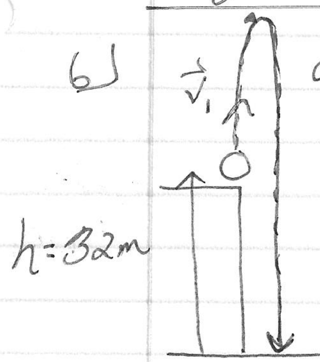
Day 4. Section 1.2 Questions #6, 7 (pg 21)

6)



a) $\vec{v}_1 = 18\,m/s$ [up] Let up = +

$\Delta\vec{d} = 32\,m$ [down]

$\vec{a} = 9.80\,m/s^2$ [down]

$\Delta t = ?$

$$\Delta\vec{d} = \vec{v}_1 \Delta t + \frac{1}{2}\vec{a}\,\Delta t^2$$

$$-32 = 18\Delta t + \frac{1}{2}(-9.80)\Delta t^2$$

$$\therefore\ 4.90\Delta t^2 - 18\Delta t - 32 = 0$$

Solve for Δt using quadratic formula:

$a = 4.90 \quad b = -18 \quad c = -32$

$$\Delta t = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

$$\Delta t = \frac{18 \pm \sqrt{18^2 - 4(4.90)(-32)}}{2(4.90)}$$

$$\Delta t = \frac{18 \pm 30.84}{9.80} \rightarrow \Delta t = -1.31\,s \text{ OR } 4.98\,s$$

inadmissable (this is the time for the ball to rise to its launch height from the ground if on the other side of the parabolic trajectory).

$\therefore$ the ball hits the ground in 5.0 s.

b) $\vec{V}_2 = ?$

$\vec{V}_1 = 18\,m/s$ [up]

$\Delta\vec{d} = -32\,m$ [down]

$\vec{a} = 9.80\,m/s^2$ [down]

up = +

$$\Delta\vec{d} = \frac{\vec{V}_2^{\,2} - \vec{V}_1^{\,2}}{2\vec{a}}$$

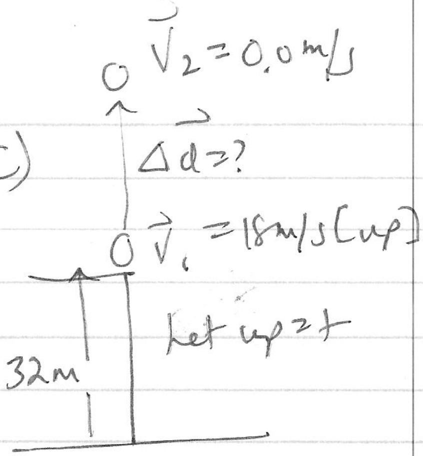
$$\therefore\ V_2 = \pm\sqrt{V_1^2 + 2a\Delta d}$$

$$\therefore\ V_2 = \pm\sqrt{(18)^2 + 2(-9.80)(-32)}$$

$$\vec{V}_2 = \pm 30.84\ m/s$$

$\therefore$ the velocity of the ball is 31 m/s [down] when it hits the ground.

c)



$$\Delta\vec{d} = \frac{\vec{V}_2^{\,2} - \vec{V}_1^{\,2}}{2\vec{a}}$$

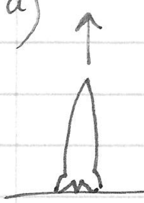
$$\Delta\vec{d} = \frac{0 - (18\,m/s)^2}{(2)(-9.80\,m/s^2)}$$

$$\Delta\vec{d} = 16.53\,m$$

$\therefore$ max height $= 32\,m + 16.53\,m = 48.53\,m \approx \underline{49\,m}$

d) As the ball was launched from a point above ground, the path is not symmetric about the maximum height. It takes longer for the ball to fall from its peak height to the ground than it takes the ball to rise to the peak from its launch point.

7) a)



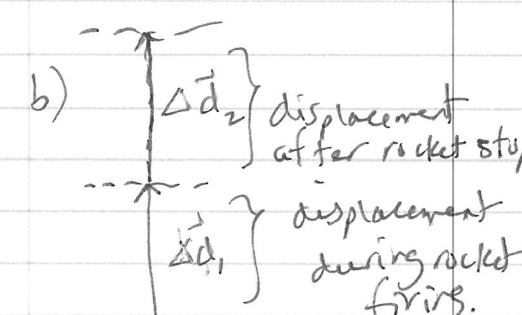
$\vec{V}_1 = 0.0\,m/s$
$\Delta t = 5.0\,s$
$\vec{a} = 39.2\,m/s^2\,[up]$
$\vec{V}_2 = ?$

Let up = +

$$\vec{V}_2 = \vec{V}_1 + \vec{a}\Delta t$$
$$\vec{V}_2 = 0.0 + (39.2\,m/s^2)(5.0\,s)$$
$$\vec{V}_2 = 196.\,m/s\,[up]$$

$\therefore$ the velocity is $2.0\times10^2\,m/s$ [up] after 5.0 s.

b)



$\Delta\vec{d}_1 = ?$
$\vec{V}_1 = 0.0\,m/s$
$\vec{V}_2 = 196.\,m/s\,[up]$
$\vec{a} = 39.2\,m/s^2\,[up]$

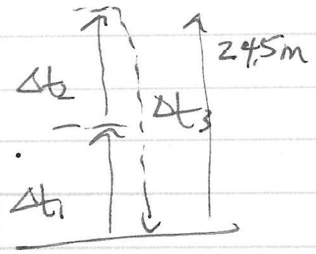
$$\Delta\vec{d}_1 = \frac{\vec{V}_2^{\,2} - V_1^2}{2\vec{a}} = \frac{196^2 - 0}{2(39.2)} = 490\,m\,[up]$$

$\Delta\vec{d}_2 = ?$
$\vec{V}_2 = 0.0\,m/s$
$\vec{V}_1 = 196.\,m/s\,[up]$
$\vec{a} = 9.80\,m/s^2\,[down]$

$$\Delta\vec{d}_2 = \frac{\vec{V}_2^{\,2} - \vec{V}_1^{\,2}}{2\vec{a}} = \frac{0.0 - (196)^2}{2(-9.80)} = 1960\,m\,[up]$$

$\therefore$ max height
$= \Delta\vec{d}_1 + \Delta\vec{d}_2$
$= 490\,m + 1960\,m$
$= 2450\,m$
$= 2.4\times10^3\,m$

Solve for $\Delta t_1 + \Delta t_2$

c) 

$\Delta t_1 = \dfrac{\vec{V}_2 - \vec{V}_1}{\vec{a}} = \dfrac{196 - 0}{39.2} = 5.00s$ ← note this was already given!

$\Delta t_2 = \dfrac{\vec{V}_2 - \vec{V}_1}{\vec{a}} = \dfrac{196 - 0}{-9.80} = 20.0s$

Solve for Δt_3: $\Delta \vec{d} = \vec{V}_1 \Delta t + \frac{1}{2}\vec{a}\Delta t^2$

$\vec{V}_1 = 0$

$\Delta \vec{d} = 2450m\,[\downarrow]$ $\quad 2450 = \cancel{(0.0)(\Delta t)}^{\,0} + \frac{1}{2}(9.80)(\Delta t^2)$

Let down = +

$\Delta t = \pm\sqrt{\dfrac{2(2450)}{9.80}} = 22.36s$

∴ the total time for the rocket to hit the ground is
$5.00s + 20.0s + 22.36s = 47.36s \simeq \underline{\underline{47s}}$

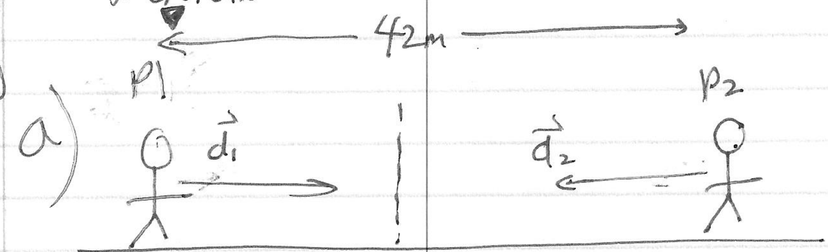
∴ the rocket lands in 47s.

Day 5 Section 1.2 pg 19 Question #5

Choose P1 position as ORIGIN

5)

a)



Let R=+

$\vec{v}_1 = 0.0\ m/s$

$\vec{a}_1 = 2.4\ m/s^2\,[R]$

$\vec{v}_2 = 5.4\ m/s\ (L)$

$\vec{d}_1 = 0.0 + \frac{1}{2} a \Delta t^2$

$= \frac{1}{2}(2.4\ m/s^2)\Delta t^2$

$\vec{d}_2 = 42.0m + v_2 \Delta t$

$= 42.0m - 5.4\ m/s\ \Delta t$

When the collide, $\vec{d}_1 = \vec{d}_2$. Equate the two expressions and solve for Δt.

$\therefore \vec{d}_1 = \vec{d}_2$

$\frac{1}{2}(2.4)\Delta t^2 = 42.0 - 5.4\Delta t$

$\therefore 1.2\Delta t^2 + 5.4\Delta t - 42.0 = 0 \quad a = 1.2,\ b = 5.4,\ c = -42.$

Use quadratic formula: $a = 1.2,\ b = 5.4,\ c = -42.0$

$$\Delta t = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a} = \frac{-5.4 \pm \sqrt{5.4^2 - 4(1.2)(-42.0)}}{2(1.2)}$$

$$= \frac{-5.4 \pm 15.19}{2.4}$$

$$= -8.58\,s \quad \text{OR} \quad 4.08\,s$$

$\therefore$ they collide in 4.1 s.

b) $\Delta \vec{d}_1 = ?$ $\quad \Delta \vec{d}_1 = \frac{1}{2}\vec{a}_1 \Delta t^2$

$\Delta \vec{d}_2 = ?$

$= \frac{1}{2}(2.4 m/s^2)(4.08 s)^2 = 19.97 m [R] \simeq 20. m [R]$

$\Delta \vec{d}_2 = \vec{V}_2 \Delta t$

$= (-5.4 m/s)(4.08 s) = -22.0 m \simeq 22 m [L]$

c) $\vec{V}_{2_1} = ?$ $\quad \vec{V}_{2_1} = \vec{V}_{1_1} + \vec{a}_1 \Delta t$

$= \emptyset + (2.4 m/s^2)(4.08 s) = 9.791 \frac{m}{s} [R] \simeq 9.8 \frac{m}{s} [R]$

∴ player 1 travels $2.0 \times 10^1 m$ [R], and player 2 travels 22 m [L] before they collide. Player 1 is travelling at 9.8 m/s [R] when they collide.