Oliver has a mass of 66.6kg and can throw a 483.0g rock with a speed of 13.8m/s. What would Oliver's recoil speed be if he were on an icy surface?

Submit Answer Tries 0/10

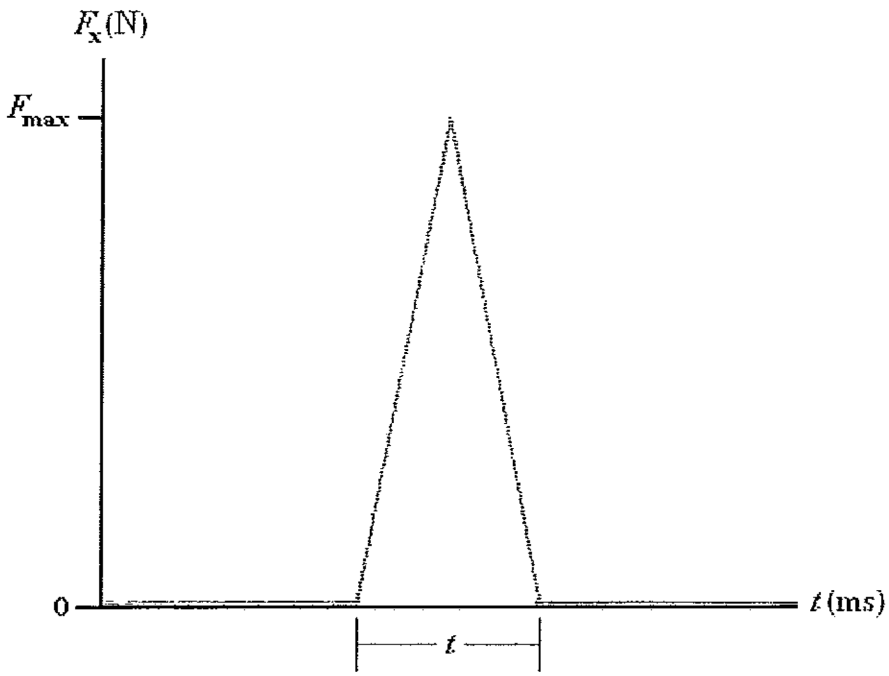
A 291.0g bird flying along at 6.35m/s sees a 9.52g insect heading straight toward it with a speed of 37.9m/s. The bird opens its mouth wide and enjoys a nice lunch. What is the bird's speed immediately after swallowing?

Submit Answer Tries 0/10

Three identical train cars, coupled together, are rolling east at 3.83m/s. A fourth car travelling east at 5.01m/s catches up with the three and couples to make a four-car train. A moment later, the train cars hit a fifth car that was at rest on the tracks, and it couples to make a five-car train. All 5 cars are identical. What is the speed of the five-car train?

Submit Answer Tries 0/10

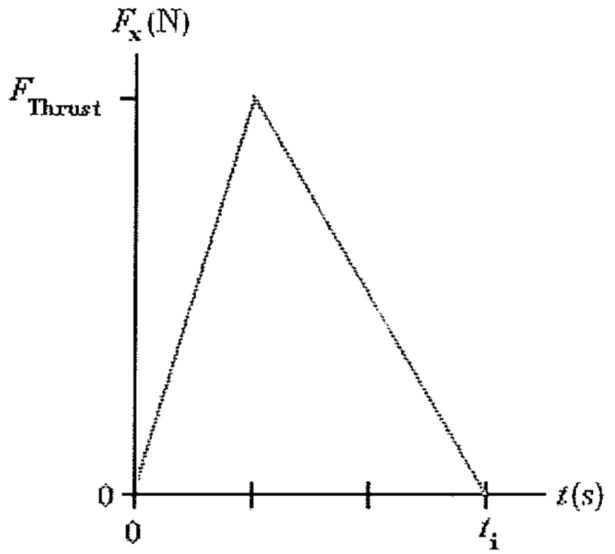
A 118.0g ball is dropped from a height of 2.35m, bounces on a hard floor, and rebounds to a height of 1.46m. The impulse received from the floor is shown below.



What maximum force does the floor exert on the ball if it is exerted for 2.00ms?

Submit Answer Tries 0/10

Far in space, where gravity is negligible, a 403.3kg rocket travelling at 81.3m/s fires its engines. The thrust force is shown as a function of time below. The mass lost by the rocket during the t_i=120.0s is negligible.



What impulse does the engine impart to the rocket if the maximum thrust force is 1275.0N?

Submit Answer Tries 0/10

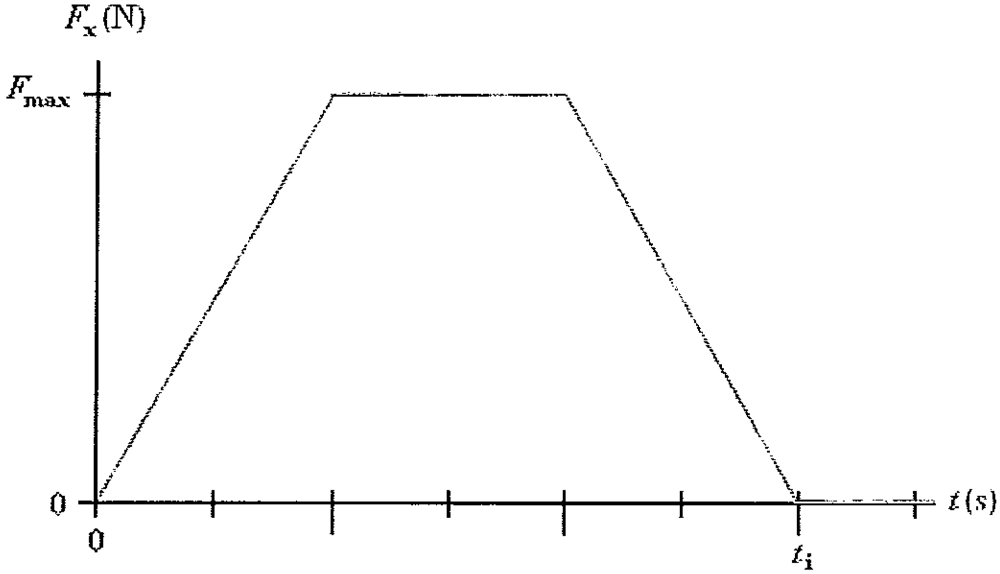
At what time does the rocket reach its maximum speed?

Submit Answer Tries 0/10

What is the maximum speed of the rocket?

Submit Answer Tries 0/10

A 54.7g tennis ball with an initial speed of 26.7m/s hits a wall and rebounds with the same speed. The figure below shows the force of the wall on the ball during the collision. What is the value of F_{max}, the maximum value of the contact force during the collision, if the force is applied for t_i=42.9ms?



Submit Answer Tries 0/10

At the center of a 48.0m diameter circular ice rink, a 71.2kg skater travelling north at 1.09m/s collides with and holds onto a 56.1kg skater who had been heading west at 4.99m/s. How long will it take them to glide to the edge of the rink?

Submit Answer Tries 0/10

Where will they reach it? Give your answer as an angle north of west.

Submit Answer Tries 0/10

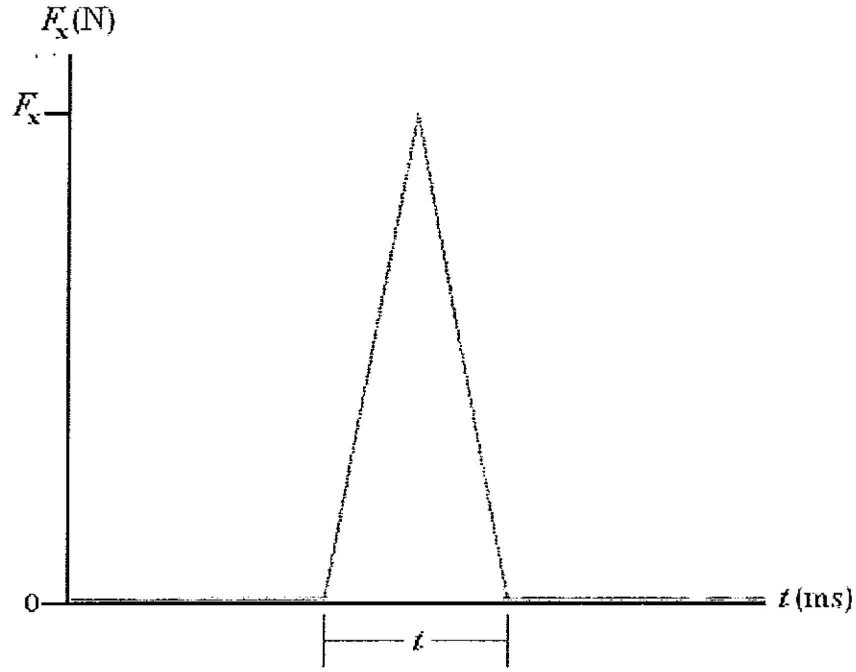
Jennifer (mass 47.0kg) is standing at the left end of a 15.0m long 479.0kg cart that has frictionless wheels and rolls on a frictionless track. Initially both Jennifer and the cart are at rest. Suddenly, Jennifer starts running along the cart at a speed of 2.40m/s relative to the cart. How far will Jennifer have run relative to the ground when she reaches the right end of the cart?

Submit Answer Tries 0/10

A 13.15g bullet is fired into a 51.1kg wood block that is at rest on a wood table. The block, with the bullet embedded, slides 5.01cm across the table. The coefficient of kinetic friction of the block on the table is 0.295. What was the speed of the bullet?

Submit Answer Tries 0/10

A 534.0g cart is released from rest 1.50m from the bottom of a frictionless, 30.0° ramp. The cart rolls down the ramp and undergoes a collision with a rubber block at the bottom. The force during the collision is shown below.



After the cart bounces, how far does it roll back up the ramp if the collision takes place over t = 20.9ms and the maximum force applied is F_x = 313.0N ?

Submit Answer Tries 0/10

A 2236.0kg truck is travelling east through an intersection at 4.50m/s when it is hit simultaneously from the side and the rear. (Some people have all the luck!) One car is a 1218.0kg compact travelling north at 5.20m/s. The other is a 1548.0kg midsize travelling east at 9.00m/s. The three vehicles become entangled and slide as one body. What is their speed just after the collision?

Submit Answer Tries 0/10

A firecracker in a cocunut blows the cocunut into three pieces. Two pieces of equal mass fly off south and west, perpendicular to each other, at 28.6m/s. The third piece has 7 times the mass as the other two. What is the speed of the third piece?

Submit Answer Tries 0/10

A 41.0g ball of clay travelling east at 6.80m/s collides with a 64.0g ball of clay travlleing 35.0° south of west at 1.10m/s. What is the speed of the resulting blob of clay?

Submit Answer Tries 0/10

Submit All

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Phys 1A03 CAPA #5.

Just a note on Q #1: This question is not entirely clear and for this reason we would accept both answers as being correct. However, it is useful to see how the two approaches differ.

Method #1 Lets assume that Oliver throws with a speed of 13.8 m/s relative to the ground.

$$\Rightarrow \vec{p}_i = \vec{p}_f \qquad p_i = 0 \quad \therefore p_f = 0$$

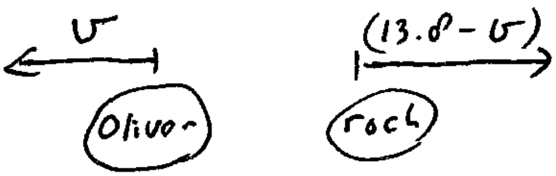
and $m_1 v_1 = m_2 v_2$

$$(66.6)(v_1) = (0.483)(13.8) \quad \Rightarrow v = 0.10 \text{ m/s}$$

Method #2 What if Oliver throws with a speed of 13.8 m/s relative to himself? In other words the rock leaves his body with a speed of 13.8 m/s.

$$p_i = 0 = p_f = \underbrace{(-v)(m_{Oliver}) + (13.8 - v)(m_{rock}) = 0}$$

$\hookrightarrow$ solve $\Rightarrow$ $v = 0.099$ m/s



Note: the only reason these two methods give the same result is because the rock is so light compared to Oliver.

Physics 1A03
Assignment 5

1. $m_1 v_1 = m_2 v_2$
$(66.6kg)v_1 = (0.483kg)(13.8m/s)$
$v_1 = 0.10m/s$

2. $m_{bird} v_{bird} - m_{bug} v_{bug} = (m_{bird} + m_{bug}) v_f$

$$v_f = \frac{m_{bird} v_{bird} - m_{bug} v_{bus}}{(m_{bird} + m_{bug})}$$

$$= \frac{(0.291kg)(6.\cancel{35}m/s) - (0.00952kg)(37.9m/s)}{0.291kg + 0.00952kg}$$

$= 4.95m/s$

3. first we need to find the speed of the 4-car train
m = mass of 1 train car
v_1 = speed of 3-car train = 3.83 m/s
v_2 = speed of 4th car = 5.01 m/s
v_3 = speed of 4-car train = ?

$3\cancel{m}v_1 + \cancel{m}v_2 = 4\cancel{m}v_3$
$4v_3 = 3(3.83m/s) + 5.01m/s$
$= \cancel{\quad} 16.5m/s$

v_4 = initial speed of 5th car = 0
v_5 = speed of 5-car train

$4\cancel{m}v_3 + \cancel{m}v_4 = 5\cancel{m}v_5$
$4v_3 + 0 = 5v_5$

$$v_5 = \frac{4v_3}{5}$$

$$= \frac{16.5m/s}{5}$$

$= 3.3m/s$

4. $m = 0.118\,kg$ $\quad$ $t = 2.0\,ms = 0.002\,s$ $\quad$ $a = -9.8\,m/s^2$

$h_1 = 2.35\,m$ $\quad$ $h_2 = 1.46\,m$ $\quad$ $\uparrow +$

$v_1 = ?$ $\quad$ $v_2 = ?$

note: v_1 and v_2 are the speeds of the ball just before and after impact. the ball starts and ends at $v_i = v_f = 0\,m/s$.

$$v_1^2 = v_i^2 + 2a\Delta h$$
$$= (0\,m/s)^2 + 2(-9.8\,m/s^2)(-2.35\,m)$$
$$v_1 = 6.77\,m/s \text{ \underline{downwards}}$$

$$v_f^2 = v_2^2 + 2a\Delta h$$
$$0 = v_2^2 + 2(-9.8\,m/s^2)(1.46\,m)$$
$$v_2^2 = 2(9.8)(1.46)$$
$$v_2 = 5.35\,m/s \text{ \underline{upwards}}$$

$$\Delta p = p_f - p_i$$
$$= mv_2 - mv_1$$
$$= m(v_2 - v_1)$$
$$= (0.118\,kg)(5.35\,m/s - (-6.77\,m/s))$$
$$= 1.43\,kg\cdot m/s$$

$$\Delta p = J = \tfrac{1}{2} F_{max} \Delta t$$

$$F_{max} = \frac{2\Delta p}{\Delta t}$$
$$= \frac{2(1.43)}{0.002\,s}$$
$$= 1430\,N$$

5. a) $I = \frac{t \cdot F_{max}}{2}$

$= \frac{(120s)(1275.0N)}{2}$

$= 7.65 \times 10^4 \ N \cdot s$

b) since force is always positive, a is always positive, meaning that the maximum speed is reached at the end of the time interval.

$t = 120s$

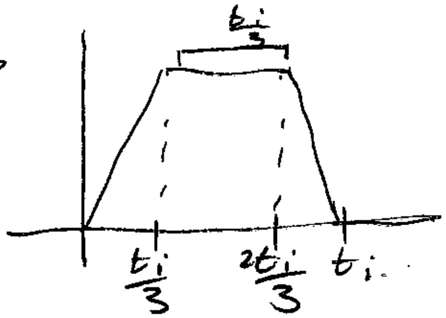
c) $I = mv_f - mv_i$

$v_f = \frac{I + mv_i}{m}$

$= \frac{7.65 \times 10^4 N \cdot s + (403.3kg)(81.3 m/s)}{403.3kg}$

$= 270.99 m/s$

6.



$I = m(v_f - v_i)$

$= 0.0547kg(26.7 m/s - (-26.7 m/s))$

$= 2.92 \ N \cdot s$

$I = \left(\frac{t_i + \frac{t_i}{3}}{2}\right) F_{max}$] area of a trapezoid

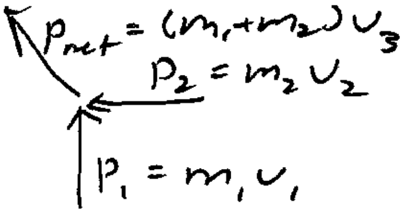
$F_{max} = \frac{2I}{4/3 t_i}$

$= \frac{3I}{2t_i}$

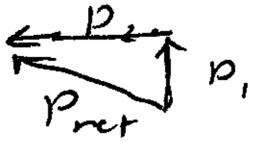
$= \frac{3(2.92 N \cdot s)}{2(0.0429 s)}$

$= 102.13 N$

7.



a) let's redraw:

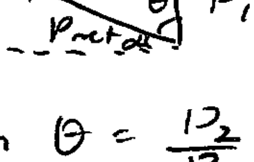


$$p_{net} = \sqrt{p_1^2 + p_2^2}$$
$$= \sqrt{(m_1v_1)^2 + (m_2v_2)^2}$$
$$= \sqrt{((71.2)(1.09))^2 + ((56.1)(4.99))^2}$$
$$= 290.498 \ N\cdot s$$

$$p_{net} = (m_1+m_2)v_3$$
$$v_3 = \frac{p_{net}}{(m_1+m_2)}$$
$$= \frac{290.5 \ N\cdot s}{(71.2+56.1)kg}$$
$$= 2.27 \ m/s$$

$$d = v\Delta t$$
$$\frac{48.0m}{2} = 2.27 m/s \cdot \Delta t$$
$$\Delta t = 10.6 s$$

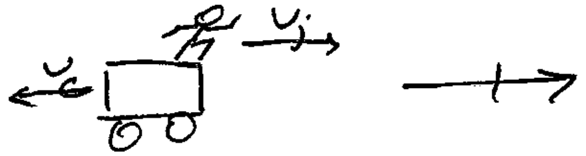
b)



we want to find α.

$$\tan\theta = \frac{p_2}{p_1}$$
$$= \frac{(56.1)(4.99)}{(71.2)(1.09)}$$
$$\theta = 74.5°$$

$$\alpha = 90 - \theta$$
$$= 15.5°$$ north of west.

8. 

note: jennifer's groundspeed is how fast she's moving relative to the ground. her 'cartspeed' is how fast she's moving relative to the cart (2.40 m/s)

ground speed = cartspeed + speed of cart

so we need to find the speed of the cart!

$$p_j = -p_{cart}$$
$$m_j v_j = -(m_c v_c)$$
$$v_c = -\frac{m_j v_j}{m_c}$$
$$= -\frac{(47.0\,kg)(2.40\,m/s)}{479.0\,kg}$$
$$= -0.24\,m/s$$

jennifer's groundspeed $= 2.40\,m/s + (-0.24\,m/s)$
$= 2.164\,m/s$

time needed to run across the cart:

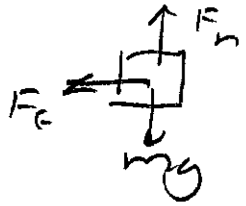
$$t = \frac{\Delta d}{v}$$
$$= \frac{15.0\,m}{2.40\,m/s}$$
$$= 6.25\,s$$

distance run relative to the ground in that time:

$$\Delta d = v \cdot t$$
$$= (2.164\,m/s)(6.25\,s)$$
$$= 13.53\,m$$

9. $m_{bullet} v_{bullet} = m_{(bullet + block)} v_{(bullet + block)}$

let's work backwards:



m = bullet + block
$= 51.1kg + 0.01315kg$
$= 51.11315kg$
$\Delta d = 0.05m$

$F_{net} = ma$
$F_f = ma$
$a = \frac{F_f}{m}$ ↙ normal force × coefficient of friction
$= \frac{\cancel{m}g \cdot \mu_k}{\cancel{m}}$
$= (9.8m/s^2)(0.295)$
$= 2.891 m/s^2$ opposite the direction of motion

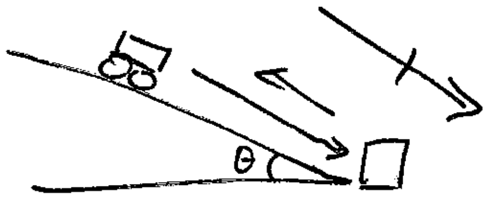
$v_f^2 = v_i^2 + 2a\Delta d$
$0 = v_i^2 + 2a\Delta d$
$v_i^2 = -2a\Delta d$
$= -2(-2.891 m/s^2)(0.05m)$
$v_i = 0.538 m/s$

this is the speed of the block and bullet right after the bullet's impact.

so:

$m_{bullet} v_{bullet} = m_{(b+b)} v_{(b+b)}$
$v_{bullet} = \frac{m_{(b+b)} v_{(b+b)}}{m_{bullet}}$
$= \frac{(51.11315kg)(0.538m/s)}{0.01315 kg}$
$= 2089.93 m/s$

10.



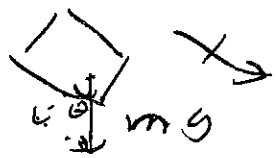
$\theta = 30°$

$$I = \frac{t \cdot F_{x\,max}}{2}$$
$$= \frac{(0.0209s)(313.0N)}{2}$$
$$= 3.27085\ N \cdot s$$

$$I = \Delta p$$
$$= m\Delta v$$
$$\Delta v = \frac{I}{m}$$
$$= \frac{3.27\ N \cdot s}{0.534\ kg}$$
$$= 6.125 m/s$$

this is the change in velocity between the cart just before (v_1) and after (v_2) collision.

now let's find v_1:



$F_{net} = ma$

$$F_{net} = F_{gx}$$
$$\cancel{m}a = \cancel{m}g \sin\theta$$
$$a = g \sin\theta$$
$$= (9.8m/s^2)(\sin 30°)$$
$$= 4.9 m/s^2$$
$$v_f^2 = v_i^2 + 2a\Delta d$$
$$= 0 + 2(4.9m/s^2)(1.50m)$$
$$v_f = 3.83 m/s$$

$\Delta v = v_1 - v_2$

$v_2 = v_1 - \Delta v$

$= 3.83\,m/s - 6.125\,m/s$

$= -2.29\,m/s$

(the cart is now travelling up the incline)

$v_i = -2.24\,m/s \quad v_f = 0 \quad a = 4.9\,m/s^2 \quad \Delta d = ?$

$v_f^2 = v_i^2 + 2a\Delta d$

$\Delta d = \dfrac{v_f^2 - v_i^2}{2a}$

$= \dfrac{0 - (-2.29\,m/s)^2}{2(4.9\,m/s^2)}$

$= -0.535\,m$

it travels 0.54 m up the ramp.

11. truck $= p_1 = (2236.0\,kg)(4.50\,m/s)$

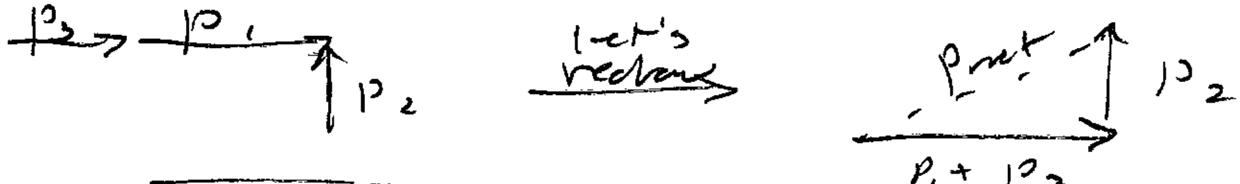
$= 10062.0\,N \cdot s$ east

compact $= p_2 = (1218.0\,kg)(5.20\,m/s)$

$= 6333.6\,N \cdot s$ north

midsize $= p_3 = (1548.0\,kg)(9.0\,m/s)$

$= 13932.0\,N \cdot s$ east



$p_{net} = \sqrt{p_{1+3}^2 + p_2^2}$

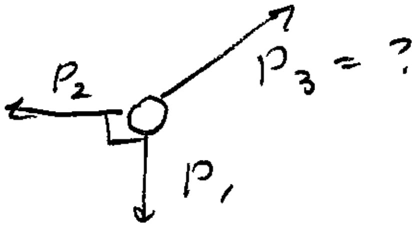
$= \sqrt{(10062.0 + 13932.0)^2 + (6333.6)^2}$

$= 24815.85\,N \cdot s$

$p_{net} = m_{tot} v_4$

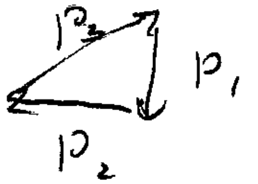
$v_4 = \dfrac{p_{net}}{m_1 + m_2 + m_3} = 4.96\,m/s$

12.



let's refer to the smaller pieces as A and the larger as B.

let's redraw:



$p_1 = p_2 = p_a$ $\qquad$ $p_3 = p_b$

$$p_3 = \sqrt{p_1^2 + p_2^2}$$
$$= \sqrt{(m_a v_a)^2 + (m_a v_a)^2}$$
$$= \sqrt{2(m_a v_a)^2}$$
$$= \sqrt{2}\, m_a v_a$$
$$= \sqrt{2}\,(28.6\,m/s)\, m_a$$

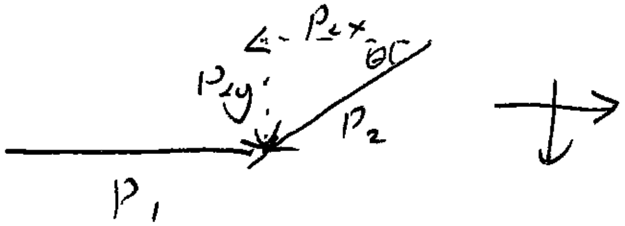
now remember:

$$m_b = 7 m_a$$

$$p_3 = p_b = m_b v_b$$

$$m_b v_b = \sqrt{2}\,(28.6\,m/s)\, m_a$$
$$7 m_a v_b = \sqrt{2}\,(28.6\,m/s)\, m_a$$
$$= \frac{\sqrt{2}\,(28.6\,m/s)\, \cancel{m_a}}{7 \cancel{m_a}}$$
$$= 5.78\,m/s$$

13.



$\theta = 35.0°$

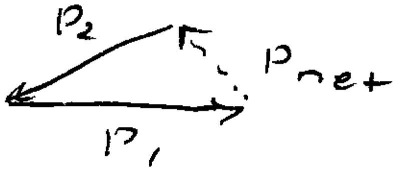
$m_1 = 0.041 kg$ $\quad v_1 = 6.80 m/s$

$m_2 = 0.064 kg$ $\quad v_2 = 1.10 m/s$

$p_1 = m_1 v_1$
$= (0.041 kg)(6.80 m/s)$
$= 0.2788 N \cdot s$

$p_2 = m_2 v_2$
$= (0.064 kg)(1.10 m/s)$
$= 0.0704 N \cdot s$

let's redraw:



to find p_{net}, let's split p_1 and p_2 into components:

x-axis

$p_{1x} = 0.2788 N \cdot s$

$p_{2x} = -p_2 \cos\theta$
$= -(0.0704) \cos 35$
$= -0.05767 N \cdot s$

$p_x = 0.2211 N \cdot s$

y-axis

$p_{1y} = 0$

$p_{2y} = p_2 \sin\theta$
$= (0.0704) \cos 35$
$= 0.040379 N \cdot s$

$p_y = 0.0404 N \cdot s$

$p_{net} = \sqrt{p_x^2 + p_y^2}$
$= 0.2248 N \cdot s$

$p_{net} = m_{net} v$

$v = \frac{p_{net}}{m_{net}}$
$= \frac{0.2248 N \cdot s}{(0.041 kg + 0.064 kg)}$
$= 2.14 m/s$