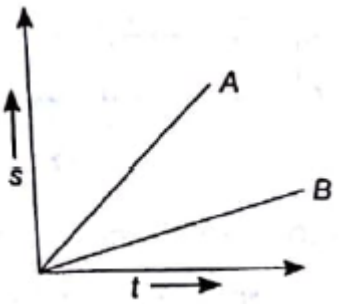
8. Motion

Assess Yourself

1. Question

Which of the two A and B has greater velocity in the following? Give reason for your reply.



Answer

A has greater velocity.

Explanation:

The slope of distance and time graph gives the velocity.

Since,

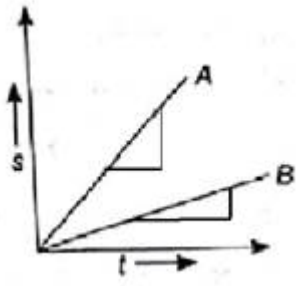
Velocity = $\frac{Distance}{Time}$

The formula for slope of any graph line is the ratio of change in value of y-axis to the change in value of x-axis.

x = t

y = s

so, slope = $\frac{\Delta s}{\Delta t}$



Thus from the above diagram, if we estimate the change of distance on y-axis to the change of time on x-axis of both A and B, then we will find that the slope corresponding to A is greater as change in distance in A is more than that of B, if we keep the change in time constant.

Hence A has higher velocity than B

2. Question

Give an example of situation in which distance is equal to

displacement.

Answer

A man climbing a ladder

Explanation:

Distance is a scalar quantity (it has magnitude only) while displacement is a vector quantity (it has magnitude and direction both)

Hence if we take any example considering a motion in which direction does not change throughout the motion and we will always get

Distance = Displacement.

3. Question

Give two examples of vector quantity.

Answer

Two examples of vector quantities are:

• Velocity

• acceleration

Since in both the cases both the magnitude as well as the direction plays a role in assessing its true value.

4. Question

Define average speed.

Answer

Average speed of a body is defined as the total distance travelled divided by the total time taken to cover the distance.

$$\text{Average speed} = \frac{\text{total distance travelled}}{\text{total time taken}}$$

Let us consider a car is travelling 2 Km in 30 minutes and then next 3 Km at 20 minutes. Then the average speed of the car is

$$\text{Average speed} = \frac{5}{30 + 20} = 0.1 \text{ Km/min}$$

5. Question

Give SI unit of angular velocity.

Answer

SI unit of angular momentum is Radian per second (rad-s^{-1})

Explanation:

Since,

$$\text{Angular Velocity} = \frac{\Delta\theta}{t}$$

SI unit of

- θ is radians
- t is seconds

Hence

SI unit of Angular velocity is radians per second (rad s^{-1})

6. Question

Give two uses of graphical representation of motion.

Answer

Two uses of Graphical representation of motion are

• Just by looking at the shape of the curve we can tell the nature of motion (i.e. uniform motion, non uniform, uniformly accelerated etc.)

For Example,

• if the distance – time graph is having straight line passing through origin then we can say that the motion is uniform motion.

• if the graph line is not straight, then it is non uniform motion.

• We can deduce different quantities and also derive equation of motion from graphs.

For example,

• from the distance – time graph, if we calculate the slope of the graph line, then we can find the velocity of the object.

• Also from the velocity – time graph, if we find the slope of the graph then we can find the acceleration of the object.

7. Question

What is meant by uniform circular motion? Why do we need a force to keep a body moving uniformly along a circular path? Name this force.

Answer

Uniform circular motion: When a body moves in a circular path with uniform speed (constant speed), its motion is called uniform circular motion.When a body moves in a circle, its direction changes continuously. Due to this change in direction we say that velocity changes and the motion is accelerated. From Newton's 1^{st} law we know that to create acceleration an external force is required. Hence **we need a force to keep the body moving in a circular path.**This force is called **Centripetal Force.**

8. Question

Define uniformly accelerated motion and give one example of it.

Answer

Uniformly Accelerated motion: When a body moves along a straight line and its velocity increases by equal amounts in equal interval of time then the motion is called uniformly accelerated motion.

E.g.:Motion of a freely falling body.

9. Question

Distinguish between scalar quantity and vector quantity. Give one example of each.

Answer

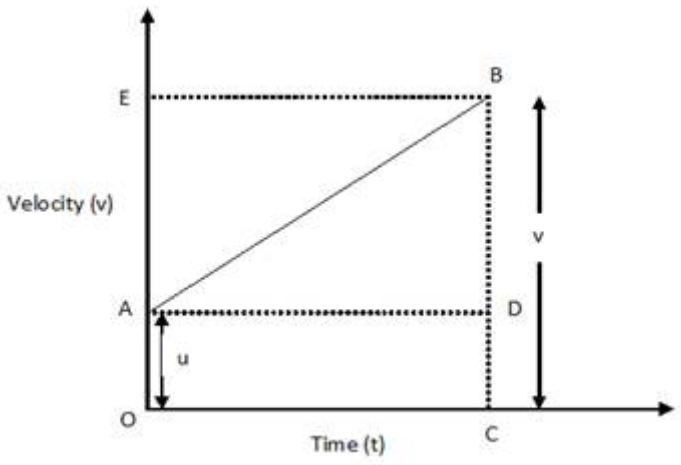
Scalar Quantity	**Vector Quantity**
A quantity that has magnitude but no direction is a scalar.	A quantity that has magnitude as well as direction is called a vector quantity.
E.g.: distance	E.g.: displacement

10. Question

Derive first equation of motion by graphical method.

Answer

Let us consider an object moving in straight line with a constant acceleration. For such a situation the first equation of motion gives the final velocity (v) after time t given that the object is having an initial velocity of u and constant acceleration of a. Now for deriving it, let us consider the following velocity time graph:



Initial velocity of the body, u = OA ... (1)

Final velocity of the body, v = BC ... (2)

From the graph BC = BD + DC

Therefore, v = BD + DC ... (3)

Again DC = OA

So, v = BD + OA

Now from equation (1), OA = u

So, v = BD + u ... (4)

We should find the value of BD now

Now, from the velocity time graph, if we calculate the change in velocity to change in time, then we can find the acceleration, a. This is nothing but the slope of the graph.

Thus,

Acceleration, a = Slope of line AB

$a = \frac{BD}{AD}$

But AC = OC = t

Hence we get

$a = \frac{BD}{t}$

BD = at

Now putting this in equation (4) we get

v = u + at

11. Question

Give one example each of uniform and non uniform in our daily life.

Answer

Uniform motion: When a car moving at a constant velocity of 50Km/hr in a straight line, then the car is covering equal distances in

equal intervals of time irrespective of the length of time. Then we can say that the car is in uniform motion.

Non Uniform motion: When a race car constantly accelerates to win the race, then the car travels unequal distances in equal intervals of time. Hence such an instance can be referred as an example of non-uniform motion.

Uniform circular motion: When a table fan rotates at a constant speed then it can be described as an uniform circular motion as it is rotating in a circle in which at all instances change of direction is taking place and movement is also circular.

Non uniform circular motion: Motion of a table fan when its switched off till its stops, can be referred as an example of non-uniform circular motion as the rotation of the fan is not constant and it is changing with time.

Uniformly accelerated Motion: When a body falls freely, then it accelerates uniformly with a magnitude of acceleration due to gravity. Thus velocity of the body increases by equal amounts in equal intervals of time. Hence it can be referred as an example of uniformly accelerated motion.

Non-uniformly accelerated motion: When a feather falls down in heavy storm, then the velocity of the feather decreases sometimes and sometimes it increases in unequal amounts in equal intervals of time. Thus it can be referred as an example of non-uniformly accelerated motion.

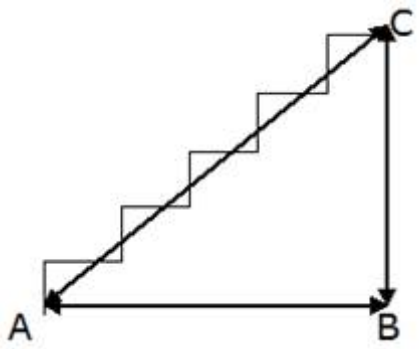
12. Question

An ant climbs up five stairs, each of width 20 cm and height 20 cm. Find the distance covered and displacement of ant.

Answer

Height = 20cm

Width = 20cm



Distance to climb 1 stair = 20 + 20 = 40cm

Distance to climb 5 stairs = AB + BC

= 5*40

= 200cm

Displacement = $\sqrt{AB * AB + BC * BC}$

= $100\sqrt{2}$

13. Question

A fan rotates at 100 rpm. Find its angular velocity and linear velocity if tip of its blades is 0.20 m away from the axis of rotation.

Answer

Frequency = υ

υ = 100 rpm

= 100/60 s^{-1}

= 5/3 Hz(s^{-1})

Angular velocity = ω

= 2*π*υ

= 2 × 3.14 × 5/3

= 10.47rad s^{-1}r = 0.20m

Linear velocity v = ω*r

= 10.47 × 0.20

= 2.094ms^{-1}

14. Question

Plot the v-t graph for the following data and state the nature of motion the body:

v(m/s)	0	5	8	12	18	25	30	35	40	45
t(s)	2	4	6	8	10	12	14	16	18	20

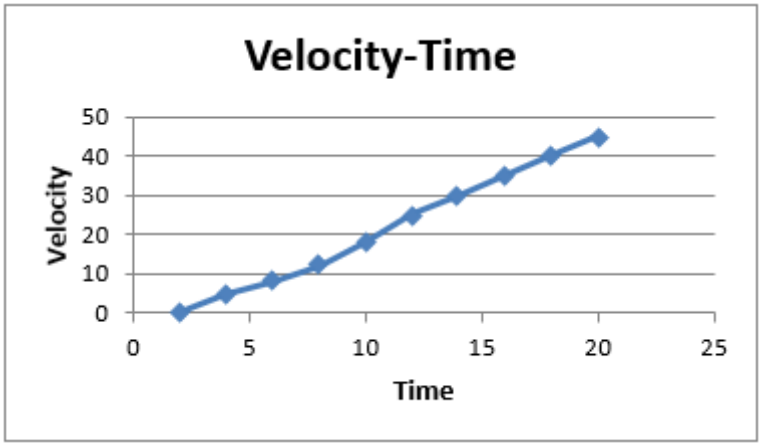
Answer

We simply plot the points on the graph containing

X axis as Time

Y axis as Velocity

Velocity v-s time graph of given data is



Deduction: We can easily see that the change in velocity per unit time is not constant. In other words velocity time graph is not a straight line, hence the motion is Non Uniformly Accelerated motion.

15. Question

A car accelerates from 6 ms^{-1} to 16 ms^{-1} in 10 sec. Calculate (a) the acceleration and (b) the distance covered by the car in that time.

Answer

Initial velocity = u

u = 6m/s

Final velocity = v

V = 16m/s

Time = t = 10 s

• Acceleration = a

a = (v-u) / t

= (16-6)/10

= 1 m/s^2

• Distance = s

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

$s = \frac{(256-36)}{(2*1)}$

= 110 m

16. Question

A circular track has a circumference of 3140 m with AB as one of its diameter. A scooterist moves from A to B along the circular path with a uniform speed of 10 m/s. Find

(a) distance covered by the scooterist,

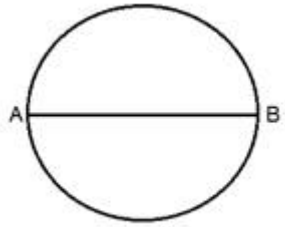
(b) displacement of the scooterist, and

(c) time taken by the scooterist in reaching

from A to B

Answer

Circumference = 3140 m



Speed = 10 m/s

a) Distance of scooter = circumference/2

= 3140/2

= 1570 m

b) Displacement of scooter = AB

= circumference/ π

= 3140/3.14

= 1000 m

c) Time taken = distance/speed

= 1570/10

= 157 s

17. Question

Define acceleration and state its SI unit. For motion along a straight line, when do we consider the acceleration to be (i) positive (ii) negative? Give example of a body in uniform acceleration.

Answer

Acceleration: Acceleration of a body is defined as the rate of change of its velocity with time

Acceleration = $\frac{change\ in\ velocity}{time\ taken}$

SI unit: ms^{-2}

For a body moving in a straight line we consider it to be moving with

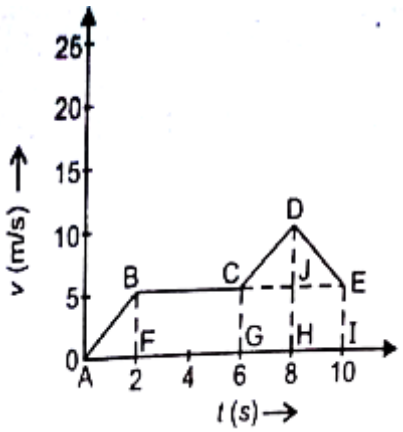
a) positive acceleration if the speed increases with time

b) negative acceleration if speed decreases with time

An example of uniform acceleration is: a ball rolling down a frictionless inclined plane.

18. Question

Find the total displacement of the body from the following graph:



Answer

Whenever we have to find total displacement from a velocity time graph we find the area under the curve.

In the figure we clearly see

• Two triangles ABF & DCE having area A_1 & A_2 respectively

• A rectangles BEIF having area A_3.

$A_1 = \frac{(2-0)*(5-0)}{2} = 5$

$A_2 = \frac{(10-5)*(10-6)}{2} = 10$

A_3 = (5-0)*(10-2) = 40

Total area under the curve = $A_1 + A_2 + A_3$

= 5 + 10 + 40 = 55

Hence total displacement = 55 m

19. Question

Instruction: The table given below shows distance (in cm) travelled by the bodies A, B and C. Read this data carefully and answer the questions which follow.

Distance (in cm) covered by different bodies

Time	Body A	Body B	Body C
1^{st} second	20	20	20
2^{nd} second	20	36	60
3^{rd} second	20	24	100
4^{th} second	20	30	140
5^{th} second	20	48	180

1. Which of the bodies is moving with

(a) constant speed?

(b) constant acceleration?

2. Which of the bodies covers

(a) maximum distance in 3^{rd} second?

(b) minimum distance in 3^{rd} second?

3. Which of the bodies is moving with non-uniform acceleration?

Answer

1. a) Body A moves with constant speed since it travels equal distance in equal interval of time.

b) Body B moves with constant acceleration since the rate of change of distance per second in it is constant.

2. a) Body C covers the maximum distance in 3rd second.

C covers 100 cm whereas A & B cover 20 cm & 24 cm in 3rd second.

b) Body A covers the minimum distance in 3rd second.

Since A covers only 20 cm which is less than covered by B (24 cm) and C (100 cm)

3. Body C is moving with non-uniform acceleration.

20. Question

An object is moving along a straight line with uniform acceleration. The following table gives the velocity of the object at various instants of time

Time (in sec.)	0	1	2	3	4	5	6
Velocity (in m/s)	2	4	6	8	10	12	14

Plot the graph.

From the graph.

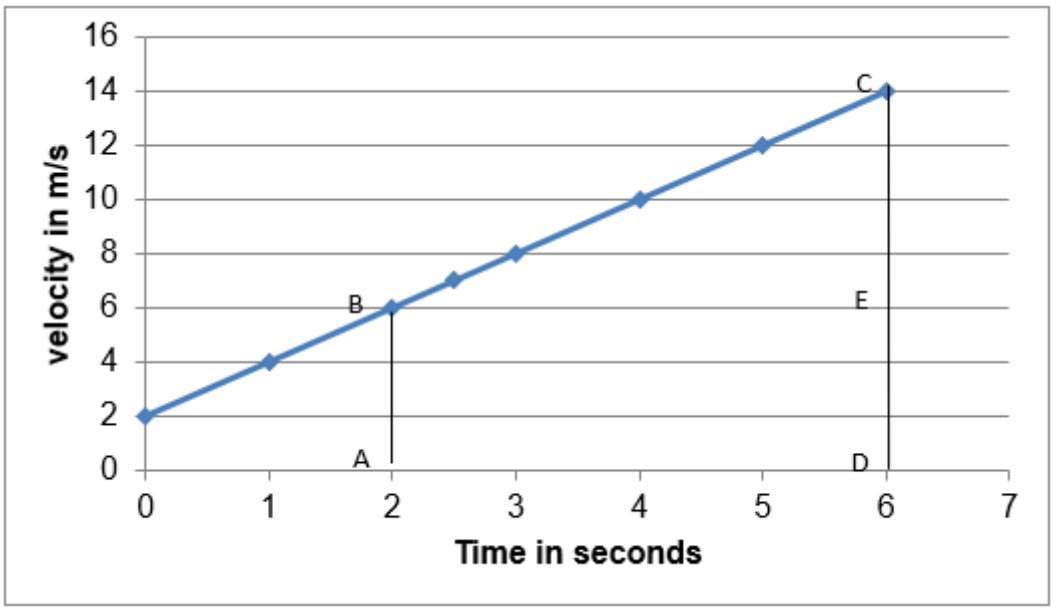
(i) find the velocity of the object at the end of 2.5 seconds.

(ii) Calculate the acceleration.

(iii) Calculate the distance covered in the last 4 seconds.

Answer

Following is the graph corresponding to the uniformly accelerated motion



a) Velocity at 2.5 seconds is 7 m/s.

b) Acceleration = slope of velocity time graph

$= \frac{(14-2)}{(6-0)}$

$= 2\ m/s^2$

c) Distance covered in last 4 seconds is the area under the curve for last 4 second

i.e.

Total distance covered in last 4 seconds

= area under ABCD

= area of ABED + area of BCE

$= ((6-0)*(6-2)) + \frac{(14-6)*(6-2)}{2}$

= 24 + 16

= 40 m

21. Question

Mehak was moving through the city roads towards her school by a car. She recorded the odometer reading of the car after every five minutes and plotted a graph for distance vs time. She then inferred about the type of motion and found average speed from the graph.

(a) Which qualities of Mehak are worth mentioning?

(b) What type of motion would she have inferred?

(c) How is average speed calculated from the graph?

Answer

(a) Mehak is curious, practical, skilled, alert and enthusiastic.

(b) Data given is insufficient to decide what kind of motion she infers.Motion can be uniform or non-uniform.

(c) Average speed = $\frac{total\ distance\ travelled}{total\ time\ taken}$

And total distance travelled is given by the area under the velocity v/s time graph

Hence,

Average speed = $\frac{area\ under\ the\ curve}{total\ time\ taken}$