/2

Wednesday, November 2, 2016 9:35 AM

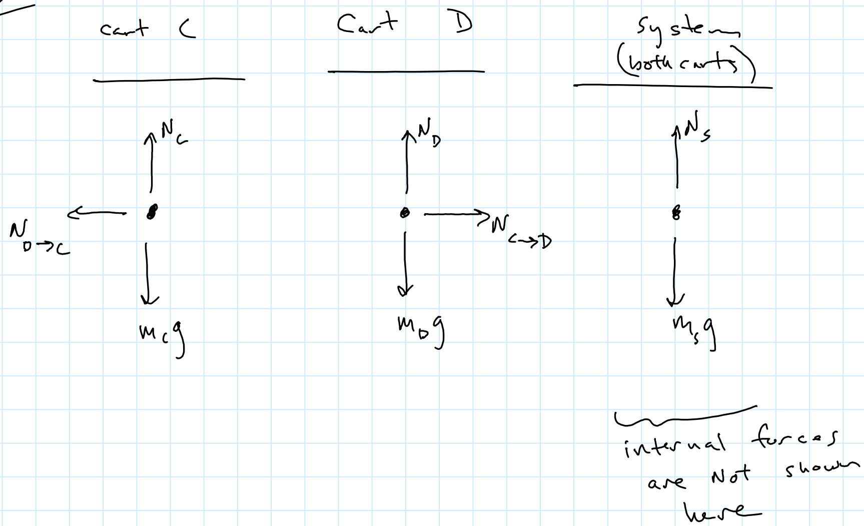
Goals for the Lecture:

1) Use the Impulse – Momentum Theorem to solve problems
2) Use Conservation of Momentum to solve problems

worksheet p.76



1) FBD



2)
$$\vec{P}_{sys} = \vec{P}_C + \vec{P}_D$$

$$\Delta \vec{P}_{sys} = \underbrace{\Delta \vec{P}_C + \Delta \vec{P}_D}_{\text{equal and opposite}}$$

$$\Delta P = F t$$

$$\Delta \vec{P}_{sys} = 0$$

P_C : yes $\quad (\vec{F}_{net})_C \neq 0$

P_D : yes $\quad (\vec{F}_{net})_D \neq 0$

P_{sys} : No $\quad (\vec{F}_{net})_{sys} = 0$

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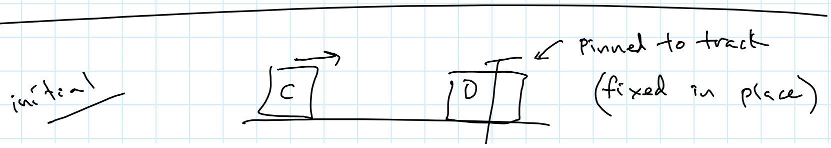
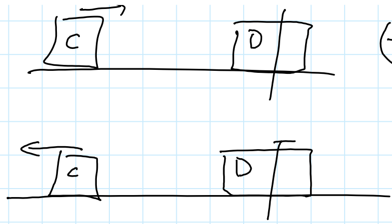
p.77 3) 1)



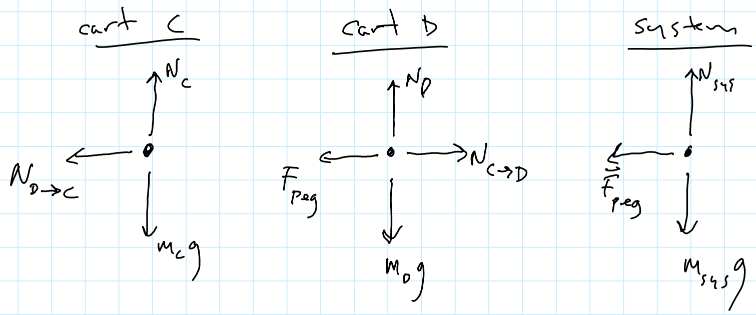
p. 77 3) 1)

initial

final



(fixed in place)



P_C : yes $\qquad (\vec{F}_{Net})_C \neq 0$

P_D : No $\qquad (\vec{F}_{Net})_D = 0$

P_{sys} : yes $\qquad (\vec{F}_{Net})_{sys} \neq 0$

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

$$\vec{a} = \frac{d\vec{v}}{dt}$$

$$\sum \vec{F} = m\frac{d\vec{v}}{dt}$$

$$= \frac{d(m\vec{v})}{dt} \quad \text{if } m \text{ is constant}$$

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

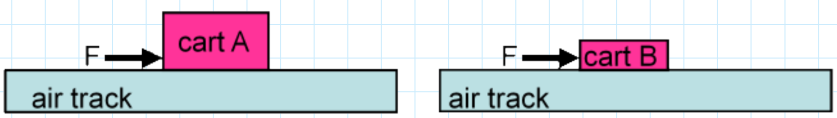
if $\Sigma F = 0$ $\qquad \vec{p} = $ constant

A constant force is exerted on a cart that is initially at rest on a frictionless air track. The force acts for a short time interval and gives the cart a final speed. To reach the same speed using a force that is half as big, the force must be exerted for a time interval that is

$F_1 t_1 = F_2 t_2$

1. Four times as long.
2. Twice as long.
3. The same length.
4. Half as long.
5. A quarter as long.

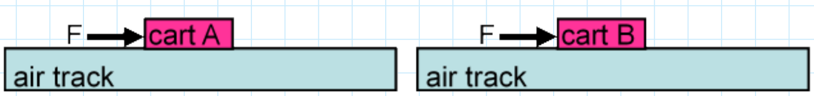
Two carts—A and B—on frictionless air tracks are initially at rest. Cart A is twice as massive as cart B. Now you exert the same constant force on both carts for 1 second. One second later, the momentum of cart A is:



$\Delta p = F t$

1. Twice the momentum of cart B
2. The same as the momentum of cart B
3. Half the momentum of cart B
4. Not enough information to determine

Two identical carts, A and B, initially are moving on frictionless air tracks. The initial speed of cart A is twice as that of cart B. You then exert the same constant force on the two carts over 1 second. One second later, the change in momentum of cart A is:



$\Delta p = F t$

1. Non-zero and twice the change in momentum of cart B
2. Non-zero and the same as the change in momentum of cart B
3. Zero.
4. Non-zero and half the change in momentum of cart B
5. Not enough information to determine

Find the momentum of the ball:

Don't forget direction

1) 8 kg, $\longrightarrow$ $3\ \frac{m}{s}$ $\qquad \vec{p} = m\vec{v} = 24\ kg\frac{m}{s} \rightarrow$

2) 2 kg, $\longleftarrow$ $7\ \frac{m}{s}$ $\qquad \vec{p} = 14\ kg\frac{m}{s} \leftarrow$

Find the change in momentum:

	initial	final	$\Delta\vec{p} = \vec{p}_f - \vec{p}_i$
1) 2 kg	$\longrightarrow 3\ \frac{m}{s}$	$\longrightarrow 5\ \frac{m}{s}$	$\Delta\vec{p}$, $-\vec{p}_i$, $\vec{p}_f$; $\Delta\vec{p} = 4\ kg\frac{m}{s} \rightarrow$; $\rightarrow +$ $(2)(5) - (2)(3) = 4\ kg\frac{m}{s}$
2) 2 kg	$\longrightarrow 3\ \frac{m}{s}$	$v = 0$	$\Delta\vec{p}$, $-\vec{p}_i$, $p_f = 0$; $\Delta p = 6\ kg\frac{m}{s} \leftarrow$
3) 2 kg	$\longrightarrow 3\ \frac{m}{s}$	$\longleftarrow 3\ \frac{m}{s}$	$\Delta\vec{p} = 12\ kg\frac{m}{s}$ to the left ; $-\vec{p}_i$, $\vec{p}_f$
4) 2 kg	$\longrightarrow 3\ \frac{m}{s}$	$\downarrow 3\ \frac{m}{s}$	$\Delta\vec{p}$, $\vec{p}_f$, $-p_i$; $\Delta p = \sqrt{6^2 + 6^2} = 6\sqrt{2}\ kg\frac{m}{s} \swarrow$

What is the direction of the impulse:

	initial	final	Impulse
1)	$\longrightarrow 3\ \frac{m}{s}$	$\longleftarrow 7\ \frac{m}{s}$	$\longleftarrow$
2)	$\longrightarrow 3\ \frac{m}{s}$	$\uparrow 4\ \frac{m}{s}$	$\vec{I}$, I_y, I_x

Application of the Day: Impulse - Momentum
Car crashes – air bags, crumple zones, sand/water barriers

Cushioned running shoes, basketball court floors that "give"

Bungee Jumping

Case for your phone

Collision:

1) 1 object becomes multiple objects (blows-up) $KE_i \neq KE_f$

2) when multiple objects become one (stick together) $KE_i \neq KE_f$

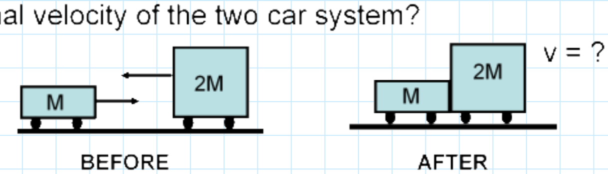
3) Objects bounce off each other

$KE_i \; ? \; KE_f$

may be the same (Elastic)

may be different (Inelastic)

A car with a mass M is moving toward another car with a mass 2 M on a frictionless surface. Both cars have a speed of 10 m/s. Subsequently, they collide and stick together. What is the final velocity of the two car system?



1. 0 m/s
2. +3.3 m/s
3. -3.3 m/s
4. +5.0 m/s

+x

$\vec{P}_i = \vec{P}_f \quad \rightarrow +$

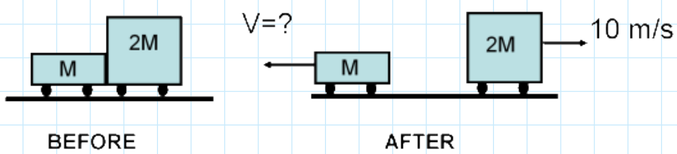
2. +3.3 m/s
3. $\boxed{\text{3.}}$ -3.3 m/s
4. +5.0 m/s
5. -5.0 m/s
6. +10 m/s
7. -10 m/s
8. None of the above

$$(P_M)_i + (P_{2M})_i = (P_{M+2M})_f$$

$$10M - 10(2M) = (3M)\, V_f$$

$$V_f = -\frac{10}{3}$$

Two cars initially at rest on a frictionless surface are blown apart by an explosion. The one with twice the mass ends up moving to the right at 10 meters/second. The less massive car ends up moving to the left at what speed?



1. 5 m/s
2. 7 m/s
3. 10 m/s
4. 14 m/s
5. 15 m/s
6. $\boxed{\text{6. 20 m/s}}$
7. 25 m/s

+x

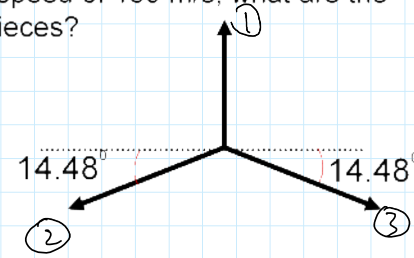
$$\vec{P}_i = \vec{P}_f$$

$$0 = P_m + P_{2m} \quad \rightarrow +$$

$$0 = m V_f + (2m)(10)$$

$$V_f = -20 \ \frac{m}{s}$$

A rocket ship parked at rest in space suddenly explodes into 3 ***equal-mass*** pieces traveling in the directions shown. If the piece traveling upward has a speed of 150 m/s, what are the speeds of the two other two pieces?



1. Both are at 150 m/s
2. $\boxed{\text{2.}}$ Both are at 300 m/s
3. Both are at 600 m/s
4. Both are at 900 m/s
5. Both are at 1200 m/s
6. Both are at 1500 m/s
7. They each have different speeds
8. None of the Above

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

$$(P_i)_x = (P_f)_x \quad \rightarrow +$$

$$0 = P_{1x} + P_{2x} + P_{3x}$$

$$= 0 - \cancel{M} V_2 \cancel{\cos 14.48^\circ} + \cancel{M} V_3 \cancel{\cos 14.48^\circ}$$

$$V_2 = V_3$$

$$(P_i)_y = (P_f)_y$$

$$0 = \cancel{M}\, 150 - 2 \cancel{m} V \sin 14.48^\circ$$

6. Both are at 1500 m/s
7. They each have different speeds
8. None of the Above

$$(p_i)_x = (p_f)_x \quad \rightarrow +$$

$$0 = P_{1x} + P_{2x} + P_{3x}$$

$$= 0 - \cancel{M} V_2 \cancel{\cos 14.48°} + \cancel{M} V_3 \cancel{\cos 14.48°}$$

$$V_2 = V_3$$

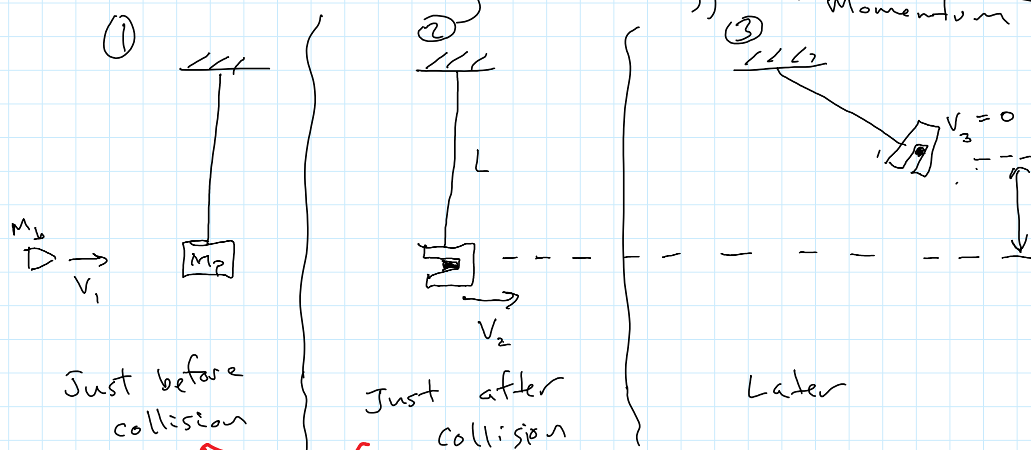
$$(P_i)_y = (P_f)_y$$

$$0 = \cancel{M}\, 150 - 2 \cancel{m} V \sin 14.48°$$

$$\frac{75}{\sin 14.48} = V$$

$$V \simeq 300$$

Ballistic Pendulum: Problems involving both Energy and Momentum



2 → 1 using momentum

3 → 2 using Energy

given: m_b, m_p, h, L

find: V_1 (speed of bullet)

3 → 2

$$E_3 = E_2$$

$$(U_g)_3 = (K)_2$$

$$\cancel{(M_b + M_p)}\, g h = \frac{1}{2} \cancel{(m_b + m_p)} V_2^2$$

$$V_2 = \sqrt{2gh}$$

2 → 1

$$\vec{P}_1 = \vec{P}_2 \quad \rightarrow +$$

$$(\vec{P}_1)_b + \cancel{(\vec{P}_1)_p}^{\,0} = (\vec{P}_2)_{b+p}$$

$$m_b V_1 = (m_b + m_p) V_2$$

$$V_1 = \left(\frac{m_b + m_p}{m_b}\right) \sqrt{2gh}$$