FREE COACHING

NEET 2025

CLASS 11

MOTION IN A STRAIGHT LINE

Lecture 2

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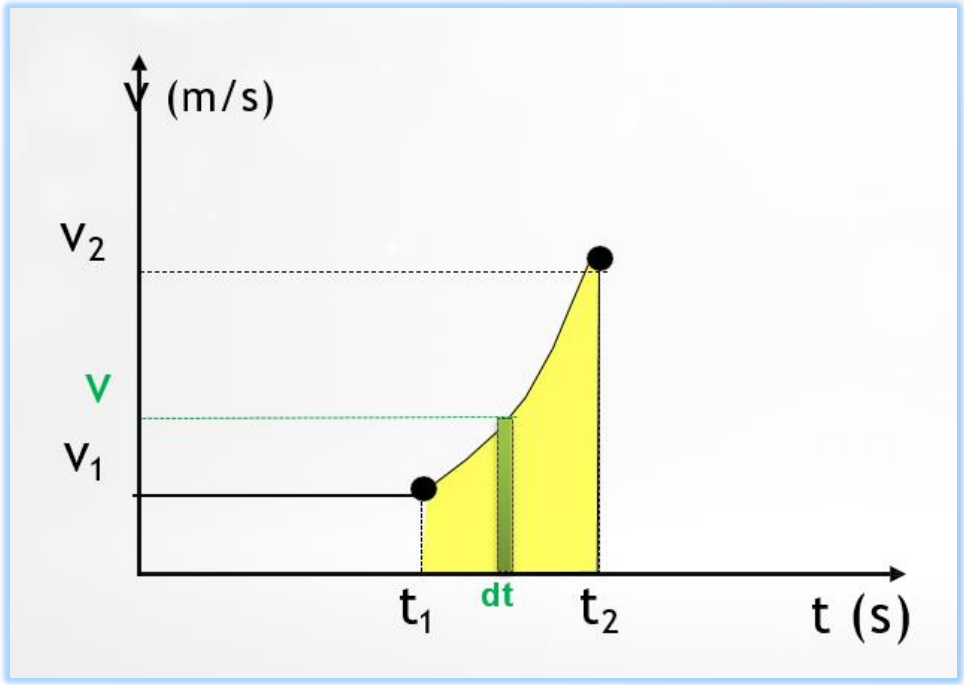
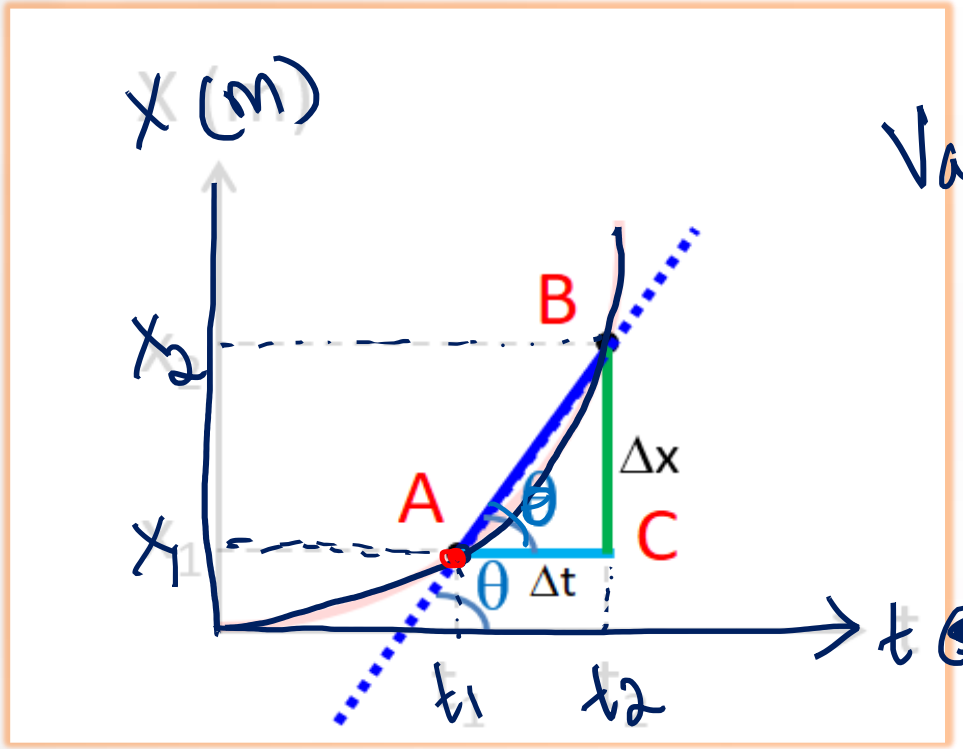


Position - Time Graph

V_{avg} = Slope of the chord

Average Velocity: **Slope of chord between any two points on position time graph gives us average velocity**

Chord



$V_{avg} = \frac{\text{Change in position}}{\text{Time taken}}$

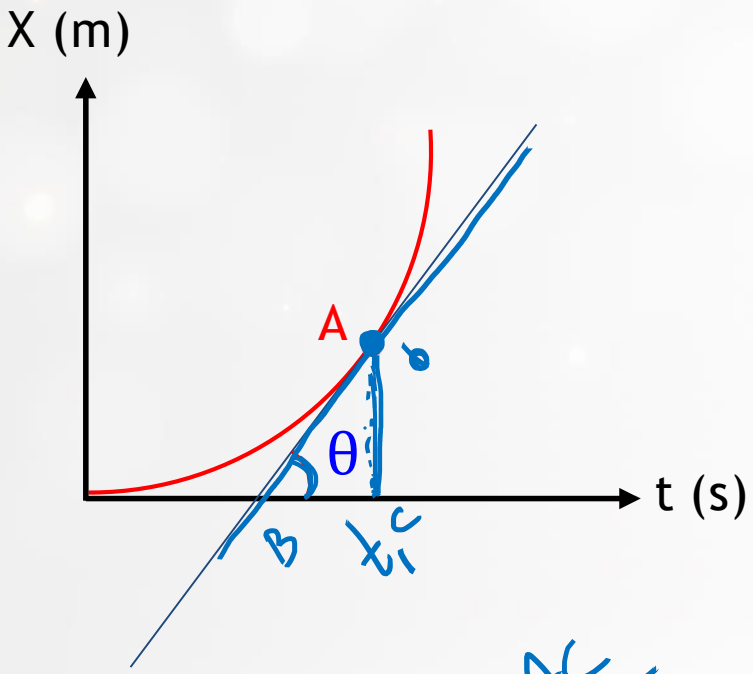
$V_{avg} = \frac{x_2 - x_1}{t_2 - t_1}$

$V_{avg} = \frac{\Delta x}{\Delta t}$

$\text{Slope} = \tan\theta = \frac{\text{opp.}}{\text{adja}} = \frac{\Delta x}{\Delta t}$

Instantaneous Velocity:

$$\vec{v}_{inst} = \frac{\overrightarrow{dS}}{dt} = \tan\theta$$



- **Slope of Tangent to position - time graph at any instant gives us instantaneous velocity at that instant**

$\tan\theta = \frac{AC}{BC}$

Example

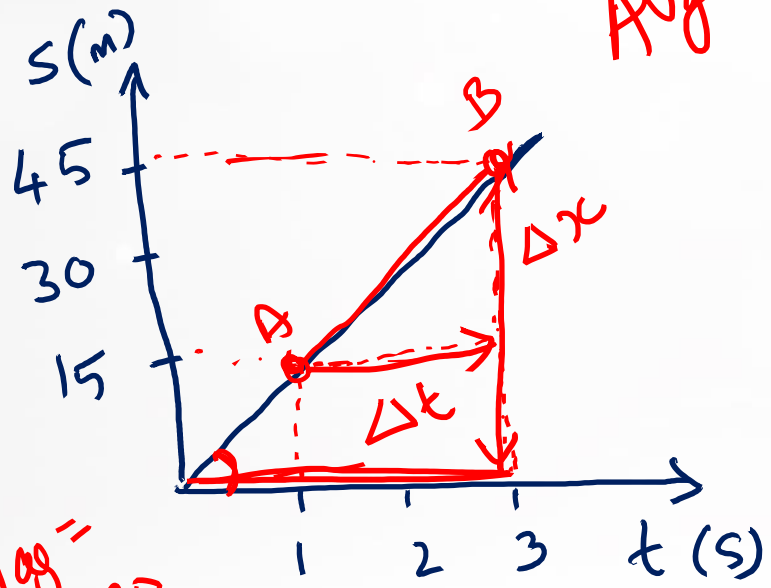
From the Position - Time graph. Average Velocity from 1s to 3s

a. 7.5 m/s

b. 15 m/s

c. 30 m/s

d. 35 m/s



Avg. velocity = change in position / time

$\frac{45-15}{2}$

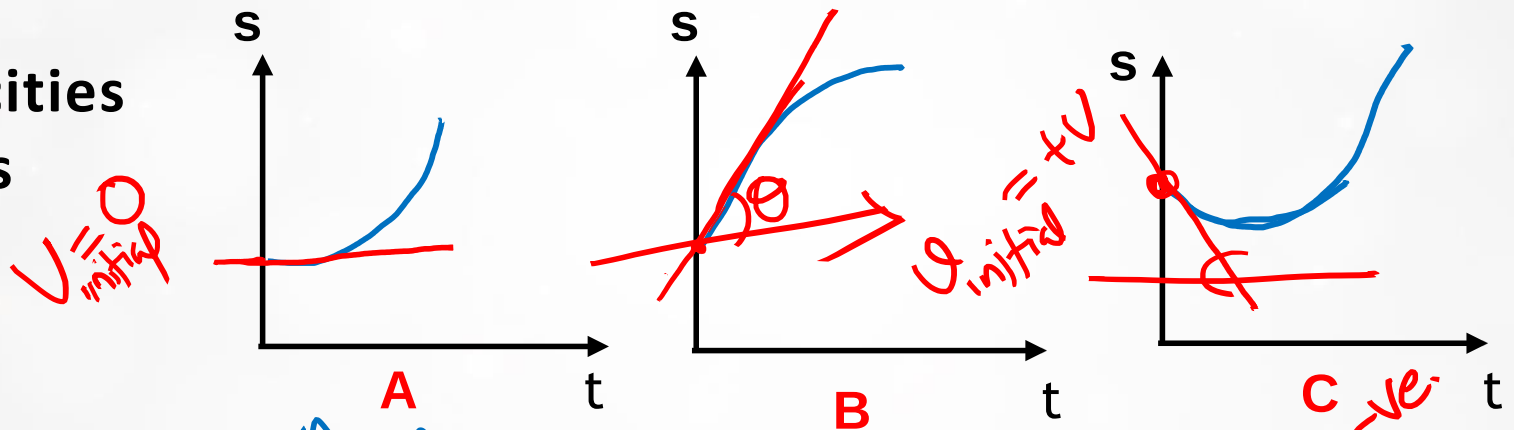
$= \frac{30}{2} = 15$

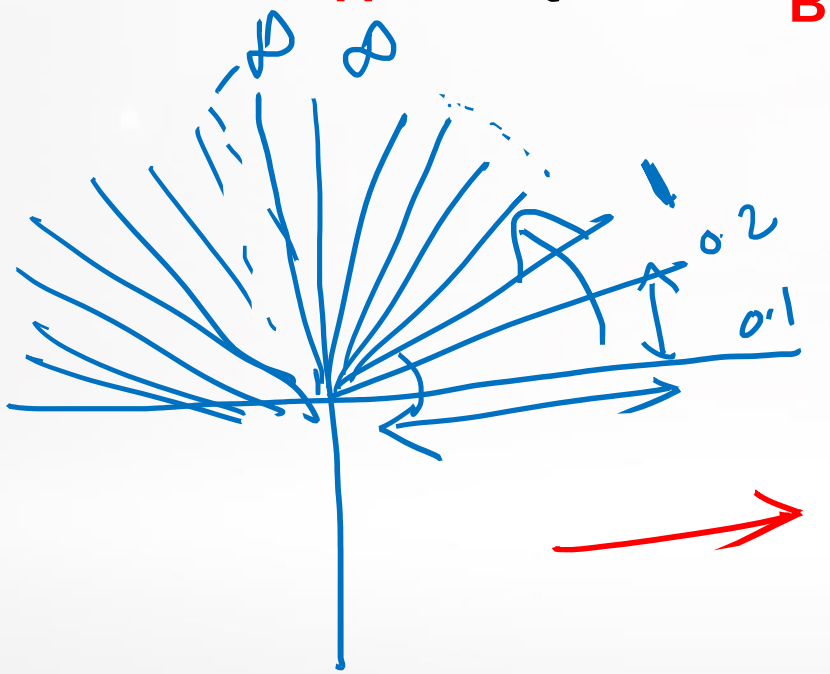
Slope = Vav = $\frac{30}{2} = 15$

$\frac{45}{3} = 15$

Example

Initial velocities from graphs





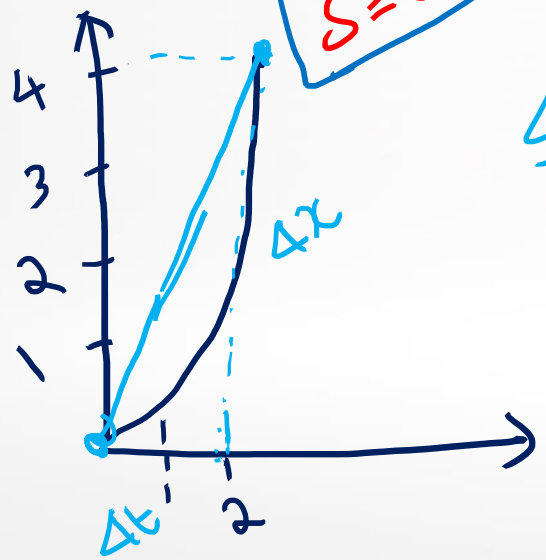
Example

Displacement & Time graph is plotted as shown. Find

1. **The average velocity during the time of motion**
2. **The time at which instantaneous velocity is equal to the average velocity over the first 2 seconds.**

$v = 2t$

$s = t^2$



$\frac{\Delta x}{\Delta t} = \frac{4}{2} = 2\ m/s$

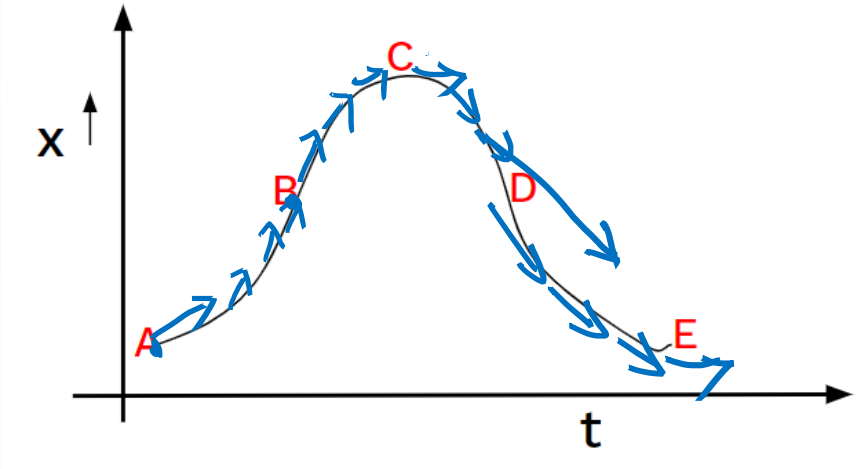
$v_{insta} = \frac{ds}{dt}$

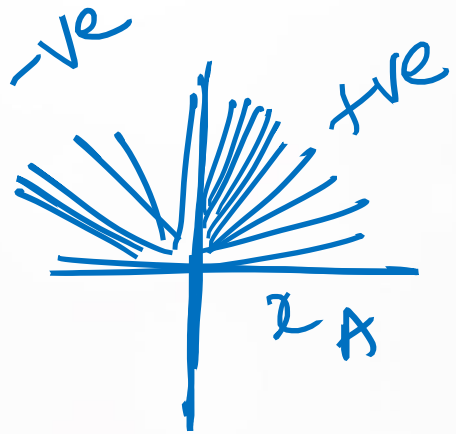
$2t = 2$

$t = 1$

Example

Determine the sign of velocity & acceleration for the given plot.

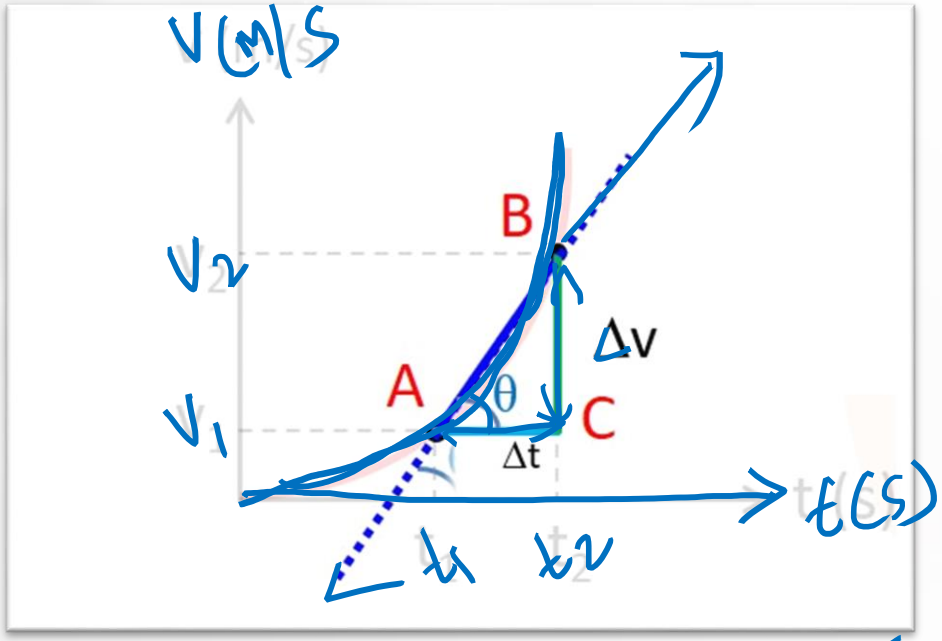




	AB	BC	CD	DE
v	+ve	+ve	-ve	-ve
a	+ve	-ve	-ve	+ve

Velocity - Time graph

- **Average Acceleration: Slope of chord between any two points on velocity - time graph gives us average acceleration.**



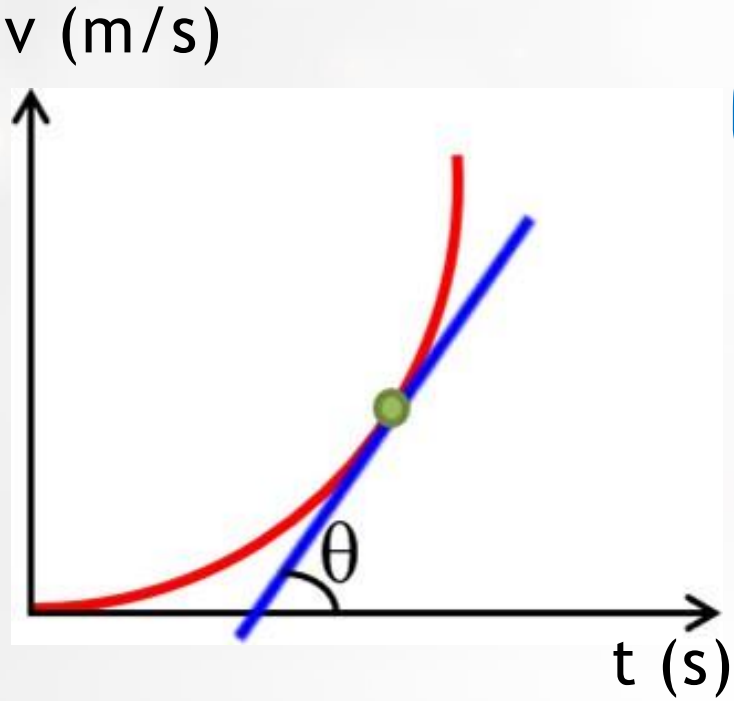
$$\vec{a}_{avg} = \frac{\vec{v}_2 - \vec{v}_1}{t_2 - t_1} = \frac{\Delta \vec{v}}{\Delta t}$$

Slope = Avg a

Slope = tanθ = $\frac{\Delta v}{\Delta t}$

Velocity - Time graph

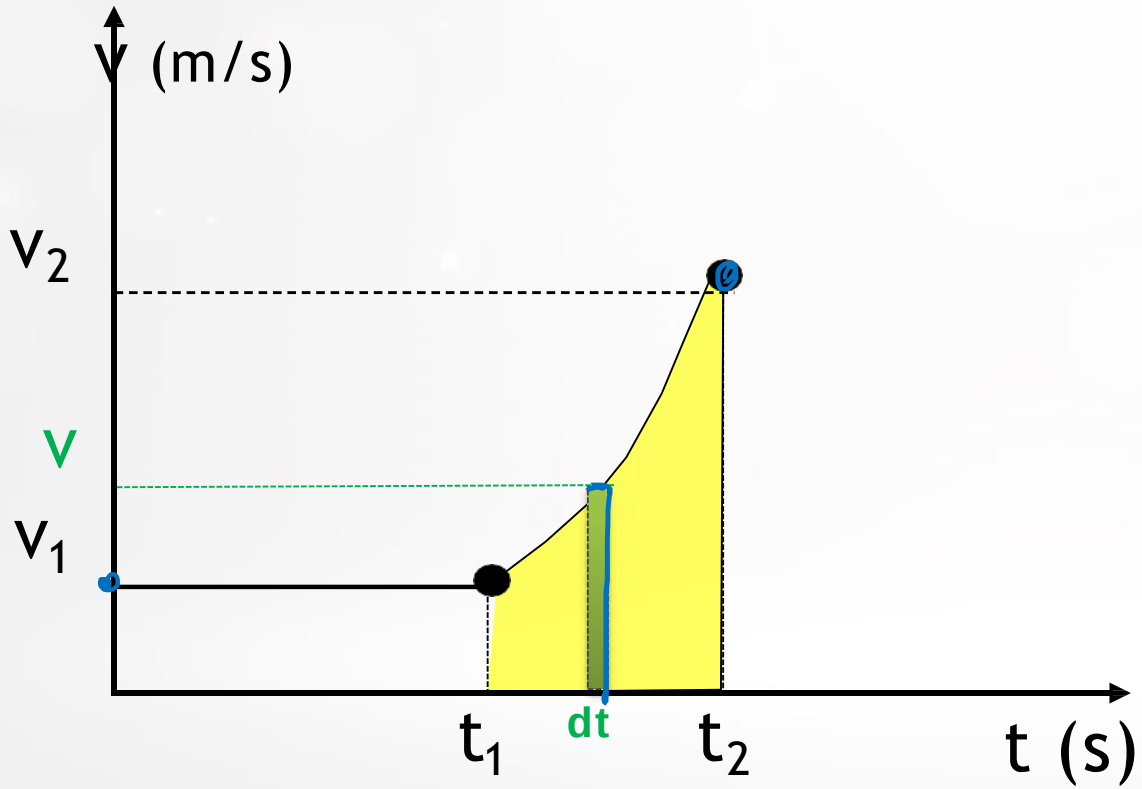
- **Instantaneous Acceleration: Slope of Tangent to velocity - time graph at any instant gives us instantaneous Acceleration at that instant**



$$\vec{a}_{inst} = \frac{\overrightarrow{dv}}{dt} = \tan\theta$$

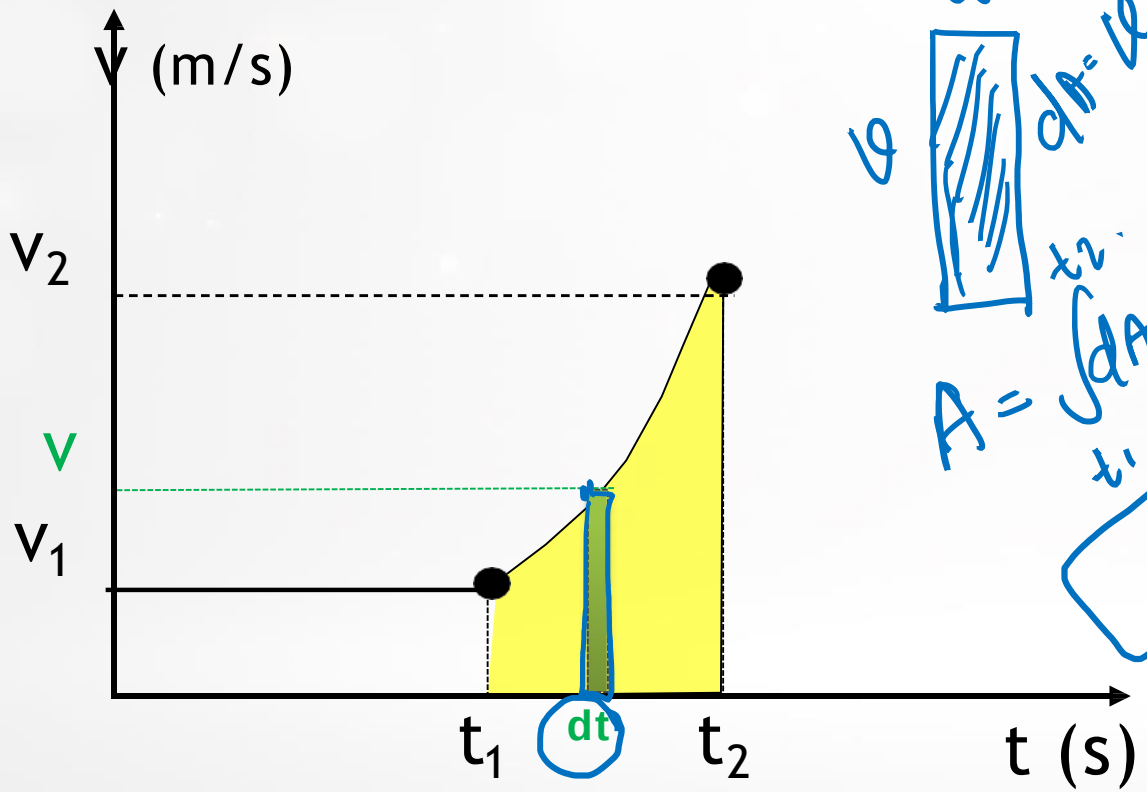
Velocity - Time graph

- **Displacement: The AREA between the curve and time axis represents the displacement of the particle during the given time interval in velocity time graph.**



Velocity - Time graph

- **Displacement: The AREA between the curve and time axis represents the displacement of the particle during the given time interval in velocity time graph.**



$v = \frac{ds}{dt}$ $\quad ds = v\,dt$

$\int ds = \int v\,dt$

$s = \int v\,dt$

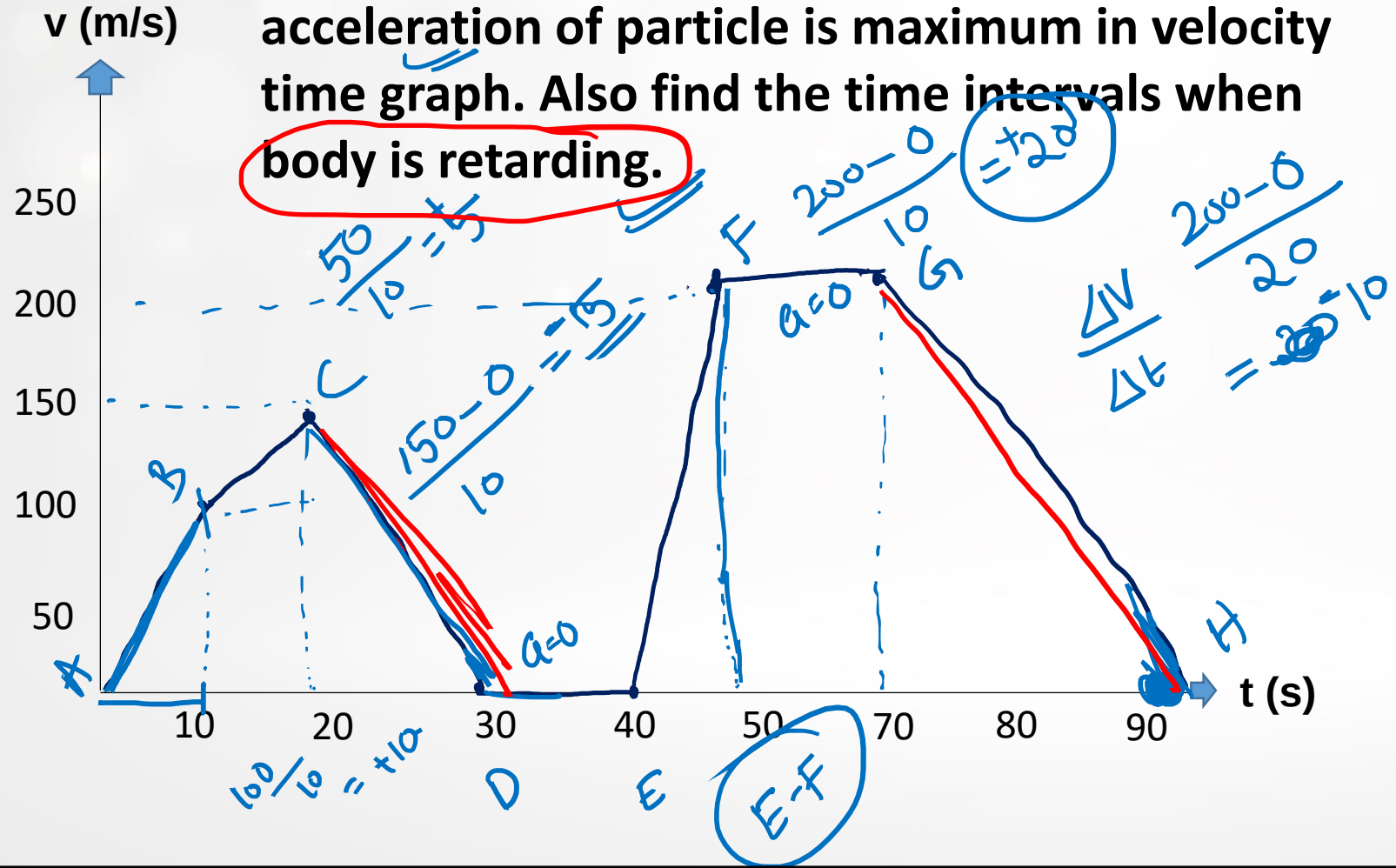
dA = v dt

$A = \int dA = \int_{t_1}^{t_2} v\,dt$

Area = S

Example

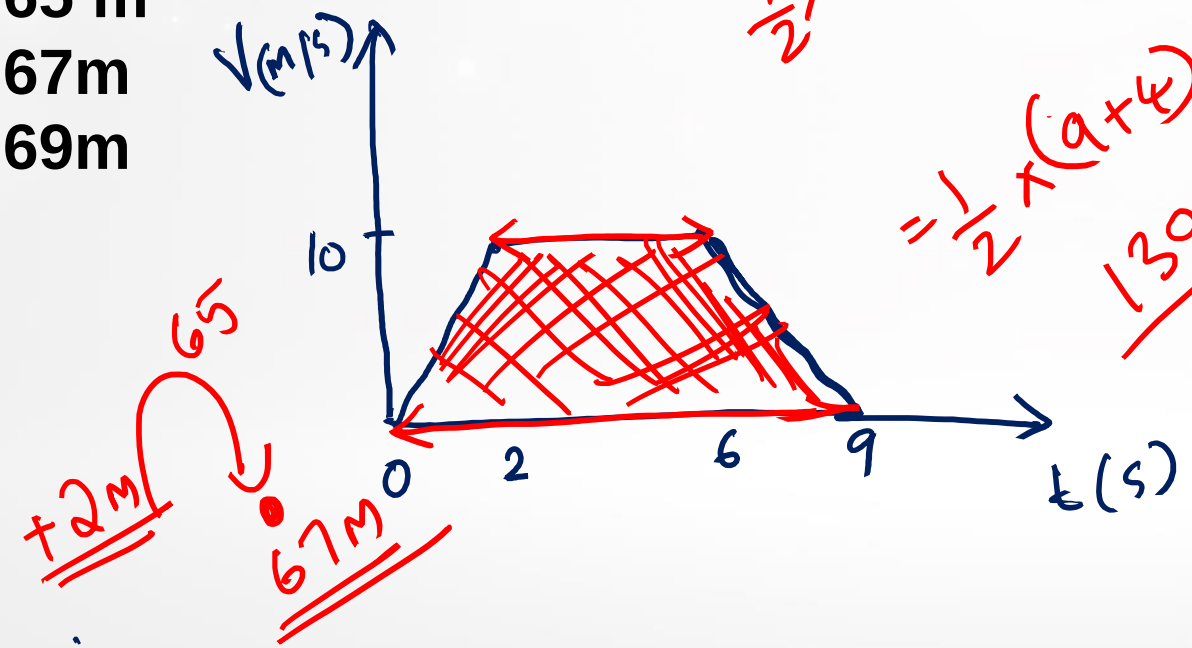
Identify the time intervals when magnitude of acceleration of particle is maximum in velocity time graph. Also find the time intervals when body is retarding.



Example

If a body is initially at x = +2m, find the position of body after 9sfrom the graph shown.

A. 63 m
B. 65 m
C. 67m
D. 69m



$\frac{1}{2}$ × (Sum of parallel sides) × (⊥r distance)

$= \frac{1}{2} \times (a+4)(10)$

$\frac{130}{2} = 65$

Acceleration -Time graph

Change in velocity:

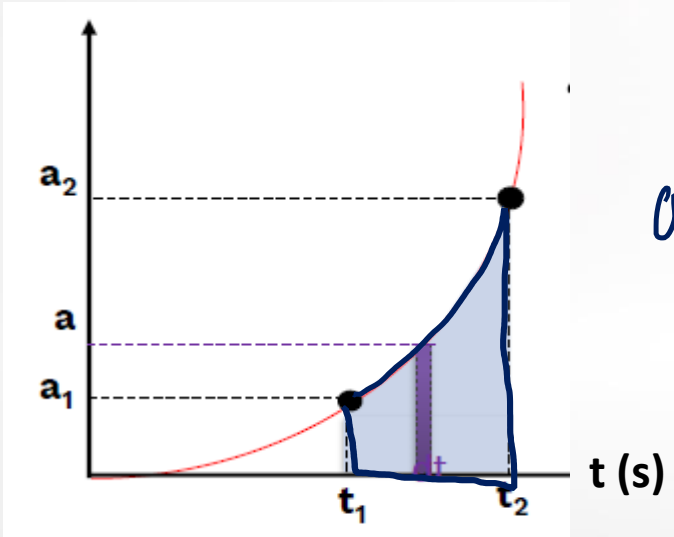
- **The Area between the curve and time axis represents the change in velocity of the particle during the given time interval in acceleration time graph**

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

$dv = a\,dt$

$\int dv = \int a\,dt$

$v - u = \int a\,dt$



v–t

dt

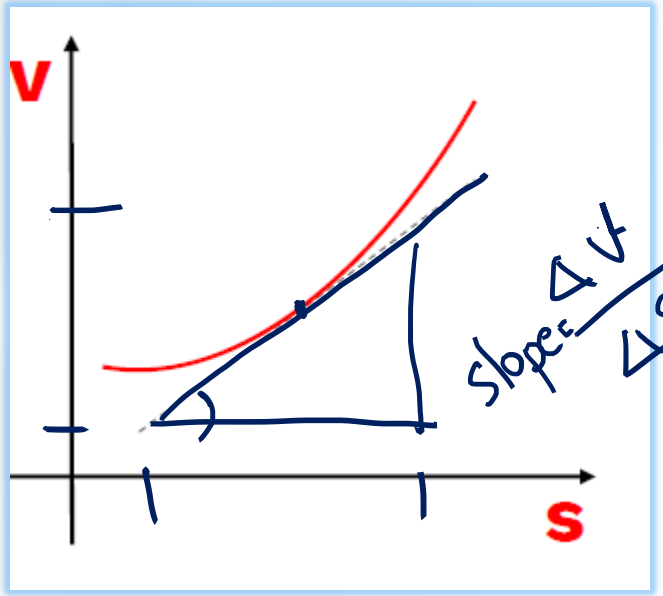
a

$A = v - u$

$a\,dt$

$A = \int_{t_1}^{t_2} a\,dt$

Velocity Displacement Graph



$$\text{Slope} = \frac{dv}{ds}$$

$$\text{Slope} = \frac{a}{v}$$

$$a = v\frac{dv}{ds}$$

$$\Rightarrow \frac{dv}{ds} = \frac{a}{v}$$

$v \cdot \frac{dv}{ds}$ — $v - t$

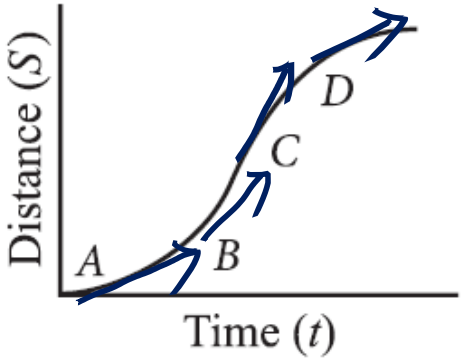
$a = v \cdot \text{slope}$

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

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

Example

A particle shows distance-time curve as given in this figure. The maximum instantaneous velocity of the particle is around the point



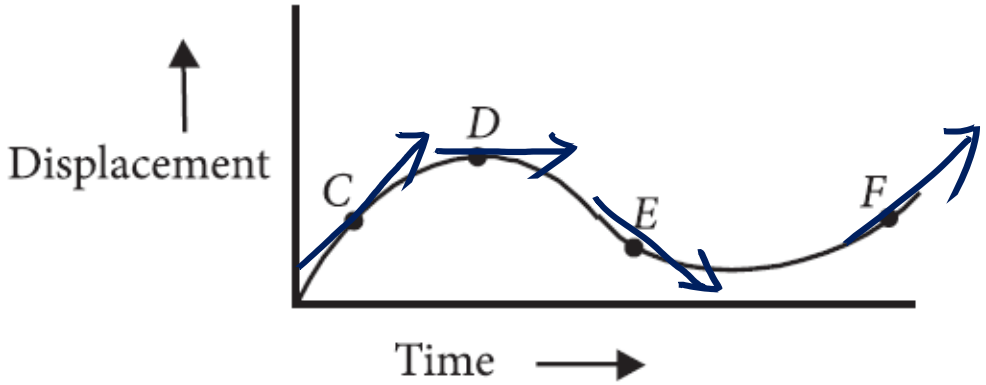
(a) D (b) A

(c) B (d) C

(2008)

Example

The displacement-time graph of a moving particle is shown below. The instantaneous velocity of the particle is negative at the point

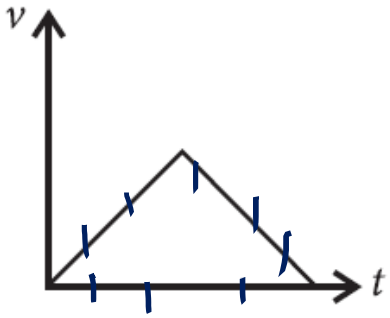


(a) E (b) F (c) C (d) D *(1994)*

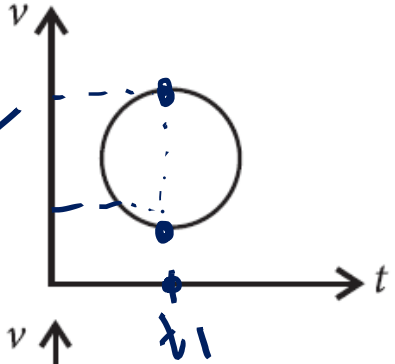
Example

Which of the following curve does not represent motion in one dimension ?

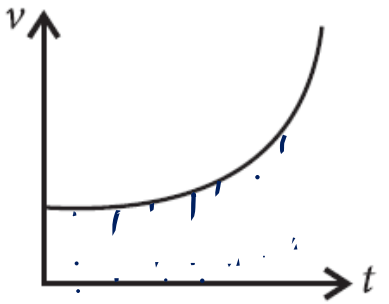
(a)



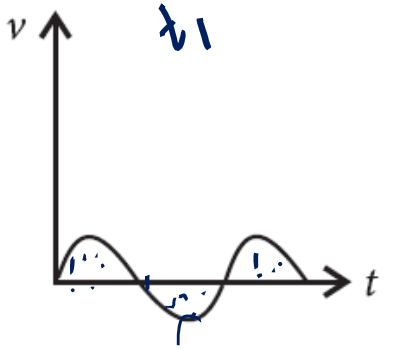
(b)



(c)



(d)



(1992)