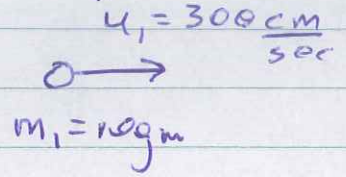
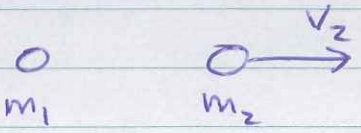
Assignment 4

1. Before Collision



After Collision



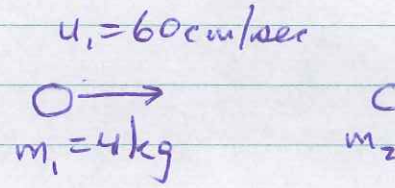
Cons. of Mom: $m_1 u_1 = m_2 V_2$

$$V_2 = \frac{m_1 u_1}{m_2}$$

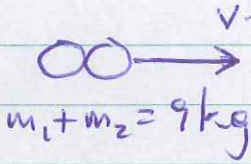
$$= \frac{10 gm \times 300 cm/sec}{30 gm}$$

$$= 100 cm/sec.$$

2. Before Collision



After Collision

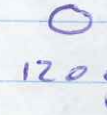


Cons. of Mom: $m_1 u_1 + m_2 u_2 = (m_1 + m_2) V$

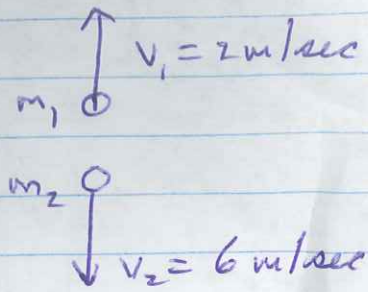
$$V = \frac{4 \times 60 + 5 \times 50}{4 + 5}$$

$$= 54 cm/sec.$$

3. Before Explosion



After Explosion



Cons. of Mom. $0 = m_1 v_1 - m_2 v_2$

$$m_1 = \frac{m_2 v_2}{v_1}$$

$$= \frac{6 m_2}{2}$$

$$= 3 m_2$$

But $m_1 + m_2 = 120$ gm.

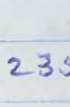
$$3 m_2 + m_2 = 120$$

$\therefore m_2 = 30$ gm. & $m_1 = 90$ gm.

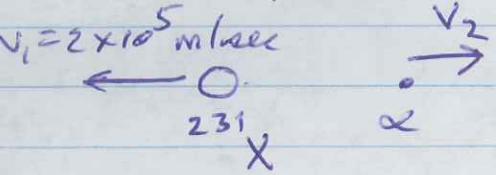
4. Decay of U: $^{235}U \longrightarrow \alpha + {}^{231}X$.

α: alpha particle

Before Decay



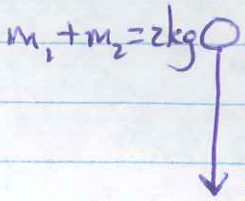
After Decay.



Cons. of Mom. $m_1 v_1 = m_2 v_2$

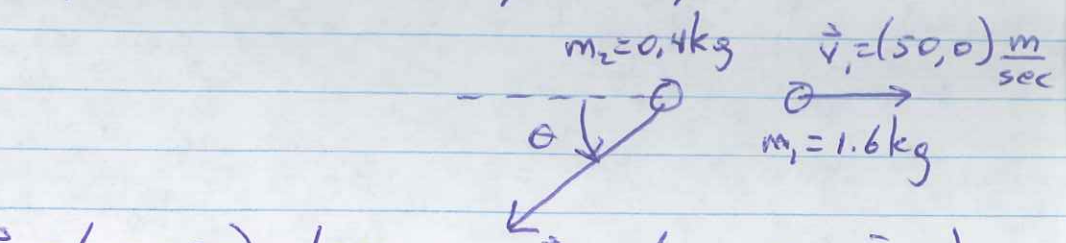
$$\therefore v_2 = \frac{231 \times 2 \times 10^5}{4} = 1.2 \times 10^7 \text{ m/sec.}$$

5. Before Explosion



$\vec{u} = (0, -30)$ m/sec

After Explosion



$\vec{v}_2 = v_2(-\cos\theta, -\sin\theta)$

Cons. of Mom: $(m_1+m_2)\vec{u} = m_1\vec{v}_1 + m_2\vec{v}_2$

$2(0,-30) = 1.6(50,0) + 0.4(-v_2\cos\theta, -v_2\sin\theta)$

$\hat{x}$ comp: $0 = 80 - 0.4v_2\cos\theta$

$v_2\cos\theta = 200 \quad (1)$

$\hat{y}$ comp: $-60 = 0 - 0.4v_2\sin\theta$

$v_2\sin\theta = 150 \quad (2)$

$(2) \div (1) \Rightarrow \tan\theta = \frac{150}{200} \Rightarrow \theta = 36.9°$

$(1)^2 + (2)^2 \Rightarrow \quad v_2^2 = 200^2 + 150^2$

$v_2 = 250$ m/sec

6a) Deceleration $= \dfrac{36\ \text{km/hr}}{0.1\ \text{sec}}$

$$= \frac{36\ \frac{\text{km}}{\text{hr}} \times 1000\ \frac{\text{m}}{\text{km}} \times \frac{1}{3600}\ \frac{\text{hr}}{\text{sec}}}{0.1\ \text{sec}}$$

$$= 100\ \text{m/sec}^2$$

$\therefore$ force of tree on car $= 1000\ \text{kg} \times 100\ \text{m/sec}^2$

$$= 10^5\ \text{Nt.}$$

b) Equating $mg = 10^5\ \text{Nt}$

$$m = 10^4\ \text{kg} = 10\ \text{tons!}$$

7) $\left|\begin{matrix}\text{Rocket Momentum} \\ \text{after burn}\end{matrix}\right| = \left|\begin{matrix}\text{Fuel Momentum} \\ \text{after burn}\end{matrix}\right|$

$$1000\text{kg} \times 600\ \frac{\text{m}}{\text{sec}} = 4000\ \text{kg} \times v_{\text{exhaust}}$$

$$v_{\text{exhaust}} = 150\ \text{m/sec.}$$

8a) # photons = $\frac{\text{atom momentum}}{\text{photon momentum}}$

$$= \frac{87 \times 1.67 \times 10^{-27}\ \text{kg} \times 330\ \text{m/sec}}{7.79 \times 10^{-28}\ \text{Nt sec}}$$

$$= 61{,}500$$

b) Deceleration = $\frac{1}{\text{Rb Mass}} \times \frac{\text{photon Momentum}}{\text{radiation time}}$

$$= \frac{1}{87 \times 1.67 \times 10^{-27}} \frac{7.79 \times 10^{-28}}{2.5 \times 10^{-8}}$$

$$= 2.14 \times 10^{5}\ \text{m/sec}^2$$

c) Time to absorb/radiate = $61{,}500 \times 2.5 \times 10^{-8}$ sec
61,500 photons

$$= 1.6 \times 10^{-3}\ \text{sec.}$$

Distance Travelled $y = v_0 t - \frac{1}{2} a t^2$

$$y = 330 \frac{\text{m}}{\text{sec}} \times 1.6 \times 10^{-3}\ \text{sec} - \frac{1}{2} 2.14 \times 10^{5} \frac{\text{m}}{\text{sec}^2} (1.6 \times 10^{-3})^2$$

$$= 2.5 \times 10^{-1}\ \text{m}$$

$$= 25\ \text{cm.}$$

d) # photons/sec to stop beam = # photons to stop one atom × # atoms/sec.

$$= 61{,}500 \times 10^{9}$$

$$= 6.2 \times 10^{13}\ \text{photons/sec}$$