

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

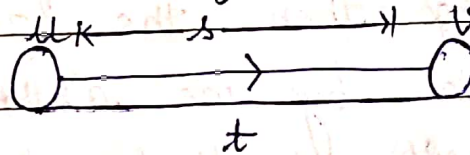
$$a = \frac{10 - 25}{5} = \frac{-15}{5}$$

$$a = -3 \text{ m/s}^2$$

Equations of Uniformly Accelerated motion:-

i) First Equation of Motion:-

Consider a body having initial velocity u suppose it is subjected to a uniform acceleration ' a '. So, that after time ' t ' its final velocity becomes v .



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

$$at = v - u$$

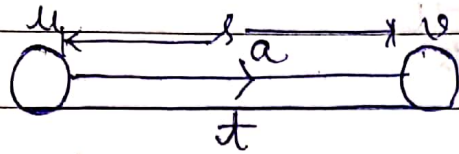
$$at + u = v$$

$$v = u + at$$

ii) Second Equation of Motion:-

Suppose a body has an initial velocity ' u ' & a uniform acceleration ' a ' for time ' t '. So, that its final velocity becomes v .

Let the distance travelled by the body in this time be 's'.



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

distance = average velocity \times time taken

$$s = \left(\frac{u+v}{2}\right) \times t \quad \text{--- (i)}$$

$$v = u + at \quad \text{--- (ii)}$$

Putting the value of v in equation i

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

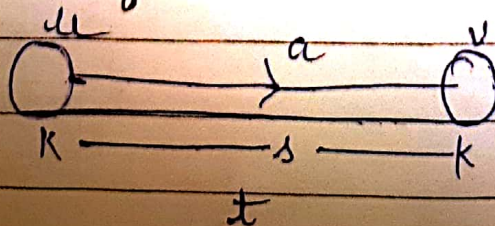
$$s = \frac{(2u + at)t}{2}$$

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

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

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

Third Equation of Motion :-



$$s = ut + \frac{1}{2}at^2 \quad \text{--- ii)}$$

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

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

Putting the value of 't' in equation (i)

$$s = u\left(\frac{v-u}{a}\right) + \frac{1}{2}a\left(\frac{v-u}{a}\right)^2$$

$$s = \frac{uv-u^2}{a} + \frac{1}{2}a\frac{(v-u)^2}{a^2}$$

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

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

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

$$\frac{s}{1} = \frac{-u^2 + v^2}{2a}$$

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

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

$$\boxed{v^2 = u^2 + 2as}$$

Notes-(i):- If a body start from rest its initial velocity $u = 0$.

(ii):- If a body comes to rest its final velocity $v = 0$.

(iii):- If a body moves with uniform velocity its acceleration $a = 0$.

Q. A moving train is brought to rest within 20 seconds by applying brakes, find the initial velocity if the retardation due to break is 2 m/s^2 .

$$v = 0$$

$$t = 20 \text{ seconds}$$

$$u = ?$$

$$a = -2 \text{ m/s}^2$$

$$v = u + at$$

$$0 = u + (-2) \times (20)$$

$$0 = u - 40$$

$$u = 40 \text{ m/s Ans.}$$

Uniform Circular Motion:-

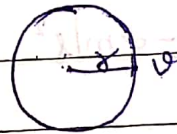
When a body moves in a circle it is called circular motion. When a body moves along a circular path then its direction of motion keeps changing continuously. When a body moves in a circular path with uniform speed its motion is called uniform

circular motion. The velocity changes due to continuous change in direction. Therefore, the motion along a circular path is said to be accelerated.

The motion in a circle with constant speed is an example of accelerated motion. A force is needed to produce circular motion.

The force which is needed to make an object travel in a circular path is called centripetal force.

Considered a particle, it travels ~~of~~ a circular path with radius r with velocity v .



$$\text{Speed} = \frac{\text{Distance}}{\text{Time taken}}$$

$$v = \frac{2\pi r}{t}$$

Examples of Uniform Circular Motion:

i) Artificial satellites move in uniform circular motion around the earth.

ii) The moon moves in uniform circular motion around the earth.

iii) The earth moves around the sun in uniform circular motion.

Q:- A cyclist goes around a circular track once every two minutes, if the radius of the circular track is 105 m. Calculate his speed.

$$t = 2 \text{ minutes} = 120 \text{ seconds}$$

$$r = 105$$

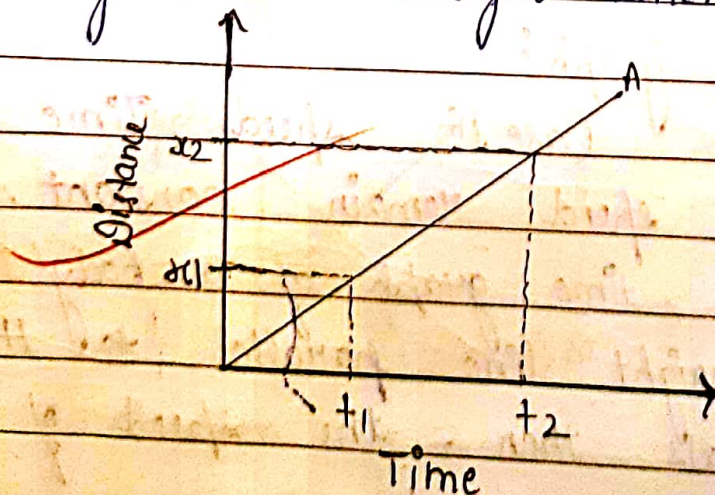
$$v = \frac{2 \times \pi \times r}{t} = \frac{2 \times \pi \times 105}{120} = \frac{11}{2}$$

$$v = 5.5 \text{ m/s} \text{ Ans.}$$

Graphical representation of Motion

i) Distance time graph:-

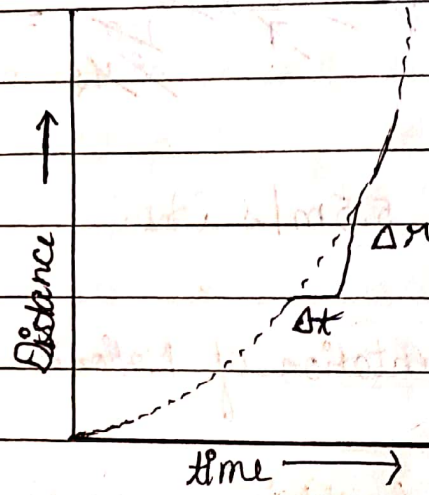
The distance time graph of a body moving at uniform speed is always a straight line.



$$v = \frac{s}{t}$$

$$v = \frac{x_2 - x_1}{t_2 - t_1} = \text{slope of graph}$$

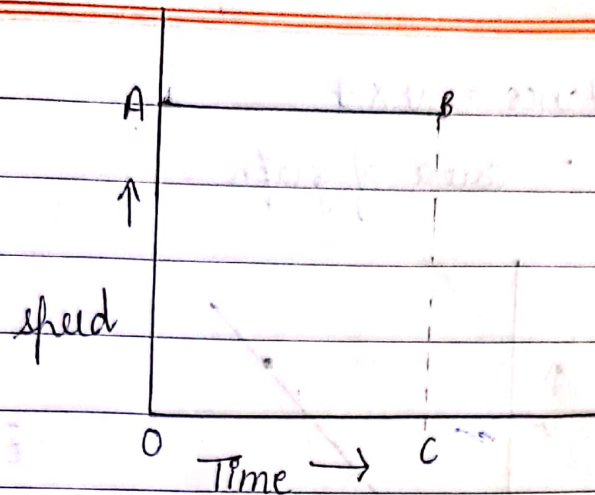
For uniform motion the graph between distance travelled & time is a curved line called a ~~parabola~~ paravola.



$$v = \frac{\Delta x}{\Delta t}$$

Speed time graph:-

Case 1^o speed time graph when the speed remain constant. If the speed time graph of a body is a straight line parallel to the time axis then, the speed of the body is constant

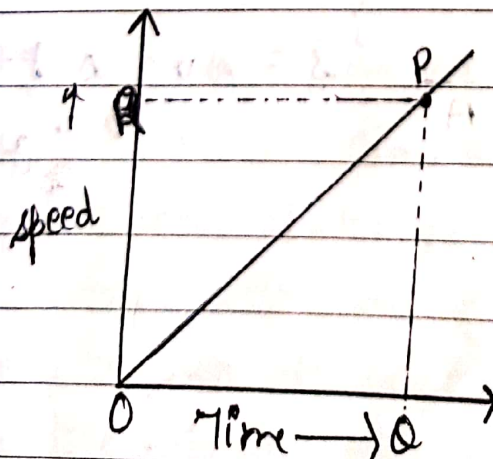


$$s = v \times t = \text{area of graph } OCB A \\ = OC \times BC = AB \times OA$$

Case:- Speed Time Graph or when speed changes at a uniform rate.

Speed Time Graph:-

The speed time for a uniformly changing speed will be a straight line.

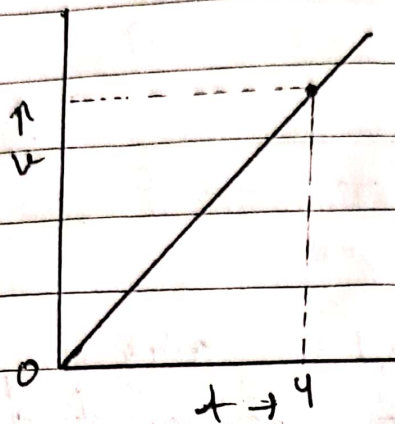


$$\text{acceleration } a = \frac{v}{t}$$

$$\text{distance} = v \times t$$

$$= \text{area of graph}$$

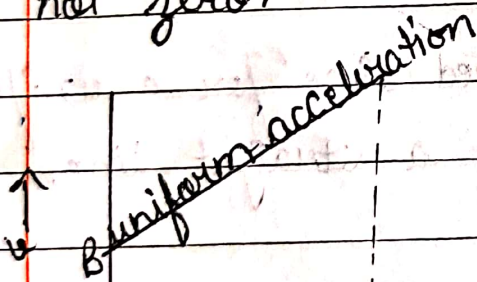
Ex 1:-



$$a = \frac{3-0}{4-0} = \frac{3}{4} \text{ m/s}^2$$

$$s = \frac{1}{2} \times 4 \times 3 \Rightarrow s = 6 \text{ m}$$

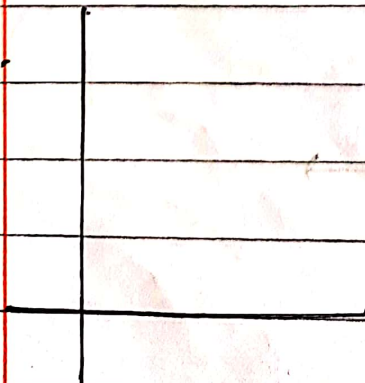
Speed Time graph when the initial speed of the body not zero:-



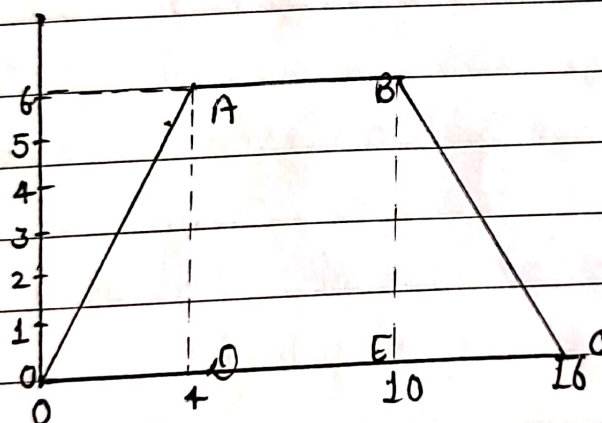
$$a = \frac{\Delta v}{\Delta t} = \text{slope of graph}$$

$$s = \Delta v \times \Delta t = \text{area of graph}$$

Ex 2:-



1. Study the speed time graph of a body given here & answer the following questions.

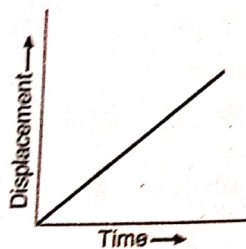


- [i] What type of motion ^{is} ~~are~~ represented by OA? ^{Acceleration}
- [ii] What type of motion ^{is} ~~are~~ represented by AB? ^{Constant velocity}
- [iii] What type of motion is represented by BC? ^{Retardation}
- [iv] Find out the acceleration of a body.
- [v] Calculate the retardation of the body.
- [vi] Find out the distance travelled by the body from A to C?

(a) $a_{OA} = \frac{6-0}{4-0} = \frac{6}{4} = \frac{3}{2} = 1.5 \text{ m/s}^2$

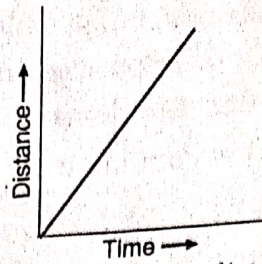
(b) $a_{BC} = \frac{0-6}{16-10} = \frac{-6}{6} = -1 \text{ m/s}^2$

- (a) What remains constant in uniform circular motion ?
- (b) What changes continuously in uniform circular motion ?
- State whether the following statement is true or false :
Earth moves round the sun with uniform velocity.
 - A body goes round the sun with constant speed in a circular orbit. Is the motion uniform or accelerated ?
 - What conclusion can you draw about the velocity of a body from the displacement-time graph shown below :



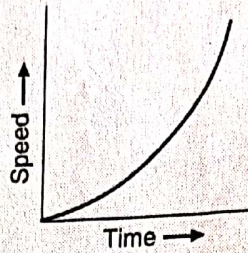
- Name the quantity which is measured by the area occupied under the velocity-time graph.
- What does the slope of a speed-time graph indicate ?
- What does the slope of a distance-time graph indicate ?
- Give one example of a motion where an object does not change its speed but its direction of motion changes continuously.
- Name the type of motion in which a body has a constant speed but not constant velocity.
- What can you say about the motion of a body if its speed-time graph is a straight line parallel to the time axis ?

11. What conclusion can you draw about the speed of a body from the following distance-time graph?



12. What can you say about the motion of a body whose distance-time graph is a straight line parallel to the time axis?

13. What conclusion can you draw about the acceleration of a body from the speed-time graph shown below?



14. A satellite goes round the earth in a circular orbit with constant speed. Is the motion uniform or accelerated?



This photograph shows a man-made 'communications satellite' going round the earth in a circular orbit (or circular path). We can see the dish antennae, and solar panels (made of solar cells) clearly in this photograph.



This photograph shows a watch. The tip of seconds' hand of this watch moves rapidly on the dial of the watch. The tips of minutes' hand and hours' hand also move on the dial but they move slowly.

15. What type of motion is represented by the tip of the 'seconds' hand' of a watch? Is it uniform or accelerated?
16. Fill in the following blanks with suitable words :
- If a body moves with uniform velocity, its acceleration is
 - The slope of a distance-time graph indicates of a moving body.
 - The slope of a speed-time graph of a moving body gives its.....
 - In a speed-time graph, the area enclosed by the speed-time curve and the time axis gives the the body.
 - It is possible for something to accelerate but not change its speed if it moves in a

Short Answer Type Questions

17. Is the uniform circular motion accelerated? Give reasons for your answer.
18. Write the formula to calculate the speed of a body moving along a circular path. Give the meaning of each symbol which occurs in it.
19. Explain why, the motion of a body which is moving with constant speed in a circular path is said to be accelerated.
20. What is the difference between uniform linear motion and uniform circular motion? Explain with examples.
21. State an important characteristic of uniform circular motion. Name the force which brings about uniform circular motion.
22. Find the initial velocity of a car which is stopped in 10 seconds by applying brakes. The retardation due to brakes is 2.5 m/s^2 .
23. Describe the motion of a body which is accelerating at a constant rate of 10 m/s^2 . If the body starts from rest, how much distance will it cover in 2 s?
24. A motorcycle moving with a speed of 5 m/s is subjected to an acceleration of 0.2 m/s^2 . Calculate the speed of the motorcycle after 10 seconds, and the distance travelled in this time.
25. A bus running at a speed of 18 km/h is stopped in 2.5 seconds by applying brakes. Calculate the retardation produced.
26. A train starting from rest moves with a uniform acceleration of 0.2 m/s^2 for 5 minutes. Calculate the speed acquired and the distance travelled in this time.
27. Name the two quantities, the slope of whose graph gives :
 - (a) speed, and
 - (b) acceleration
28. A cheetah starts from rest, and accelerates at 2 m/s^2 for 10 seconds. Calculate :
 - (a) the final velocity
 - (b) the distance travelled.
29. A train travelling at 20 m/s accelerates at 0.5 m/s^2 for 30 s. How far will it travel in this time?
30. A cyclist is travelling at 15 m/s . She applies brakes so that she does not collide with a wall 18 m away. What deceleration must she have?
31. Draw a velocity-time graph to show the following motion :
A car accelerates uniformly from rest for 5 s ; then it travels at a steady velocity for 5 s.
32. The velocity-time graph for part of a train journey is a horizontal straight line. What does this tell you about
 - (a) the train's velocity, and
 - (b) about its acceleration?

Long Answer Type Questions

33. (a) Explain the meaning of the following equation of motion :

$$v = u + at$$

where symbols have their usual meanings.

- (b) A body starting from rest travels with uniform acceleration. If it travels 100 m in 5 s, what is the value of acceleration?
34. (a) Derive the formula : $v = u + at$, where the symbols have usual meanings.
(b) A bus was moving with a speed of 54 km/h . On applying brakes it stopped in 8 seconds. Calculate the acceleration.
35. (a) Derive the formula : $s = ut + \frac{1}{2}at^2$, where the symbols have usual meanings.
(b) A train starting from stationary position and moving with uniform acceleration attains a speed of 36 km per hour in 10 minutes. Find its acceleration.
36. (a) Write the three equations of uniformly accelerated motion. Give the meaning of each symbol which occurs in them.
(b) A car acquires a velocity of 72 km per hour in 10 seconds starting from rest. Find (i) the acceleration, (ii) the average velocity, and (iii) the distance travelled in this time.
37. (a) What is meant by uniform circular motion? Give two examples of uniform circular motion.
(b) The tip of seconds' hand of a clock takes 60 seconds to move once on the circular dial of the clock. If the