

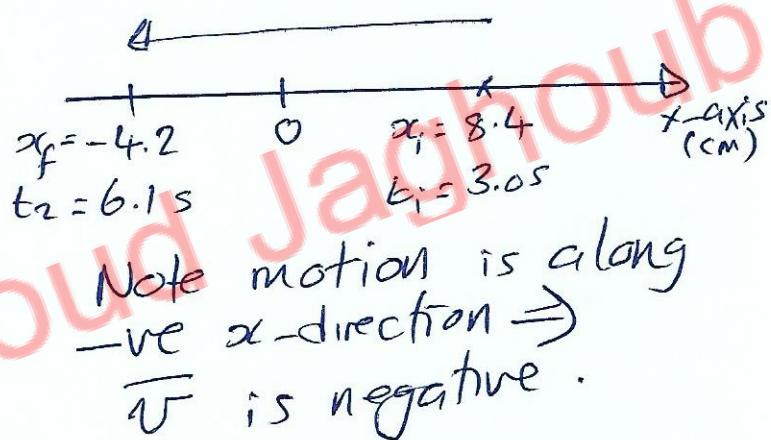
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Solutions for Chapter(2) | Giancoli | 7th edition.
Prof. Mahmoud Jaghoub

4] $x_1 = 8.4 \text{ cm}, x_2 = -4.2 \text{ cm}$

$$\begin{aligned}\overline{v} &= \frac{v(6.1) - v(3)}{6.1 - 3} \\ &= \frac{-4.2 - 8.4}{3.1} \\ &= -4.06 \text{ cm/s} \\ &= -4.06 \times 10^{-2} \text{ m/s}\end{aligned}$$



20] $v_i = 65 \frac{\text{km}}{\text{h}} = 65 \times \frac{1000}{3600} \frac{\text{m}}{\text{s}} \approx 18.1 \text{ m/s}$

$$v_f = 120 \frac{\text{km}}{\text{h}} \approx 33.3 \text{ m/s}$$

$a = 1.8 \text{ m/s}^2$. [Note because a in m/s^2 we change v from $\frac{\text{km}}{\text{h}}$ → m/s . Alternatively you can leave v in km/h but have to change $a \Rightarrow \text{km/h}^2$]
 $[a = 23328 \text{ km/h}^2]$

$$v_f = v_i + at$$

$$t = \frac{v_f - v_i}{a} = \frac{33.3 - 18.1}{1.8} \approx 8.4 \text{ s.}$$

28] comming to a stop $\Rightarrow v_f = 0$. $v_i = ?$

$$a = -4 \text{ m/s}^2$$

$$x_i = 0$$

$$v_f = 0$$

$$x_f = 65 \text{ m}$$

$$v_f^2 - v_i^2 = 2a(x_f - x_i)$$

$$0 - v_i^2 = 2(-4)(65 - 0) \Rightarrow v_i \approx 22.8 \text{ m/s}$$

39] Time of flight = 3.4 s

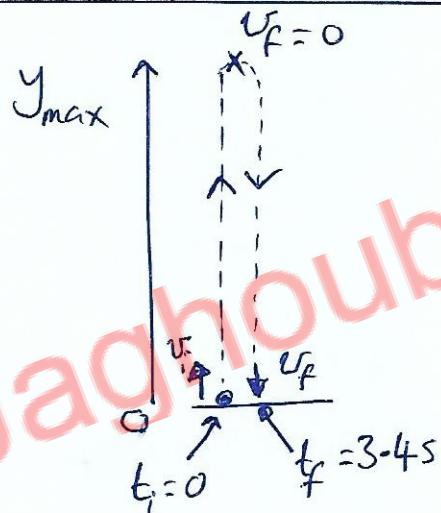
$$\text{Time to max. height} = \frac{3.4}{2} = 1.7 \text{ s.}$$

+ $\ddot{a} = -g$

$$y_f - y_i = v_i t - \frac{1}{2} g t^2$$

$$0 - 0 = v_i(3.4) - \frac{9.81}{2}(3.4)^2$$

$$\therefore v_i \approx 16.66 \text{ m/s.}$$



$$y_{\max} - y_i = v_i t - \frac{1}{2} g t^2$$

$$y_{\max} - 0 = 16.66(1.7) - \frac{9.81}{2}(1.7)^2$$

$$y_{\max} \approx 14.1 \text{ m.}$$

Note: time to reach y_{\max} is 1.7 s.

Alternatively:

$$\text{at max. height } -v_f^2 - v_i^2 = -2g(y_{\max} - y_i)$$

$$0 - (16.66)^2 = -2(9.81)(y_{\max} - 0)$$

$$\therefore y_{\max} \approx 14.1 \text{ m} \quad \underline{\text{as before!}}$$

43] $\uparrow \alpha = -g \Rightarrow v_i = 24 \text{ m/s}$.

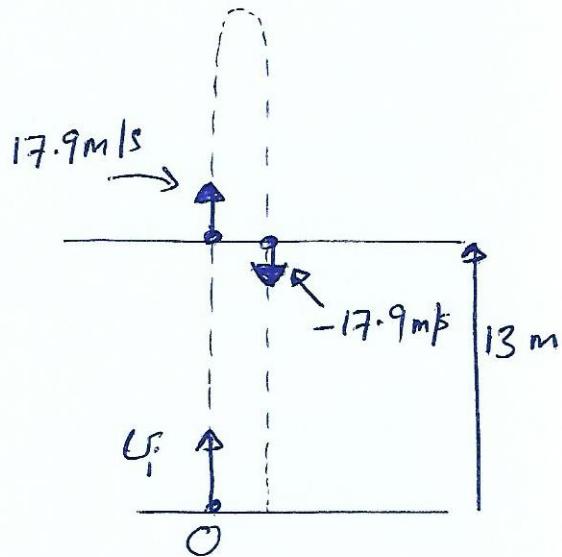
a) $v_f^2 - v_i^2 = -2g(y_f - y_i)$

$$v_f^2 - (24)^2 = -2(9.81)(13 - 0)$$

$$\Rightarrow v_f = \pm 17.9 \text{ m/s}$$

$v_f = 17.9$ while moving up

$v_f = -17.9$ while moving down.



b) $y_f - y_i = v_i t - \frac{1}{2} g t^2$

$$13 - 0 = 24t - \frac{9.81}{2} t^2$$

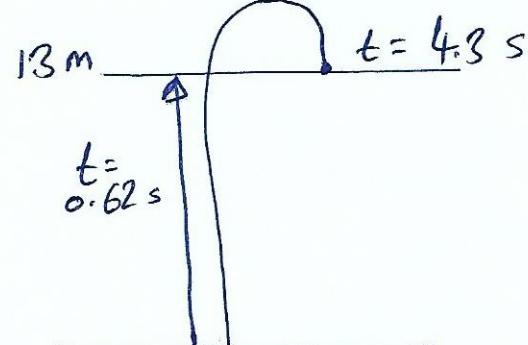
$$4.905 t^2 - 24t + 13 = 0$$

$$t = \frac{24 \pm \sqrt{(24)^2 - 4(4.905)(13)}}{2 \times 4.905} = \frac{24 \pm \sqrt{320.94}}{9.81}$$

$t = \frac{24 - 17.9}{9.81} \approx 0.62 \text{ s}$. (on the way up)

$$t = \frac{24 + 17.9}{9.81} \approx 4.3$$

(on the way down).



$$v_i = 15.5 \text{ m/s}$$

65] \uparrow $a = -g$

(a) $y_f - y_i = v_i t - \frac{1}{2} g t^2$
 $0 - 75 = 15.5t - \frac{9.81}{2} t^2$
 $4.905t^2 - 15.5t - 75 = 0$

$$t = \frac{15.5 \pm \sqrt{(15.5)^2 - 4(4.905)(-75)}}{2 \times 4.905}$$

$$= \frac{15.5 \pm 41.4}{9.81}$$

$$t = \frac{15.5 + 41.4}{9.81} \approx 5.80 \text{ s} \quad (\text{ignore negative value}).$$

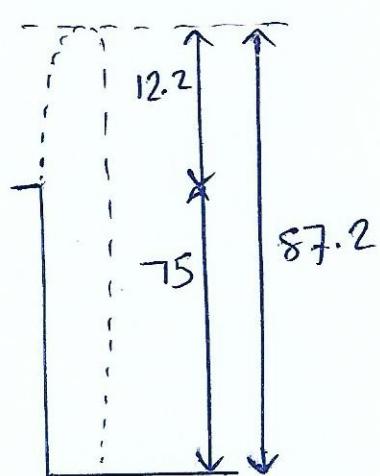
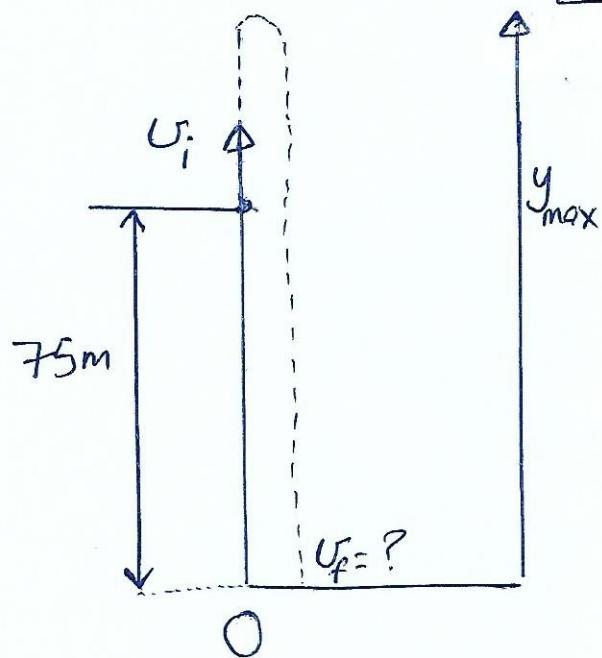
(b) $v_f = v_i - gt = 15.5 - 9.81(5.8) \approx -41.4 \text{ m/s}$
 (moving down)

(c) $v_f^2 - v_i^2 = -2g(y_{\max} - y_i)$
 $0 - (15.5)^2 = -2(9.81)(y_{\max} - 75)$
 $\therefore y_{\max} \approx 87.2 \text{ m}$

$$\text{total distance covered} = (87.2) \times 2 - 75 = 99.4 \text{ m}$$

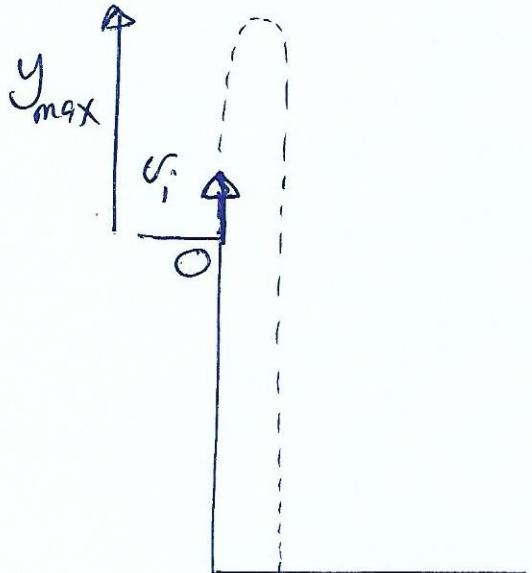
$$\text{average speed } \bar{s} = \frac{99.4}{5.80} = 17.1 \text{ m/s}$$

$$\text{average velocity } \bar{v} = -\frac{-41.4 + 15.5}{2} = \frac{v_f + v_i}{2} \approx -13 \text{ m/s}$$



OR $\bar{v} = \frac{y_f - y_i}{t_f - t_i} = \frac{0 - 75}{5.8} \approx -13 \text{ m/s}$

Suppose a student chose the origin at the cliff of the building. and still chose up as positive.



$$\textcircled{a} \quad y_f - y_i = v_i t - \frac{1}{2} g t^2$$

$$-75 - 0 = (15.5)t - \frac{9.81}{2}t^2$$

$$\therefore 4.905t^2 - 15.5t - 75 = 0$$

$$\text{(same as before)} \Rightarrow t \approx 5.80 \text{ s.}$$

$$\text{Note: } y_i = 0$$

$$\textcircled{b} \quad v_f^2 - v_i^2 = -2g(y_{\max} - y_i)$$

$$0 - (15.5)^2 = -2(9.81)(y_{\max} - 0) \Rightarrow y_{\max} \approx 12.2 \text{ m/s.}$$

$$\textcircled{c} \quad \text{distance covered} = 2 \times y_{\max} + 75$$

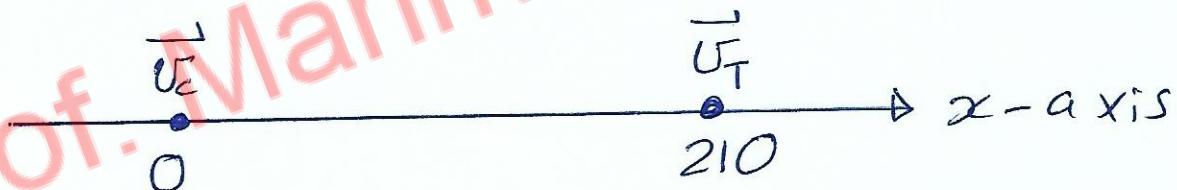
$$= 2 \times 12.2 + 75 = 99.4 \text{ m as before.}$$

Solutions to selected Problems
Chapter 2 / Giancoli 7th edition

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2] average speed $\bar{s} = \frac{\text{total distance}}{\text{total time}} = \frac{235}{2.75} \approx 85.5 \frac{\text{km}}{\text{h}}$

11] Note the car and the truck are moving at constant velocities $\Rightarrow a=0$ for each.



$$x_f - x_i = v_i t + \frac{1}{2} a t^2 = v_i t \quad \text{since } a = 0$$

for car: $x_f^c - 0 = v_c t$ (at $t=0$ the car was at $x=0$)

for truck: $x_f^T - \frac{210}{1000} = v_T t$ (at $t=0$ the truck was at $x=210 \text{ m}$)

$$\therefore x_f^c = 95t$$

$$x_f^T = \frac{210}{1000} + 75t$$

when the car reaches the truck $\Rightarrow x_f^c = x_f^T$

$$\Rightarrow 95t = \frac{210}{1000} + 75t \Rightarrow 20t = \frac{210}{1000}$$

$$\therefore t = 0.0105 \text{ h} = 37.8 \text{ s}$$

$$23] v_i = 14 \text{ m/s} , v_f = 21 \text{ m/s} , \Delta t = 6 \text{ s} .$$

$$v_f = v_i + at \Rightarrow a = \frac{v_f - v_i}{t} = \frac{21 - 14}{6} = \frac{7}{6} \text{ m/s}^2$$

$$x_f - x_i = v_i t + \frac{1}{2} a t^2$$

$$\Delta x = x_f - x_i = 14(6) + \frac{1}{2} \left(\frac{7}{6}\right)(6)^2 = 105 \text{ m} .$$

$$24] v_i = 0 , v_f = 35 \text{ m/s} , a = 3 \text{ m/s}^2$$

$$v_f^2 - v_i^2 = 2a(x_f - x_i)$$

$$(35)^2 - 0 = 2(3)\Delta x$$

$$\therefore \Delta x = \frac{(35)^2}{6} \simeq 204.2 \text{ m}$$

$$30] v_i = 95 \frac{\text{km}}{\text{h}} \simeq 26.4 \text{ m/s} .$$

During the reaction time (0.4s) the car moves at constant velocity and moves a distance $\Delta x_1 = 0.4 \times 26.4 = 10.56 \text{ m}$.

The car moves an additional distance during deceleration.

$$(i) a = -3 \text{ m/s}^2 \Rightarrow v_f^2 - v_i^2 = 2a \Delta x_2$$

$$\Delta x_2 = \frac{0 - (26.4)^2}{2(-3)} = 116.16 \text{ m}$$

$$\Rightarrow \text{total stopping distance} = 10.56 + 116.16 = 126.72 \text{ m}$$

$$(ii) a = -6 \Rightarrow \Delta x_2 = \frac{0 - (26.4)^2}{2(-6)} = 58.1 \text{ m}$$

$$\Rightarrow \text{total stopping distance} = 58.1 + 10.56 = 68.66 \text{ m}$$

$$31] v_i = 18 \text{ m/s} , a = -3.65 \text{ m/s}^2$$

Displacement covered before applying the breaks (during the reaction time) is

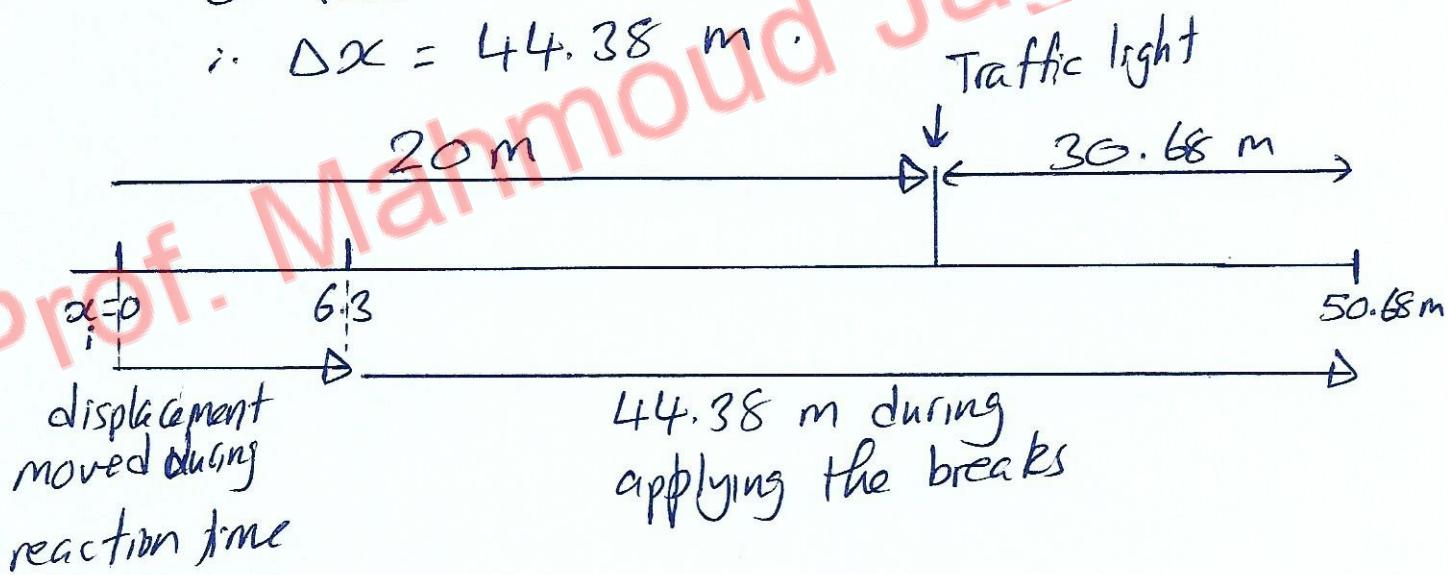
$$\Delta x_i = 18 \times 0.35 = 6.3 \text{ m.}$$

Displacement while applying breaks until car stops is

$$v_f^2 - v_i^2 = 2a \Delta x$$

$$0 - (18)^2 = 2(-3.65) \Delta x$$

$$\therefore \Delta x = 44.38 \text{ m.}$$



she will not stop on time. She will pass the traffic light. When it stops the car will be at $x = 50.68 \text{ m} = 6.3 + 44.38$

That is $50.68 - 20 = 30.68 \text{ m}$ past the traffic light.

$$35] v^{\text{Mary}} = v^M, v^{\text{Sally}} = v^S$$

make a sketch of the situation at $t=0$

$$\rightarrow v_i^M = 4 \text{ m/s} \quad \rightarrow v_i^S = 5 \text{ m/s}$$

Write the equation of motion for each:

$$\text{For Mary: } x_f^M - x_i^M = v_i^M t + \frac{1}{2} a t^2$$

$$x_f^M - 0 = 4t + \frac{1}{2}at^2 \Rightarrow x_f^M = 4t + \frac{1}{2}at^2 \quad \text{--- (1)}$$

$$\text{For Sally: } x_f^S - x_i^S = v_i^S t + \frac{1}{2}a_s t^2$$

$$x_f^S - 5 = 5t - 0.2t^2$$

$$x_f^S = 5 + 5t - 0.2t^2 \quad \text{--- (2)}$$

crossing the line side-by-side $\Rightarrow x_M = x_S = 22$ at the same instant of time t . We use (2) to find t :

$$22 = 5 + 5t - 0.2t^2 \Rightarrow 0.2t^2 - 5t + 17 = 0$$

$$\therefore t = 4.05 \text{ (ignore } t = 21 \text{ s, see below)}$$

Substitute for t in (1) to find $a \Rightarrow$

$$22 = 4(4.05) + \frac{1}{2}a(4.05)^2 \Rightarrow a \approx 0.71 \text{ m/s}^2$$

\Rightarrow Mary has to accelerate at 0.71 m/s^2 .

Note another solution for $t \approx 21 \text{ s}$

This time means Sally will be at $x = 22 \text{ m}$ while moving to the left after reversing her direction of motion. But surely she will stop when she reaches the finish line. So just ignore $t = 21 \text{ s}$.

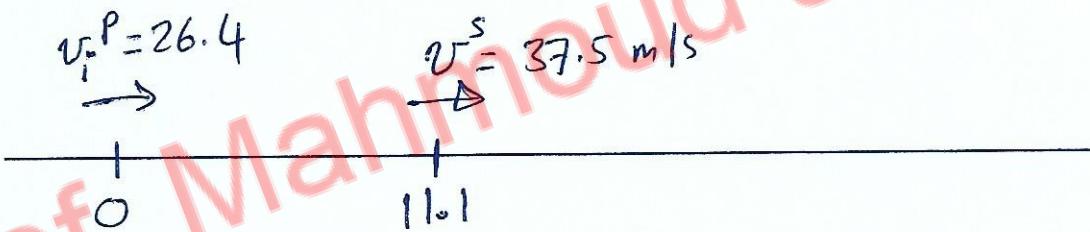
$$36] \quad v^{\text{speeder}} = v^s \quad , \quad v^{\text{police}} = v^p$$

$$v^s = 135 \frac{\text{km}}{\text{h}} = 37.5 \text{ m/s} \cdot (\text{constant}) .$$

$$v^p = 95 \frac{\text{km}}{\text{h}} = 26.4 \text{ m/s}$$

Assume $t=0$ when the policeman starts to accelerate and assume the policeman to be at the origin at this moment ($t=0$).

Also, at $t=0$ the speeder is ahead of the policeman by $(37.5 - 26.4) \times 1 = 11.1 \text{ m}$



$$\text{for policeman } x_f^p - x_i^p = v_i^p t + \frac{1}{2} a t^2$$

$$x_f^p - 0 = 26.4 t + \frac{1}{2} (2.6) t^2$$

$$\text{for speeder } x_f^s - 11.1 = 37.5 t \quad (\text{note } a=0 \text{ for speeder})$$

at the moment of overtaking \Rightarrow

$$x_f^p = x_f^s$$

$$26.4 t + 1.3 t^2 = 11.1 + 37.5 t$$

$$1.3 t^2 - 11.1 t - 11.1 = 0$$

$$t = \frac{11.1 \pm \sqrt{(11.1)^2 - 4(1.3)(-11.1)}}{2(1.3)} = \frac{11.1 \pm 13.5}{2.6}$$

$$\therefore t = \frac{24.6}{2.6} \sim 9.46 \text{ s}$$

just to check calculate
 x_f^p and x_f^s

at $t=9.46 \text{ s}$.

You will find they are equal

$\sim 366 \text{ m}$.

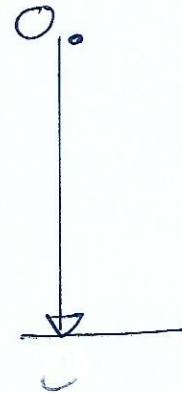
37] dropped $\Rightarrow v_i = 0$

$$\downarrow \boxed{a = +g}$$

$$y_f - y_i = v_i t + \frac{1}{2} g t^2$$

$$y_f - 0 = 0 + \frac{1}{2} (9.81) (3.55)^2$$

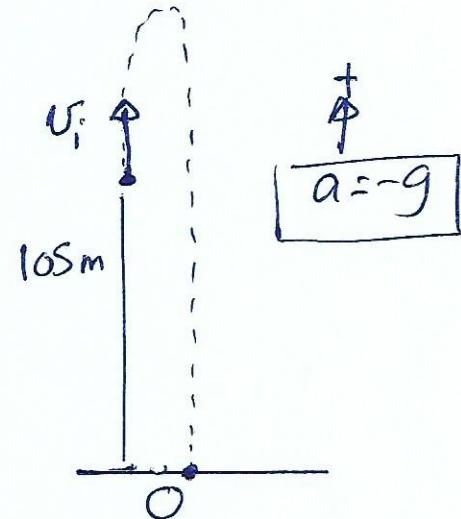
$$y_f = 61.8 \text{ m} \equiv \text{height of cliff.}$$



46] At the instant of dropping the package, it must have the same ^{initial} upward speed as the helicopter. That is it does NOT start moving down immediately after release.

At $t=0$ the system looks like in the graph.

$v_i = 5.4 \text{ m/s}$, at a height of 105 m. Note after dropping the package is in free fall.



$$y_f - y_i = v_i t - \frac{1}{2} g t^2$$

$$0 - 105 = 5.4 t - 4.905 t^2$$

$$4.905 t^2 - 5.4 t - 105 = 0$$

$$\Rightarrow t = \frac{5.4 \pm \sqrt{(5.4)^2 - 4(4.905)(-105)}}{2(4.905)} = \frac{5.4 \pm 45.7}{9.81}$$

$$t = 5.2 \text{ s} \text{ (ignore negative answer).}$$