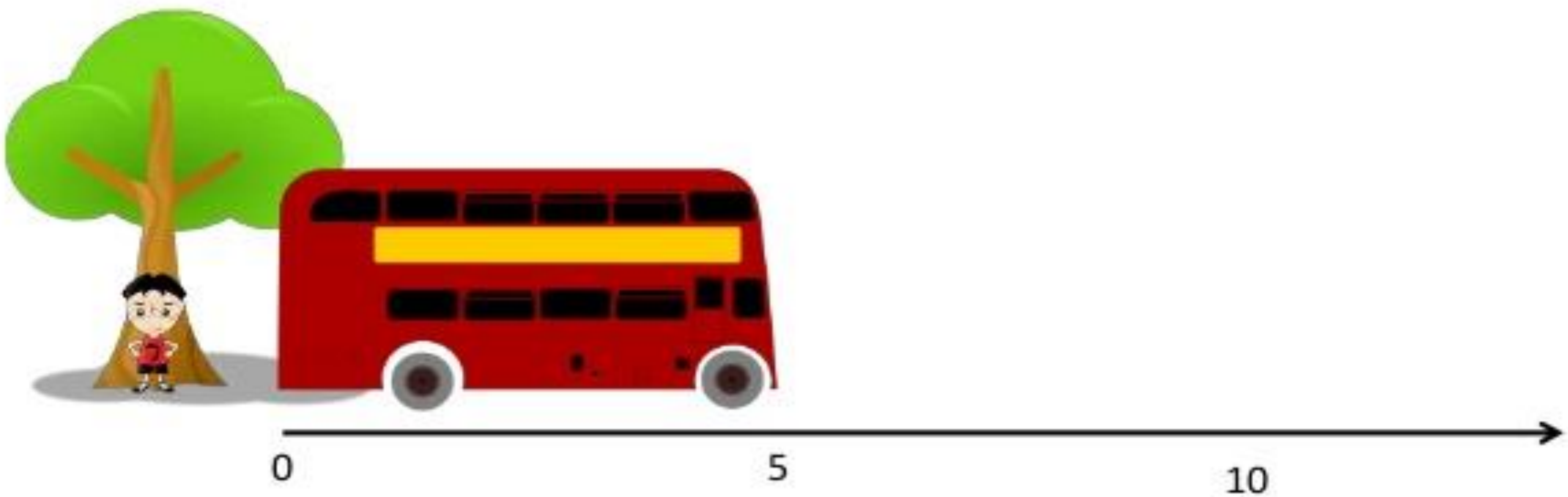
MOTION

By : Ms. Simran

Refrence Point/ Origin:

Person outside the bus

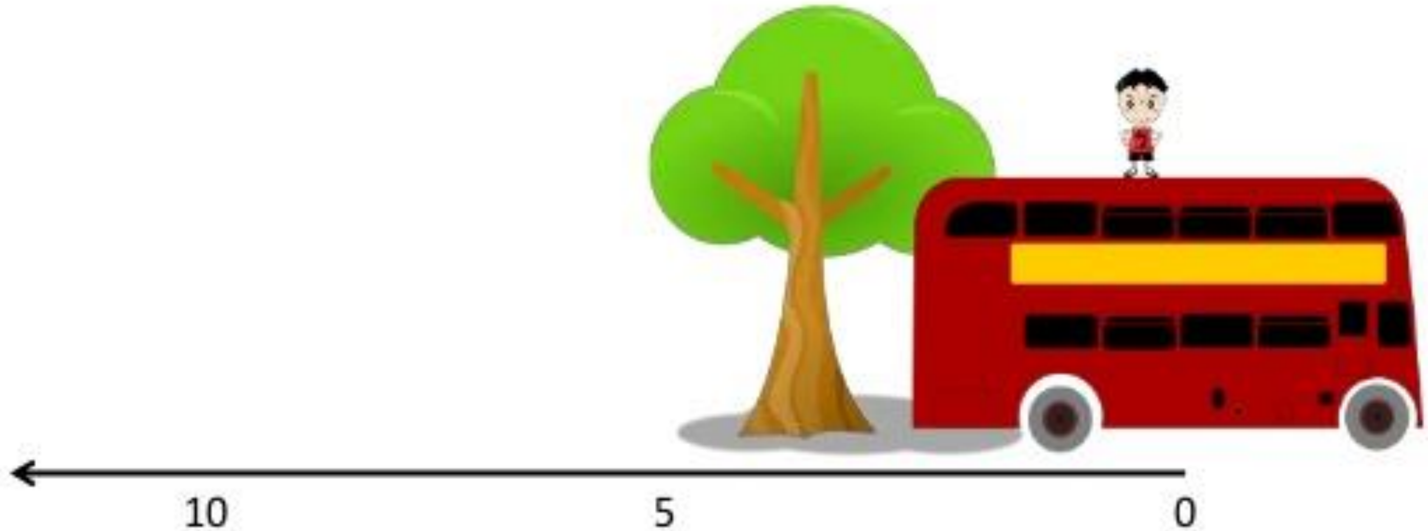


The **bus moved** away from the tree

The person is comparing the position of the bus with respect to the position of the tree

Reference (or origin) is position of the tree

Person inside the bus



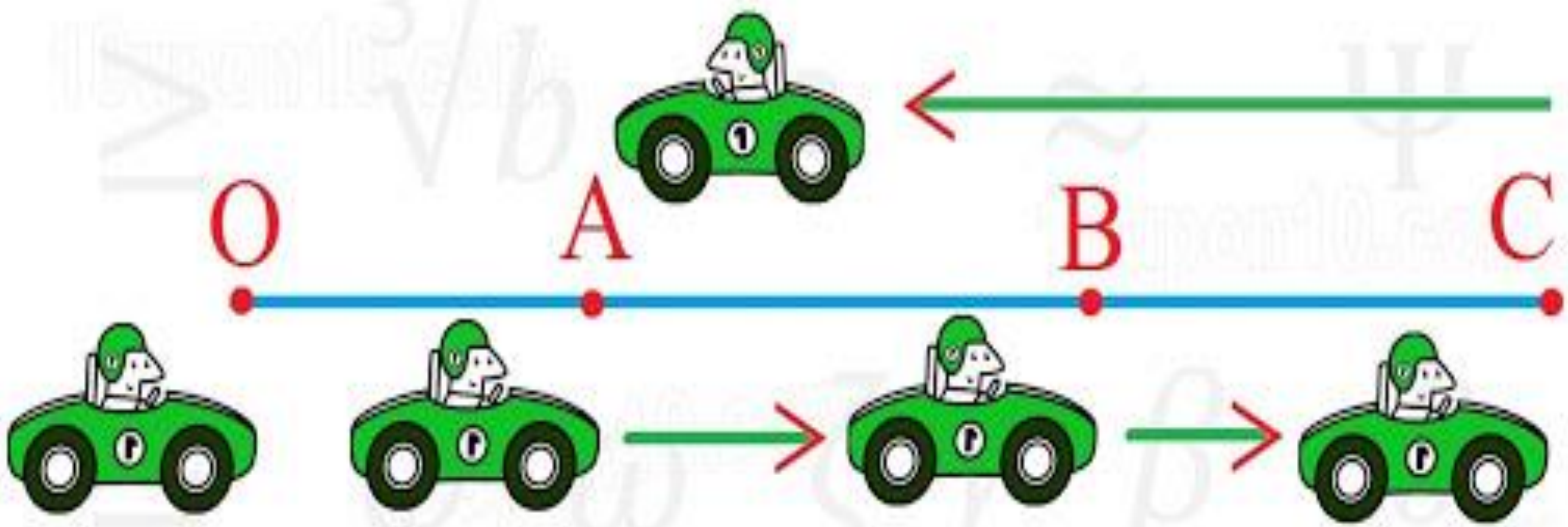
The **tree moved** away from the bus.

The person is comparing the position of the tree with respect to the position of the bus.

Reference (or origin) is position of the bus.

Motion In A Straight Line

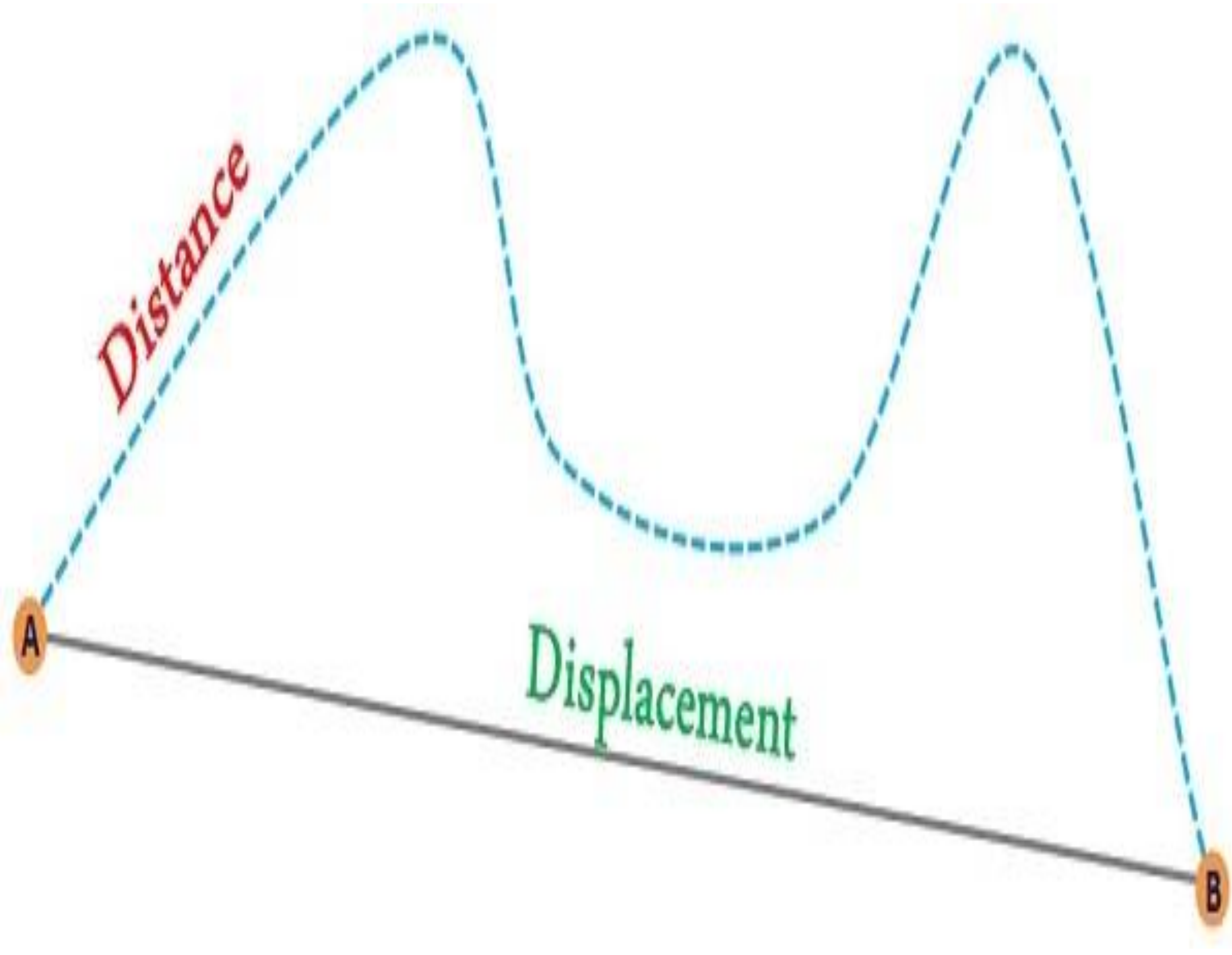
Motion of a Car Along a Stright Line



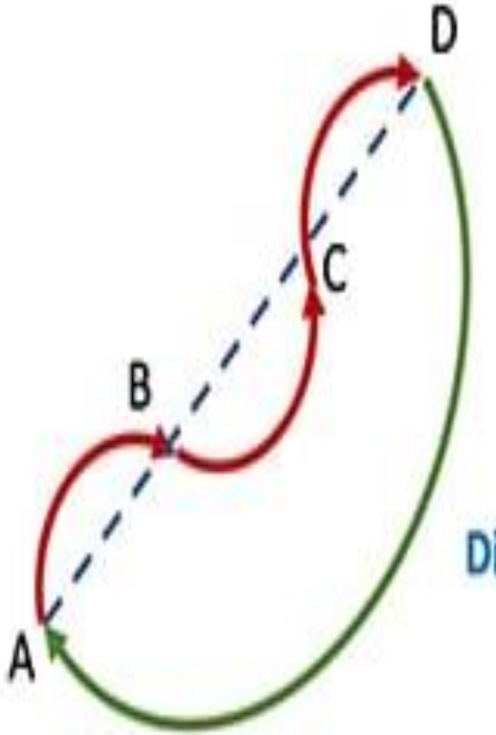
Class Eleventh Physics

Motion Along a Straight Line

- In this chapter we will study kinematics, i.e., how objects move along a straight line.
- The following parameters will be defined:
  Displacement
  Average velocity
  Average speed
  Instantaneous velocity
  Average and instantaneous acceleration
- For constant acceleration we will develop the equations that give us the velocity and position at any time.
- we will study the motion under the influence of gravity close to the surface of the Earth.
- Finally, we will study a graphical integration method that can be used to analyze the motion when the acceleration is not constant.


Distance
A
Displacement
B

DISTANCE VS DISPLACEMENT



Distance - If a body moves from a point '**A**' to point '**D**' then the total length of the curved path '**ABCD**' (red) is called the distance moved by the body.

Displacement - Actual distance moved by a body from a point '**A**' toward point '**D**' in straight line (blue dashed).

Difference between Distance and Displacement :

If body travels a path 'ABCD' and returns back to point 'A' after taking another path 'DA' (green) then the total distance travelled by the body will be the length of the path 'ABCDA', however its displacement will be zero, as the initial and the final points are the same.

Difference between

Distance & Displacement

- *The Distance travelled by a body is the actual length of the path.*
- *Distance is a Scalar quantity.*
- *Distance can not be ZERO.*

- *Displacement is the Shortest Distance between the initial position & the final position.*
- *Displacement is a vector quantity.*
- *Displacement can be ZERO.*

Distance is a scalar quantity because it has the magnitude but not the specified direction.

Displacement is a vector quantity because it has the magnitude as well as the direction.

UNIFORM MOTION	NON-UNIFORM MOTION
Uniform motion implies the movement of a body along a straight line with steady speed.	Non-uniform motion alludes to the movement of an object along a straight line with variable speed.
Covers equal distances in equal time interval.	Covers unequal distances in equal time interval.
Is similar to actual speed of the object.	Is different from actual speed of the object.
Distance-time graph shows a straight line	Distance-time graph shows a curved line
Zero acceleration	Non-zero acceleration

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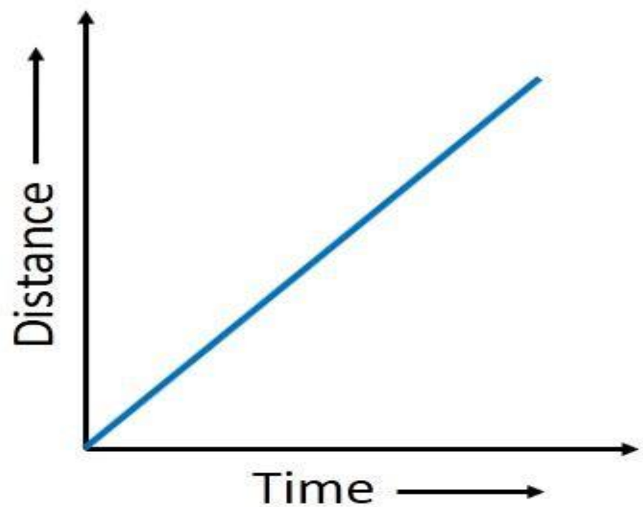
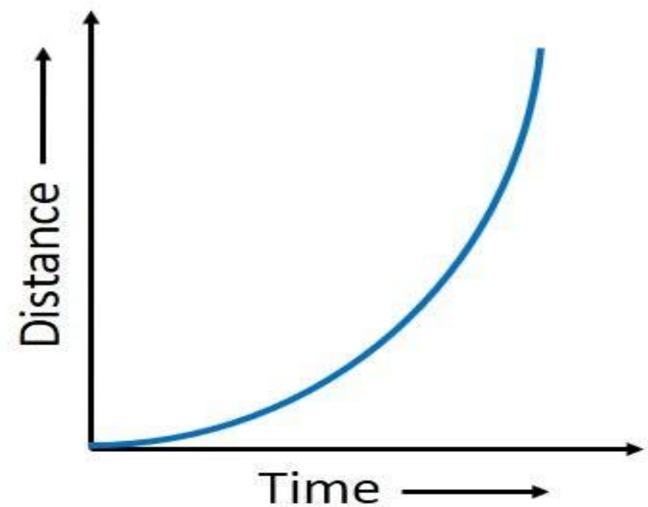
What is the nature of the distance-time graphs for uniform and non-uniform motion of an object?

Uniform Motion



The Distance - Time graph for uniform motion is a **straight line.**

Non-Uniform Motion



The Distance - Time graph for uniform motion is a **curved line.**

AVERAGE SPEED

When calculating the AVERAGE SPEED of an object you need to know the DISTANCE travelled by the object and the TIME taken to travel that distance. You then use the following equation:

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

$$V = \frac{d}{t}$$

Where v – average speed (m/s)

d - distance (m)

t - time (s)

Average Speed vs. Average Velocity

Average Velocity

Ratio of displacement to time

$$average\ velocity = v_{avg} = \frac{displacement}{time} = \frac{\Delta x}{\Delta t} = \frac{x_2 - x_1}{t_2 - t_1}$$

Average Speed

Ratio of total distance to time

$$average\ speed = \frac{total\ distance}{time}$$

Difference Between Speed and Velocity

Speed	Velocity
1. The speed is the distance travelled by a body in a unit time.	1. The velocity is the displacement of a body in a unit time.
2. It is a scalar quantity. The speed does not tell us the direction of the motion of a body.	2. It is a vector quantity. The velocity tells us the speed and direction of the motion of a body.
3. The speed is always positive.	3. The velocity can be positive and negative depending on the direction of the motion.
4. During the circular motion, the average speed does not become zero after completing one round.	4. During the circular motion, average velocity becomes zero after completing one round.

Acceleration:

- The rate of change of velocity is called acceleration.

- Usually, **acceleration** means the speed is changing, but not always.

- When an object moves in a circular path at a constant speed, it is still **accelerating**, because the direction of its velocity is changing.

ACCELERATION

- Acceleration has the formula:

$$\text{Acceleration} = \frac{\text{(Final Velocity)} - \text{(initial velocity)}}{\text{(Final time)} - \text{(Initial time)}}$$

OR

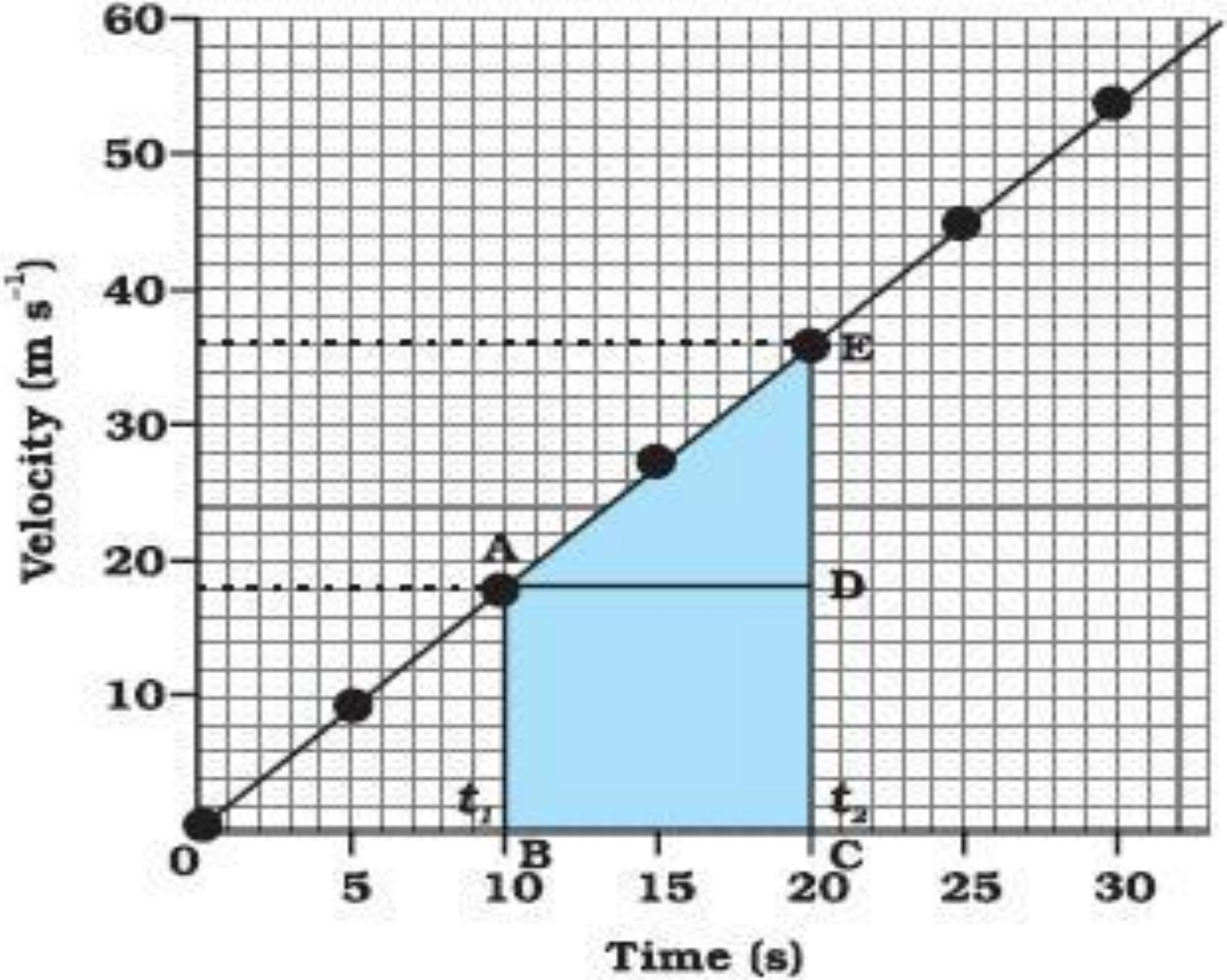
$$\frac{\text{(Final Velocity)} - \text{(initial velocity)}}{\text{(time it takes to change velocity)}}$$

$$A = \frac{v_f - v_i}{t_f - t_i} = \frac{\Delta v}{\Delta t}$$

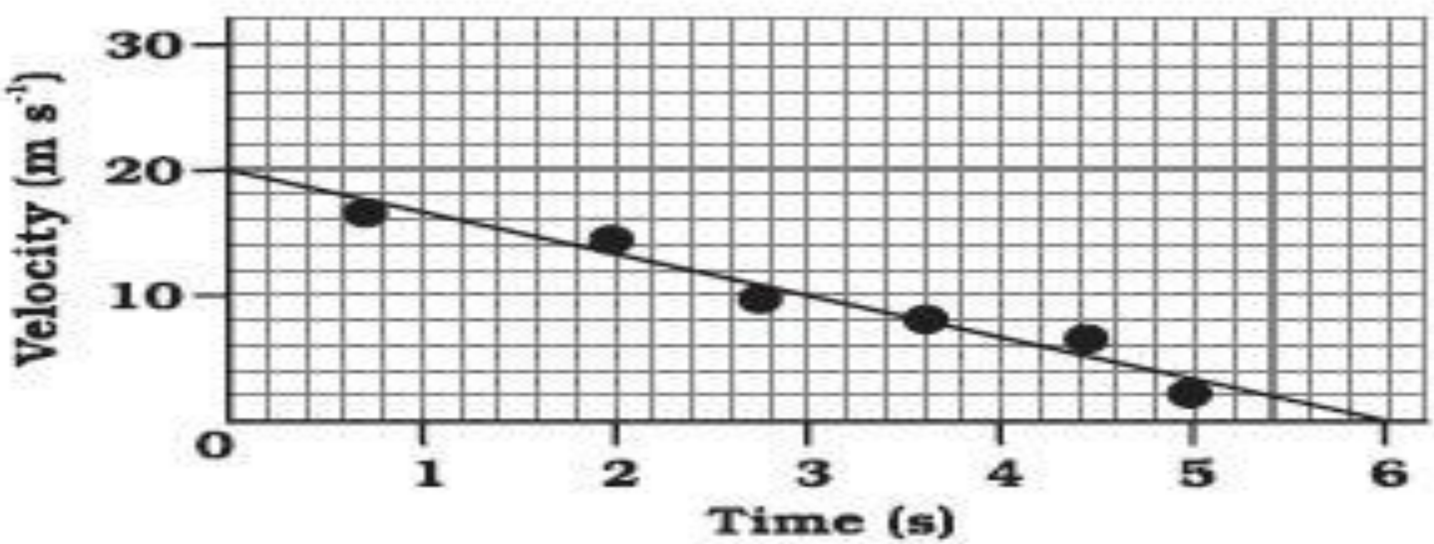
Δ means "change in"

Acceleration has the units of (distance unit)/(time unit)

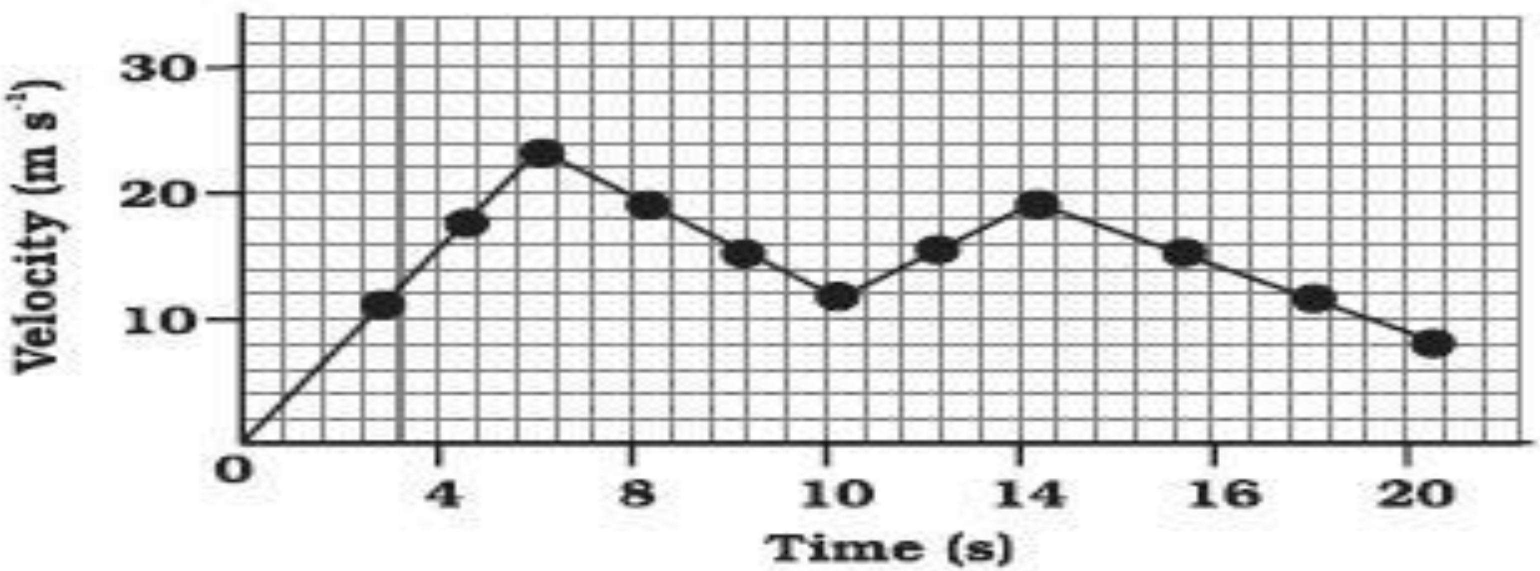
Ex: m/s^2 or mi/h^2



60
50
40
30
20
10
0
5
10
15
20
25
30
Velocity (m s-1)
Time (s)
A
B
C
D
E
t1
t2


30
20
10
Velocity (m s⁻¹)
0
1
2
3
4
5
6
Time (s)

(a)


30
20
10
Velocity (m s⁻¹)
0
4
8
10
14
16
20
Time (s)

(b)

a) Equation for velocity – time relation ($v = u + at$) :-

Consider a velocity – time graph for a body moving with uniform acceleration 'a'. The initial velocity is u at A and final velocity is v at B in time t.

Perpendicular lines BC and BE are drawn from point B to the time and velocity axes so that the initial velocity is OA and final velocity is BC and time interval is OC. Draw AD parallel to OC.

We observe that

$BC = BD + DC = BD + OA$

Substituting $BC = v$ and $OA = u$

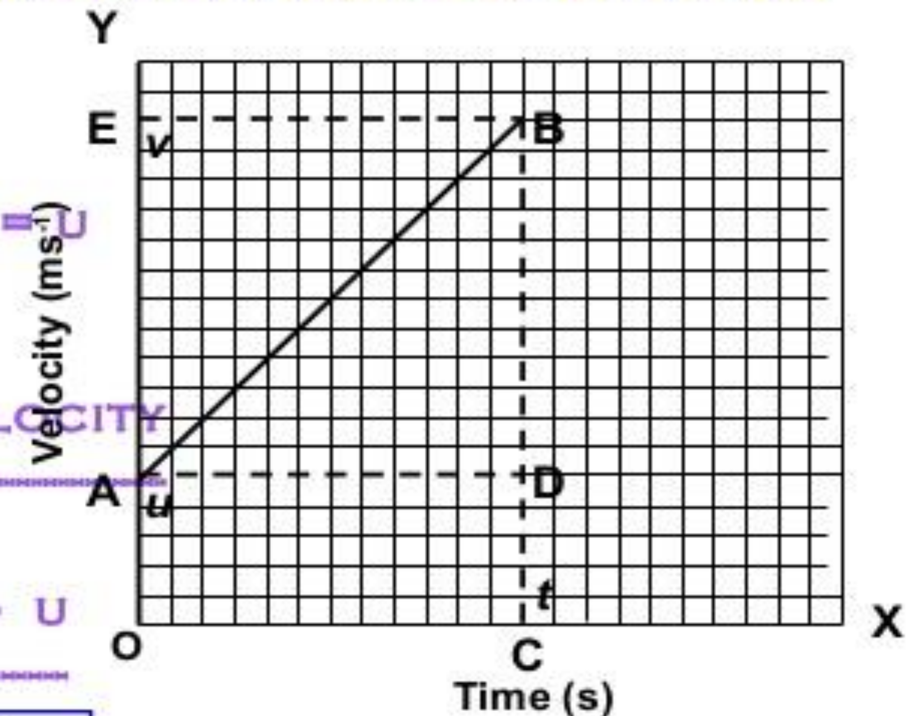
We get $v = BD + u$

or $BD = v - u$

$$\text{Acceleration} = \frac{\text{Change in velocity}}{\text{Time}}$$

$$a = \frac{BD}{AD} = \frac{BD}{OC} \quad \text{or} \quad a = \frac{v - u}{t}$$

$v - u = at$ or $v = u + at$



Velocity – time graph for a uniformly accelerated motion

b) Equation for position – time relation ($s = ut + \frac{1}{2} at^2$) :-

Consider a velocity – time graph for a body moving with uniform acceleration 'a' travelled a distance s in time t.

The distance traveled by the body between the points A and B is the area OABC.

s = area OABC (which is a trapezium)

= area of rectangle OABC + area of triangle ABD

$$= OA \times OC + \frac{1}{2} (AD \times BD)$$

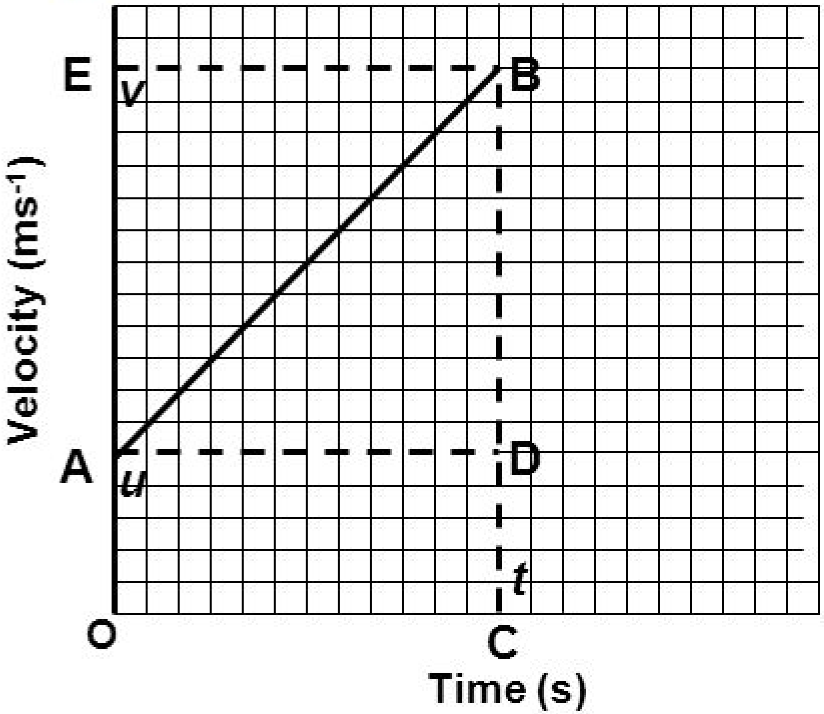
Substituting OA = u, OC = AD = t,

BD = v – u = at

We get

$$s = u \times t + \frac{1}{2} (t \times at)$$

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



Velocity – time graph for a uniformly accelerated motion

c) Equation for position – velocity relation ($2as = v^2 - u^2$) :-

Consider a velocity – time graph for a body moving with uniform acceleration 'a' travelled a distance s in time t.

The distance travelled by the body between the points A and B is the area OABC.

s = area of trapezium OABC

$$s = \frac{(OA + BC) \times OC}{2}$$

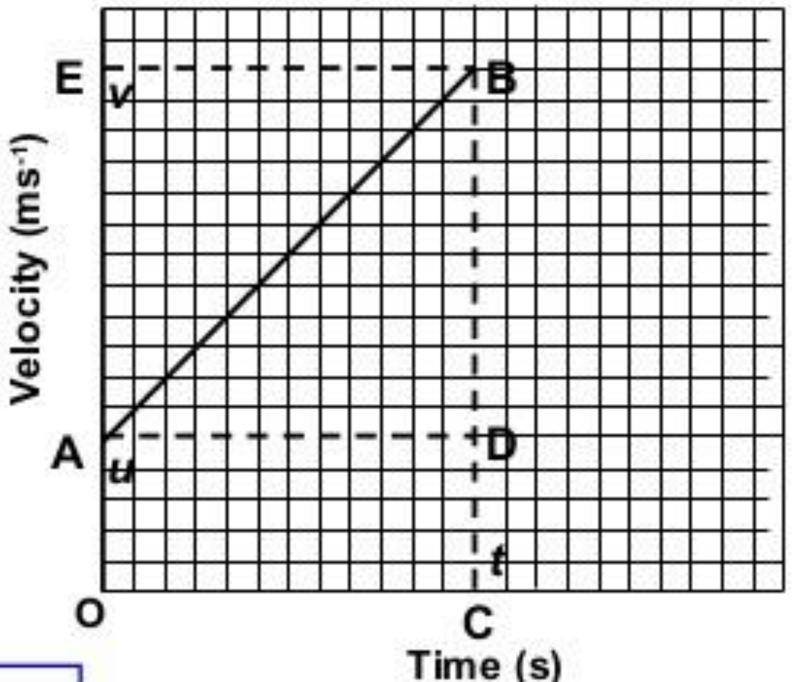
Substituting OA = u, BC = v and OC = t

We get $$s = \frac{(u + v) \times t}{2}$$

From velocity – time relation

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

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



Velocity – time graph for a uniformly accelerated motion


Thank
You