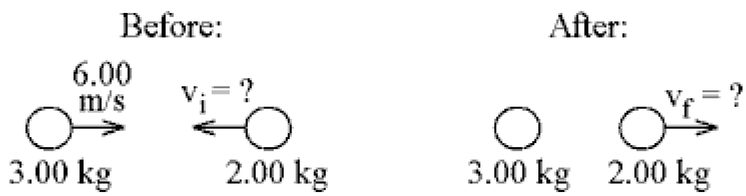
Phy 131- Assignment 6

A. 1. a. The only force on the falling ball is its <u>weight</u> (Earth's gravity pulling down on the ball).

b. The reaction to this is the ball's gravity pulling up on the Earth. (Earth pulls on ball, ball pulls on Earth.)

2.



Cons. of p: $(3\text{ kg})(6\text{ m/s}) + (2\text{ kg})(-v_i) = 0 + (2\text{ kg})(v_f)$

$18 - 2v_i = 2v_f$

$9 - v_i = v_f$

Because it's perfectly elastic, cons. of E: $\frac{1}{2}(3)(6)^2 + \frac{1}{2}(2)(-v_i)^2 = 0 + \frac{1}{2}(2)(v_f)^2$

$54 + v_i^2 = v_f^2$

Substitute from cons. of p: $54 + v_i^2 = (9 - v_i)^2$

$54 + v_i^2 = 81 - 18v_i + v_i^2$

$54 = 81 - 18v_i$

$18v_i = 27 \rightarrow v_i = 27/18 =$ **<u>1.50 m/s (A)</u>**

$v_f = 9 - v_i = 9 - 1.5 =$ **<u>7.50 m/s (B)</u>**

B. 1. a. $E_i + W = E_f$

$\frac{1}{2} mv_i^2 + W = \frac{1}{2} mv_f^2$ (${mgh}_i = {mgh}_f$ and so it drops out.)

$\frac{1}{2} m(0)_i^2 + W = \frac{1}{2}(1500\text{ kg})(10\text{ m/s})^2$

W = $\boxed{75\ 000\text{ J}}$

b. $P_{av} = \frac{W}{t} = \frac{75\ 000}{3\ s} =$ **25 000 watts**

2.

A) $I = \Delta P$

$= m v_f - m v_0 = m(v_f - v_0) = (.15\ kg)[50\ m/s - (-40\ m/s)]$ (← going left)

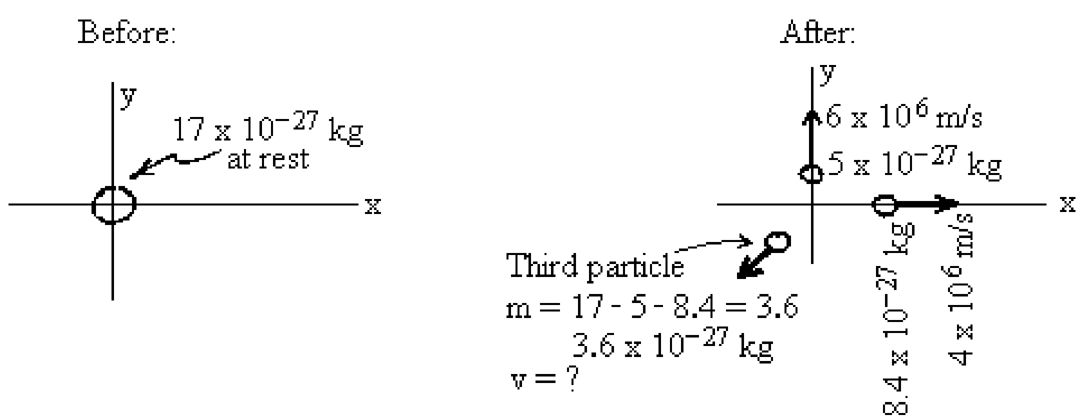
$= (.15)(90) =$ **$13.5\ \frac{kg \cdot m}{s}$** ANS (direction: toward pitcher.)

B) $I = F \Delta t$

$13.5 = F(2 \times 10^{-3}\ s) \implies F = \frac{13.5}{.002} =$ **6750 N** ANS.

C. 1. Each force acts on a different body. (A exerts a force on B, B exerts an equal & opposite force on A.) If I bump into you, the reaction that pushes back on me has no effect on you. Only forces that push on you affect you. So, my push on you does not get cancelled out by its reaction.

2.



This amounts to a perfectly inelastic collision happening in reverse, so mechanical energy is not conserved. Use conservation of momentum.

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

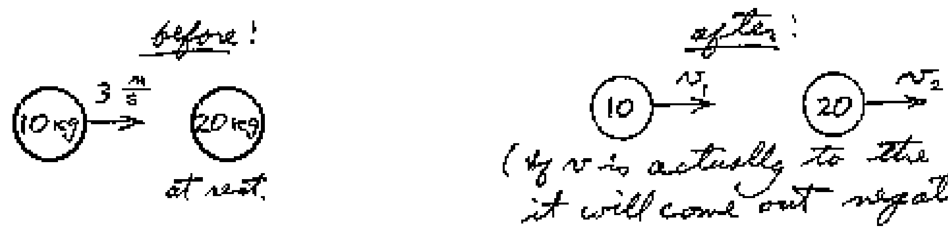
$$(17\times10^{-27}\,\text{kg})(0) = (5\times10^{-27}\,\text{kg})(6\times10^{6}\,\hat{j}) + (8.4\times10^{-27}\,\text{kg})(4\times10^{6}\,\hat{i}\ \text{m/s}) + (3.6\times10^{-27}\,\text{kg})\vec{v}$$

$$0 = 30\times10^{6}\,\hat{j} + 33.6\times10^{6}\,\hat{i} + 3.6\,\vec{v}$$

$$-3.6\,\vec{v} = 30\times10^{6}\,\hat{j} + 33.6\times10^{6}\,\hat{i}$$

$$\vec{v} = -\frac{1}{3.6}\left(30\times10^{6}\,\hat{j} + 33.6\times10^{6}\,\hat{i}\right) = \boxed{(-9.33\,\hat{i} - 8.33\,\hat{j})\times10^{6}\ \text{m/s}}\ \text{ANS}$$

D. Elastic means mechanical energy is conserved.



(If v is actually to the left, it will come out negative.)

Conservation of $\vec{P}$: $(10)(3\ \tfrac{m}{s}) + (20)(0) = (10)(v_1) + (20)(v_2)$

divide thru by 10: (to clean it up) $3 = v_1 + 2v_2$

$$3 - 2v_2 = v_1$$

Conservation of E: $\tfrac{1}{2}(10)(3\ \tfrac{m}{s})^2 + \tfrac{1}{2}(20)(0)^2 = \tfrac{1}{2}(10)(v_1^2) + \tfrac{1}{2}(20)v_2^2$

divide thru by 5: $9 = v_1^2 + 2v_2^2$

solve these two equations simultaneously for v_1 & v_2:

$$9 = (3 - 2v_2)^2 + 2v_2^2$$

$$9 = (9 - 12v_2 + 4v_2^2) + 2v_2^2$$

$$0 = -12v_2 + 6v_2^2$$

$$0 = v_2(-12 + 6v_2)$$

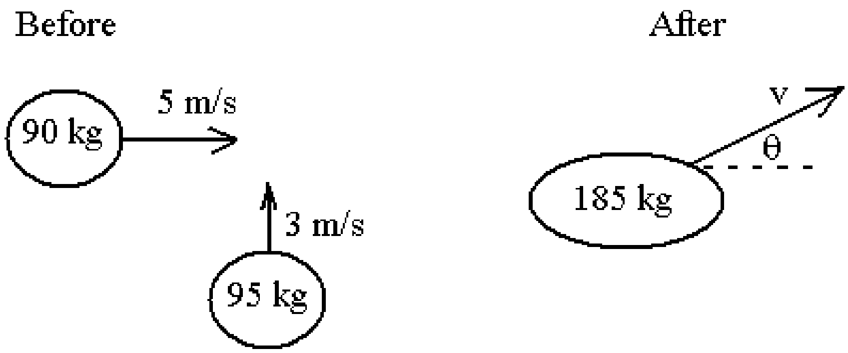
$v_2 = 0$; $6v_2 = 12 \Rightarrow v_2 = \frac{12}{6} = 2\ \tfrac{m}{s}$

You must now decide which is the extraneous root. If $v_2 = 0$, then the 20 kg was undisturbed by the collision, which does not make physical sense. So,

$$\boxed{v_2 = 2.00\ \text{m/s}}$$

Plug this into $v_1 = 3 - 2v_2$. $v_1 = 3 - (2)(2) = \boxed{-1.00\ \text{m/s}}$

E.



(Objects stick together in a perfectly inelastic collision.)

a. Cons. of momentum: (90)(5i) + (95)(3j) = (185)**v**

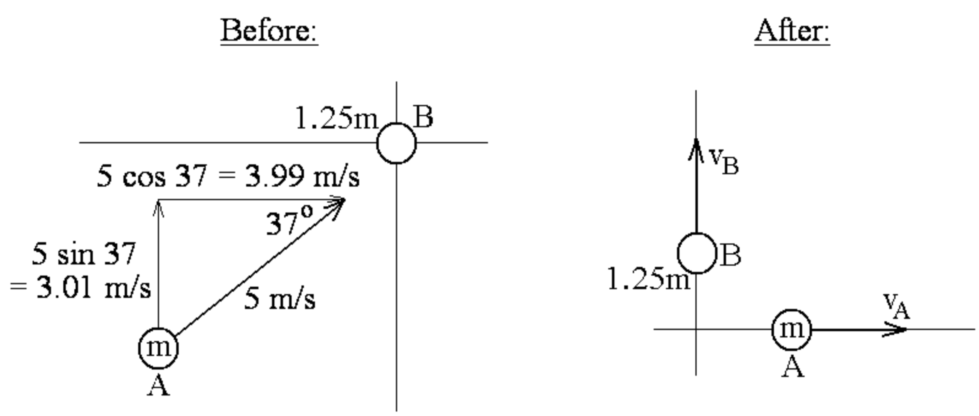
450i+285j = 185**v**

2.432i + 1.541j = **v**

speed (magnitude of **v**): $\sqrt{2.432^2+1.541^2} = 2.879 m/s$ ans:2.88 m/s

direction: arc tan (1.54/2.43) = 32.4° (ans)

F. It's easiest to take x and y to be the directions of the pucks after the collision. That way, there is only one unknown in the x equation and one unknown in the y equation. It also works if you use the direction of A before the collision as your x axis, but it causes more pain and suffering along the way.



Conservation of momentum:

$(m)(3.99\hat{i} + 3.01\hat{j}) + 1.25m(0) = m\, v_A\, \hat{i} + 1.25m\, v_B\, \hat{j}$

Divide through by m:

$3.99\hat{i} + 3.01\hat{j} = v_A\, \hat{i} + 1.25\, v_B\, \hat{j}$

Set the x components from each side equal, and set the y's equal:

$3.99 = v_A$

$3.01 = 1.25\, v_B$

$\boxed{v_A = 3.99 \text{ m/s}}$

$\boxed{v_B = 2.41 \text{ m/s}}$