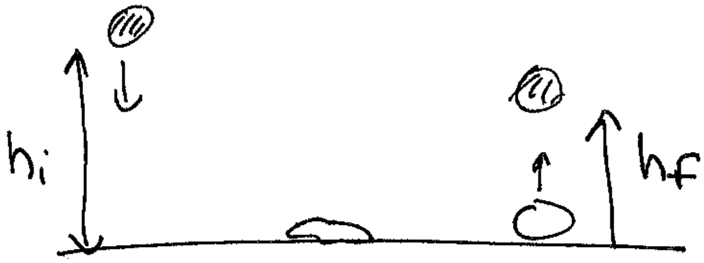
Physics 160, HW # 8:

Mastering Physics: 8 problems from Chapter 8

Written: 8.101

A SUPERBALL Collides Inelastically with a table

Before   During   AFTER



For Me: $m = 50g = .05kg$

$h_i = 1.5m$, $h_f = 1m$

$t_c = 15ms = .015s$

FIND MOMENTUM OF BALL INSTANT BEFORE Collision → BALL hits TABLE WITH THE FINAL SPEED OF ITS FALL FROM h_i.

FOR FALL TO TABLE, NEGLECT AIR RESISTANCE, SO GRAVITY only FORCE DOING WORK

$$\Rightarrow \frac{1}{2}\cancel{m}v_i^2 + mgy_i = \frac{1}{2}mv_f^2 + \cancel{mgy_f}$$

$V_i = 0$ (DROPPED), $y_i = h_i$, $V_f = ?$, $y_f = 0$

$$\Rightarrow \cancel{m}gh_i = \frac{1}{2}\cancel{m}V_f^2 \Rightarrow V_f = \sqrt{2gh_i}$$

BALL moving only in y-DIRECTION $\Rightarrow \vec{V}_F = \sqrt{2gh_i}$, DOWN

$$\Rightarrow P_{BEFORE,y} = -mV_f = -m\sqrt{2gh_i} = -.05kg\sqrt{2(9.8m/s^2)(1.5m)}$$

$$P_{BEFORE,y} = -.05kg\,(5.422m/s) = -.2711\,Kg\cdot m/s$$

$$= -.27\,Kg\cdot m/s$$

FIND MOMENTUM INSTANT AFTER.

BALL HAS SPEED EQUAL to its INITIAL SPEED while Rising to h_f

$$\frac{1}{2} m v_i^2 + \cancel{mgy_i} = \frac{1}{2} \cancel{m v_f^2} + mgy_f$$

$$v_i = ?,\quad y_i = 0,\quad v_f = 0 \text{ at } y_f = h_f$$

$$\Rightarrow \frac{1}{2} m v_i^2 = mgh_f \Rightarrow v_i = \sqrt{2gh_f}$$

BALL moving only in y-DIRECTION $\Rightarrow \vec{v}_i = \sqrt{2gh_f}$, up

$$P_{after,y} = +m v_i = +m\sqrt{2gh_f} = .05\,kg\,\sqrt{2(9.8\,m/s^2)(1m)}$$

$$= .05\,Kg\,(4.427\,m/s) = .22136\,Kg\cdot m/s$$

$$\boxed{P_{after,y} = .22\,kg\cdot m/s}$$

PART C: Impulse, $J_y = \Delta P_y = P_{after,y} - P_{Before,y}$

$$\Rightarrow J_y = .22\,Kg\cdot m/s - (-.27\,Kg\cdot m/s)$$

$$= .22\,kg\cdot m/s + .27\,kg\cdot m/s$$

$$\Rightarrow \boxed{J_y = .49\,Kg\cdot m/s}$$

Part D: Find Avg Force

$$\vec{J} = \vec{F}_{AV}\,\Delta t \Rightarrow J_y = F_{Avg,y}\,\Delta t_c$$

$$F_{Avg,y} = \frac{J_y}{\Delta t} = \frac{.49\ \text{Kg}\cdot\text{m/s}}{.015\text{s}} = 32.666..\text{N} \Rightarrow \boxed{F_{Avg,y} = 33\text{N}}$$

Part E: Find $\Delta K = K_{AFTER} - K_{BEFORE}$

Looking back: $\frac{1}{2}mv_i^2 + mgy_i = \frac{1}{2}mv_f^2 + mgh_f$

$$\Rightarrow mgh_i = \frac{1}{2}mv_f^2 = K_{BEFORE}$$

AND $\underbrace{\frac{1}{2}mv_i^2}_{K_{AFTER}} = mgh_f$

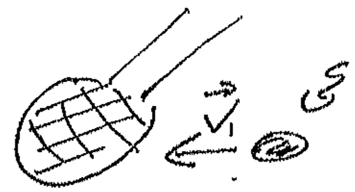
$$\Rightarrow K_{AFTER} - K_{BEFORE} = mgh_f - mgh_i = mg(h_f - h_i)$$

$$= .05\text{Kg}(9.8\text{m/s}^2)(1\text{m} - 1.5\text{m}) = .05\text{Kg}(9.8\text{m/s}^2)(-.5\text{m})$$

$$\Rightarrow \boxed{\Delta K = -.245\text{J} = -.25\text{J}}$$

8.69

Weight = .56N



$\vec{V}_1 = (20\,m/s)\hat{i} - (4\,m/s)\hat{j}$

For $3.00\,ms = 3\times10^{-3}s$, $\sum \vec{F} = -(380N)\hat{i} + (110N)\hat{j}$

a) WHAT ARE X AND Y COMPONENTS OF $\vec{J}$?

Constant Force $\Rightarrow (\sum \vec{F}) \cdot \Delta t = \vec{J}$

$\Rightarrow J_x = (\sum F_x)\Delta t, \quad J_y = (\sum F_y)\Delta t$

$\Rightarrow J_x = (-380N)(3\times10^{-3}s) = -1.14\,N\cdot s = -1.14\,kg\cdot m/s$

$J_y = (110N)(3\times10^{-3}s) = .33\,N\cdot s = .33\,kg\cdot m/s$

b) WHAT ARE COMPONENTS OF $\vec{V}_2$?

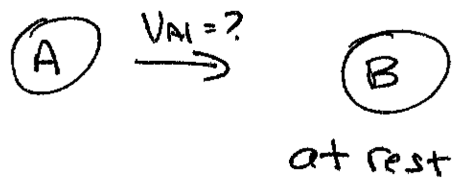
$\vec{J} = \Delta\vec{p} \Rightarrow \Delta p_x = MV_{2,x} - MV_{1,x} = J_x. \Rightarrow V_{2,x} = V_{1,x} + \frac{J_x}{M}$

$.56N = Mg \Rightarrow M = \frac{.56N}{9.8\,m/s^2} = .0571\,kg \Rightarrow V_{2,x} = 20\,m/s + \frac{-1.14\,kg\cdot m/s}{.0571\,kg} = .035$

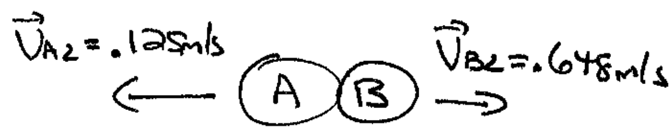
$\Delta p_y = J_y \Rightarrow \ldots V_{2,y} = V_{1,y} + \frac{J_y}{M} = -4\,m/s + \frac{.33\,kg\cdot m/s}{.0571\,kg} = \underline{1.78\,m/s}$

Collisions in One-Dimension

$M_A = .246\,kg,\ M_B = .368\,kg$



BEFORE



AFTER

Part A: $V_{A1} = ?$

$$M_A \vec{V}_{A1} + M_B \vec{V}_{B1} = M_A \vec{V}_{A2} + M_B \vec{V}_{B2}$$

$$\Rightarrow M_A V_{A1,x} + \cancel{M_B V_{B1,x}}^{\,0} = M_A V_{A2,x} + M_B V_{B2,x}$$

$V_{A1,x} = V_{A1} = ?,\quad V_{B1,x} = 0,\quad V_{A2,x} = -.125\,m/s,\quad V_{B2,x} = .648\,m/s$

$$\Rightarrow .246\,kg\, V_{A1} = .246\,kg(-.125\,m/s) + .368\,kg(.648\,m/s)$$

$$\Rightarrow .246\,kg\, V_{A1} = -.03075\,kg\cdot m/s + .238464\,kg\cdot m/s = .207714\,kg\cdot m/s$$

$$\Rightarrow V_{A1} = \frac{.207714\,kg\cdot m/s}{.246\,kg} = .844\,m/s$$

PART B: $\Delta K = ?$

$$\Delta K = K_2 - K_1$$

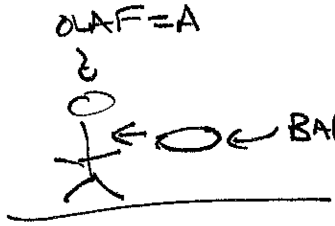
$$K_2 = \frac{1}{2} M_A V_{A2}^2 + \frac{1}{2} M_B V_{B2}^2 = \frac{1}{2}(.246\,\text{kg})(.125\,\text{m/s})^2 + \frac{1}{2}(.368\,\text{kg})(.648\,\text{m/s})^2$$

$$\Rightarrow K_2 = .07918\ \text{J}$$

$$K_1 = \frac{1}{2} m_A V_{A1}^2 + \frac{1}{2} M_B V_{B1}^2 = \frac{1}{2}(.246\,\text{kg})(.844\,\text{m/s})^2 + 0 = .08762\ \text{J}$$

$$\Rightarrow \Delta K = .07918\ \text{J} - .08762\ \text{J} = -.00844\ \text{J}$$

CATCHING A BALL ON ICE:

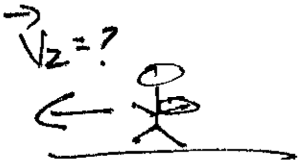


BEFORE

$M_A = 65.4\,kg \quad V_{A1} = 0$

$M_B = .4\,kg, \quad \vec{V}_{B1} = 11.6\,m/s$, to LEFT

PART A: OLAF CATCHES BALL



After

Completely Inelastic Collision

$$M_A \vec{V}_{A1} + M_B \vec{V}_{B1} = (M_A + M_B)\vec{V}_2$$

$V_{A1} = 0$, $\vec{V}_{B1}$ to left $\Rightarrow V_{B1,x} = -11.6\,m/s$

$V_{B1,y} = 0$

$$\Rightarrow V_{2,y} = 0 \quad \text{(HORIZONTAL MOTION)}$$

AND $\cancel{M_A V_{A1,x}} + M_B V_{B1,x} = (M_A + M_B) V_{2,x}$

$$\Rightarrow .4\,kg(-11.6\,m/s) = (65.4\,kg + .4\,kg)\,V_{2,x}$$

$$\Rightarrow -4.64\,kg \cdot m/s = (65.8\,kg)\,V_{2,x}$$

$$\Rightarrow V_{2,x} = -\frac{4.64\,kg \cdot m/s}{65.8\,kg} = -.0705\,m/s$$

SPEED $\Rightarrow V_2 = +.0705\,m/s$

PART B: BALL BOUNCES at 7.3 m/s in opposite DIRECTION

$$M_A V_{A1,x} + \cancel{M_B V_{B1,x}} = M_A V_{A2,x} + M_B V_{B2,x}$$

(x-Component only since $V_{B2,y} = 0$)

$$\therefore\ .4\,Kg(-11.6\,m/s) = (65.4\,Kg)V_{A2,x} + (.4\,Kg)(7.3\,m/s)$$

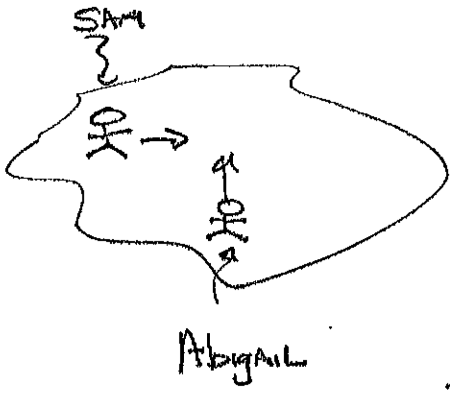
$$\Rightarrow -4.64\,Kg\cdot m/s = (65.4\,kg)V_{A2,x} + 2.92\,Kg\cdot m/s$$

$$\Rightarrow (65.4\,kg)V_{A2,x} = -4.64\,Kg\cdot m/s - 2.92\,Kg\cdot m/s = -7.56\,kg\cdot m/s$$

$$\Rightarrow V_{A2,x} = \frac{-7.56\,Kg\cdot m/s}{65.4\,kg} = -.11559\,m/s$$

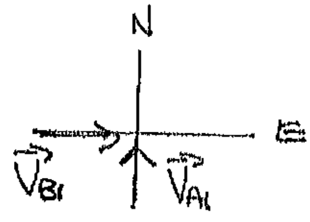
$$\Rightarrow V_{A2} = .116\,m/s$$

8.74

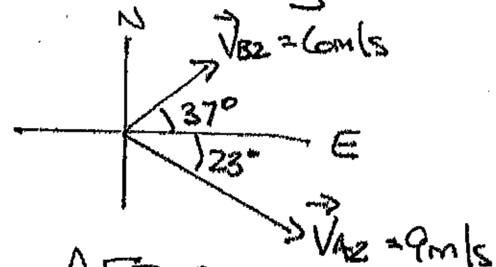


LET ABIGAIL be A $\Rightarrow M_A = 50\text{ kg}$

SAM be B $\Rightarrow M_B = 80\text{ kg}$



BEFORE



AFTER

a) SPEED BEFORE COLLISION?

USE EAST $= x$, NORTH $= y$ COORDINATES $\Rightarrow$

$$V_{B1,x} = V_{B1}$$
$$V_{B1,y} = 0$$
$$V_{A1,x} = 0$$
$$V_{A1,y} = V_{A1}$$

$$V_{B2,x} = 6\text{ m/s} \cos 37°; \quad V_{B2,y} = 6\text{ m/s} \sin 37°$$

$$V_{A2,x} = 9\text{ m/s} \cos 23°; \quad V_{A2,y} = -9\text{ m/s} \sin 23°$$

DOWNWARD

MOMENTUM CONSERVATION:

$$M_A V_{A1,x} + M_B V_{B1,x} = M_A V_{A2,x} + M_B V_{B2,x} \Rightarrow$$

$$0 + (80\text{kg})V_{B1} = (50\text{kg})(9\text{m/s})\cos 23° + (80\text{kg})(6\text{m/s})\cos 37°$$

$$\Rightarrow (80\text{kg})V_{B1} = 797.57\text{ kg}\cdot\text{m/s} \Rightarrow \underline{\underline{V_{B1} = 9.97\text{m/s}}}$$

$$M_A V_{A1,y} + M_B V_{B1,y} = M_A V_{A2,y} + M_B V_{B2,y}$$

$$\Rightarrow (50\text{kg})(V_{A1}) = {}^{+}(50\text{kg})(\underbrace{-9\text{m/s}}_{\text{Negative}})\sin 23° + (80\text{kg})(6\text{m/s})\sin 37°$$

$$\Rightarrow (50\text{kg})V_{A1} = 113.04\text{ kg}\cdot\text{m/s} \Rightarrow \underline{\underline{V_{A1} = 2.26\text{m/s}}}$$

b) LOST KINETIC ENERGY?

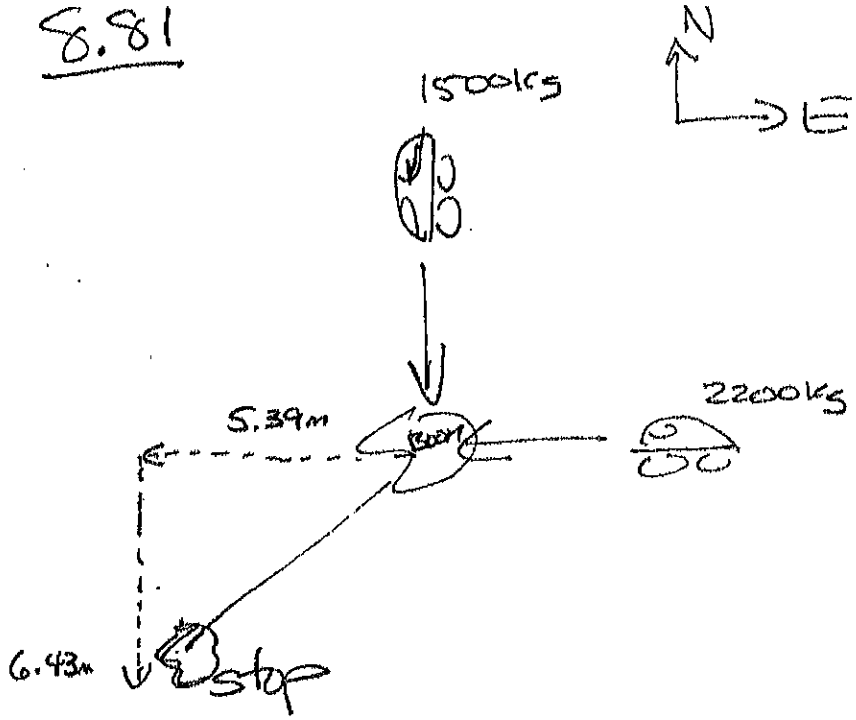
$$K_1 = \tfrac{1}{2}M_A V_{A1}^2 + \tfrac{1}{2}M_B V_{B1}^2 = \tfrac{1}{2}(50\text{kg})(2.26\text{m/s})^2 + \tfrac{1}{2}(80\text{kg})(9.97\text{m/s})^2$$

$$\Rightarrow K_1 = 4103.726\text{J}$$

$$K_2 = \tfrac{1}{2}M_A V_{A2}^2 + \tfrac{1}{2}M_B V_{B2}^2 = \tfrac{1}{2}(50\text{kg})(9\text{m/s})^2 + \tfrac{1}{2}(80\text{kg})(6\text{m/s})^2$$

$$\Rightarrow K_2 = 3465\text{J} \quad \Rightarrow \Delta K = K_2 - K_1 = \underline{-639\text{J}}$$

8.81



Would have been better with a Smart Car!

Enmeshed

$\mu_k = .75$

How fast was each car going before?

Let $M_A = 1500\,kg$, $M_B = 2200\,kg$

And let South and West be positive (and be x & y)

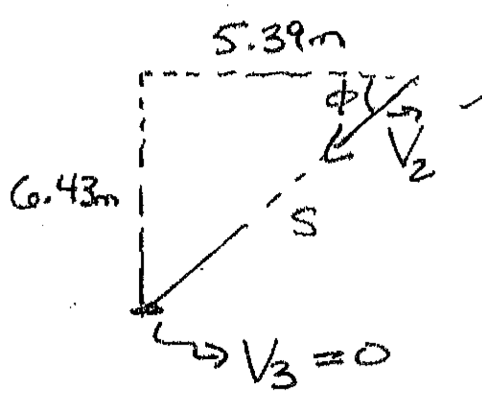
$\Rightarrow V_{A1,x} = 0 \quad V_{A1,y} = V_{A1} = ?$

$V_{B1,x} = V_{B1} = ?, \quad V_{B1,y} = 0$

Enmeshed $\Rightarrow$ Completely Inelastic

$\Rightarrow M_A \vec{V}_{A1} + M_B \vec{V}_{B1} = (M_A + M_B)\vec{V}_2$

LET'S ASSUME (REASONABLY) THAT FRICTION IS ONLY FORCE ~~ACTING~~ DOING WORK ON CARS AFTER COLLISION., A little less REASONABLY but to simplify lets ASSUME CARS SLIDE IN STRAIGHT LINE.

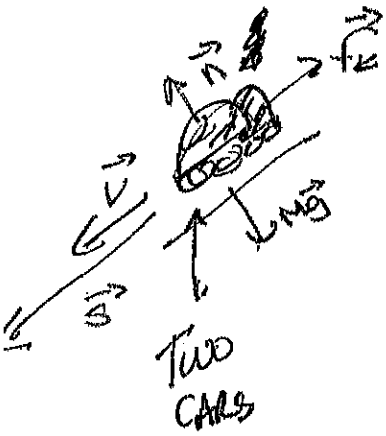


$\vec{V}_2$ MUST be At Angle ϕ BECAUSE Cars go in straight LINE

$$\tan\phi = \frac{6.43}{5.39} \Rightarrow \phi = \tan^{-1}\left(\frac{6.43}{5.39}\right) = 50^\circ$$

$$S = \sqrt{(5.39m)^2 + (6.43m)^2} = 8.32152m$$

Friction ONLY force DOING WORK $\Rightarrow \frac{1}{2}mV_2^2 + W_f = \frac{1}{2}mV_3^2$



$$W_f = f_k S \cos 180^\circ = -f_k S$$

IF WE ASSUME simple $f_k = \mu_k n$ AND $\vec{s}$ IN A STRAIGHT LINE.

GRAVITY NOT DOING WORK BECAUSE ROAD IS HORIZONTAL $\Rightarrow n = Mg$

$$\therefore \frac{1}{2}\cancel{M}V_2^2 - \mu_k \cancel{M}gs = \frac{1}{2}\cancel{M}V_3^2$$

$V_2 = ?, \quad S = 8.32152m, \quad \mu_k = .75, \quad V_3 = 0$

$\Rightarrow \frac{1}{2} V_2^2 = \mu_k g s \Rightarrow V_2 = 2\mu_k g s = \sqrt{2(.75)(9.8m/s^2)(8.32152m)}$

$\Rightarrow V_2 = 11.06 m/s$

$\vec{V_2} = 11.06 m/s$ at $50°$

Finally: $M_A \vec{V_{A1}} + M_B \vec{V_{B1}} = (M_A + M_B)\vec{V_2}$

$M_A = 1500kg, \; V_{A1,x} = 0, \; V_{A1,y} = V_{A1}, \; M_B = 2200kg, \; V_{B1,x} = V_{B1}, \; V_{B1,y} = 0$

$M_A V_{A1,x} + M_B V_{B1,x} = (M_A + M_B) V_{2,x}$

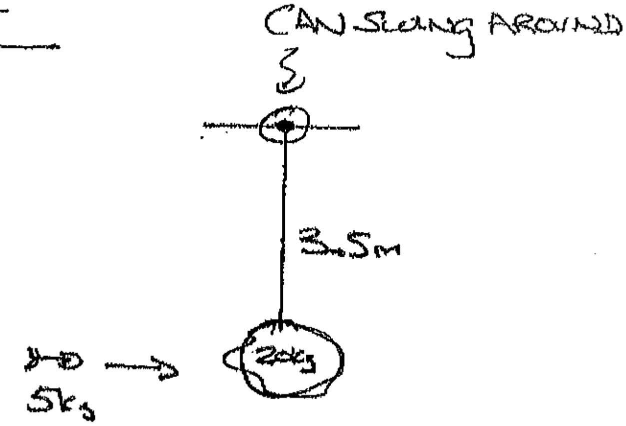
$\Rightarrow 0 + 2200kg \, V_{B1} = (3700kg)(11.06m/s)\cos 50°$

$\Rightarrow V_{B1} = 11.956 = \underline{12m/s}$

$M_A V_{A1,y} + M_B V_{B1,y} = (M_A + M_B) V_{2,y} \Rightarrow 1500kg \, V_{A1} + 0 = (3700kg)(11.06m/s)\sin 50°$

$\Rightarrow V_{A1} = 20.8987 = \underline{21m/s}$

8.88



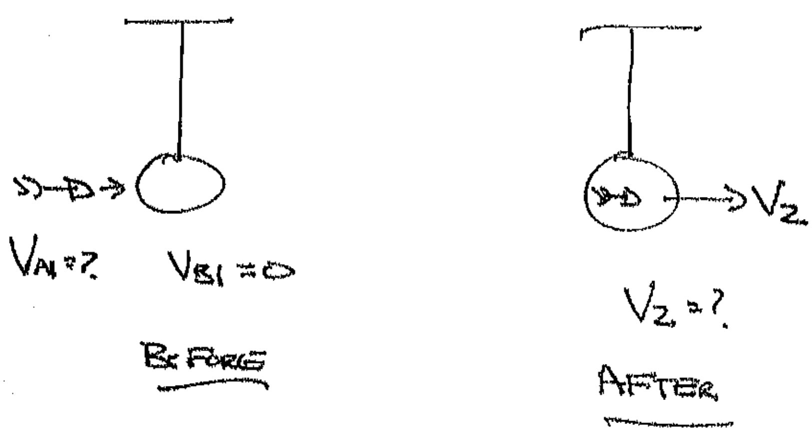
DART EMBEDS ITSELF

FIND MINIMUM INITIAL SPEED OF DART SO MAKES COMPLETE REVOLUTION

HERE, WE HAVE TWO EVENTS OCCURING ONE AFTER THE OTHER:

1. THE COMPLETELY INELASTIC COLLISION OF 5kg DART AND 20kg LEAD
2. THE SWING OF THE 25kg DART/LEAD COMBO.

COLLISION IS HORIZONTAL $\Rightarrow$ 1D



MOM. CONSERVATION:

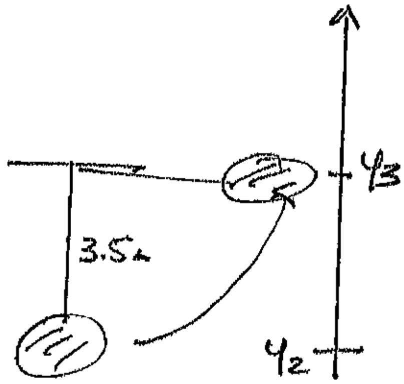
$M_A V_{A1} + 0 = (M_A + M_B) V_2$

$\Rightarrow 5\text{kg}\, V_{A1} = (5\text{kg} + 20\text{kg}) V_2$

$\Rightarrow 5\text{kg}\, V_{A1} = (25\text{kg}) V_2$

NEED V_2

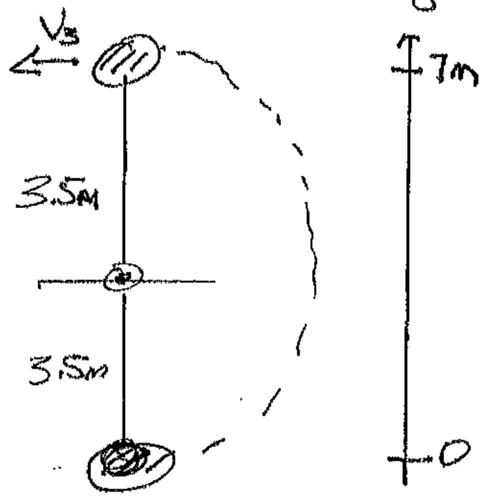
DURING SWING, TENSION DOES NO WORK ⇒ ENERGY CONSERVED



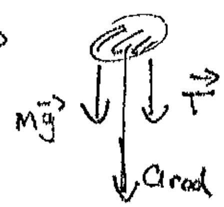
$$\frac{1}{2}MV_2^2 + Mgy_2 = \frac{1}{2}MV_3^2 + Mgy_3$$

$M = M_{TOTAL}$ (BUT DOESN'T MATTER BECAUSE IT CANCELS)

THE CRUCIAL step to MAKING A Complete Revolution is at the top.
(THAT'S where it's going slowest)



AT TOP



IF it BARELY MAKES it: $T = 0$

$\Rightarrow \Sigma F_y = Mg$

is $Mg = Ma_{rad}$

$\Rightarrow a_{rad} = g \Rightarrow \frac{V^2}{r} = g$

$\therefore V_{MIN}^2 = rg = (3.5m)(9.8m/s^2) = 34.3 m^2/s^2$

$\therefore V_2 = ?,\ y_2 = 0,\ V_3^2 = V_{MIN}^2 = 34.3 m^2/s^2,\ y_3 = 7m$

$$\frac{1}{2}MV_2^2 + Mg\cancel{y_2}^{0} = \frac{1}{2}MV_3^2 + Mgy_3$$

$$\Rightarrow \frac{1}{2}V_2^2 = \frac{1}{2}(34.3\,m^2/s^2) + (9.8\,m/s^2)(7\,m)$$

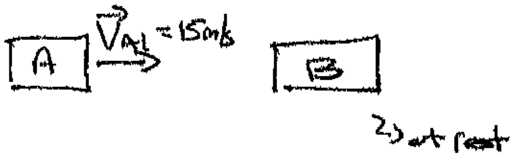
$$\Rightarrow V_2 = \sqrt{171.5\,m^2/s^2} \approx 13.0958\,m/s$$

So Finally: $(5\,kg)V_{A1} = (25\,kg)V_2$

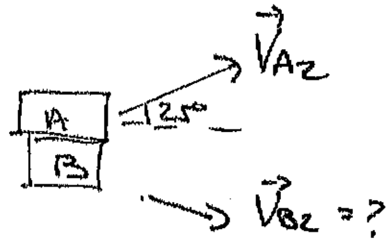
$$\Rightarrow (5\,kg)V_{A1} = (25\,kg)(13.0958\,m/s)$$

$$\Rightarrow V_{A1} = 65.479\,m/s = \underline{\underline{65.5\,m/s}}$$

8.99



BEFORE



AFTER

$M_A = M_B = M.$ Collision Completely Elastic

As shown, set up coordinates with $V_{A1,x} = 15$ m/s

$$V_{A1,y} = 0$$

$$V_{B1,x} = V_{B1,y} = 0$$

Momentum Conservation: $M_A V_{A1,x} + M_B V_{B1,x} = M_A V_{A2,x} + M_B V_{B2,x}$

$$\Rightarrow \cancel{M_A}(15\text{ m/s}) + 0 = \cancel{M_A} V_{A2} \cos 25° + \cancel{M_B} V_{B2,x}$$

$$M_A = M_B \Rightarrow 15\text{ m/s} = V_{A2} \cos 25° + V_{B2,x}$$

$$M_A V_{A1,y} + M_B V_{B1,y} = M_A V_{A2,y} + M_B V_{B2,y}$$

$$\Rightarrow 0 + 0 = \cancel{M_A} V_{A2} \sin 25° + \cancel{M_B} V_{B2,y}$$

$$M_A = M_B \Rightarrow 0 = V_{A2} \sin 25° + V_{B2,y} \Rightarrow V_{B2,y} = -V_{A2} \sin 25°$$

WE KNOW COLLISION IS ELASTIC, SO WE CAN USE

$$\frac{1}{2} m_A V_{A1}^2 + \frac{1}{2} m_B V_{B1}^2 = \frac{1}{2} m_A V_{A2}^2 + \frac{1}{2} m_B V_{B2}^2$$

$$\Rightarrow \frac{1}{2} \cancel{m_A} (15\,m/s)^2 + 0 = \frac{1}{2} \cancel{m_A} V_{A2}^2 + \frac{1}{2} m_B V_{B2}^2$$

$$m_A = m_B \Rightarrow \cancel{\tfrac{1}{2}} (15\,m/s)^2 = \cancel{\tfrac{1}{2}} V_{A2}^2 + \cancel{\tfrac{1}{2}} V_{B2}^2$$

$$\Rightarrow V_{A2}^2 + V_{B2}^2 = 225\,m^2/s^2$$

$$V_{B2}^2 = \text{SPEED}^2 = V_{B2,x}^2 + V_{B2,y}^2 \Rightarrow V_{A2}^2 + V_{B2,x}^2 + V_{B2,y}^2 = 225\,m^2/s^2$$

FROM X-MOMENTUM: $V_{B2,x} = 15\,m/s - V_{A2} \cos 25°$

Y-MOMENTUM: $V_{B2,y} = -V_{A2} \sin 25°$

$$\Rightarrow V_{A2}^2 + (15\,m/s - V_{A2} \cos 25°)^2 + (-V_{A2} \sin 25°)^2 = 225\,m^2/s^2$$

$$\Rightarrow V_{A2}^2 + \underbrace{(15\,m/s)^2}_{\cancel{225\,m^2/s^2}} - 2(15\,m/s) V_{A2} \cos 25° + V_{A2}^2 \cos^2 25° + V_{A2}^2 \sin^2 25° = \cancel{225\,m^2/s^2}$$

$$\Rightarrow V_{A2}^2 - \overset{2(15\,m/s)}{\cancel{30\,m/s}} V_{A2} \cos 25° + V_{A2}^2 \underbrace{(\cos^2 25° + \sin^2 25°)}_{1} = 0$$

$$\Rightarrow \cancel{2}V_{A2}^2 - \cancel{2}(15\,m/s)\cos 25^\circ\, V_{A2} = 0$$

$$\Rightarrow V_{A2}\left(V_{A2} - 15\,m/s\cos 25^\circ\right) = 0$$

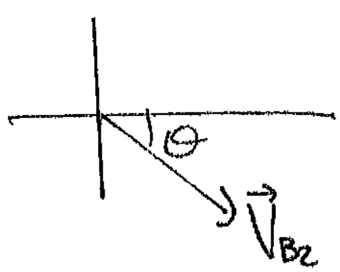
$$\Rightarrow V_{A2} = 0 \quad \text{OR} \quad V_{A2} = 15\,m/s\cos 25^\circ = 13.595\,m/s = \underline{\underline{13.6\,m/s}}$$

$$V_{B2,x} = 15\,m/s - V_{A2}\cos 25^\circ = 15\,m/s - (15\,m/s\cos 25^\circ)\cos 25^\circ$$

$$= 15\,m/s\,(1-\cos^2 25^\circ) = 15\,m/s\,\sin^2 25^\circ = 2.679\,m/s$$

$$V_{B2,y} = -V_{A2}\sin 25^\circ = -15\,m/s\cos 25^\circ \sin 25^\circ = -5.7453\,m/s$$

$\Rightarrow$



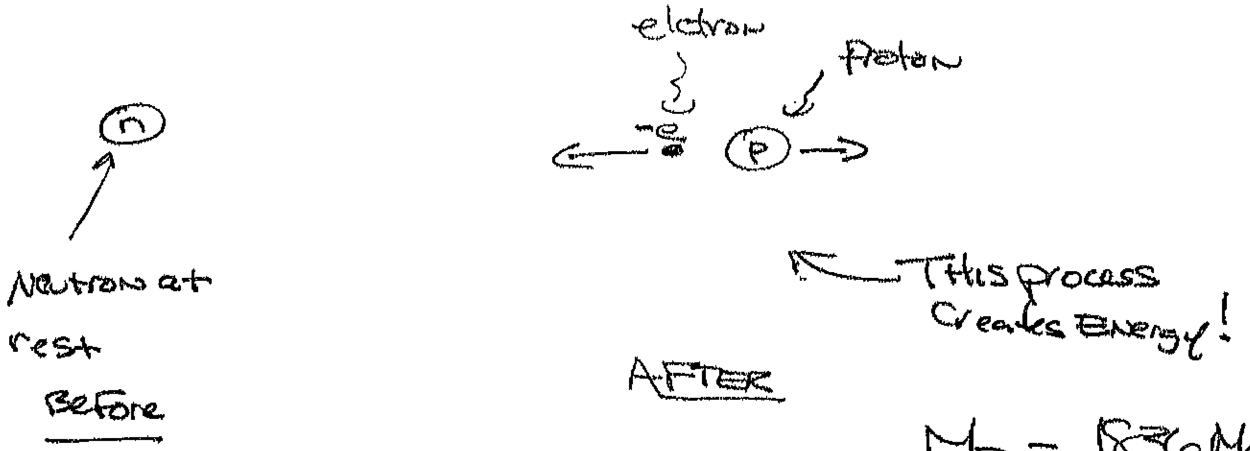
$$\theta = \tan^{-1}\left(\frac{V_{B2,y}}{V_{B2,x}}\right) = \tan^{-1}\left(-\frac{5.7453}{2.679}\right)$$

$$= \underline{\underline{-65^\circ}}$$

Notice how $65^\circ + 25^\circ = 90^\circ$

$$V_{B2} = \sqrt{V_{B2,x}^2 + V_{B2,y}^2} = \sqrt{(2.679\,m/s)^2 + (5.7453\,m/s)^2} = 6.3392 = \underline{\underline{6.34\,m/s}}$$

8.101



$M_p = 1836 M_e$

WHAT FRACTION OF TOTAL ENERGY RELEASED goes into Proton's Kinetic?

TOTAL ENERGY = Proton's Kinetic + Electron's Kinetic $= K_p + K_e$

FRACTION, $F = \dfrac{K_p}{K_p + K_e} = \dfrac{K_p}{K_p\left(1+\frac{K_e}{K_p}\right)} = \dfrac{1}{1+\frac{K_e}{K_p}}$

$$\frac{K_e}{K_p} = \frac{\frac{1}{\cancel{2}} m_e V_e^2}{\frac{1}{\cancel{2}} m_p V_p^2} = \left(\frac{m_e}{m_p}\right)\left(\frac{V_e}{V_p}\right)^2$$

RATIO OF SPEEDS

$\Rightarrow$ MOMENTUM

Conservation of Momentum:

$$M_n\vec{V}_n = M_p\vec{V}_p + M_e\vec{V}_e$$

$$\vec{V}_n = 0 \Rightarrow M_p\vec{V}_p + M_e\vec{V}_e = 0 \Rightarrow M_p\vec{V}_p = -M_e\vec{V}_e$$

$\Rightarrow \vec{V}_p, \vec{V}_e$ in opposite directions (As drawn in original picture)

If we put x-axis along direction of velocities

$$V_{p,x} = V_p \quad , V_{e,x} = -V_e \Rightarrow M_p V_{p,x} = -M_e V_{e,x}$$

$$\Rightarrow M_p V_p = M_e V_e \Rightarrow \frac{V_e}{V_p} = \frac{M_p}{M_e}$$

(This says that ~~Lighter~~ Lighter particle goes faster after)

$$\therefore \frac{K_e}{K_p} = \left(\frac{M_e}{M_p}\right)\left(\frac{M_p}{M_e}\right)^2 = \frac{M_e M_p^2}{M_p M_e^2} = \frac{M_p}{M_e}$$ ← Electron gets more of Kinetic Energy

$$M_p = 1836 M_e \Rightarrow \frac{K_e}{K_p} = \frac{1836 \cancel{M_e}}{\cancel{M_e}} = 1836. \quad \text{Finally}$$

$$F = \frac{1}{1+\frac{K_e}{K_p}} = \frac{1}{1+1836} = \frac{1}{1837} = 5.44\times10^{-4}. \quad F\times100\% = \underline{.0544\%}$$ ← Proton gets Almost NONE!