4 SEPTEMBER, 2023

UNIT #2

KINEMATICS

Questions.

Q1: Define Kinematics.

Ans: It is the study of object without discussing the cause of motion.

For example:-

When a ball is thrown vertically upward, In kinematics we study what is the motion of the ball.

Q2: Differenciate between rest and motion.

REST	MOTION
(1) A body is said to be at rest if it does not change its position according to its surrounding	(1) A body is said to be in motion if it does change its position according to its surrounding.
(2) A book on a table is at rest because it does not change position according to its surrounding	(2) A car moving on the road is in motion because it changes its position according to its surrounding.

(3) In rest, sum of all forces acting on a body is zero.	(3) In motion, sum of all forces acting on a body is not zero.

Q3: Rest and motion are relative. Explain with an example.

Ans: Yes, rest and motion are relative.

FOR EXAMPLE: A tissue box on the dash board of a car is at rest with respect to a person inside the car. However the same tissue box is in motion with respect to a person on ground.

Q4: Define the term 'position'.

Ans: Position describes the location of an object with respect to reference point is known as origin. We use vector to show position.

For example:-

For describing position of our school from our home, by using line with arrowhead. We use one, two or three axis to show position.

Q5: What is meant by Rectangular Coordinate System?

Ans: A coordinate system is used to locate the position of any point and that point can be plotted as an ordered pair (x, y) known as coordinates. The horizontal number line is called 'X-axis'. The point and the vertical number line is called 'Y-axis'. The point of intersection of these two axes is known as the origin and it is denoted as 'O'.

Rameez
14/01/23

Q6: Write down the different types of motion.

Ans:

(1) **TRANSLATORY MOTION:**

Change in position of a body as a whole. The line or path of motion could be straight, curved or random.

Example:

Motion of ball, car, flying birds, aeroplane etc.

(2) **ROTATORY MOTION:**

Rotation of a body around a fixed rotation axis. The particles of the object in rotation move in a circle.

Example:

motion of helicopter rotors, blades of fan etc.

(3) **VIBRATORY MOTION:**

The to and fro motion of an object about its mean position. The object in vibration repeats its motion.

Example:

motion of swing, strings of sitar, guitar, etc.

Q7: Write down types of translatory motion.

Ans:

(1) **RECTILINEAR MOTION:**

Straight line motion.

Example:

Motion of a free falling body.

(2) **CURVILINEAR MOTION:**

Circular or curved path motion.

Example:

Motion of cars around a turn.

(3) **RANDOM MOTION:**

Irregular motion.

Example:

Motion of butterfly.

Q8: Differenciate between scalars and Vectors.

Ans:

SCALAR	VECTOR
① Physical quantities which can be completely described only by its numerical magnitude (or size) with proper unit are termed as scalar quantities or simply scalars	① Physical quantities which require not only numerical magnitude (or size) with proper unit, but also the direction for their complete description are termed as vector quantities or simply vectors.

(2) EXAMPLES: density, distance, energy, charge volume etc.	(2) EXAMPLES: weight, velocity, accelleration, force etc.
(3) It follows algebraic laws.	(3) It does not follow algebraic laws.
(4) Scalar quantities are never negative.	(4) Vector quantities may or may not be negative. It depends on the direction.

Qs: How do we represent vectors?

Ans: **SYMBOLICALLY:**

Symbolically a vector can be represented by a letter either capital or small. [e.g F and f or A and B) with an arrow over or below it.

GRAPHICALLY:

Graphically, a vector is represented by an arrow, the length of the arrow gives the magnitude with proper unit (under certain scale) and the arrow heads points the direction of the vector. To use vectors, we place them in coordinate axis.

Q 10: How do we represent vectors in Co-ordinate system?

Ans: The following method is used to represent a vector in a coordinate system.

(1) Choose and draw a Coordinate system

(2) Select a suitable scale

(3) Draw a line in a fixed direction. Cut the line equal to the magnitude of the vector according to the chosen scale.

(4) Put an arrow along the direction of the vector.

Q11: Differenciate between Distance and displacement

DISTANCE	DISPLACEMENT
(1) Total length between two points is known as distance	(1) Shortest distance between two points is known as displacement
(2) It is a scalar quantity	(2) It is a vector quantity
(3) It can never be negative	(3) It may be positive or negative depending on direction.
(4) It is represented by S	(4) It is represented by $\vec{d}$

Q12: Can displacement be greater than distance?

Ans: No, it is not possible because distance is the total length between two points while displacement is shortest length between two points.

19/9/23

Q13: Can distance and displacement be equal?

Ans: Yes, it is possible, distance and displacement become equal when body moves in a straight line.

Q14: ~~If on a 400m running track~~
Differenciate between speed and velocity.

Ans:

SPEED	VELOCITY
(1) Measure of distance covered with Passage of time is known as Speed	(1) Measure of displacement covered with passage of time is known as velocity
(2) It is scalar quantity	(2) It is vector quantity
(3) It is always positive	(3) It may be positive or negative depending on direction
(4) Speed = $\frac{\text{distance}}{\text{time}}$	(4) Velocity = $\frac{\text{displacement}}{\text{time}}$

Q15: Define Average Speed.

Ans: The Average Speed is the total distance covered in total time.

Mathematically:

$$V_{av} = \frac{\text{Total distance}}{\text{Total time}}$$

Q16: Define Average Velocity?

Ans: The average velocity is the total displacement covered in total time

Mathematically:

$$V_{av} = \frac{\text{Total displacement}}{\text{Total time}}$$

Q17: Define uniform speed?

Ans: If an object covered equal distance in equal interval of time, we say that it is moving with uniform speed.

Q18: Define uniform Velocity?

Ans: If an object covered equal displacement in equal interval of time, we say that it is moving with uniform Velocity.

Q19: Define Variable Speed?

Ans: If an object does not cover equal distance in equal interval of time then we say that it is moving with Variable speed.

Q20: Define Variable Velocity?

Ans: If an object does not cover equal displacement in equal interval of time then we say

that it is moving with variable velocity.

Q21: Define acceleration?

Ans: The measure of change in velocity (Δv) with Passage of time (Δt) is called acceleration.

MATHEMATICALLY:-

$$\text{acceleration} = \frac{\text{change in velocity}}{\text{elapsed time}}$$

$$\text{or} \quad \vec{a} = \frac{\Delta \vec{v}}{\Delta t}$$

$$\text{or} \quad \vec{a} = \frac{\vec{v_f} - \vec{v_i}}{t_f - t_i}$$

Acceleration is vector quantity, its unit is m/s^2

Q22: Difference between Positive and negative acceleration.

POSITIVE ACCELERATION	NEGATIVE ACCELERATION
① A positive acceleration means an increase in velocity with time.	① Negative acceleration means a decrease in velocity with time
② In positive acceleration velocity and acceleration both have same direction	② In negative acceleration velocity and acceleration has opposite direction.
③ In positive acceleration $V_i > V_f$	③ In negative acceleration $V_f > V_i$
④ Acceleration is taken positive.	④ Acceleration is taken negative.

Q3: Define uniform acceleration.

Ans: "When an object is changing its velocity at the same rate in each second we call it uniform acceleration."

Q4: What do you know about Graph?

Ans: Graph is a pictorial way to represent information about relation between various Quantities.

⇒ Graph is always plotted between two quantities.

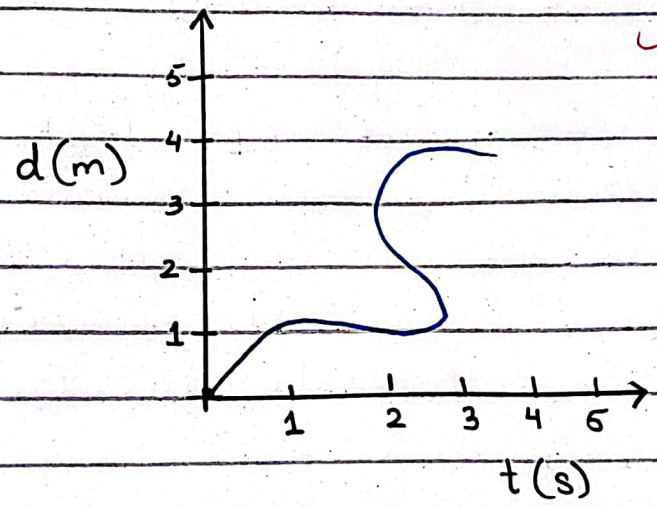
⇒ The quantities between which graph plotted are known as variables.

Q25: What is distance-time graph?

Ans: The graph plotted between distance and time is known as distance-time graph.

⇒ In distance-time graph x-axis shows time while y-axis shows distance

⇒ It's slope gives us speed of the body

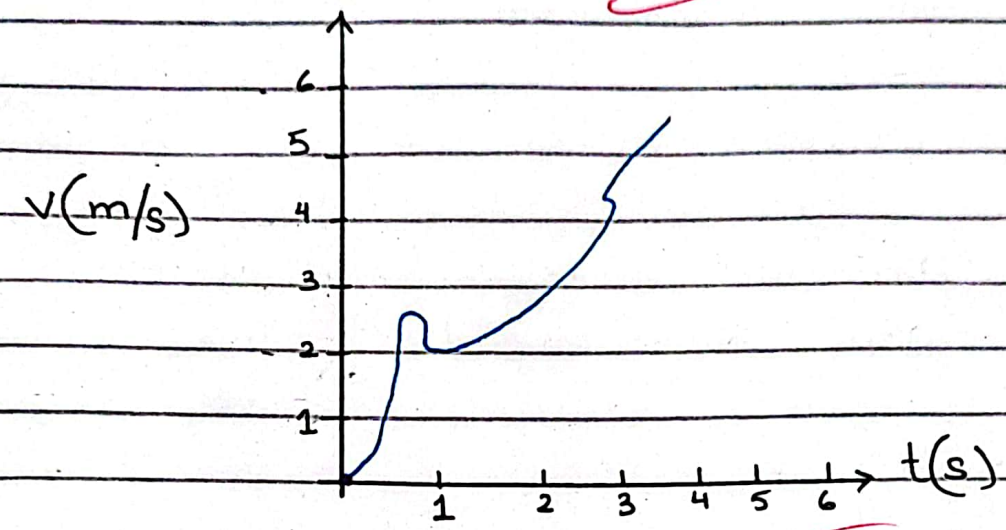


Q26: What is speed-time graph?

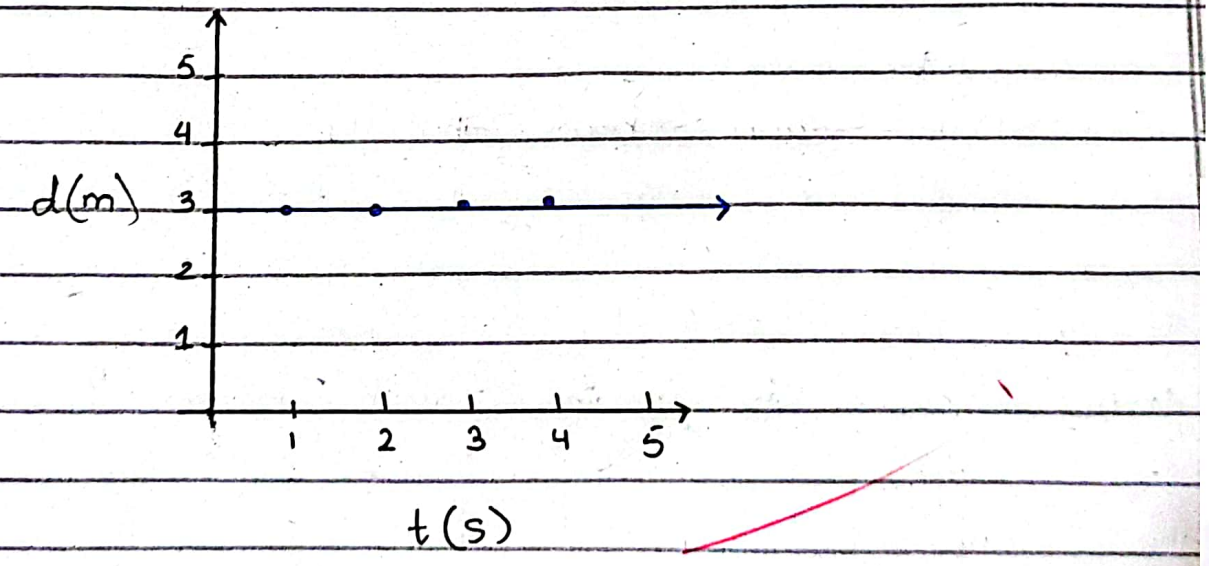
Ans ⇒ The graph plotted between speed and time is known as speed-time graph.

⇒ In speed-time graph x-axis represent time while y-axis shows speed.

⇒ Its slope gives us acceleration.



Q1: Draw distance-time graph when object is at rest.

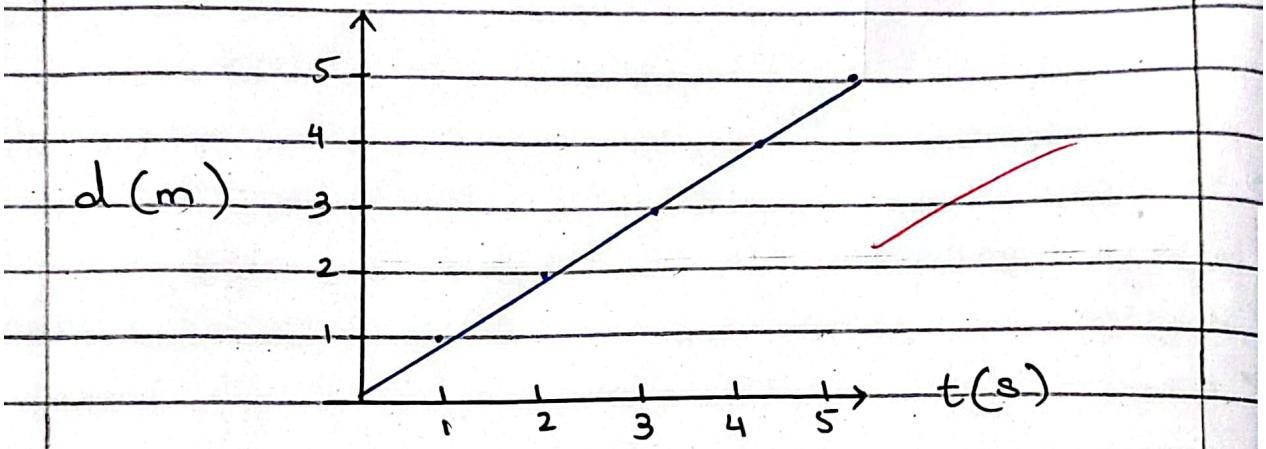


⇒ The above graph shows that body does not cover any distance as time passes.

⇒ Straight line parallel to time-axis shows that object is at rest.

⇒ It's slope is zero.

Q28: Draw distance-time graph when object is moving with uniform speed.

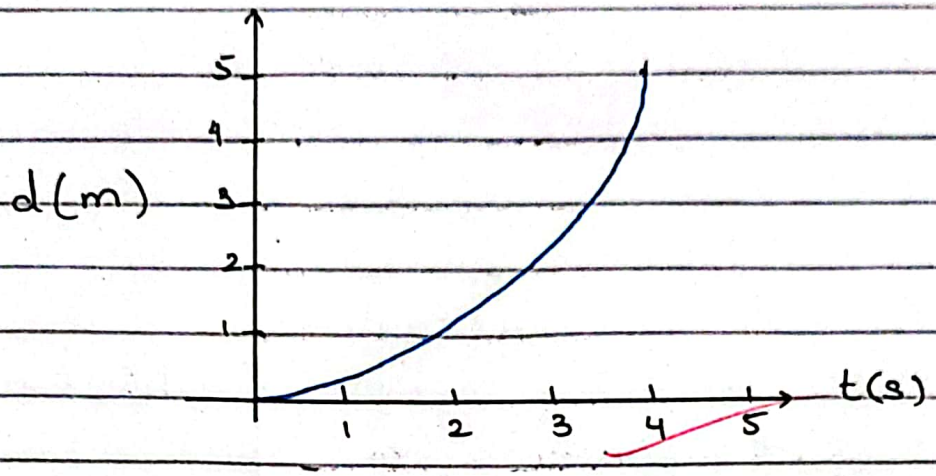


⇒ The above graph shows that body covers equal distance in equal interval of time.

⇒ Straight line inclind to time axis shows that body is moving with uniform speed.

⇒ Its slope is constant.

Q29: Draw distance – time graph when object is moving with increasing speed.

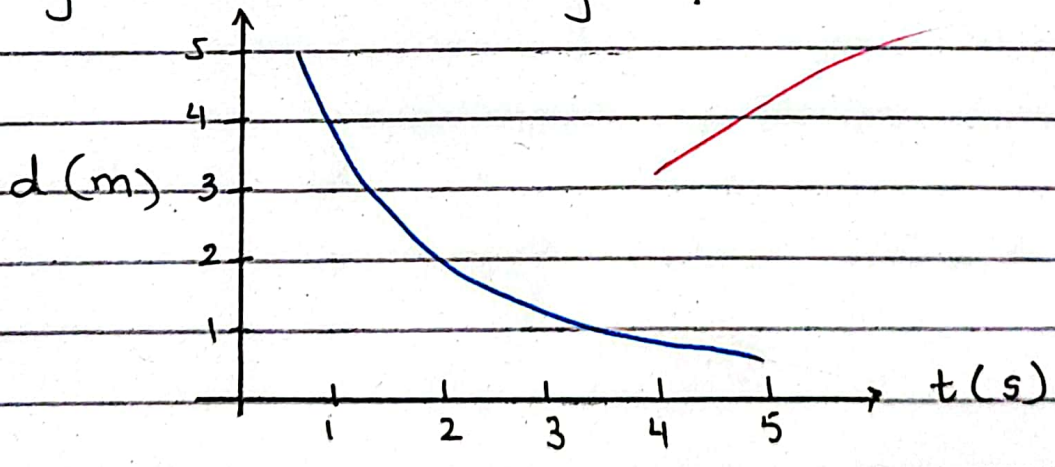


→ The above graph shows that body covers more and more distance as time passes.

→ Not a straight line (curve up) shows that body is moving with increasing speed.

→ Its slope increases (positive).

Q30: Draw distance time graph when object is moving with decreasing speed.



→ The above graph shows that body covers less distance as time passes.

→ Not a straight line (curved down) shows that body is moving with decreasing speed.

→ Its slope decreases (negative)

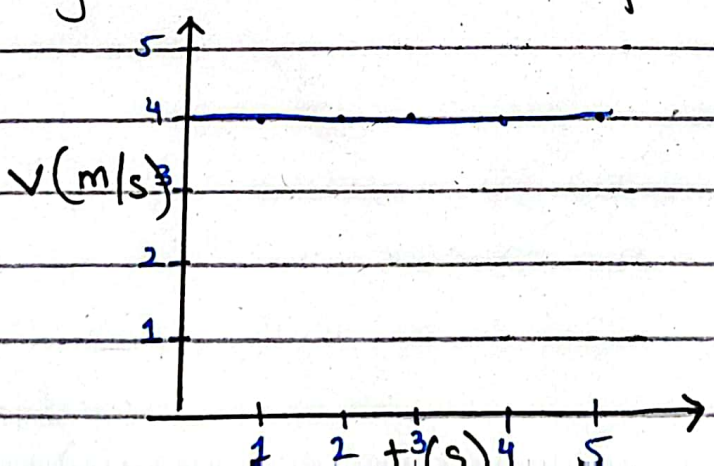
Q31: What is the purpose of speed – time Graph?

Ans: Speed – time graph serves two purposes.

(1) Slope of graph gives magnitude of acceleration

(2) Area under the graph gives us distance travelled.

Q32: Draw speed – time graph when object is moving with constant speed?

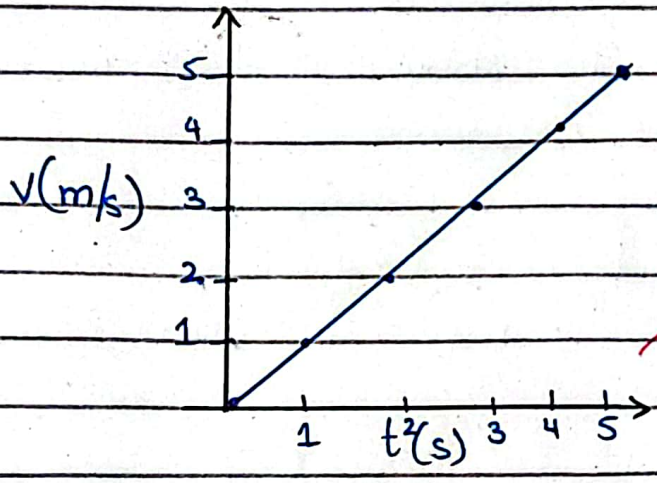


⇒ The above graph shows that body does not change its speed at time passes.

⇒ Straight line parallel to line axis shows that body is moving constant speed.

⇒ It's slope is zero (a = 0)

Q33: Draw speed-time graph when object is moving with uniform speed.

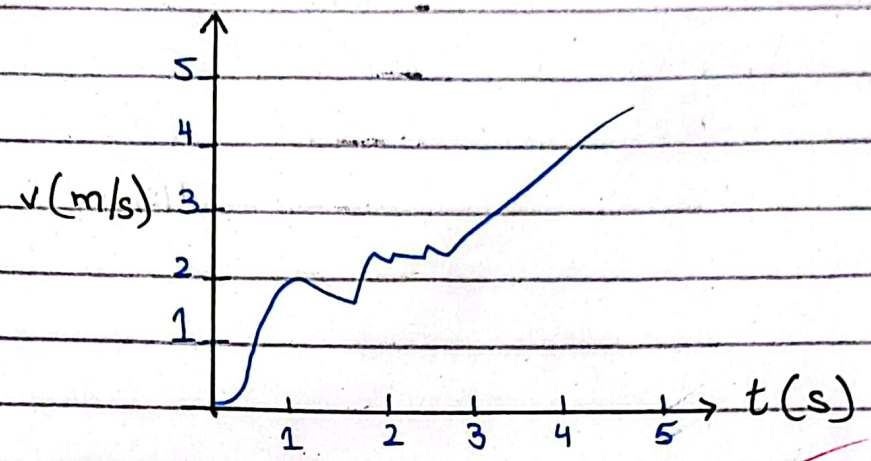


⇒ The above graph shows that body changes equal speed in equal interval of time

⇒ Straight line inclined to time-axis shows that body is moving with uniform speed.

⇒ It's slope is constant (a = constant)

Q34: Draw speed time graph when object is moving with variable speed.

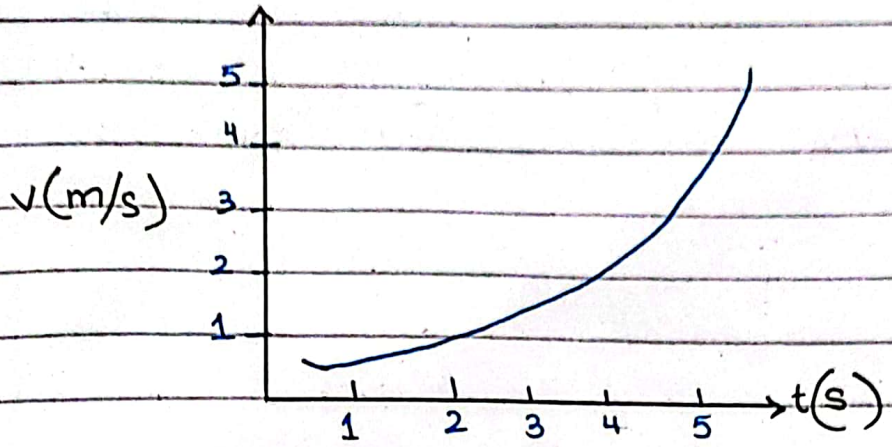


⇒ The above graph shows that body speed changes as time passes.

⇒ Not a straight line (zig-zag) shows that body is moving with variable speed.

⇒ It's slope may be positive or negative

Q35: Draw speed-time graph when object is moving with increasing speed.

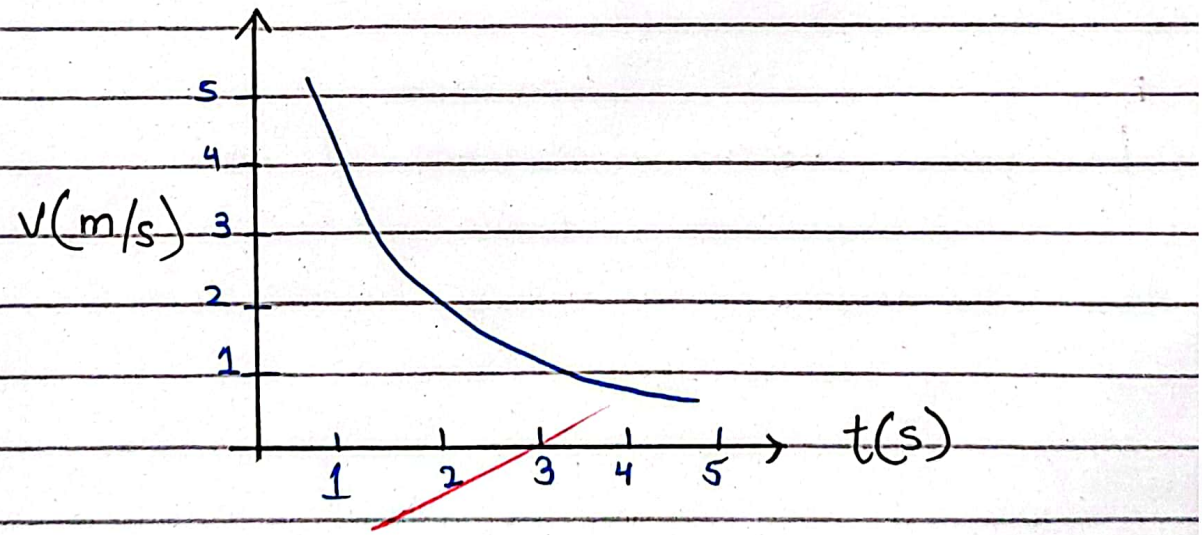


⇒ The above graph shows that body speed increases as time passes.

→ Not a straight line (curved upward) shows that body is moving with increasing speed

→ It's slope is positive.

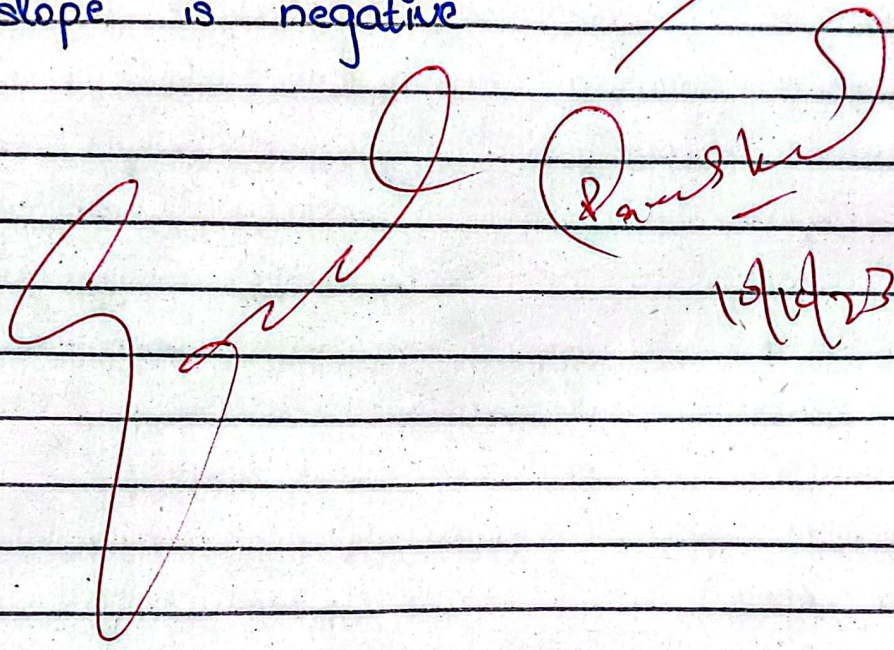
Q36: Draw speed-time graph when object is moving with decreasing speed.



⇒ The above graph shows that body speed decreases as time passes.

⇒ It is not a straight line (curved downwards). This shows that body is moving with decreasing speed.

→ It's slope is negative



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Equations Of Motion

1st equation of motion = $(v_f = v_i + at) \rightarrow$ Slope

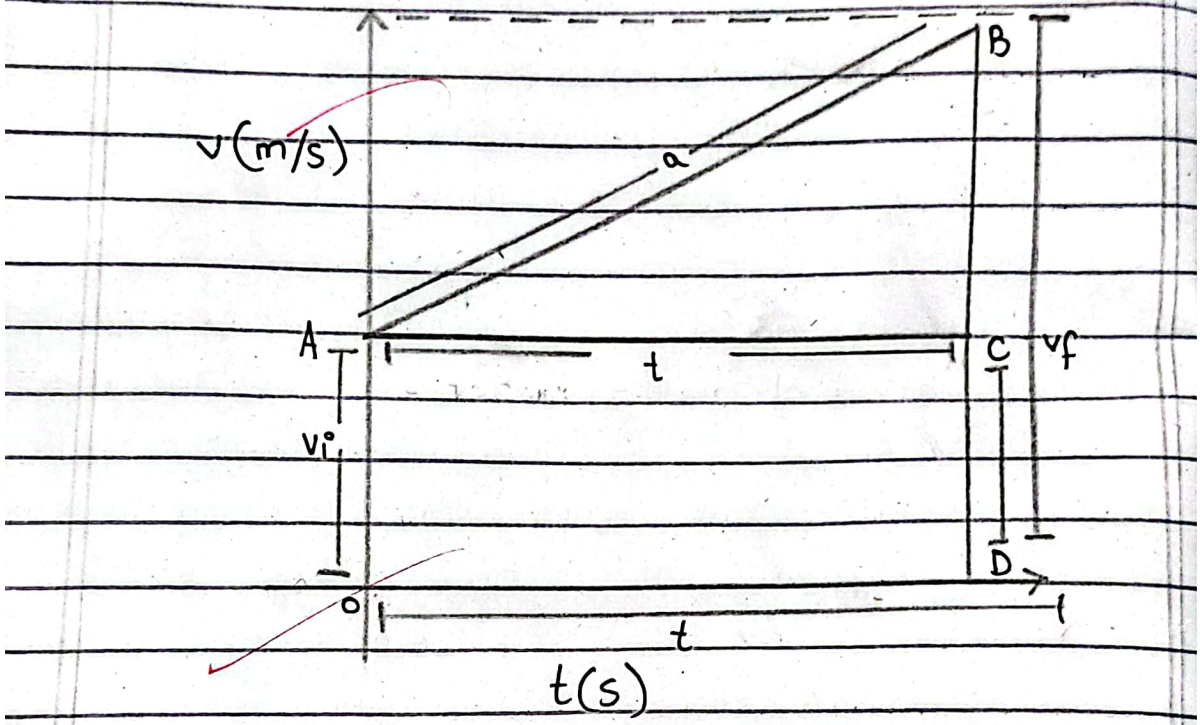
2nd equation of motion = $(S = v_i t + \frac{1}{2} a t^2) \rightarrow$ Distance

3rd equation of motion = $(2as = v_f^2 - v_i^2) \rightarrow$ Area

EQUATIONS OF MOTION

Q37. Derive 1st equation of Motion.

Ans: Consider an object that has initial velocity 'V_i' at point A. which changes uniformly to point B as 'V_f'. In the figure OA = DC represent V_i while BD represent V_f. Time is represented by OD = AC = t



Slope of line AB is

$$\text{Slope} = \frac{BC}{AC}$$

Also

Slope of AB $= \frac{BD - DC}{AC}$

As AB = a , BD = V_f , DC = V_i and AC = t

So:-

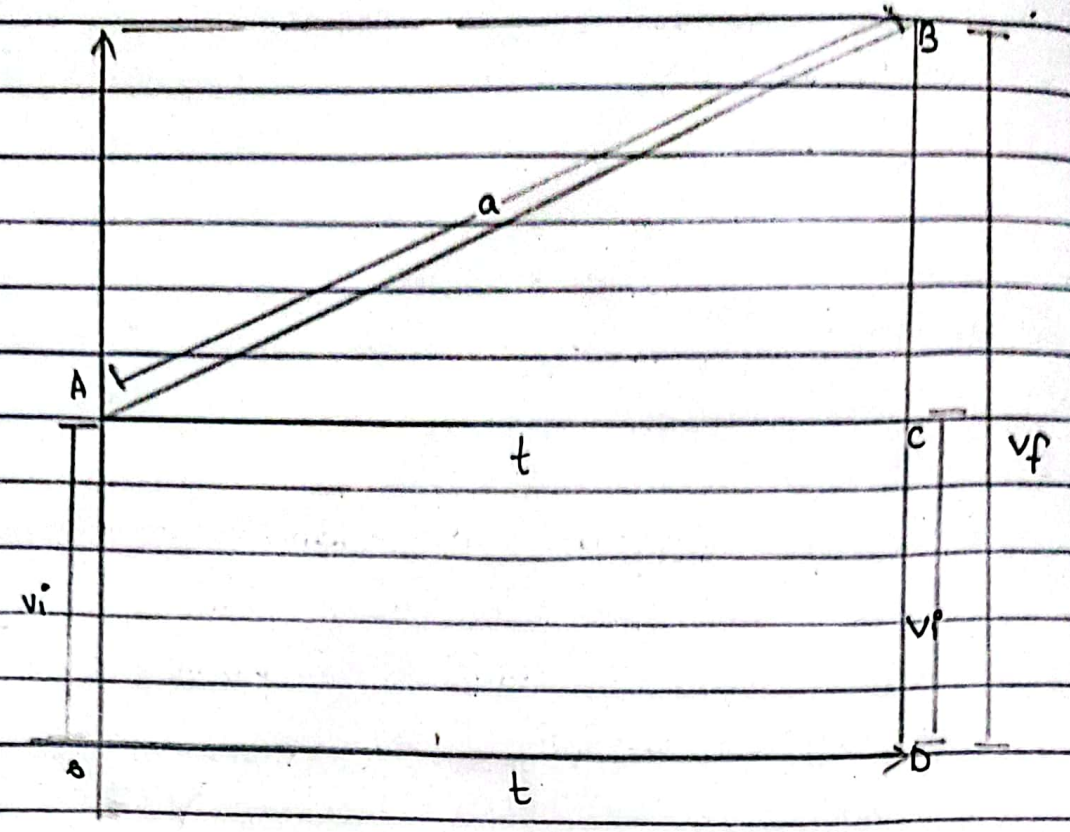
$$a = \frac{V_f - V_i}{t}$$

$$at = V_f - V_i$$

$$\Rightarrow V_f = V_i + at$$

Q.3: Derive 2nd equation of motion.

Ans: Consider an object that has intial velocity "Vi" at point at which changes uniformly to point B as "Vf". In the figure OA = DC represent V_i while BD represents by OD = AC = t



Total distance = Area of triangle + Area of rectangle

Area of rectangle OACD = (OA)(OD)

$= v_i t$

Area of triangle ABC $= \frac{1}{2}$ (AC)(BC)

$= \frac{1}{2}(t)(v_f - v_i)$

$= \frac{1}{2}(t)(at)$

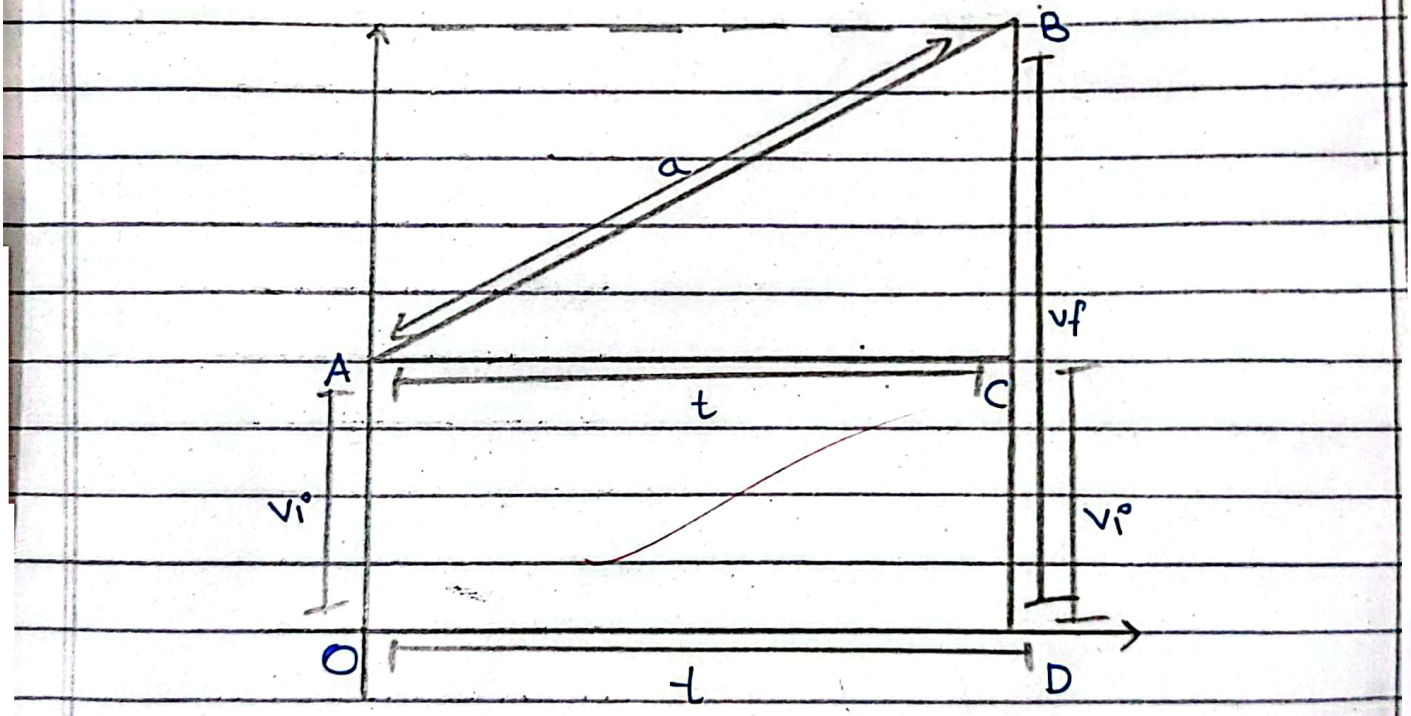
$$= \frac{1}{2} at^2$$

So,

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

Q.9s Derive 3rd equation of motion.

Ans: Consider an object that has initial velocity 'V_i' at point A. Which changes uniformly to point B as 'V_f'. In this figure OA = DC represent V_i while BD represent V_f time is represented by OD = AC = t



Total Area = $\frac{\text{Sum of Parallel sides} \times \text{height}}{2}$

$$S = \frac{OA + BD}{2} \times OD$$

$$S = \left(\frac{v_i + v_f}{2}\right) \times t$$

$$S = \left(\frac{v_i + v_f}{2}\right)\left(\frac{v_f - v_i}{a}\right)$$

$$S = \frac{v_f^2 - v_i^2}{2a}$$

$$\boxed{2aS = v_f^2 - v_i^2}$$

Q: What is meant by gravitational acceleration?

Ans: The first scientist to measure speed as distance over time was Galileo. He dropped various objects of different masses from the leaning tower of Pisa. He found that all of these reach the ground at the same time. The acceleration of freely falling bodies is called gravitational acceleration or acceleration due to gravity. denoted by 'g'.

Q: Write equation of motion for free falling bodies.

EQUATION FOR FREE FALLING BODIES:-

We will have to replace acceleration 'a' with acceleration due to gravity 'g' and distance 's' with height 'h'

$$V_f = V_i + gt \quad \text{——(i)}$$

$$h = V_i t + \frac{1}{2} g t^2 \quad \text{——(ii)}$$

$$2gh = V_f^2 - V_i^2 \quad \text{——(iii)}$$

CONCEPTUAL QUESTIONS

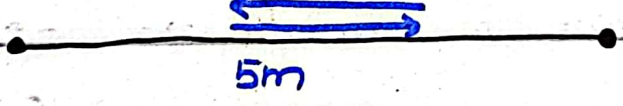
1: In a park, children are enjoying a ride on big wheel, what kind of motion big wheel has and what kind of motion the riders have?

Ans: The big wheel itself has rotatory motion because it spins about its axis. Whereas, the riders do not spin about their axis. Instead they move in circular path and possess circular motion

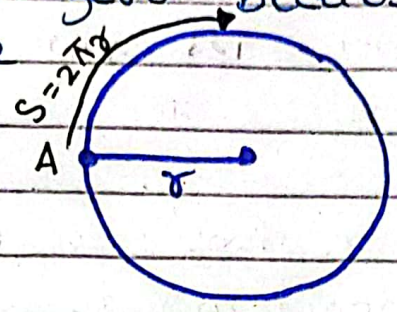
2: A boy moves for some time, give two situations in which his displacement is zero but covered distance is not zero.

Ans: Displacement is the shortest distance from start point till end point

Case 1:- When a boy moves in a straight line from A to B and then from B to A, it covers some distance but displacement is zero because start point and end point are same.

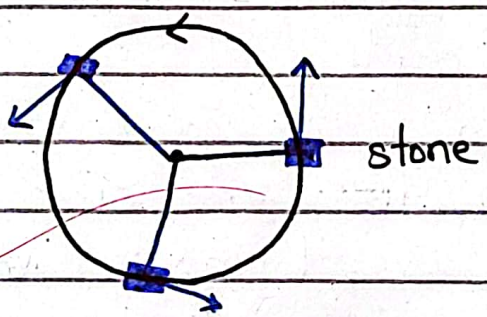


Case 2 :- When a boy moves on a circular track. It covers some distance equal to $2\pi r$, but displacement is zero because start and end point are same



Q38: A stone tied to a string is whirling in a circle. what is direction of its velocity at any instant?

Ans: When a stone moves in a circle, the direction of its velocity is always perpendicular to its radius at each point as shown in figure



Q48 It is possible to accelerate an object without speeding it up or slowing it down?

Ans Yes an object can be accelerated without speeding up or slowing down. we know that

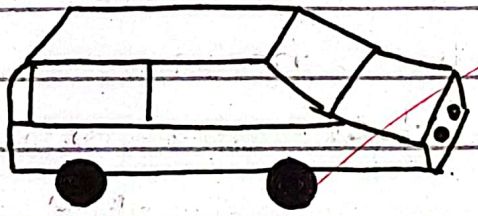
acceleration is referred as the rate of change in velocity in a particular direction. So if direction changes, body has acceleration.

For example:-

When a body moves in a circle, it has acceleration.

Qs: Can a car moving towards right have direction of acceleration towards left?

Ans: Yes, when a car moving towards right is under the action of applied brakes, its speed decreases and the acceleration is negative called 'deacceleration'. The negative acceleration is always negative to the direction of Motion. So if the car is moving towards right, its direction of acceleration is towards left.



Q6. With the help of daily life examples, tell the situation in which

a) Acceleration is in the direction of motion.
When a car starts moving from rest, its velocity increases and hence acceleration is in the direction of motion.

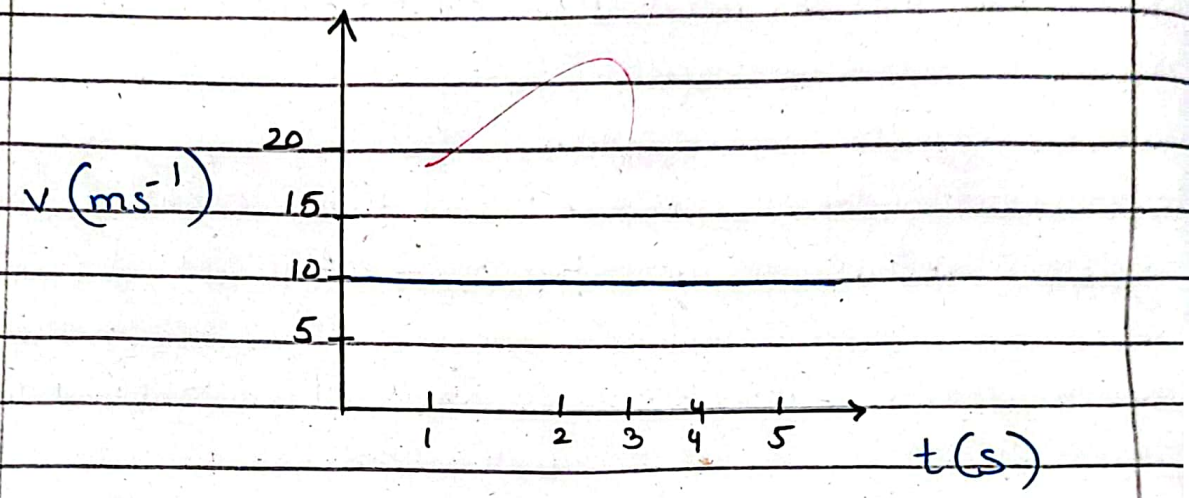
b) Acceleration is against the direction of motion.
When brakes are applied to a moving car, its velocity decreases but acceleration increases. The acceleration is against the direction of motion.

c) Acceleration is zero and body is in motion.
When a car moves from uniform velocity in a straight line, its acceleration is zero because rate of change in velocity is zero.

Q7. Examine distance time graph of a motorcyclist. What does the graph tell us about the speed of motorcyclist. Plot the velocity time graph for it.

Ans: The graph tells us that the speed (velocity) of the motorcyclist is uniform (constant) because it covers equal distance (displacement) in equal intervals of time.

Velocity time Graph for the above motion. (Moving with uniform velocity).



Q8: which controls of the car produce acceleration and deacceleration in it?

Accelerator: Accelerator in the car increases the speed of the car when pressed, so it produces acceleration in the car.

Brakes:- Brakes in the car decrease

the speed of the car when pressed, so brakes produce deacceleration in the car.

Q: If two stones of 10 kg ..... resistance.

Ans: Both will hit the ground at the same time with same velocity i.e

$$V_f = \sqrt{2gh} = \sqrt{2 \times 10 \times 1000}$$

Proof :-

As both balls are dropped from rest, so their initial velocity $= V_i = 0$

Acceleration in the balls is due to gravity, So Accelegation $= a = g = 10 ms^{-1}$

Now accord and

height $= h = 1$ km $= 1 \times 1000$ m $= 1000$ m

According to 3rd equation of motion;

$2as = V_f^2 - V_i^2$ change to $2gh = V_f^2 - V_i^2$

Or $2gh = V_f^2 - 0$

OR

$$2g\ v_f^2 = 2gh$$

OR

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

Q10: A 1 kg steel ball is ..... (resistance)

Ans: These are two steel balls, each of which is 1kg. One is dropped (from rest) while other is thrown downward with $5 ms^{-1}$. Both of these balls are now moving under the force of gravity with an acceleration of $g = 10 ms^{-2}$. So, both of the balls will have 'same acceleration'.

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8 October, 2023

... NUMERICAL QUESTIONS ...

SOLVE THE FOLLOWING NUMERICAL QUESTIONS.

1) Convert the following

a) 36 km/hr into m/s

$$= \frac{36 \times 1000}{3600}$$

$$= 10 \text{ m/s}$$

b) 120 m/s into km/hr

$$= \frac{120 \times 3600}{1000}$$

$$= 432 \text{ km/hr}$$

c) 10 km/hr^2 into m/s^2

$$= \frac{10 \times 1000}{(3600)^2}$$

$$= 7.7 \times 10^{-4} \text{ m/s}^2$$

(d) $1\ m/s^2$ into km/hr^2

$$= \frac{1 \times (3600)^2}{1000}$$

$$= 12960\ km/hr^2$$

Q28 A morning walker completes one lap on a 628 m-long circular track. If the beginning and ending and positions are same, calculate the distance and displace he travelled. Determine his average speed and average velocity after he completed the trip in 2 minutes.

Length of circular track = 628m

distance = ?

displacement = ?

$t = 2\ min = 2 \times 60 = 120\ s$

Average speed = ?

Average velocity = ?

Sol:-

a) It covered distance 628m

b) Displacement is zero because starting and ending point is same

c) Average Speed = $\frac{\text{Total distance}}{\text{Total Time}}$

$= \frac{628}{120}$

$= 5.2 \text{ m/s}$

d) Average Velocity = $\frac{\text{Total displacement}}{\text{Total Time}}$

$= \frac{0}{120}$

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

exy imp.

Q38 In 10 seconds, a cyclist increases its speed from 5 km/hr to 7 km/hr, while a car moves from rest to 20 km/hr in same time. Calculate acceleration of each? which has greater acceleration.

$$t = 10\,s$$

(a) $V_i = 5\,km/h \times \frac{1000}{3600}$

$= 1.38\ m/s$

$V_f = 7\,km/hr \times \frac{1000}{3600}$

$= 1.94\ m/s$

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

$$= \frac{1.94 - 1.38}{10}$$

$$= \frac{0.564}{10}$$

$$= 0.056\ m/s^2$$

(b) $V_i = 0$

$V_f = 70\ km/hr \times \frac{1000}{3600}$

$= 5.55\ m/s$

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

$= \frac{5.55 - 0}{10}$

$= 0.55\ m/s^2$

* Car has greater acceleration.

Qs: A car starts its motion and accelerates at rate of $2\ m/s^2$. Find its velocity after covering distance of 500 m.

$V_i = 0$

$a = 2\ m/s^2$

$V_f = ?$

$S = 500\ m$

$2as = v_f^2 - v_i^2$

$2(2)(500) = v_f^2 - (0)^2$

$2000 = v_f^2$

Taking square root

$\sqrt{2000} = \sqrt{v_f^2}$

$44.7 \text{ m/s} = v_f$ // Ans.

Q4: A car is moving with uniform velocity of 20 m/s for 20 seconds. Then brakes are applied and it comes to rest with uniform acceleration of 1 minute.

(a) Calculate the total distance covered by car using mathematical equation

(a) $v_i = v_f = 20 \text{ m/s}$

$a = 0$

$t = 20\text{s}$

(b) $v_i = 20\ m/s$

$v_f = 0$

$t = 60s$

$$a = \frac{v_f - v_i}{t}$$

$$a = \frac{v_f - v_i}{t}$$

$$a = \frac{0-20}{60} = -\frac{1}{3}$$

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

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

$$= 400 + 0$$

$S_1 = 400\ m$

$$S = (20)(60) + \frac{1}{2}\left(-\frac{1}{3}\right)(60)^2$$

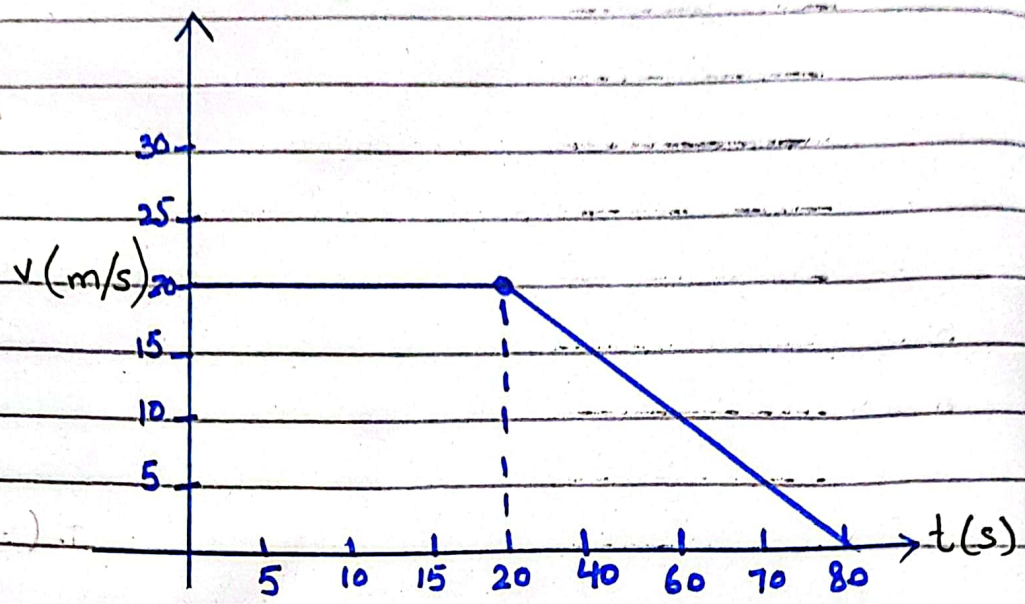
$$S = 1200 - \frac{1}{6}(3600)$$

$$= 1200 - 600$$

$$= 600\ m$$

$S = S_1 + S_2 = 1000\ m$ // Ans.

(b) Plot the graph to calculate this distance using speed time graph.



$$S = (20 \times 20) + \frac{1}{2}(60)(20)$$

$$S = 400 + 600$$

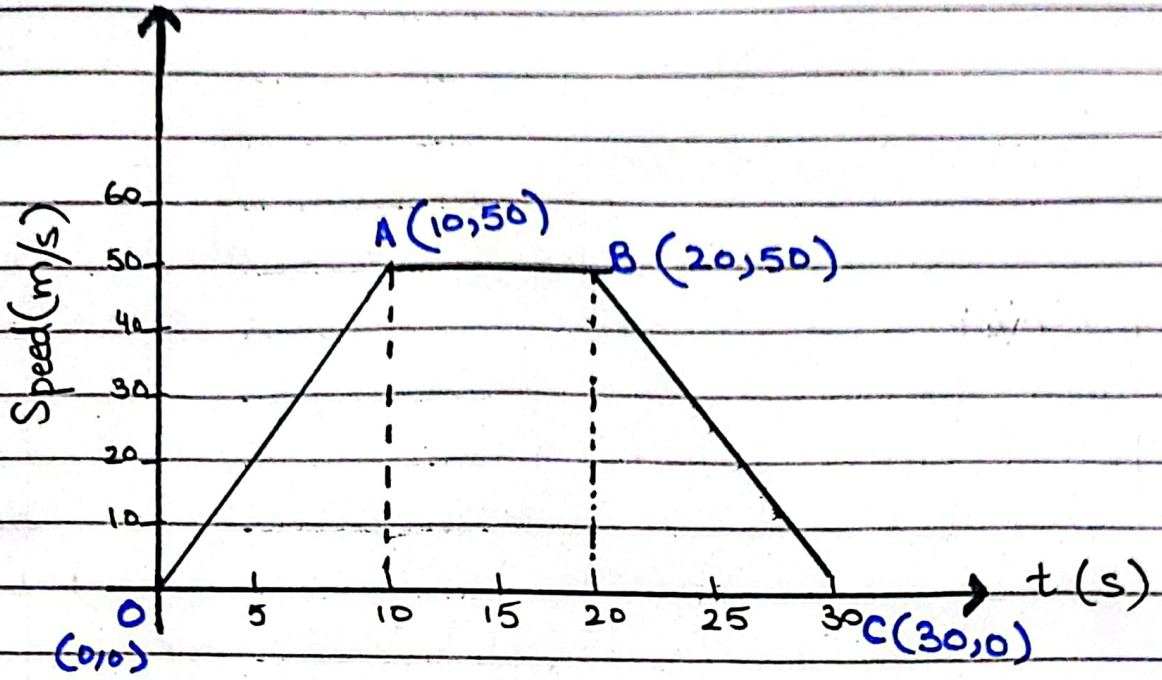
$$\boxed{S = 1000\ m}$$

Qc: Consider the following speed-time graph. Tell

(a) Which part of the Graph is showing acceleration, deacceleration and zero acceleration

b) Calculate covered distance from 10 seconds

to 20 seconds from the Graph.



A) Slope of A $= \frac{50-0}{10-0} = \frac{50}{10} = 5\ m/s^2$

Slope of AB $= \frac{50-50}{20-10} = \frac{0}{10} = 0\ m/s^2$

Slope of BC $= \frac{0-50}{30-70} = -\frac{50}{10} = 5\ m/s^2$

So,

OA represent acceleration

AB represent zero-acceleration

BC represent decelleration

(B) Area gives us distance $= 10 \times 50$.

$$S = 500\ m.$$

Q: If a ball is dropped from a high building and it reaches ground in 5 seconds. Find the velocity with which it hits the ground? What is its average speed? What is the height of the building?

$$V_i^\circ = 0$$

$$t = 5s$$

$$V_f = ?$$

(a) $$V_f = V_i^\circ + gt$$

$$V_f = 0 + (10)(5)$$

$$V_f = 50\ m/s$$

$$h = vit + \frac{1}{2} gt^2$$

$$h = (0)(5) + \frac{1}{2} (\cancel{10}^{5})(5)$$

$$h = 0 + 125$$

$$\boxed{h = 125\ m}$$

(c) Average Speed = $\frac{\text{Total distance}}{\text{Total time}}$

$$= \frac{\cancel{125}^{25}}{\cancel{5}}$$

$$\boxed{\text{Average Speed} = 25\ m/s}$$

Q88 A ball is thrown upward with the velocity of 20 m/s from ground.

(a) In how much time will it reach the top of its path?

(b) It falls back on ground, what is total tir of its trip.

(c) How high will it rise?

(a) $t = ?$

$V_f = V_i + gt$

$0 = 20 + (-10)t$

$0 = 20 - 10t$

$10t = 20$

$t = \frac{20}{10}$

$t = 2s$

(b) Total time = time up + time down

$= 2 + 2$

$= 4s$

(c) $h = V_i t + \frac{1}{2} g t^2$

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

$h = 40 - 20^{(5 \times 4)}$

$h = 20m.$

Pass 20/10