THE COPPERBELT UNIVERSITY
SCHOOL OF MATHEMATICS AND NATURAL SCIENCES
DEPARTMENT OF PHYSICS

PH 110 INTRODUCTORY PHYSICS

TUTORIALSHEET 3: Kinematics_2023/2024

1. A toy boat moves horizontally in a pond. The displacement–time graph of the boat is shown in **Figure 1**. Find the **average velocity** and the **average speed** in the time intervals:
   (a) 0 to 8 s
   (b) 0 to 12 s
   (c) 8 s to 16 s
   (d) 0 to 24 s
   (e) 12 to 24 s

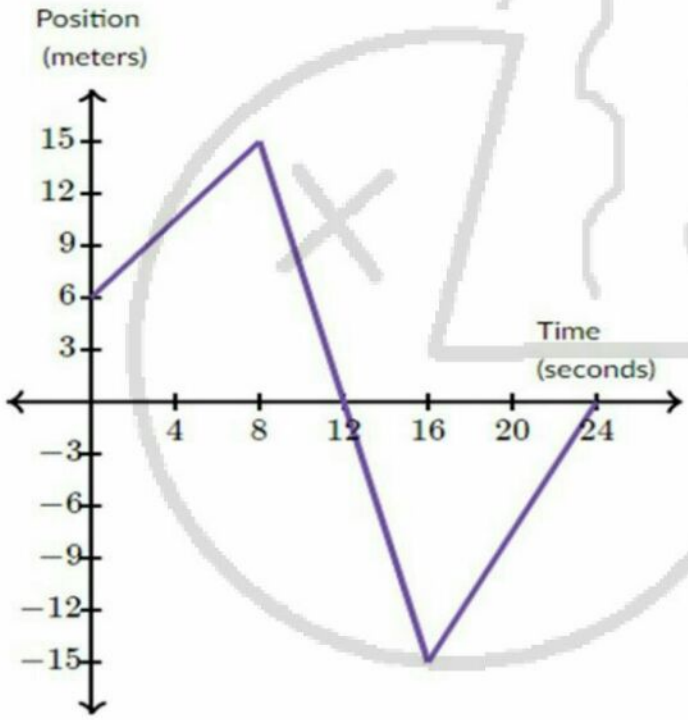


Figure 1

2. Two trains, one travelling at 72 km/h and the other one at 144 km/h, are headed toward one another along a straight level track. When they are 950 m apart, each engineer sees the other's train and applies breaks. If the breaks decelerate each train at the rate of $1 m/s^2$, is there a collision?

3. A car travels 1 km between two stops. It starts from rest and accelerates at 2.5 m/s^2 until it attains a velocity of 12.5 m/s. The car continues at this velocity for some time and decelerates at 3 m/s^2 until it stops. Calculate the total time for the journey.

4. A motorcycle policewoman hidden at an intersection observes a car that ignores a stop sign, crosses the intersection, and continues on at constant speed of 72 km/h. 2 seconds after the car crosses the intersection, the policewoman starts off in pursuit, accelerating uniformly at 3 m/s^2 until she catches the car.
   (a) How long does it take the motorcycle to catch up with the car?
   (b) How far will the car move when this happens?

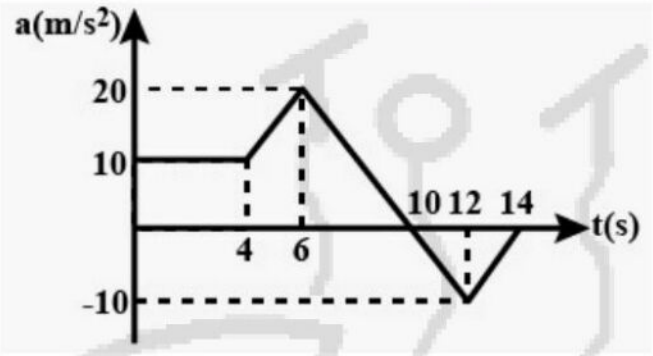
5. Two parallel rail tracks run north-south. Train A moves north with a speed of 54 km/h and train B moves south with a speed of 90 km/h. What is the relative velocity in m/s of
   (a) B with respect to A
   (b) the ground with respect to B
   (c) a monkey running on the roof of train A against its motion (with velocity 18 km/h with respect to A) as observed by a man standing on the ground.

6. A ball is thrown upward and reaches height of 4 meters. Find the initial speed and time taken by ball to come to the thrower (g=10).

7. A Bullet is fired from a rifle with a velocity 750m/s. If length of rifle barrel is 50cm, calculate average velocity of the bullet, while being accelerate in barrel. Find the time taken by the bullet to travel.

8. A projectile is fired from the top of a cliff of height h above the ocean below. If it was fired at an angle θ above the horizontal with an initial speed v_o.
   i) Find a symbolic expression in term of the variables v_o, g and θ for the time at which the projectile reaches its maximum height.
   ii) Using the result in part (i), find an expression for the maximum height above the ocean attained by the projectile in terms of h, v_o, g and θ.

9. Acceleration-time graph of a particle moving in a straight line is as shown in **Figure 2** At time $t = 0$ velocity of the particle is zero. Find the average acceleration in a time interval from $t = 6s$ to $t = 12s$.



10. A projectile is fired with an initial speed of 113 m/s at an angle of 60 ° above the horizontal from the top of a cliff 49 m high.

    Find:
    (a) the time to reach the maximum height,
    (b) the maximum height,
    (c) the total time in the air,
    (d) the horizontal range and
    (e) the components of the final velocity just before the projectile hits the ground.

11. Two stones are dropped from the edge of a 60m cliff, the second stone 1.6s after the first. How far below the top of the cliff is the second stone when the separation between the two stones is 36m?

12. Just as a car starts to accelerate from rest at a constant acceleration of $2.44 m/s^2$, a bus moving at a constant speed of 19.6m/s passes the car in a parallel lane.
    a) How long does it take the car to overtake the bus?
    b) How fast is the car moving?
    c) How far has the car gone at that point?

13. A ball thrown from the top of a 50m tall building is given an initial velocity of 20m/s straight upwards. The ball just misses the edge of the roof on its way down.
    a) Determine the time at which the ball reaches its maximum height.
    b) Determine the maximum height.
    c) The time at which the ball returns to the height from which it was thrown.
    d) The velocity of the ball at this instant.

e) The velocity and position of the ball at $t = 5s$.

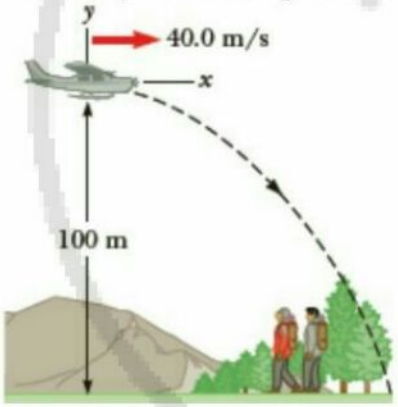
14. A stone is released from a hot- air balloon which is rising steadily at 4m/s. Find the velocity of the stone after 3 s of release.

15. A stone is dropped by a person from the top of a building, which is 200 m tall. At the same time, another stone is thrown upwards, with a velocity of 50 m/s by a person standing at the foot of the building. Find the time after which the two stones meet.

16. Show that time of ascent of an object thrown vertically upwards is equal the time of its descent.

17. A bullet is fired from the ground vertically upwards with an initial velocity of 100 m/s.
    (i) Find the total time of flight.
    (ii) Find the total distance covered by the bullet.
    (iii) What is the bullet's velocity on the ground?
    (iv) What are the assumptions made in these calculations?

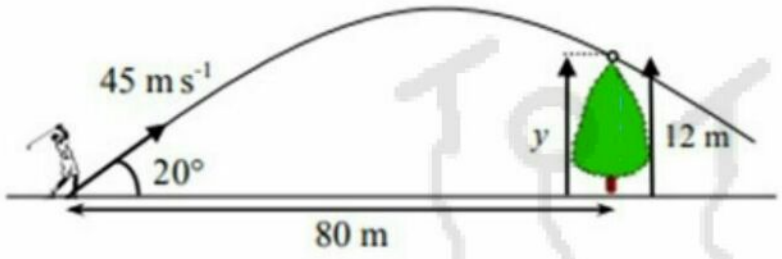
18. An Alaskan rescue plane drops a package of emergency rations to stranded hikers, as shown in the Figure below. The plane is traveling horizontally at 40.0 m/s at a height of 1.0×10^2 m above the ground. Neglect air resistance.



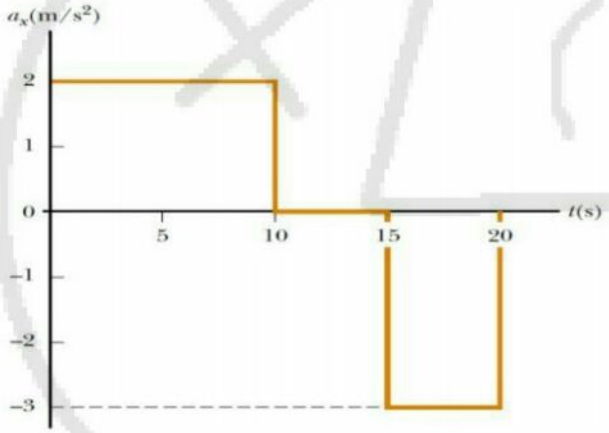
    a) Where does the package strike the ground relative to the point at which it was released?
    b) What are the horizontal and vertical components of the velocity of the package just before it hits the ground?
    c) What is the angle of the impact?

19. A ball of mass 200 g covers a maximum vertical distance of 10 m when it is kicked at an angle of 30° from the horizontal ground.
    (a) How long will the ball be in the air?
    (b) How far from the point of projection will the ball land?

20. If the golf ball is hit in the direction of a 12-meter tree which is 80 meters from the golfer, will the ball pass over the tree or hit it? See the figure below (Not drawn to scale)



21. A particle starts from rest and accelerates as shown in the figure below.
    (a) Find the particle's speed at t = 10 s and at t = 20 s.
    (b) Draw the velocity-time graph for a particle in the interval from t=0 to t=20s.
    (c) Determine the distance traveled in the first 20 seconds.



1

(a) 0s to 8s

note that :

average velocity = $\frac{\text{displacement}}{\text{time}}$, where :

Displacement = $x_f - x_i$

average speed = $\frac{\text{Total distance}}{\text{Total time}}$

(i) ave vel = $\frac{\text{displ}}{\text{time}}$

$= \frac{15 - 6}{8}$

$= \frac{9}{8}$

ave vel = 1.125 m/s

(ii) ave spd = $\frac{\text{dist}}{\text{time}}$

$= \frac{9}{8}$

ave spd = 1.125 m/s

(b) 0s to 12s

(i) ave vel = $\frac{\text{displacemnt}}{\text{time}}$

$= \frac{0 - 6}{12}$

ave vel $= \frac{-6}{12} = -0.5$ m/s

ave spd = $\frac{\text{dist}}{\text{time}}$

ii ave spd = $\frac{\text{distance}}{\text{time}}$

$= \frac{9 + 15}{12}$

$= \frac{24}{12}$

ave spd = 2m/s

c 8s to 16s

(i) ave vel = $\frac{\text{displac}}{\text{time}}$

$= \frac{-15 - 15}{16 - 8}$

$= \frac{-30}{8}$

ave vel = -3.75m/s

(ii) ave spd = $\frac{\text{distance}}{\text{time}}$

$= \frac{15 + 15}{16 - 8}$

$= \frac{30}{8}$

ave spd = 3.75m/s

(d) 0s to 24s

(i) ave vel = $\frac{\text{displacement}}{\text{time}}$

$= \frac{0 - 6}{24}$

$= \frac{-6}{24}$

ave vel = 0.25m/s

(ii) ave spd = $\frac{\text{distance}}{\text{time}}$

$= \frac{9 + 30 + 15}{24}$

$= \frac{54}{24}$

ave spd = 2.25m/s

e 12s to 24s

(i) ave vel = $\frac{\text{displacement}}{\text{time}}$

$= \frac{0 - 0}{12}$

ave vel = 0 m/s

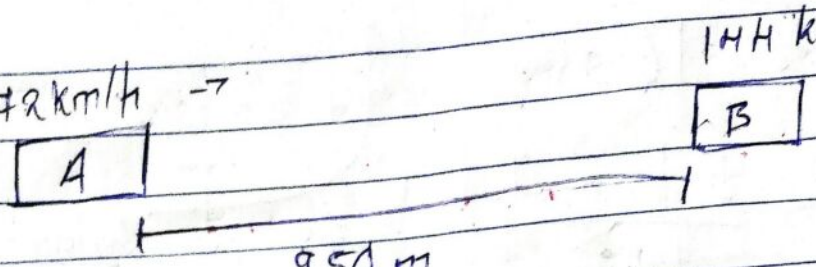
ave spd = $\frac{\text{distance}}{\text{time}}$

$= \frac{15 + 15}{12}$

$= \frac{30}{12}$

ave vel = 2.5 m/s

2



Data for Train A
$V_i = 72 km/h = 20 m/s$
$V_f = 0 m/s$
$a = -1 m/s^2$
$s = ?$

Data for Train B
$V_i = 144 km/h = 40 m/s$
$V_f = 0 m/s$
$a = -1 m/s^2$
$s = ?$

For Train A

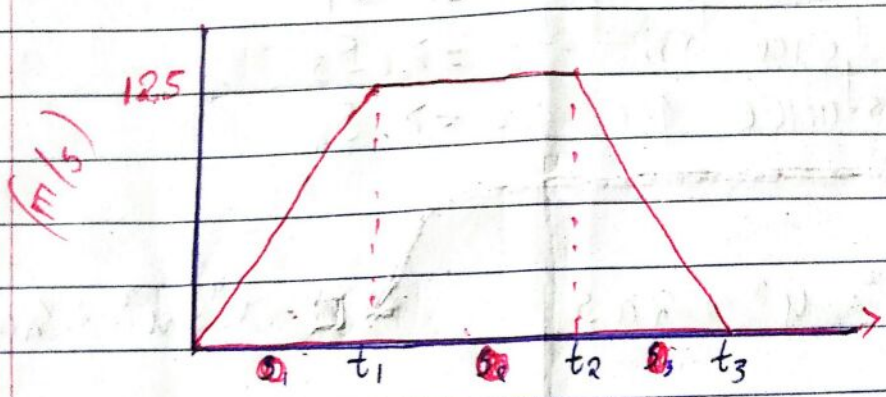
$V_f^2 = V_i^2 + 2as$
$(0)^2 = (20)^2 + 2(-1)(s)$
$0 = 400 - 2s$
$-2s = -400$
$\frac{-2s}{-2} = \frac{-400}{-2}$
$s = 200 m$

For Train B

$V_f^2 = V_i^2 + 2as$
$(0)^2 = (40)^2 + 2(-1)s$
$0 = 1600 - 2s$
$\frac{-2s}{-2} = \frac{-1600}{-2}$
$s = 800 m$

∴ There was a collision between the two cars since 200m + 800m = 1000m but only 950m was the space in between

3 lets create velocity - time graph



$V_F = V_i + at$

so finding t_1

$t = \frac{V_F - V_i}{a}$

$t = \frac{12.5 - 0}{2.5}$

$t_1 = 5s$

finding t_2

Here we need to find the distance.

finding t_3

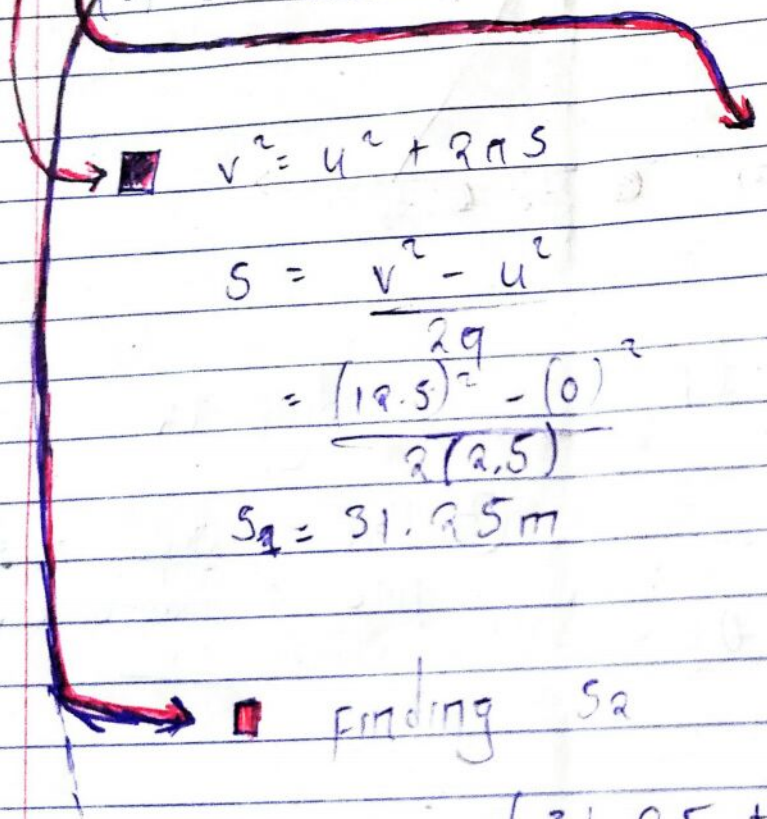
$t = \frac{V_F - V_i}{a}$

$= \frac{0 - 12.5}{-3}$

$t_3 = 4.17 s$

To find t_2 we need to do the following

(1.) distance for $t_1 \Rightarrow S_1$
(2.) Distance for $t_3 \Rightarrow S_3$
(3.) Distance for $t_2 \Rightarrow S_2$



$v^2 = u^2 + 2as$

$$s = \frac{v^2 - u^2}{2a}$$

$$= \frac{(12.5)^2 - (0)^2}{2(2.5)}$$

$S_2 = 31.25\,m$

$v^2 = u^2 + 2as$

$$s = \frac{v^2 - u^2}{2a}$$

$$= \frac{(0)^2 - (12.5)^2}{2(-3)}$$

$S_3 = +26.04\,m$

finding S_2

$1000 - (31.25 + 26.04)$
$1000 - (57.29)$
942.71

$$s = ut + \frac{1}{2}at^2$$

$$942.71 = 12.5t + \frac{1}{2}(0)t^2$$

$$\frac{942.71}{12.5} = \frac{12.5t}{12.5}$$

$t_2 = 75.4\,s$

Total time for the whole journey

$t_1 + t_2 + t_3$

$5 + [illegible] + 75.4 + [illegible] 4.17$

Time = 84.57s

4

data for police

$v_i = 0 m/s$

$v_f = ?$

$a = 3 m/s^2$

$t = t_p$

$s = ?$

data for car

$v_i = v_f = 20 m/s$

$a = 0 m/s$

$t = t_p + 2$

$s = ?$

when the catch up they would have covered the same displacement !!

$$s_p = s_c$$

$$\left(ut + \frac{1}{2}at^2\right)_p = \left(ut + \frac{1}{2}at^2\right)_c$$

$$\left(\frac{1}{2}at^2\right)_p = (ut)_c$$

$$\frac{1}{2}(3)t_p^2 = 20(t_p + 2)$$

$$\frac{3}{2}t_p^2 = 20t_p + 40 \quad] \times 2$$

$$3t_p^2 = 40t_p + 80$$

$$3t_p^2 - 40t_p - 80 = 0$$

let $t_p = x$

$$3x^2 - 40x - 80 = 0$$

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

$$= \frac{-(-40) \pm \sqrt{(-40)^2 - 4(3)(-80)}}{2(3)}$$

$$= \frac{40 \pm \sqrt{1600 + 960}}{6}$$

$$x = \frac{40 \pm 50.596\,4256}{6}$$

$$x = \frac{40 + 50.596\,4256}{6} \quad \text{or} \quad \frac{40 - 50.596\,4256}{6}$$

$$x = \frac{90.596\,4256}{6} \qquad \frac{-10.596}{6}$$

$$x = 15.099 \qquad x = -1.766$$

$\therefore t_p = 15.099\text{s}$ or $t_p = -1.766\text{s}$

$\therefore$ since time can't be (-)

$t_p = 15.099\text{s}$

It takes 15.099s for the motorcycle to catch up with the car

(b.) $s = ut + \frac{1}{2}at^2$

you can either find the distance using the cars data or the police's data, it will give you the same ans

$s_c = ut + \frac{1}{2}at^2$

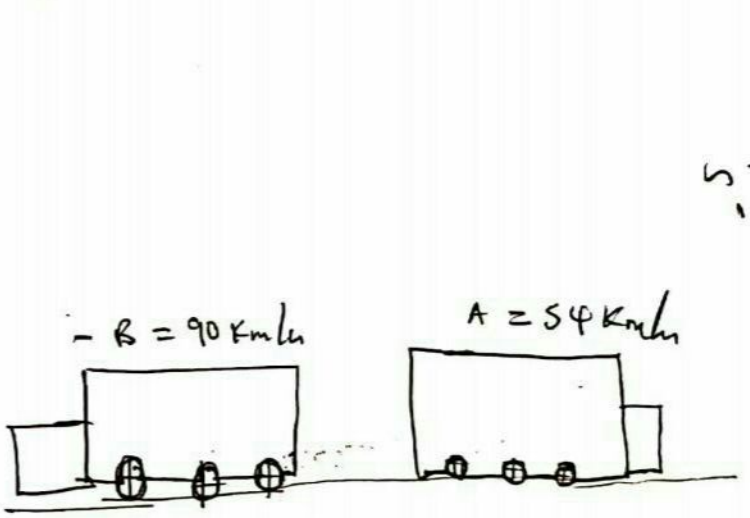
$= (20)(15.099 + 9) + \frac{1}{2}(0)(15.099+2)^2$

$= 20(17.099)$

$s_c = 341.98\,m$

A+ student... behind the scene 😂😂💀

Question 5



(a) $\vec{V}_{BA} = \vec{V}_B - \vec{V}_A$

$V_{BA} = 54 - (-90)$

$V_{BA} = 144 \text{ Km/h}$

(b) Velocity of ground with respect to B

$\vec{V}_{gB} = \vec{V}_g - \vec{V}_B$

$\vec{V}_{gB} = -90 \text{ Km/hr}$ (towards North)

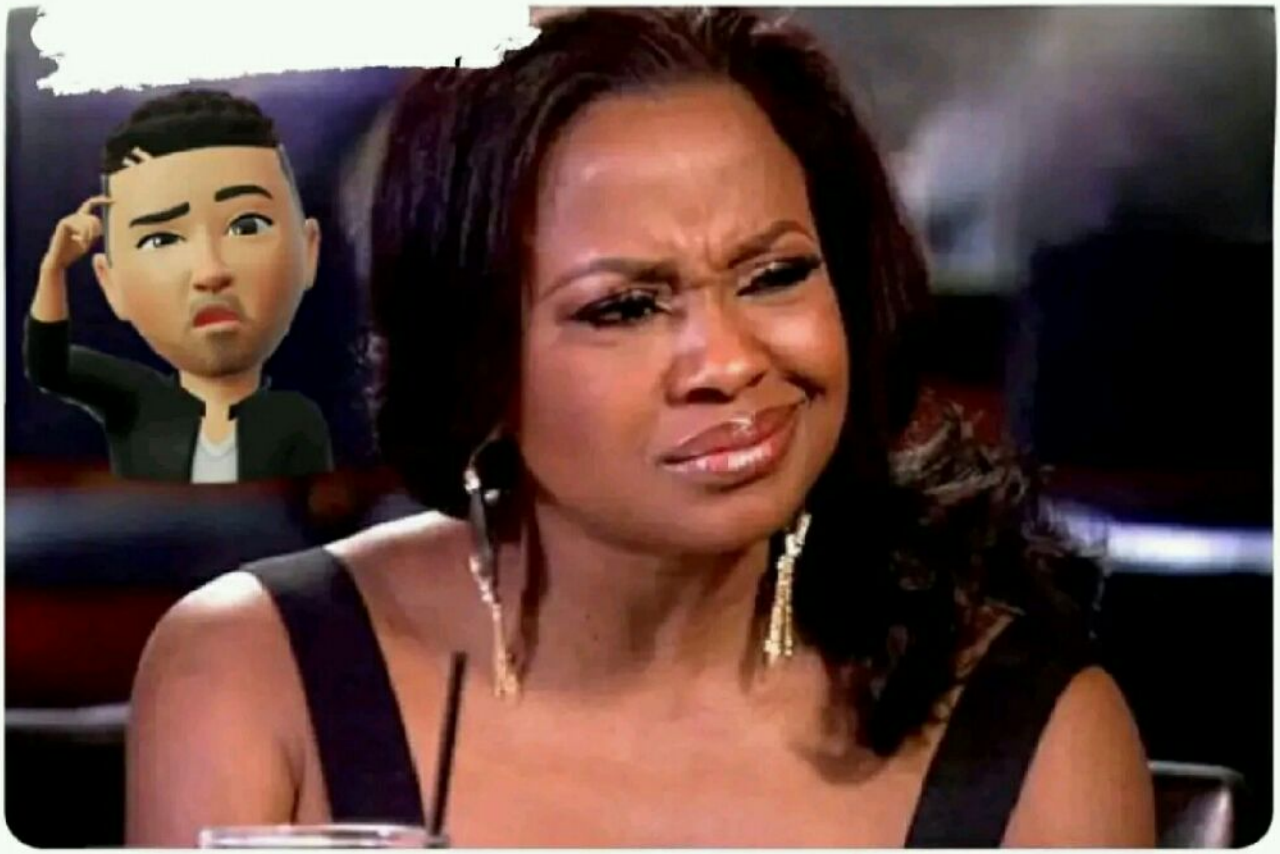
(c) $\vec{V}_{mg} = \vec{V}_{mA} + \vec{V}_{Ag}$

$\vec{V}_{mg} = 18 \text{ Km/h} - 54$

$\vec{V}_{mg} = -36 \text{ Km/h}$

But remember that your question wants answers in m/s

Jamaica not being in Africa still doesn't make sense to me.



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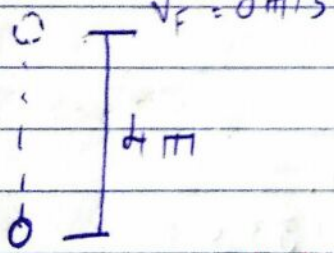


note that $g = -10 m/s^2$

$v^2 = u^2 + 2as$

$(0)^2 = u^2 + 2(-10)(4)$

$\sqrt{u^2} = \sqrt{80}$

$u = 8.94 m/s$

7 data

$V_i = 0 \text{ m/s}$

$V_f = 750 \text{ m/s}$

$s = 50 \text{ cm} = 0.5 \text{ m}$

$$\text{average velocity} = \frac{v + u}{2}$$

$$= \frac{750 + 0}{2}$$

$$\text{average velocity} = 375 \text{ m/s}$$

$$\text{average velocity} = \frac{\text{displacement}}{\text{time}}$$

$$\text{time} = \frac{\text{displ}}{\text{a.v}}$$

$$= \frac{0.5}{375}$$

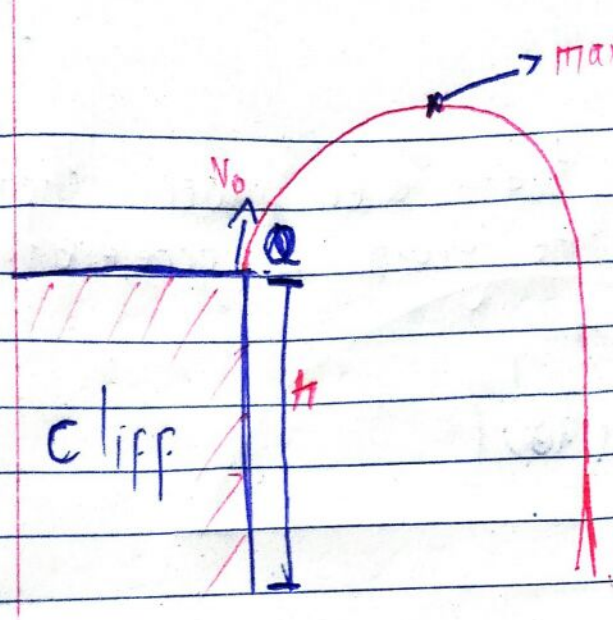
$$\text{time} = 0.00133 \text{ s}$$

or

$$\text{time} = 1.33 \times 10^{-3} \text{ s}$$

$$\underline{\text{time} = 1.33 \text{ ms}}$$

8



$$v^2 = u^2 + 2as$$

$$V_{y_f}^2 = V_{y_i}^2 + 2(-g)H_{max}$$

$$\frac{2gH_{max}}{2g} = \frac{V_{y_i}^2 - V_{y_f}^2}{2g}$$

$$H_{max} = \frac{V_{y_i}^2 - V_{y_f}^2}{2g}$$

At the toppest top $V_{y_f} = 0\ m/s$.
$V_{y_i} = V_i \sin\theta$

$$H_{max} = \frac{(V_i \sin\theta)^2}{2g}$$

$$H_{max} = \frac{V_i^2 \sin^2\theta}{2g}$$

(ii) $$H_{max} = \frac{V_i^2 \sin^2\theta}{2g} + h$$

9 # Keep in mind that area under the graph of acceleration - time graph is acceleration

$V_1 = \frac{1}{2} bh$

$= \frac{1}{2} (4)(20)$

$=$

From 0s to 4s what was the change in velocity

$V_1 = lb$

$= 10 \times 4$

$= 40 m/s$

from 4s to 6s

$V_2 = \frac{1}{2}(a+b)h$

$= \frac{1}{2}(10+20)2$

$V_2 = 30 m/s$

at $t = 6s$ Velocity is $40 + 30 = 70 m/s$

from 6s to 10s

$V_3 = \frac{1}{2} bh$

$= \frac{1}{2}(4)(20)$

$V_3 = 40 m/s$

From 10s to 12s

$V_4 = \frac{1}{2} bh \Rightarrow = \frac{1}{2}(2)(-10) = -10 m/s$

(2) at $t = 12s$ velocity is :

$$v_1 + v_2 + v_3 + v_4$$

$$40 + 30 + 40 + (-10)$$

$$100 \, m/s$$

average aceleration $= \dfrac{v_f - v_i}{\Delta t}$

$$= \frac{100 - 70}{12 - 6}$$

$$= \frac{30}{6}$$

$$= 5 \, m/s$$

QUESTION 10

DATA

X motion

$x = ?$

$V_{0x} = 113\cos 60^\circ$

$V_{0x} = V_{Ax} = V_{Bx}$

Y- motion

$Y_B = -49m$

$V_{oy} = 113\sin 60^\circ$

$V_{Ay} = 0$

$a_y = -9.8 m/s^2$

(a)

$V_{fy} = V_{iy} + gt_1$

$t_1 = \dfrac{V_{fy} - V_{iy}}{g}$

$= \dfrac{0 - 113\sin 60^\circ}{-9.8}$

$= 9.99_s$

(b) $Y = V_{iy}t + \frac{1}{2}gt^2$

$Y = 113\sin 60^\circ (9.99) - \frac{1}{2}(9.8)(9.99)^2$

$Y = 489m$

© finding the total time in the air

$$Y = V_{by} + \frac{1}{2} a_y t_2^2$$

$$-49m = (113 \sin 60) t_2 - \frac{1}{2}(9.8) t^2$$

$$-49m = 97.97 - 4.9 t^2$$

$$4.9t^2 - 97.9t - 49 = 0$$

$t_2 = 20.5\ s$ $\quad t = {}_2 - 0.49\ s$

We reject the second solution (it gives the time the projectile would leave 2ft the ground, if it had been thrown from there)

(a) Find the horizontal range (x_B)

$$V_{Bf} = V_i t + \frac{1}{2} g t^2$$

$$= (113 \cos 60)(20.5) = -103\ m$$

(b) find the components of the final velocity

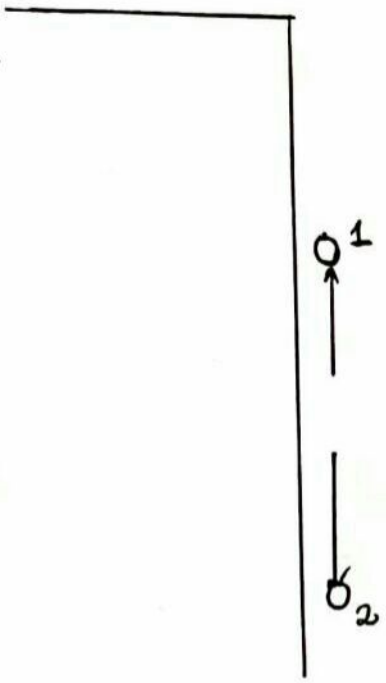
$$V_{fy} = V_{iy} + gt$$
$$= 113 \sin 60 - 9.8(20.5)$$
$$= \underline{-103\ m/s}$$

$$V_{xf} = V_{ix} = 113 \cos 60 \quad \underline{= 56.5\ m/s}$$

11

DATA

Stone 1	Stone 2
$u = 0 m/s$	$u = 6 m/s$
$t = t$	$t = t - 1.6$
	$d = d - 36$
$a = 9.8 m/s^2$	$a = 9.8 m/s$



for Stone 1

$$d = u_i t + \frac{1}{2} a t^2$$

$$d = 0 + \frac{1}{2}(9.8) t^2$$

$$d = 4.9 t^2 \quad \ldots \ldots \text{(1)}$$

Stone 2

$$d - 36 = ut + \frac{1}{2} a t^2$$

$$d - 36 = \frac{1}{2}(9.8) t^2$$

$$d - 36 = 4.9 (t - 1.6)^2$$

$$(t - 1.6)^2$$

$$t(t - 1.6) - 1.6(t - 1.6)$$

$$t^2 - 1.6t - 1.6t + 2.56$$

$$t^2 - 3.2t + 2.56$$

$$d - 36 = 4.9(t^2 - 3.2t + 2.56)$$

$$d - 36 = 4.9 t^2 - 15.7t + 12.5$$

$$d = 4.9 t^2 - 15.7t + 12.5 + 36$$

$$d = 4.9 t^2 - 15.7t + 48.5 \quad \ldots \text{(2)}$$

$$4.9 t^2 = 4.9 t^2 - 15.7t + 48.5$$

$-15.7t + 48.5 = 0$

$\frac{15.7t}{15.7} = \frac{48.5}{15.7}$

$t = 3.09\ s$

$S = d - 36$

$d = 4.9(3.09)^2$

$d = 47m$

for the second stone

$d = 47 - 36 = 11m$

QUESTION 12

Car

$a = 2.44 m/s^2$

$v_i = 0 m/s$

Bus

$V = 19.6 m/s$

$a = 0 m/s$

(a) How long does it take to overtake the bus

• Car

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

$S = 0 + \frac{1}{2}(2.44)t^2$

$S = 1.22 t^2$ . . . . . (i)

The bus

$S = V_i + \frac{1}{2} a t^2$

$S = 19.6t + 0 = 19.6t$

$S = 19.6t$ . . . (ii)

$V_f = v_i$

$$\frac{19.6t}{1.22t} = \frac{1.22t^2}{1.22t}$$

$$t = 16.1\,s$$

(b) How fast is the car moving?

$t = 16.1\,s$

$v_i = 0\,m/s$

$a = 2.44\,m/s^2$

$v_f = v_i + at$

$v_f = 0 + (2.44)(16.1)$

$v_f = \underline{39.3\,m/s}$

(c) How far has the car gone at the point?

$s = 1.22t^2$

$s = 1.22(16.1)^2$

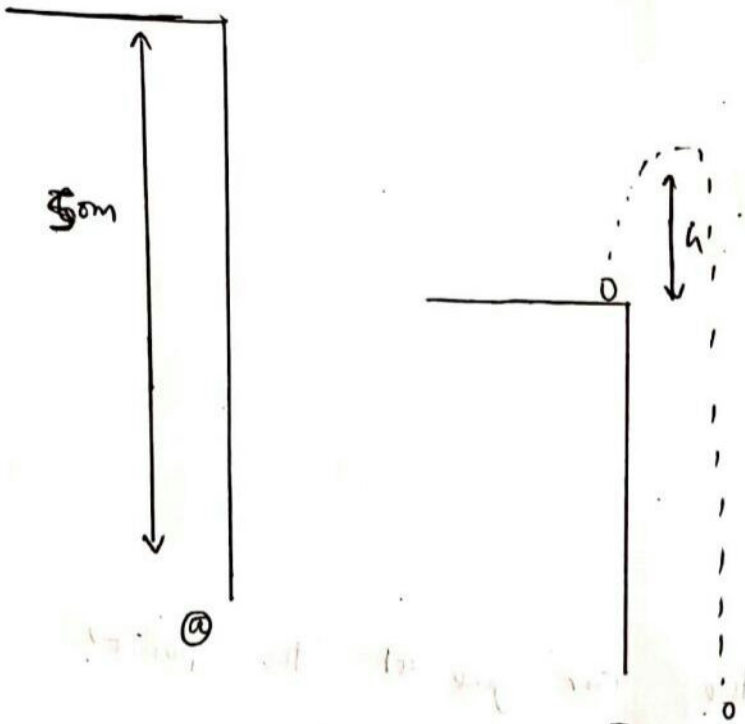
$s = 316.2\,m$

QUESTION 13

DATA

$V_i = 20 m/s$

$H = 80m$



@ AT maximum height

$V_f = 0 m/s$

$V_i = 20 m/s$

$a = -9.8 m/s^2$

$t = \frac{V_f - u_i}{g}$

$t = \frac{0 - 20}{-9.8}$

$t = 2.05 s$

The maximum height

(b) $S = v_i t + \frac{1}{2} a t^2$

$S = (20 m/s)(2.05) + \frac{1}{2}(-9.8)(2.05)^2$

$S = 41 + (-4.9)(4.20)$

$S = 41 - 20.6$

$S = 20.4$

(c) tmie = 2 tmie taken in the rise

$= 2(2.05)$

$= 4.1_s$

(d) The velocity of the ball

- Ignoring air resistance

$v_f = v_i = 20 m/s$

(e) The velocity and position of the ball at $t = 5_s$

$V_f = 20 m/s + (-9.8)(5)$

$v_f = 20 m/s - 49 m/s$

$V_f = -29 m/s$

$s = v_i t + \frac{1}{2} g t^2$

$s = (20)(5) + \frac{1}{2}(-9.8)(5)^2$

$s = 100 + (-4.9)(25)$

$s = 100 - 122.5$

$s = -22.5\ m$

The -ve means the stone will be below the starting point

QUESTION 4

What if God gave us a second kidney as a business capital?

Question 15

. Let the two stones meet at a distance x m from the top of the tower

t be the time taken.

let downward direction positive,

- for the stone that was dropped

$V = 0 m/s$

$s = x$

$g = 9.8 m/s^2$

$x = v_i t + \frac{1}{2} a t^2$

$x = 0 + \frac{1}{2}(9.8) t^2$

$x = 4.9 t^2 \quad \ldots\ldots (1)$

for the stone projected vertically upwards

$v_i = -50 m/s$

$s = -(200 - x)$

$s = v_i t + \frac{1}{2} a t^2$

$-(200 - x) = -50t + \frac{1}{2}(9.8) t^2$

$-(200 - x) = -50t + 4.9t^2$

$(200 - x) = 50t - 4.9t^2$

$200 = 50t - 4.9t^2 + x$

$200 = 50t - 4.9t^2 + (4.9t^2)$

You can solve for t from here my child

Question 16

Let

v_i = initial velocity

v_f = final velocity

h = heights attained

a = acceleration

t = time

Ascent

B ball thrown upwards with velocity u so, $v_f = 0$ at maximum height h also $a = -g$

Now using $v_f = v_i + at$

$$0 = v_i - gt_a$$

$$t_a = \frac{v_i}{g}$$

where t_a = time of ascent

Also by using $v_f^2 = v_i^2 + 2as$

$$0 = v_i^2 + 2gh$$

$$v_i = \sqrt{2gh} \quad \ldots\ldots\ldots \text{(2)}$$

from equation 1 and (2) we get

$$t_a = \sqrt{\frac{2h}{g}} \quad \ldots\ldots \text{(3)}$$

Descent

Ball is Thrown down from height h so, $u = 0$

and $a = g$

$$v_f = u_i + at$$

$$v_f = 0 + gt_d$$

$$v_f = gt_d \quad \ldots\ldots (1)$$

where t_d = Time of descent

$$t_d = \frac{v_f}{g}$$

Now using $v_f^2 = v_i^2 + 2as$

$$v_f^2 = 0 + 2as$$

$$v_f = \sqrt{2gh}$$

$$v_f = \sqrt{2gh}$$

$$t_d = \frac{\sqrt{2gh}}{g}$$

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

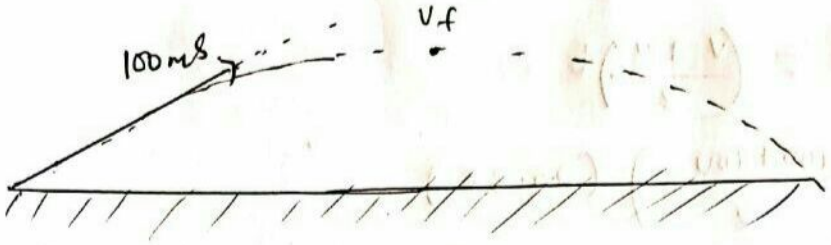
$$t_a = t_d .$$

Question 17

$v_i = 100 m/s$

② too

$g = -9.8$



total

① find the time of flight

$v_t = v_i + at$

$0 = 100 m/s + (-9.8)t$

$\frac{100 \cancel{m/s}}{9.8 \cancel{m/s^2}} = \frac{9.8 \cancel{m/s^2} t}{9.8 \cancel{m/s^2}}$

$t = 10.2 s$

So total time

$2t = 2(10.2)$

$= 20.4 s$

$s = ut + \frac{1}{2}at^2$

$s = (100)(20.4) + \frac{1}{2}(9.8)(20.4)^2$

$s = 2040m = 2039.2\ m$

$s = \left(\frac{v+u}{2}\right)t$

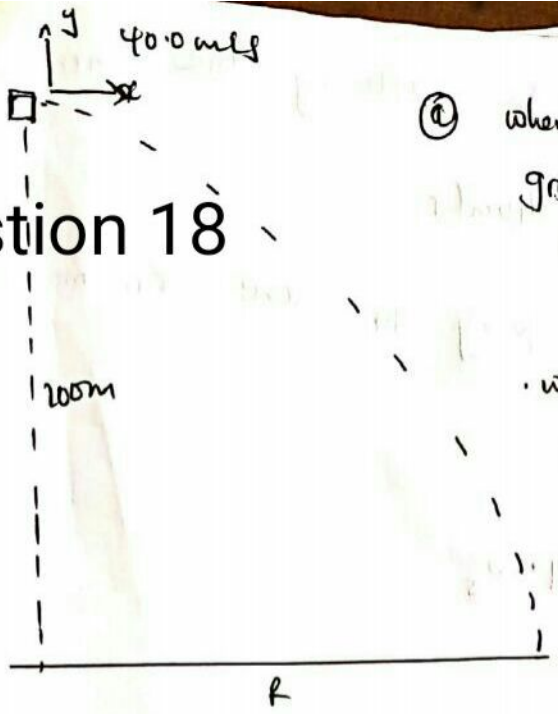
$s = \left(\frac{100+100}{2}\right)(20.38)$

$s = 2038cm$

(iii) $u = v = 100 m/s$

(iv) The assumption is that the air does not affect the motion and the bullet falls freely under the influence of only gravity

Question 18



(a) where does the package strike the ground relative to the point at which it was released?

we want to get the horizontal range

$u = 0$

$s = -100m$

The downward acceleration is

$a = g = 9.81 m/s^2$

$s = ut + \frac{1}{2}at^2$

$-100m = 0 + 0.5(-9.81 m/s^2)t^2$

$\frac{100 m}{4.9 m/s^2} = \frac{4.9 m/s^2 t^2}{4.9 m/s^2}$

$t = \sqrt{\frac{100}{4.9 s^2}}$

$t = 4.52 s$

$4.52 s$ is the time of flight.

$x = V_x t$

$x = 40 m/s (4.52) s$

$x = 180.8 m$

(b) The horizontal Component of Velocity does not change and is V_x = Homb

To find V_y we are going to use Kinematics

$V_i = 0$

The time of flight is $t = 4.52_s$

The downward acceleration is

$$a = -g = -9.81 \, m/s^2$$

$$V_{fy} = V_{iy} + gt$$

$$= 0 - 9.81 \, m/s^2 (4.52_s)$$

$$V_{fy} = -44.3 \, m/s$$

(c)

$$\tan\theta = \left(\frac{V_{fy}}{V_{ix}}\right)$$

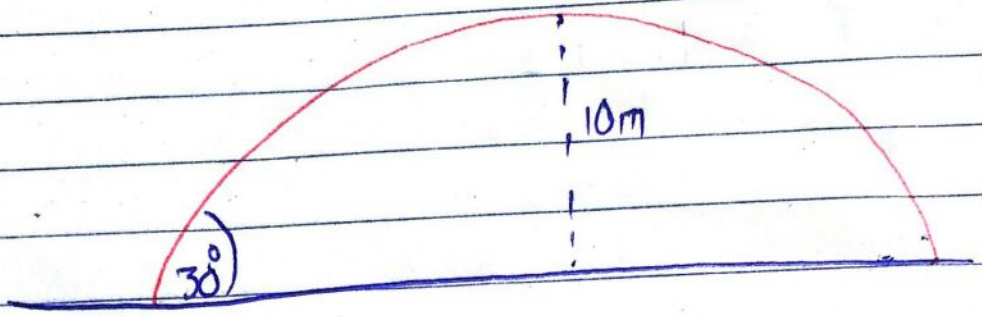
$$\theta = \tan^{-1}\left(\frac{-44.3}{40}\right)$$

$$\theta = -47.9^\circ$$

Therefore, the angle is 47.9° from the negative x-axis

19

(11)



Here we are looking for time of flight

$$T = \frac{2 V_0 \sin\theta}{g}$$

But V_0 we don't, lets use max height

$$H = \frac{V_0^2 \sin^2\theta}{2g}$$

$$V_0^2 \sin^2\theta = 2gH$$

$$V_0 = \sqrt{\frac{2gH}{\sin^2\theta}}$$

$$V_0 = \frac{\sqrt{2gH}}{\sin\theta}$$

$$V_0 = \frac{\sqrt{2(10)(8)}}{\sin 30^\circ}$$

$$V_0 = \frac{12.649}{0.5}$$

$$V_0 = 25.298 \text{ m/s}$$

$$T = \frac{2 V_0 \sin\theta}{g}$$

$$T = \frac{2 (25.298) \sin 30^\circ}{10}$$

$$T = 2,53_5$$

(b) $$R = \frac{V_0^2 \sin 2\theta}{g}$$

$$= \frac{(25.298)^2 \sin 2 \times 30^\circ}{10}$$

$$R = 55.43\,m$$

or

$$R = V_0 \cos\theta \, t$$

$$= 25.298 \cos 30 \times 2.53$$

$$R = 55.43\,m$$

Question 20

* To know whether it will pass over or hit the tree we need to know its height after a distance of 80 m horizontally.

* If the height is less than or equal to 12 m then it hits the tree other than this well it doesn't

using the cartesian equation

$$y = \tan\theta\, x - \frac{g x^2}{2 v_0^2 \cos^2\theta}$$

$$y = \tan 20^\circ \times 80 - \frac{10 (80)^2}{2(45)^2 (\cos 20^\circ)^2}$$

$$y = 29.1176 - 17.8959$$

$$y = 11.2\ m$$

∴ it hits the tree !!

Question 21

(a) $v_f = v_i + at$

$v_i = 0 \qquad a = 2 m/s^2$

$v_f = 2 m/s^2 \times 10 s$

$v_f = 20 m/s$

(b) $v_f = v_i + at$

~~$v_f = 0 + 20 \times$~~

The speed of the particle at $t = 15.0 s$ is

$v_i = 20 m/s \qquad a = -3 m/s$

~~$v_f = 20 m/s + 3 \times 15$~~

~~$z = 3$~~

$v_f = 20 m/s - 3 m/s^2 \times 5 s$

$v_f = 20 m/s - 15 m/s$

$v_f = 15 m/s$

It's only in Zimbabwe where you find married bread 😂

Even bread has a partner ise tilibe 😂