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Section : -c

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Question # 1

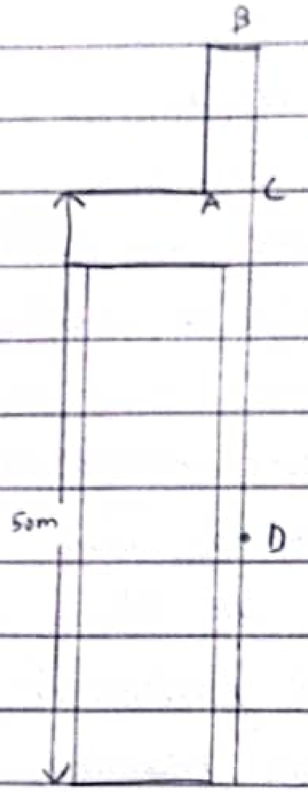
A stone thrown from the top of building is given an initial velocity of $20ms^{-1}$ straight upward. The stone is launched 50m above the ground, and stone just misses the edge of the roof on its way down as shown in fig

(a) Using $t_A = 0$ as the time the stone leaves the thrower's hand at position A Determine time at which the stone reaches its Maximum height.

(b) Find the Maximum height of the stone

(c) Find the velocity and position of stone when it ~~entered~~ returns to the height where it was thrown

(d) What if the throw was from 30m above the ground instead of 50m. Which answer in part (a) to (d) would change.



$V_i = 20 m/s$

(a) As $v_f = 0$, $g = -10 ms^{-2}$

$v_f = v_i + gt$

$0 = 20 + (-10)t$

$\boxed{t = 2s}$

(b) For Maximum height,

Using 3rd equation:-

$2aS = v_f^2 + v_i^2$

$2(-10)S = 0 - (20)^2$

$-20S = -400$

$\boxed{S = \frac{-400}{-20} = 20m}$ from where ball is thrown

$\rightarrow$ $\boxed{S = 20+50 = 70m}$ Actual highest hight

(c) As $t = 2s$ (time for upword motion is equal to time for downword motion)

$v_f = v_i + gt$

$v_f = 0 + (-10)(2)$

$\boxed{v_f = -20ms^{-1}}$

(d) As $t = 3$ (tim for down motion only)

For v_f:-

$v_f = v_i + gt$

$v_f = 0 - (10)3$

$\boxed{v_f = -30ms^{-1}}$

For S:-

$S = v_i t + \frac{1}{2}gt^2$

$S = (0\times3) + \frac{1}{2}(10)9$

$\boxed{S = 45}$ (hight w.r.t highest point)

(e)

if ~~throug~~ throw was from 30m instead of 50m

than max. hight would change

For hight :- (from top of building)

$$2aS = v_f^2 - v_i^2$$

$$2(-10)S = 0 - (20)^2$$

$$\boxed{S = 20m}$$

Actual hight :-

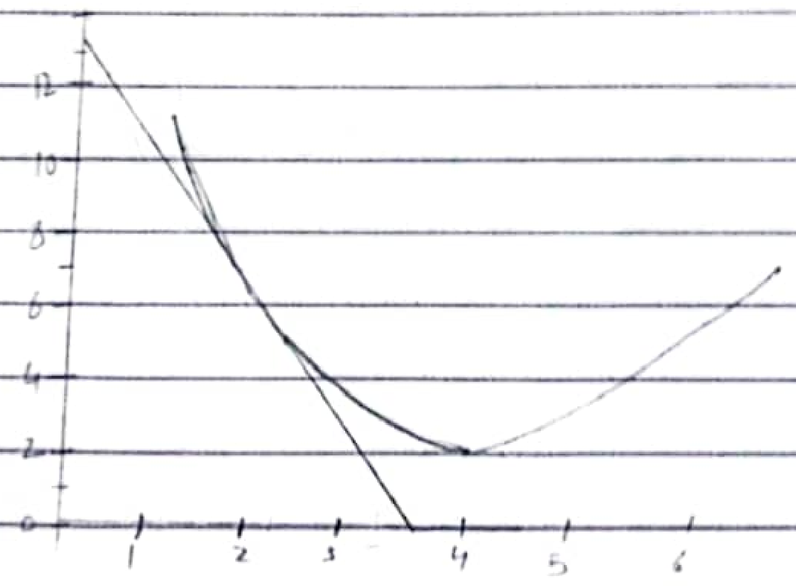
$$S = 20 + 30$$

$\boxed{S = 50m}$ hight point from ground.

Question # 2

A position-time graph for a particular moving along x-axis (a) Find the average velocity in the time interval $t = 1.5s$ to $t = 4s$ (b) Determine the instantenous velocity at $t = 2s$ by measuring the slope of the tangent (c) At what value of t is the velocity zero?

Answer # 2



$$V_{avg} = \frac{x_2 - x_1}{t_2 - t_1}$$

$$= \frac{2 - 8}{4 - 1.5}$$

$$= -2.4 m/s$$

(b) V_{ins} at $t = 2s$

Slope of tangent $= \frac{2 - 9.5}{3 - 1}$

$$= -3.7 ms^{-1}$$

(c) At $t = 4s$, velocity is zero

As tangent at 4s is horizontal and slope of horizontal tangent is zero

Question # 3

A truck on a straight road strat from rest, accelerating at $2 m/s^2$ until it reaches a speed of $20 m/s$. Then the truck travels for 20s at const speed until the brakes are applied, stopping the truck in a uniform manner in an additional 5s. (a) How long is the truck in motion? (b) What is the avg velocity of the truck for the motion described?

(a) Total motion & time:-

phase 1 :- $a = 2 m/s^2$, $v_f = 20 m/s$

$$v_f = v_i + at$$

$$20 = 0 + 2(t)$$

$$\boxed{10s = t_1}$$

phase 2 :- $20s = t_2$

phase 3 :- $5s = t_3$

$$t = t_1 + t_2 + t_3$$

$$= 10 + 20 + 5 = 35s$$

(b) Avg velocity :-

$$v_{avg} = \frac{\Delta x}{t_{total}}$$

For $\Delta x_1 = v_i t + \frac{1}{2} a t^2$

$= 0 \times t + \frac{1}{2}(2)(10)^2$

$\boxed{\Delta x_1 = 100m}$

For $\Delta x_2 = v \cdot t$

$= 20 \times 20$

$\boxed{\Delta x_2 = 400m}$

~~For $\Delta x_3 = v_i t + \frac{1}{2} a t^2$~~

For $\Delta x_3 = \frac{1}{2}(v_i + v_f) \cdot t$

$= \frac{1}{2}(20 + 0) \cdot 5$

$\boxed{\Delta x_3 = 50m}$

For $\Delta x = \Delta x_1 + \Delta x_2 + \Delta x_3$

$= 100 + 400 + 50$

$\boxed{\Delta x = 550m}$

$$v_{avg} = \frac{\Delta x}{\Delta t} = \frac{550}{35} = 15.7 \, m/s$$

Question #4

A shelter Island ferry boat moves with a constant velocity $V_{0x} = 8m/s$ for 60sec. It then shuts off its engines and coasts. Its coasting velocity is given by $V_x = V_{0x}\, t_1^2/t^2$, where $t_1 = 60s$. What is the displacement of the boat for the interval $0 < t < \infty$?

For interval $t=0$ to $t=60s$

$V_{0x} = 8m/s$

$$S_1 = v \times t = 8 \times 60 = 480m$$

For interval $t=60$ to $t=\infty$

$v_i = 8m/s$,

$$v_x = v_0 \cdot \frac{t_1}{t}$$

$$S_2\ \cancel{\Delta x_T} = \int_t^{\infty} v_x\, dt$$

$$S_2 = \int_{t_1}^{\infty} v_{0x}\, dt$$

$$= \int_{t_1}^{\infty} v_{0x} \left(\frac{t_1}{t}\right)^2 dt$$

$$= \int_{60}^{\infty} (8)\, \frac{(60)^2}{t^2}\, dt$$

$$= \int_{60}^{\infty} 28800\, \frac{1}{t^2}\, dt$$

$$= 28800 \left[\frac{t^{-2+1}}{-2+1} \right]_{60}^{\infty}$$

$$= 28800 \left[\left(-\frac{1}{\infty}\right) - \left(-\frac{1}{60}\right) \right]_{60}^{\infty}$$

$$= 28800 \left[0 + 0.016 \right]$$

$$S_2 = 480 \text{ m}$$

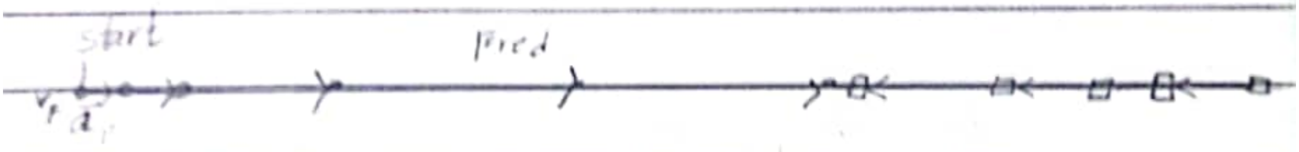
Also ; $S_1 = v_{0x} t = 8 \times 60 = \underline{480 \text{ m}}$

$$\boxed{S = S_1 + S_2 = 480 + 480 = 960 \text{ m}}$$

Question # 5

Fred catches the football while starting directly on the goal line. He immediately starts running forward with acceleration of $6 ft/s^2$. As catch is made. Tommy is twenty yards away and is towards Fred with $15 ft/s$. where tommy tackle Fred

Answer # 5



$a_F = 6 ft/s^2$

$v_T = 15 ft/s$

Freed motion.

$$\boxed{x_F = \frac{1}{2} a_F t^2} = \frac{1}{2}(6)t^2 = 3t^2$$

Tommy motion.

$$x_T = 60 - v_T$$

$$\boxed{x_T = 60 - 15t} = -4$$

For time they meet.

$$x_F = x_T$$

$$\cancel{\frac{1}{2} a_F t^2 = 60}$$

$$3t^2 = 60 - 15t$$

$$3t^2 + 15t - 60 = 0$$

$$t^2 + 5t - 20 = 0$$

By Quadratic equation

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

$$= \frac{-5 \pm \sqrt{25 \cdot 4(1)(-20)}}{2}$$

$$t = \frac{-5 \pm 10.25}{2}$$

$$t = \frac{-5 + 10.25}{2}, \quad t = \frac{-5 - 10.25}{2}$$

$$\boxed{t = 2.63\,s} \qquad t = \text{Discard Negative value}$$

let $t = 2.63s$ in x_F

$= 3t^2 =$

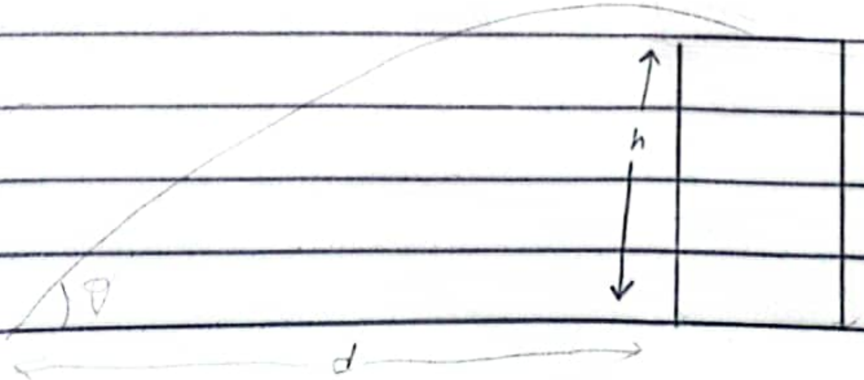
$= 3(2.63)^2$

$\boxed{= 20.76 \text{ feet}}$

Question #6

A playground is on the flat root of a city school, 6m above the street, the vertical wall of the building is $h = 7m$ high, forming a 1m high railing around the playground. A ball fallen to the street below, and a passerby returns it by launching it at an angle of $\theta = 53°$ above the horizontal at a point p $d = 24m$ from the base of the building wall. The ball takes 2.2s to reach point vertically above the ~~b~~ wall
(a) Find the speed at which ball is launched
(b) Find the vertical distance by which the ball clears the wall, (c) Find the horizontal distance.

Answer # 6



(a) As we know, (c)

$x = v_x t$

$x = v_0 \cos\theta \times t \qquad v_x = v_0\cos\theta$

$24 = v_0 \cos 53 \times 2.2$

$\frac{24}{2.2} = v_0 \cos 53$

$\boxed{v_0 = 18.1\ ms^{-1}}$

(b)

$y = v_{0y} t - \frac{1}{2} g t^2$

$y = v_0 \sin 53 (2.2) - \frac{1}{2}(+10)(2.2)^2$

$\boxed{y = 8.2\ m}$

As $\Delta y = y_f - y_i$

$= 8.2 - 7$

$\boxed{= 1.2m}$ The ball clear wall by $1.2ms^{-1}$

(c) For total horizontal distance

$x_t = v_x t_t$

$\Delta y = v_0 \sin 53 \times t - \frac{1}{2} g t^2$

$6 - 0 = 14.46 \times t - 5 t^2$

$5t^2 - 14.46t + 6 = 0$

By Quadratic equation:-

$$t = \frac{-(-14.6) \pm \sqrt{(-14.5)^2 - 4(4.9)(6)}}{2(4.9)}$$

$$t \quad \frac{14.5 \mp \sqrt{92.65}}{98} , \frac{14.5 - \sqrt{12.6}}{9.8}$$

$\boxed{t_T = 2.5 s}$, $\boxed{t = 0.49 s}$

$x_{total} = V_0 \cos 53 \times t_f$

$x = 18.1 \cos 53 \times 2.5$

$\boxed{x = 27.3m}$

$\Delta x = 27.3 - 24$

$\boxed{\Delta x = 3.3m}$

Question # 7

A motorcycle shunt rider rides off the edge of a cliff. Just at the edge his velocity is horizontal, with magnitude 9m/s Find the motorcycle's position. Distance from the edge of the cliff and velocity after 0.5s.

Answer # 7

$v_x = 9m/s$, $t = 0.5s$ $V_{iy} = 0m/s$

Horizontal motion

$$x = v_x \cdot t$$

$$\boxed{x = 9 \times 5 = 4.5m}$$

Vertical motion:

$$y = v_{iy} \times t + \frac{1}{2} g t^2$$

$$y = \frac{1}{2} \times 10 \times \left(\frac{1}{2}\right)^2$$

$$\boxed{y = 1.23m}$$

Velocity after 0.5 seconds

Horizontal velocity:-

$v_x = 9 m/s$

Vertical velocity

$v_y = v_{iy} \mp gt$

$= 0 + 10 \times \frac{1}{2} = -5 m/s$

Total velocity:-

$v = \sqrt{v_x^2 + v_y^2}$

$= \sqrt{9^2 + 5^2}$

$\boxed{v = 10.25 m/s}$

For θ:-

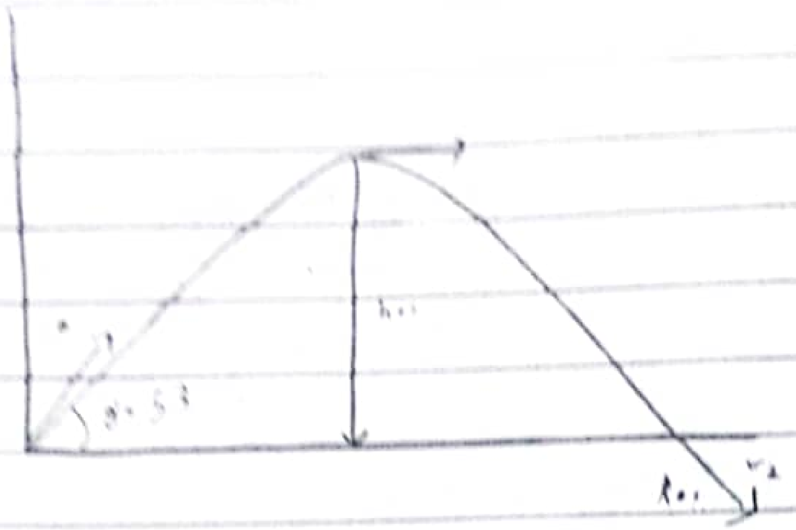
$\theta = \tan^{-1}\left(\frac{v_y}{v_x}\right)$

$= \tan^{-1}\left(\frac{-4.9}{9}\right)$

$\boxed{\theta = -28.6°}$

Question # 8

A batter hits a basket ball so that it leaves the bat at $V_0 = 37 m/s$ at an angle $53.1°$ (a) Find position of the ball and Magnitude at $t = 2s$. (b) Find Range



Answer # 8

$V_0 = 37 m/s$
$\theta = 53.1^\circ$
$t = 2s$

(a) $V_{ix} = V_0 \cos\theta = 37 \cos 53.1 = 22.2 m/s$
$V_{iy} = V_0 \sin\theta = 37 \sin 53.1 = 29.6 m/s$

$x = V_{ix} t$
$= 22.2 \times 2$
$x = 44 m$

Vertical position at $t=2s$

$$y = V_{iy} + t + \frac{1}{2}gt^2$$
$$= 29.6 \times 2 + \frac{1}{2} \times 10 \times 2^2$$
$$\boxed{y = 39.6\,m}$$

velocity at $t=2s$

$$\boxed{V_x = V_{ix} = 22.2\,m/s}$$
$$V_y = V_{iy} - gt$$
$$= 29.6 - 10 \times 2$$
$$= \cancel{19.6\,m/s}\ 19.6$$
$$\boxed{V_y = 9.6\,m/s}$$

$$V = \sqrt{V_x^2 + V_y^2}$$
$$\sqrt{(22.2)^2 + (9.6)^2}$$
$$\boxed{V = 24.34\,m/s}$$

Direction:-

$$\theta = \tan^{-1}\left(\frac{\cancel{V_x}}{V_x}\right)$$
$$= \tan^{-1}\left(\frac{10}{22.2}\right)$$
$$= 24.2^\circ$$

(b) Time for Max. hight

$$V_y = V_{iy} - g\,t$$
$$0 = 29.6 - 10t$$
$$\boxed{t = 2.96s \approx 3s}$$

$$y = V_{iy} \cdot t + \frac{1}{2} g t^2$$
$$= 29.6 \cdot 3 - \frac{1}{2} \times 10 \times (3)^2$$
$$\boxed{y = 45m}$$

(c) R :-

$$t_t = 2 \cdot t_{max}$$
$$\boxed{t = 2 \cdot 3 = 6s}$$

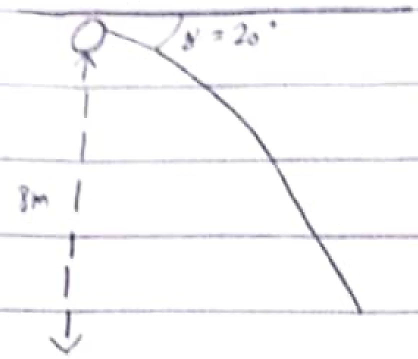
$$R = V_{ix} \times t$$
$$\boxed{R = 22.2 \cdot 6 = 134.1m}$$

Question # 9

You toss a ball from your window 8m above the ground. When the ball leaves your hand. It is moving 10m/s at 20°. What is Range R?

Answer # 9

Horizontal velocity



$x = V_x t$

$V = 10 m/s$

$y = V_y t - \frac{1}{2} g t^2$

$-8 = (-V \sin\theta) t - \frac{1}{2}(10) t^2$

$-8 = -3.4t - 4.9t^2$

$4.9t^2 + 3.4t - 8 = 0$

Using Quadradic eq.

$$t = \frac{-(3.4) \pm \sqrt{3.4^2 - 4(4.9)(-8)}}{2(4.9)}$$

$$t = \frac{-3.4 \pm 12.9}{9.8}$$

$$t = \frac{-3.4 + 12.9}{9.8}, \quad t = \frac{-3.4 - 12.9}{9.8}$$

$\boxed{t = 0.976s}$; Neglect it

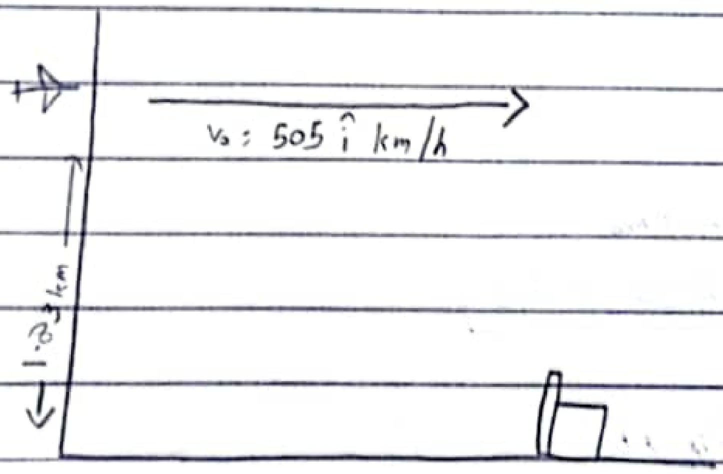
$x = V \cos 20° \times 0.97$

$= 10 \cos 20 \times 0.97 = \underline{9.11m}$

Question # 10

A pilot learns how to hit a target by dropping mock on an abandoned building as seen. The bomber flies at speed of 505 km/hr at altitude of 1.83. How far the bomber drops its mock bomb.

Answer # 10



$v_x = 505\ km/h = 140\ m/s$

$h = 1.83\ km = 1830\ m$

$g : 9.8\ m/s$

For time:-

$$h = \frac{1}{2} g t^2$$

$$\sqrt{\frac{2h}{g}} = t$$

$$t = \sqrt{\frac{2 \times 1830}{10}} = 19.32\ s$$

Horizontal distance:-

$$d = v_x \cdot t$$

$$d = 140 \cdot 3 \cdot 19.32$$

$$\boxed{d = 2711.8\ m}$$