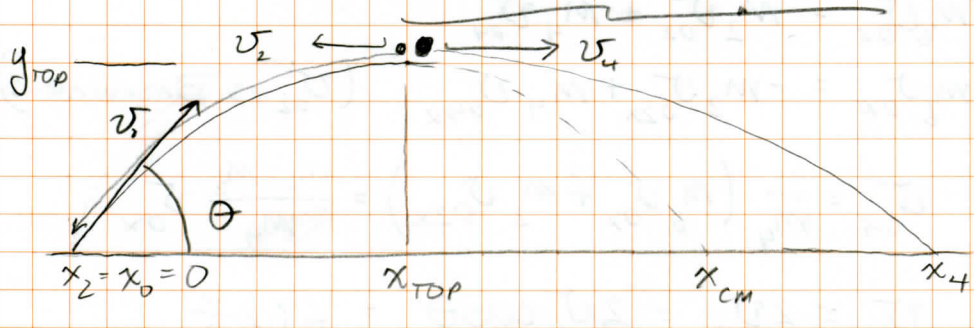
T3 PR 7.45

T3 7-45 A 6 kg PROJECTILE EXPLODES AT THE TOP OF ITS FLIGHT INTO 2kg AND 4 kg PIECES THAT MOVE AWAY HORIZONTALLY. THE 2 kg PIECE LANDS AT THE LAUNCH POINT

a) WHERE DOES THE 4 kg PIECE LAND?

b) WHAT IS THE EXPLOSION ENERGY? $(T_{BITS} - T_{WHOLE} = E_{BOOM})$



$v_0 = 40\ m/s$

$\theta = 30°$

a) FIND x_{TOP} & y_{TOP}

$x_{TOP} = (v_0 \cos\theta)\, t_{TOP}$

$v_{y,TOP} = v_0 \sin\theta - g t_{TOP}$

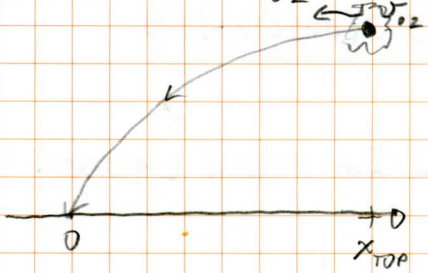
$\Leftarrow t_{TOP} = \frac{v_0}{g}\sin\theta$

(1) $x_{TOP} = \frac{v_0^2}{g}\sin\theta\cos\theta$

$y_{TOP} = \cancel{y_0}^{\,0} + (v_0 \sin\theta)\, t_{TOP} - \frac{1}{2} g t_{TOP}^2 = \frac{v_0^2 \sin^2\theta}{g} - \frac{g}{2}\left(\frac{v_0^2}{g^2}\sin^2\theta\right)$

(2) $y_{TOP} = \frac{v_0^2}{2g}\sin^2\theta$

FIND v_{02} TO LAND AT LAUNCH POINT



$\cancel{x_2}^{\,0} = x_{02} - v_{02x} t_{FALL}$

$\Rightarrow v_{02x} = \frac{x_{02}}{t_{FALL}} = \frac{x_{TOP}}{t_{FALL}}$

$\cancel{y_2}^{\,0} = y_{02} + \cancel{v_{0y2}}^{\,0} t_{FALL} - \frac{1}{2} g t_{FALL}^2$

$\Rightarrow t_{FALL} = \sqrt{\frac{2 y_{02}}{g}} = \sqrt{\frac{2 y_{TOP}}{g}}$

$\Rightarrow t_{FALL} = \sqrt{\frac{2}{g}\left(\frac{v_0^2}{2g}\sin^2\theta\right)} = \frac{v_0}{g}\sin\theta$

$\Rightarrow v_{02x} = \frac{x_{TOP}}{t_{FALL}} = \frac{\left(\frac{v_0^2}{g}\sin\theta\cos\theta\right)}{\frac{v_0}{g}\sin\theta}$

$v_{0x} = 34.6\ m/s$

$= \boxed{v_0 \cos\theta = v_{0x,\,ORIGINAL}}$ (3)

↳ YES, SAME SPEED TO GET BACK!

NOTE BOOK

2) T3 7-45 CONTINUED

FIND v_{0x4} FROM CONSERVATION OF MOMENTUM

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

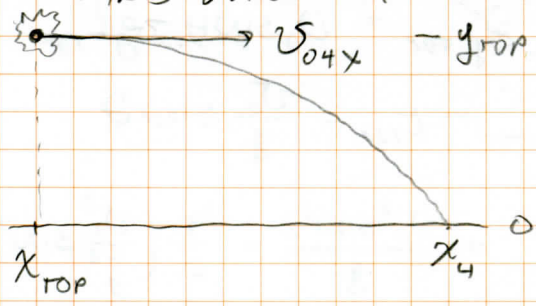
$$m_6\vec{v}_{0x} = m_2\vec{v}_{02} + m_4\vec{v}_{04}$$

$$m_6 v_{0x} = -m_2 v_{02x} + m_4 v_{04x} \qquad (v_{02} \text{ IS BACKWARDS})$$

$$v_{04} = \frac{1}{m_4}\left(m_6 v_{0x} + m_2 v_{02x}\right) = \frac{m_6 + m_2}{m_4} v_{0x}$$

$$v_{04} = 2v_{0x} = 2v_0\cos\theta = 69.2\ \frac{m}{s}$$

FIND LANDING PLACE OF 4 kg MASS



$$x_4 = x_{04} + v_{04x}\, t_{FALL}$$

t_{FALL} SAME AS FOR m_2

$$x_4 = x_{TOP} + (2v_0\cos\theta)\left(\frac{v_0}{g}\sin\theta\right)$$

$$x_4 = \frac{v_0^2}{g}\sin\theta\cos\theta + \frac{2v_0^2}{g}\sin\theta\cos\theta$$

$$x_4 = \frac{3v_0^2}{g}\sin\theta\cos\theta = \frac{3(40)^2}{9.8}\sin(30)\cos(30)$$

$$\boxed{x_4 = 212\text{m}}$$ ← m_4 LANDS 212m FROM LAUNCH

b. FIND h ENERGIES

$$\vec{T}_i + \vec{T}_{EXPLOSION} = \vec{T}_f$$

$$T_{EX} = \frac{1}{2}m_4 v_{04}^2 + \frac{1}{2}m_2 v_{02}^2 - \frac{1}{2}m_6 v_{06}^2$$

$$T_{EX} = \frac{1}{2}(4)(69)^2 + \frac{1}{2}(2)(35)^2 - \frac{1}{2}(6)(35)^2 = \boxed{7200\text{ J} = E_{EX}}$$