UNIT - 4

Introduction :-
A Body will be motion than changing over position from one point to other

Displacement:-
When a body changing over position with a path such as straight line and other irregular direction.
If the displacement of a body when a particular direction (spacific direction) this types displacement is known as vector quantity displacement.
Any body change over position from one point to other a straight line, a curve line or rotary line as classify.

(I) Rectilinear motion:-
A body called a rectilinear motion when it travels a straight line path.

(II) Curve Linear motion:-
A Body called curve linear motion if it travels a curve path.

(III) Rotary motion:-
A Body rotary motion is called when it travels a full circular path. This types motion is a part of curve linear motion.

SPEED :- If a body changing over position a irregular direction then rate of change displacement is known as "Speed"
It is a scalar quantity and unit m/s.

Velocity :- When a body changing over position with a magnitude and specific direction. Than the change of position to the time taken, is known as "Velocity."
Due to spacific direction velocity is the vectory quantity and unit m/s.

Acceleration :- The rate of change of velocity of a body is known as Acceleration.
If the velocity of a body is increasing than rate of change is positive acceleration. When the changing of velocity is negative than decreasing of acceleration. It is also known as Retardation.

$$\boxed{a = \frac{v-u}{t} \ m/s^2}$$

Q A car starting from a point 'A', velocity 20m/s and cross a point B and at that time velocity of car 30m/s find the acceleration of car. Distance travel 45 sec both points.

$v = u + at$, $\cancel{at = u-v}$

Solⁿ As per given data

$v = 30 m/s$, $u = 20 m/s$ & $t = 45$ sec

$$a = \frac{v-u}{t} = \frac{10}{45} = 0.2 m/s^2$$

Uniform velocity:-
A velocity of a moving body may be define as its travel equal displacement with a spacific direction in equal intervel of time, is known as UV.
And opposite of this is known as ~~the~~ Non uniform velocity (NUV).

Uniform Acceleration (UA):-
The rate of change of velocity equal magnitude in equal interval of time.
If the velocity of body changes by unequal amount in equal interval of time is said to be Non-uniform Acceleration (NUA).

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MOTION Of Body:-

Equation's of motion:-

(1) first eqⁿ of motion:-
consider linear motion of a body starting from point A. And moving along X-direction with a uniform acceleration 'a' As shown in figure

A ———————— B
u m/s v m/s

The body reach at a B point after t time.
The initial velocity at point 'A' is u m/s and final velocity at point 'B' is v m/s

from the Definition of acceleration
mathematicaly
$$\boxed{a = \frac{v-u}{t}} \quad - (9)$$

$$\Rightarrow \quad at = v - u$$
$$\boxed{v = u + at} \quad - (1)$$

This is the first eq^n of motion

(II) **Second Eq^n of motion:-**

since the uniform acceleration, the avarage velocity is just the avarage of initial and final velocity.

$$\boxed{\text{Average velocity} = \frac{u+v}{2}} \quad - (b)$$

we know that the distance traveled by body

$$S = \text{Average velocity} \times \text{time}$$
$$S = \left\{\frac{u+v}{2}\right\} t \quad - (c)$$

from (b) & (c)

$$2S = (u + u + at)t$$
$$2S = 2ut + at^2$$
$$\boxed{S = ut + \frac{1}{2}at^2} \quad - (2)$$

This is the second eq^n of motion.

* Distance travelled by n^{th} sec from - (2)
distance travelled by the body in 'n' second

$$\boxed{S_n = un + \frac{1}{2}an^2} \quad - (d)$$

And distance travelled in (n-1) second

$$\boxed{S_{n-1} = u(n-1) + \frac{1}{2}a(n-1)^2} \quad \text{— (e)}$$

Substracting the eqn (d) & (e) we get the distance travelled in nth second

$S^{nth} = S_n - S_{n-1}$

$$\boxed{S^{nth} = u + \frac{1}{2}a(2n-1)}$$

(III) <u>Third Eqn of motion</u> :-

from eqn (a)

$$t = \frac{v-u}{a} \quad \text{— (f)}$$

putting the value of t in eqn (c) we have

$$S = \left\{\frac{u+v}{2}\right\}\left\{\frac{v-u}{a}\right\}$$

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

$$\boxed{v^2 = u^2 + 2aS} \quad \text{— (3)}$$

This is third eqn of motion.

Q A car travelling at 54 km/h is accelerated at the rate of 1 m/s². what is the distance travelled by car in 12 sec.

<u>solⁿ</u> As Given data $t = 12$ sec.

$a = 1\ m/s^2$

$u = 54\ km/h$

$u = 54 \times \frac{5}{18} = 15\ m/s$

$S = 15 \times 12 + \frac{1}{2} \times 1 \times 12 \times 12 = 180 + 72$

$= \underline{252\ m}$

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Q A car start from ~~west~~ rest and move with a constant acceleration of $1.2 m/s^2$. find the velocity after it has travelled for 60 m.

Sol^n

As Given data

$u = 0, \quad a = 1.2 m/s^2$

$S = 60 m$

from the ~~second~~ first s Eq^n of motion

$\cancel{S = ut + \frac{1}{2}at^2}$ | $\cancel{v = at, t =}$

$\cancel{v =} \; u + at$

$v^2 = u^2 + 2aS$

$v^2 = 0 + 2 \times 1.2 \times 60$

$= 2.4 \times 60$

$v^2 = 144$

$\boxed{v = 12 m/s}$

Q A motor ~~starting~~ cross a point "A" at velocity 72 km/h on turning a corner he find a child on the road 40m ahead. He instantly stop engine and apply break. So as to stop the card Determine the required Retardation

Q is right

Sol^n $u = 72 km/h = 20 m/s$

$S = 40 m, \quad v = 0$

$\cancel{0 = u^2 + 2 \times a x}$

$0 = (20)^2 + 2 \times a \times 40$

$a = \frac{-(400)}{80} = -5 m/sec^2$

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Q A car takes 10 sec to cover 30 m and 12 sec to cover 42 m. find its velocity at the end of 15 sec.

Solⁿ from eqⁿ (2) of motion.

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

$t_1 = 10$ sec , $t_2 = 12$ sec

$S_1 = 30$ m , $S_2 = 42$ m

$30 = 10u + 50a$; $42 = 12u + 72a$

$3 = u + 5a$ — (1) ; $14 = 4u + 24a$

$7 = 2u + 12a$ — (2)

(1) × 2 − (2)

$6 = 2u + 10a$

$-\ 7 = 2u + 12a$

$-1 = -2a$ $a = 1/2$ m/s²

$3 = u + 5/2$, $u = 3 - 5/2 = 1/2$ m/s

when $t = 15$ sec

$v = u + at$

$= \frac{1}{2} + \frac{1}{2} \times 15$

$v = \frac{1+15}{2} = 8$ m/s

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Q A car moving with uniform acceleration passe 72m in the 11th second and 96m in the 15th second. Determine the distance travelled by the car during first 20 seconds

Solⁿ
As given that

$$S_{11} = 72m$$
$$S_{15} = 96m$$

$$\because S_n = u + \frac{1}{2}a(2n-1)$$

$$S_{11} = u + \frac{1}{2}a(21) = 72$$
$$S_{15} = u + \frac{1}{2}a(29) = 96$$

$$\frac{29}{2}a - \frac{21}{2}a = 96 - 72$$

$$4a = 24$$
$$\boxed{a = 6\ m/s^2}$$

$$u + \frac{1}{2} \times 6 \times 21 = 72$$
$$u = 72 - 63$$
$$u = 9\ m/s$$

$$S_{20} = 9 + \frac{1}{2} \times 6 \times (39)$$
$$= 9 + 117$$
$$= 126m$$

u = 9 m/s
a = 6 m/s²
t = 20 sec

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

then $S = 1380 m$

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Q. A car moving with ~~constant velocity~~ uniform accelaration passes 110m in the 11^{th} second and 150m in 15^{th} second. Determine the distance travelled by the car during 1^{st} 20 second

Sol^n Given $S_{11} = 110m$

$$u + \frac{1}{2}a(21) = 110 \quad — ①$$

$$S_{15} = 150m$$

$$u + \frac{1}{2}a(29) = 150 \quad — ②$$

② − ①

$$\frac{29}{2}a - \frac{21}{2}a = 40$$

$$\boxed{a = 10 m/sec^2}$$

$$u + \frac{1}{2} \times 10 \times 21 = 110$$

$$u = 110 - 105$$

$$u = 5 m/s$$

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

$$= \cancel{50 \times 20} + \cancel{\frac{1}{2} \times 10 \times 20 \times 20}$$

$$= \cancel{2900} + \cancel{2000}$$

$$= \cancel{4200 m}$$

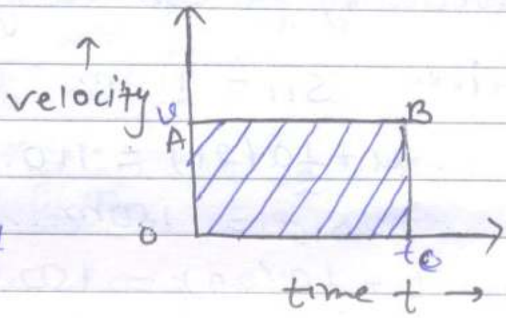
$$= 5 \times 20 + \frac{1}{2} \times 10 \times 20 \times 20$$

$$= 100 + 2000$$

$$\boxed{S = 2100 m}$$

* Velocity - Time Graph :-

If velocity is constant then the ploat b/w velocity and time is —



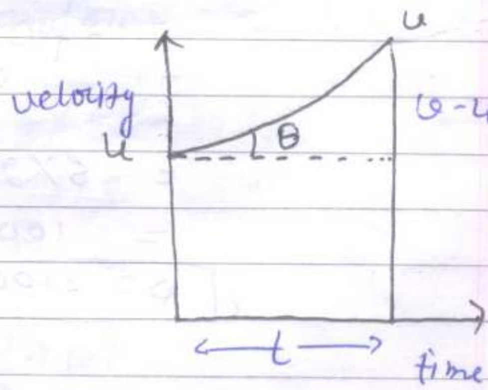
The motion of body may be presented by means of graph.

when the body is moving with a constant velocity v is represented on velocity - time graph taking t along x-axis and v velocity along y-axis as shown in figure.

The area of OABC = $v \times t$

But $\boxed{v \times t = s}$

Therefore ~~this graph represents~~ area under velocity time graph give the distance travelled by the body in the time t.



we can write

$\tan\theta = \frac{v-u}{t}$

But $\boxed{\frac{v-u}{t} = a}$

So $\boxed{\tan\theta = a}$

Therefore the slope of velocity curve ~~is~~ gives acceleration.

$$g = 9.81 \, m/s^2$$
$$\text{or} \quad g = 10 m/s^2$$

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* Vertical motion under Gravity :-

The force exerted applied by the earth on the body is known as gravitational force & the acceleration of the body is due to gravitation.

when the body move vertically downward its velocity goes on increasing due to gravity (g). Hence the eqn of motion under gravity

first. $v = u + gt$

Second. $h = ut + \frac{1}{2}gt^2$

third. $v^2 = u^2 + 2gh$

If the body is projected vertically upward direction its velocity goes on decreasing due to gravity (g). The corresponding eqn of motion

first $v = u - gt$

second $h = ut - \frac{1}{2}gt^2$

third $v^2 = u^2 - 2gh$.

* Motion with variable Acceleration :-

In actual practice the body always move partially with uniform acceleration and partially with variable ,, .

consider a particle is moving along OAB and it has travelled distance ds after reaching the point A in a time dt. The velocity of particle at point B $v = \frac{ds}{dt}$ — ①

acceleration at B $a = \frac{dv}{dt} = \frac{d^2s}{dt^2}$ — ②

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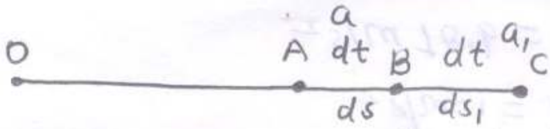

$\because ds_1 > ds$

also acceleration can be written :

$$a = \frac{dv}{dt} = \frac{dv}{ds} \cdot \frac{ds}{dt}$$

$$a = \frac{dv}{ds} \cdot v \qquad -③$$

Now consider particle has travelled from B to C point. A distance ds_1 which is grater then ds. During the same time dt then

$$v_1 = \frac{ds_1}{dt} \qquad — ④$$

$$a_1 = \frac{d^2 s_1}{dt^2} \quad -⑤$$

$\because ds_1$ is grater then ds then $a_1 > a$

$$\boxed{ds_1 > ds \text{ so } a_1 > a}$$

Q. The Eqn of motion of a car is given by S $S = 12t + 3t^2 - 2t^3$. Determine

(I) velocity and acceleration of the car at start

(II) acceleration when the car stoped

(III) max^m velocity of the car

Soln

As. given

$$S = 12t + 3t^2 - 2t^3$$

$$v = \frac{ds}{dt} = 12 + 6t - 6t^2$$

(i) at t=0 $v]_{t=0} = 12 \, m/s$

$$a = \frac{dv}{dt} = 6 - 12t$$

$$a]_{t=0} = 6 \, m/s^2$$

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(ii) At the end point $v=0$

then $0 = 12 + 6t - 6t^2$

$\Rightarrow 6t^2 - 6t - 12 = 0$

$(t-2)(t+1) = 0$

$t = 2$ second

then $a = 6 - 12t$

$= 6 - 12 \times 2$

$= -18 \, m/s^2$

(iii). when the velocity is max^m the acceleration is 0 then

$0 = 6 - 12t$

$\boxed{t = 0.5 \text{ sec}}$

$v = 12 + 6t - 6t^2$

$= 12 + 6 \times \frac{1}{2} - 6 \times \frac{1}{2} \times \frac{1}{2}$

$= 12 + 3 - 1.5$

$\boxed{v = 13.5 \, m/s}$

Q A stone is thrown from the top of building The height of building is 70 m. what velocity will hit the ground.

Sol^n from the third eq^n

$v^2 = u^2 + 2gh$

$\because u = 0 \;\&\; g = 9.8 m/s^2$

$v^2 = 0 + 2 \times 9.81 \times 70$

$v = \sqrt{\quad}$ 37.059 m/s

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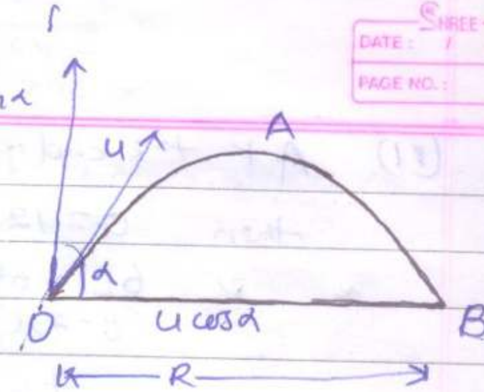
projectile motion :-



consider a particle projected into the space with a velocity u making an angle α with horizontal as shown in figure.

If we study of motion of the particle we find that the velocity of particle has two components namely vertical & horizontal component.

The function of vertical component is projected the body vertically upward and horizontal is to move the body horizontally in its direction. The combined effect of both components is to move the particle along a parabolic path. This is called projectile.

NOTE
The vertical component of the motion is always subjected to gravitational acceleration. But the horizontal component remain constant.

{1} Trajectory :- The path follow by the projectile is called trajectory.
OAB as shown in figure.

(2) velocity of projection :- The initial velocity by which the projectile is thrown, is known as velocity of projection. It is denoted by u.

(3) Angle of projection:- The angle with the horizo l, made by projectile at which a projectile is projected, is known as angle of projection. And it is denoted by 'α'.

(4) Time of flight :- The time taken by projectile moving along the projectile till, it comes to end, is known as time of fligh and denoted by T.

(5) Range of projectile:- The horizontal distance covered by the projectile during its time of flight is known as Range of projectile. It is denoted by R.

(6) Height of projcetile :- The maxm height reach by the projectile moving along a projectile with reference level. is known as Height of projectile. It is denoted by H.
At this point vertical velocity of the particle become zero.

Equation of the path:-

Consider a projectile is projected from O with a velocity u, making an angle α with axis after time t the projectile reach at point P.
At the time of projection when t=0
the horizontal component ~~as~~ is u_x ~~co~~ = $u \cos \alpha$

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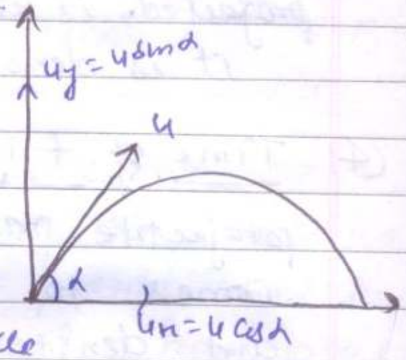
and verticle component $u_y = u\sin\alpha$.
when the particles reached at P the di
x is horizontal direction.

$x = u_x \times t$

$x = u\cos\alpha \times t$

$$\boxed{t = \frac{x}{u\cos\alpha}} \quad \text{①}$$



The distance y in verticle upward direction is given by

$h = u_y t - \frac{1}{2}gt^2$

$\because h = y$

$y = u\sin\alpha\, t - \frac{1}{2}gt^2$ — ②

from ① & ②

$y = u\sin\alpha \cdot x \frac{x}{u\cos\alpha} - \frac{1}{2} g \times \frac{x^2}{u^2\cos^2\alpha}$

$y = x\tan\alpha - \frac{1}{2} g \left(\frac{x}{u\cos\alpha}\right)^2$ — ③

Let $c_1 = \tan\alpha$, $c_2 = -\frac{1}{2}\frac{g}{(u\cos\alpha)^2}$

Then ③ becomes as

$$\boxed{y = c_1 x + c_2 x^2}$$

This is eqn of parabolic path.

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Time of flight

consider the motion of projectile from O to B in verticle direction the displacement in verticle direction is zero.

By the eqn of second of motion

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

here $h = 0,\ a = -g,\ u = u_y$

then

$$0 = u_y t - \frac{1}{2}gt^2$$

$$\Rightarrow \quad 0 = u\sin\alpha\, t - \frac{1}{2}gt^2$$

$$u\sin\alpha = \frac{1}{2}gt$$

$$\boxed{t = \frac{2u\sin\alpha}{g}}$$

* Horizontal Range of (R):-

The range of projectile can be calculated by multiplying horizontal velocity to time of flight.

$$R = u_x \times t_{flight}$$

$$= u\cos\alpha \times \frac{2u\sin\alpha}{g}$$

$$\boxed{R = \frac{u^2\sin 2\alpha}{g}}$$

* maximum Height (H):- we know that the initial velocity in vertical direction $u\sin\alpha$ and the velocity at the point of maximum height is zero.

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Then using eqn (3) we have

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

here $a = -g$, $s = H$ then,

$u = u_y = u\sin\alpha$

$$v^2 = u_y^2 - 2gH$$

At the maximum height velocity is zero

then $v = 0$, $u_y = u\sin\alpha$

$$0 = u^2\sin^2\alpha - 2gH$$

$$\boxed{H = \frac{u^2\sin^2\alpha}{2g}}$$

Velocity After Given Time:-

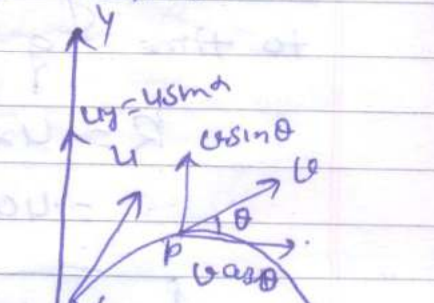
Assume that the particle has reached to the position 'p'. After a time interval 't' and its velocity is 'v'. The velocity component of u and v along x & y-direction.

$u_x = u\cos\alpha$

$u_y = u\sin\alpha$

$v_x = v\cos\theta$

$v_y = v\sin\theta$



Since the Horizontal components always remain constant.

$$\boxed{v\cos\theta = u\cos\alpha} \quad (4)$$

Considering the motion in vertical direction from O to P point.

from the eqn of motion

$v = u + at$

here $v = v\sin\theta$, $u = u\sin\alpha$, $a = -g$
then

$v\sin\theta = u\sin\alpha - gt$ — (5)

Squaring the eqn (4) & (5) then adding

$v^2\cos^2\theta + v^2\sin^2\theta = u^2\cos^2\alpha + u^2\sin^2\alpha + g^2t^2 - 2ugt\sin\alpha$

$v^2 = u^2 + g^2t^2 - 2ugt\sin\alpha$

$$\boxed{v = \sqrt{u^2 + g^2t^2 - 2ugt\sin\alpha}} \quad (6)$$

Dividing eqn (5) by (4) we have

$$\boxed{\tan\theta = \frac{u\sin\alpha - gt}{u\cos\alpha}}$$

These two equations give velocity and direction of a particle moving along projectile after time 't'.

Velocity at height :-

If at a height 'h' velocity of projectile 'v'

$v_y^2 = u_y^2 - 2gh$

Here $v_y = v\sin\theta$, $u_y = u\sin\alpha$

$$\boxed{(v\sin\theta)^2 = (u\sin\alpha)^2 - 2gh} \quad (8)$$

The Horizontal component of projectile remain Constant.

$$\boxed{v\cos\theta = u\cos\alpha} \quad (9)$$

Squaring the eqⁿ (9) and adding with (8) we have

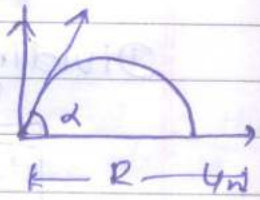
$$u^2\sin^2\theta + v^2\cos^2\theta = u^2\sin^2\alpha + u^2\cos^2\alpha - 2gh$$

$$v^2 = u^2 - 2gh$$

$$\boxed{v = \sqrt{u^2 - 2gh}} \quad \text{— (10)}$$

Q. A particle through from ground in projectile from comes back to the ground in 4 second. At a distance 60m from the point of projection. Determine the angle of projection.

Solⁿ



$$t_{flight} = 4s$$

$$R = 60m$$

$$\because \quad R = u_x \times t_{flight}$$

$$u_x = \frac{60}{4} = 15 m/s$$

$$\because R = \frac{u_x^2 \sin 2\alpha}{g}$$

$$\sin 2\alpha = \frac{R \times g}{u_x^2}$$

$$= \frac{60 \times 9.81}{15 \times 15}$$

$$=$$

from the eqⁿ of 2nd.

$\because$ displacement $h = 0$ then

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

$$0 = u_y \times 4 - \frac{1}{2} \times 9.81 \times 4 \times 4$$

$$u_y = 19.62 \ m/s$$

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$$\therefore \alpha = \tan^{-1}\left(\frac{u_y}{u_x}\right)$$
$$= \tan^{-1}\left(\frac{19.62}{15}\right)$$
$$\boxed{\alpha = 52.60^\circ}$$

Q2. A ball is projected from ground at an angle 60° with the horizontal with a velocity of 30 m/s. Determine the distance from point of projection after 2 seconds.

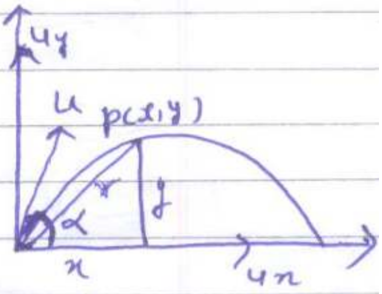
Solⁿ

As per given data

angle of projection $\alpha = 60^\circ$

& $u_x = 30$ m/s

$t_{flight} = 2s$



$\therefore u_x = u\cos\alpha = 30$

$\Rightarrow \cos u = \frac{30}{\cos\alpha}$

$u = \frac{30}{\cos 60} = 60$ m/s

$u_y = u\sin\alpha = 30 \times \sin 60 = 25.98$ m/sec

$u_x = u\cos\alpha = 30 \times \cos 60 = 15$ m/s

$x = u_x \times t$
$= 15 \times 2$
$= 30$ m

$y = u_y t - \frac{1}{2} g t^2$
$= 25.98 \times 2 - \frac{1}{2} \times 9.81 \times 2 \times 2$
$= 32.39$ m

$r = \sqrt{x^2 + y^2}$

$r = 44.11$ m

Q. A gun is fired at a target lying on the ground at a distance 3180 m from the gun point. If the gun is fired from the ground at a velocity of 240 m/s. Determine the angle made by the gun with horizontal in order to hit the target. Also find the time taken for hitting the target.

Soln As given

$R = 3180\,m$

$u = 240\,m/s$

$R = \frac{u^2 \sin 2\alpha}{g}$

$\sin 2\alpha = \frac{3180 \times 9.81}{240 \times 240}$

$= 0.541$

$2\alpha = \sin^{-1}(0.541)$

$\alpha = 16.39°$

$\therefore t_{flight} = \frac{R}{u_x} = \frac{3180}{230.242}$

$= 13.81$ sec

$= 14$ sec.

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

$h = 0,$

$0 = \cancel{240 \times 0.28 - \frac{1}{2} \times 9.}$

$t = \frac{2u_y}{g} = \frac{2 \times 240 \times 0.28}{9.81}$

$= 13.80$ sec

$R = 3180\,m$

$u = 240\,m/s$

$R = \frac{u^2 \sin 2\alpha}{g}$

$\frac{3180 = \cancel{u} \times 9.81}{240 \times 240} = \sin 2\alpha$

$t = \frac{R}{u_x}$

$R = 3H$

Q A stone is projected with such an angle with horizontal the range is three time the gratest height atend by the body.
(1) find angle of projection (ii) if with this angle range is 360 m. find necessary velocity for projection
(iii) Time of flight

$$\because \quad H = \frac{u^2 \sin^2\alpha}{2g} \quad , \quad R = \frac{u^2 \sin 2\alpha}{g}$$

for the max^m height ~~$\alpha = 45^0$~~

$$\cancel{H} = \cancel{\frac{u^2 \sin^2 45}{2g}}$$

$R = 3H$

$$\frac{u^2 \sin 2\alpha}{g} = 3 \times \frac{u^2 \sin^2\alpha}{2g}$$

$\because$ Given that

$$R = 3H$$

$$\frac{u^2 \sin 2\alpha}{g} = 3\, \frac{u^2 \sin^2\alpha}{2g}$$

$$2 \sin\alpha \cos\alpha = \frac{3}{2} \sin^2\alpha$$

$$\cancel{2 = \tan\alpha}$$

$$\tan\alpha = 4/3$$

(i) $\boxed{\alpha = 53.13^0}$

(ii)

$R = 360 m$

$$\because R = \frac{u^2 \sin 2\alpha}{g}$$

$$u = \sqrt{\frac{R \times g}{\sin 2\alpha}} = \sqrt{\frac{360 \times 9.81}{\sin(106)}}$$

$$= \sqrt{\frac{360 \times 9.81}{0.96}}$$

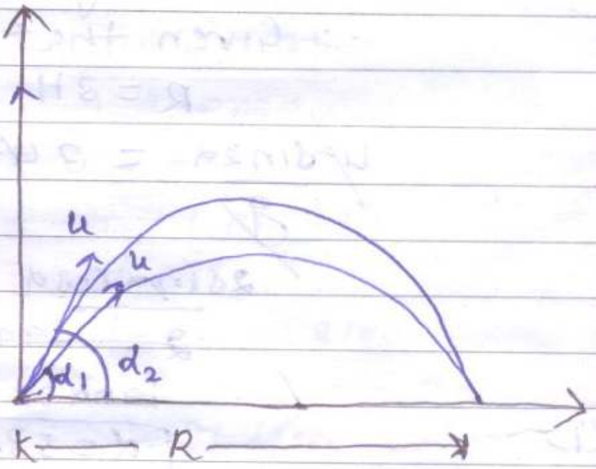
$$u = 60.65 \text{ m/s}$$

(ii) Time of flight

$$t_{flight} = \frac{2 \times 60.65 \times \sin 53.13}{9.81}$$

$$\boxed{t_{flight} = 9.89 \text{ sec}}$$

(Q) Two adjecent gun having shoot the bullet at a velocity 490 m/s simultaneously at diff angle for the same target at a range of 9.8 km. Determine the time diff b/w hits.



$R_1 = R_2$

$$\frac{u^2 \sin 2\alpha_1}{g} = \frac{u^2 \sin 2\alpha_2}{g}$$

$\Rightarrow 2\alpha_1 = 180 - 2\alpha_2$

$$\boxed{\alpha_1 = 90 - \alpha_2}$$

$\because R = \frac{u^2 \sin 2\alpha_1}{g}$

$$\sin 2\alpha_1 = \frac{9800 \times 9.81}{490 \times 490}$$

$$\boxed{\alpha_1 = 11.80}$$

$\sin\theta = \sin\alpha$

$\theta = \cancel{n\pi+(-1)}^n\pi - \alpha$

$\alpha_2 = 90 - \alpha_1$

$= 90 - 11.8°$

$\boxed{\alpha_2 = 78.19°}$

$\because T_1 = \frac{2u\sin\alpha_1}{g}$

$= \cancel{2\times 4}$

$T_2 = \frac{2u\sin\alpha_2}{g}$

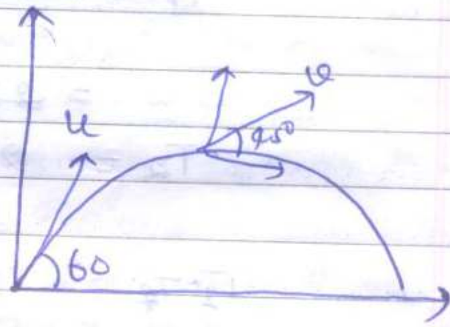
$T_2 - T_1 = \frac{2u}{g}[\sin\alpha_2 - \sin\alpha_1]$

$\Delta T = \frac{2\times 490}{9.81}[\sin 78.19 - \sin 11.8]$

$= 99.89[0.204 - 0.97$

$= \frac{2\times 490}{9.89}[.978$

Q A stone is projected upward at an angle of 60° to determine lapse before it move upward and makes an angle 45° to the horizontal. The velocity of projection 120 m/s



As we know that

eq $v\cos\theta = u\cos\alpha$

$v\cos 45 = 120\cos 60$

$v = 60\sqrt{2}$ m/s

$u_y = 120\sin 60 = 103.92$ m/s

$v_y = 60\sqrt{2}\sin 45 = 60$ m/s

$\because \quad v = u + at$

$v_y = u_y - gt$

$60 = 103.92 - 9.81\times t$

$t = \dfrac{103.92-60}{9.81}$

$\boxed{t = 4.47\ \text{sec}}$

Newton's law of motion

(i) first law of motion:-

It states every body continue in its state of rest or of uniform motion in a state line unless it is acted upon by some external force to change the state.

(ii) IInd Law of motion:-

The rate of change momentum of a moving body is directly proportional to the force acting on it and takes place in the same direction

Let initial velocity is u and final velocity is v then initial momentum is mu and final momentum is mv then rate of change of momentum is

$$\frac{dp}{dt} = \frac{m \times v - m \times u}{t}$$

$$= m\left(\frac{v-u}{t}\right) = ma$$

According to Newton's second Law of motion

$f \propto ma$ $\boxed{f = kma}$

(iii) Newton's third law of motion:-

It state ~~these~~ to every action there is always an equal and opposite reaction.

for ex:- When a bullet is fired from a gun the bullet move out with a great velocity and the reaction of the bullet in opposite direction: force are uppleasent shock to to man holding the gun.

D'ALEMBERT'S Principle :-

It state that if a rigid body is acted upon by a system of forces. This system may be reduced to single resultant force whose magnitude, direction and line of action may be find out by the graphical statics.

The force acting on a body is given by $\boxed{f = ma}$ — (1)

$$\boxed{f - ma = 0} \quad \text{— (2)}$$

It may be noted that equation Ist is the equation of dynamic and equation second is the equation of statics.

Q. A Body has weight 490N on earth find its weight on moon as sun; where the gravitional acceleration are $1.7 m/s^2$ and $270 m/s^2$.

Solⁿ The weight of body on the earth is

$w = mg$

$$m = \frac{w}{g} = \frac{490}{9.81} = 49.94 \, kg$$

at moon weight of Body

$$W_m = mg_m = 49.94 \times 1.7$$
$$= 84.91 N$$

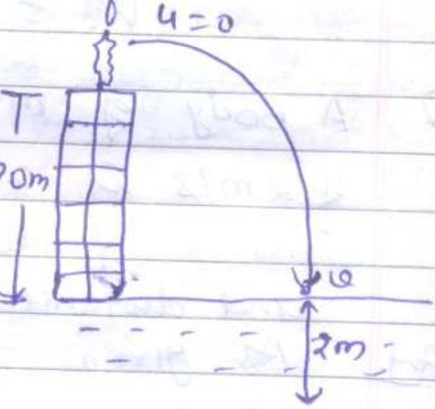
at sun
weight of body
$$W_s = m g_s$$
$$= 49.94 \times 270$$
$$W_s = 13483.8\ N$$

Q A Body of mass 8kg moving with a velocity of 2m/s if a force of 16N is applied on body determine the velocity after 2sec. and distance travelled in that 2 sec.

Ans As given
$m = 8kg$
$u = 2m/s$
$F = 16N$
$v = u + at$
$f = ma$
$$a = \frac{f}{m} = \frac{16}{8} = 2m/s^2$$
$$v = 2 + 2 \times 2$$
$$= 6m/s$$
$$S = ut + \frac{1}{2}at^2$$
$$= 2 \times 2 + \frac{1}{2} \times 2 \times 2 \times 2$$
$$\boxed{S = 8\ m}$$

Q A man of mass 80kg dives vertically downward in to a swimming pool from a height of 20m. He was found to go down in water by 2m and then starting insi[illegible]. Determine average resistance of the water.

Solⁿ



mass of man = 80kg

$H = 20m$

Now from the IIIʳᵈ Eqⁿ of motion

$$v^2 = u^2 + 2gh$$

$$= 0 + 2 \times 9.81 \times 20$$

$$\boxed{v = 19.81\ m/s}$$

Now this velocity becomes initial velocity for the motion in water and final velocity is zero.

Now $v'^2 = v^2 - 2as$

$$0 = (19.81)^2 - 2 \times a \times 2$$

$$a = 98.01\ m/s^2$$

Now the resistance force applied by water on human body is

$$f = ma$$

$$f = 80 \times 98.01$$

$$f = 7840.8N$$

Teacher's Signature