

ARJUNA 2.0

-JEE 2024 Exam-

☐ Physics

☐ Motion in a Straight Line

Lecture No.- 09

By- Himanshu Gupta





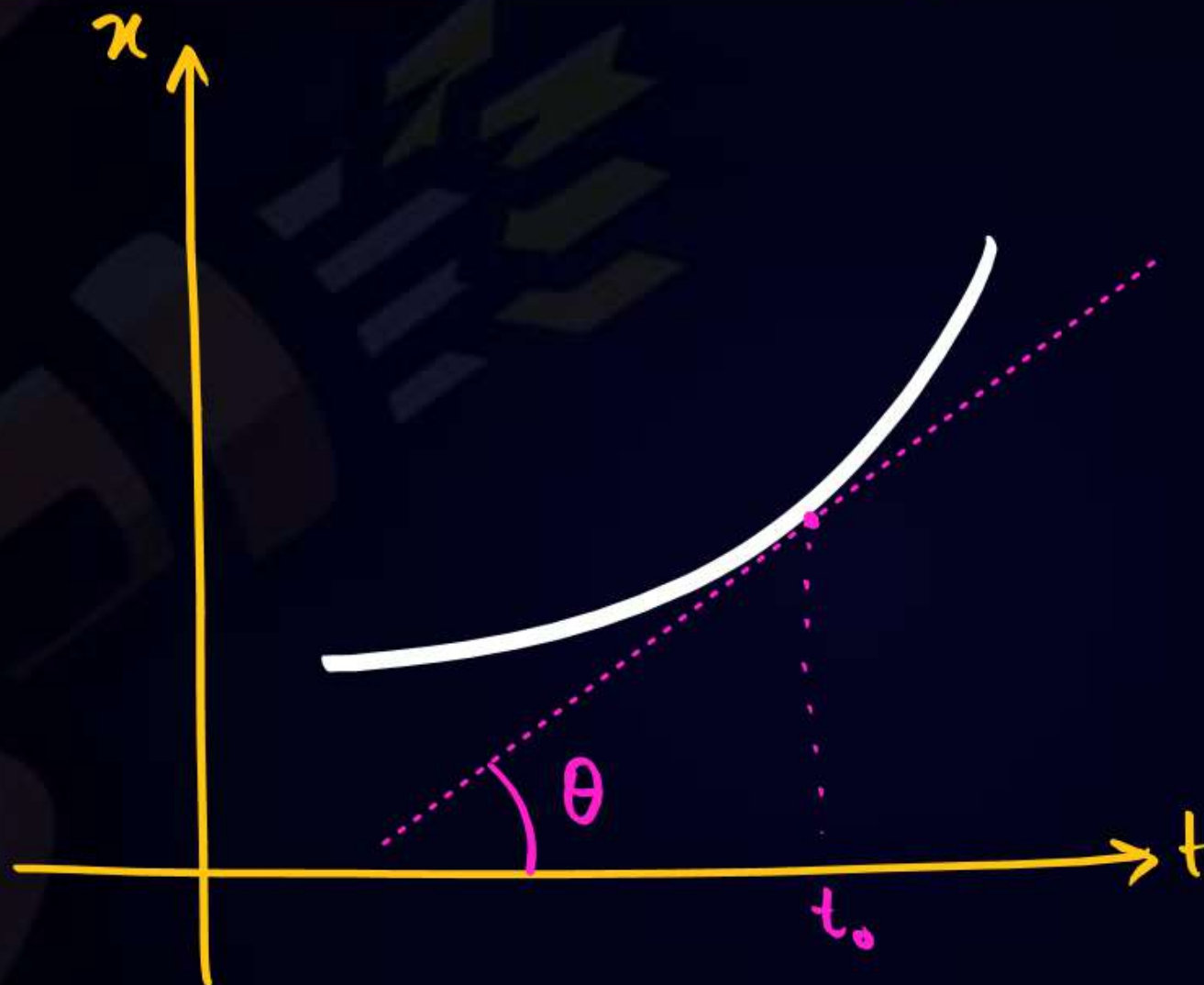
Kinematics Graphs



Today's Targets



x-t Graph



Slope of tangent \rightarrow

$$\tan \theta = \frac{dx}{dt} = v_{t_0}$$

Question

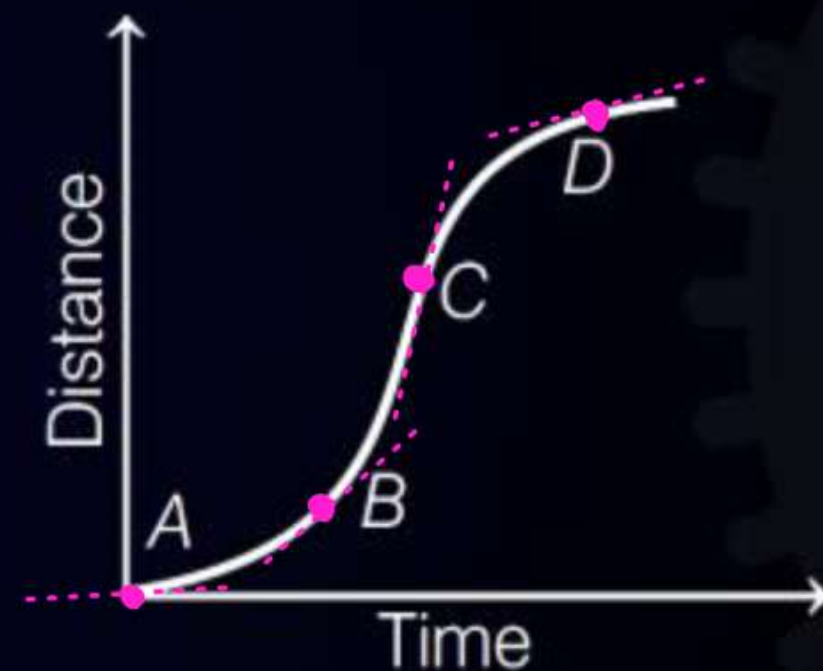
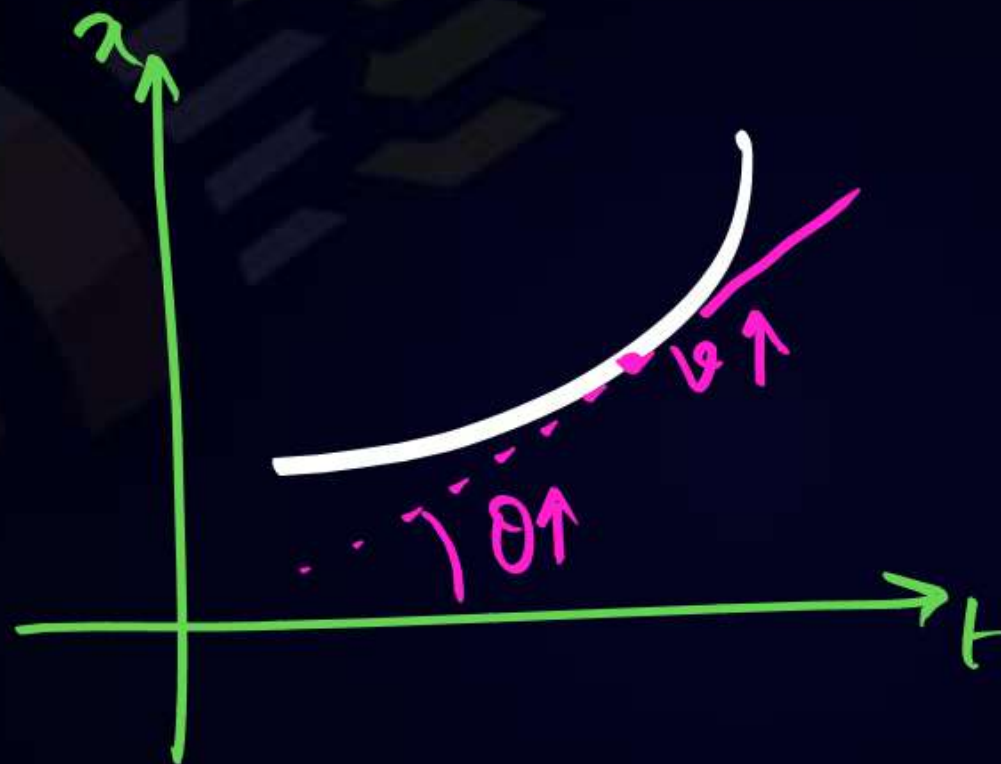
A particle shows distance-time curve as given in this figure. The maximum instantaneous velocity of the particle is around the point

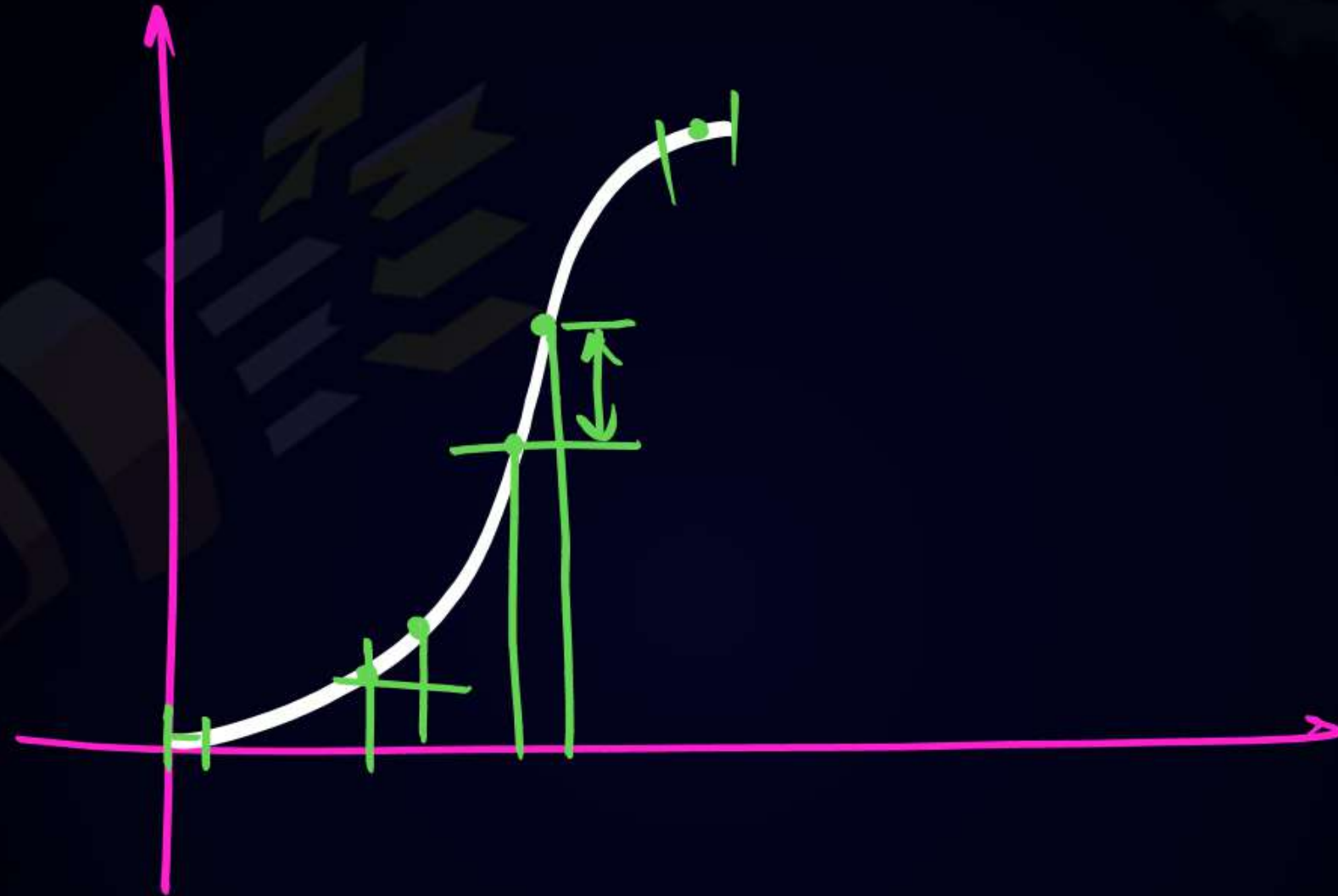
1 B

2 C

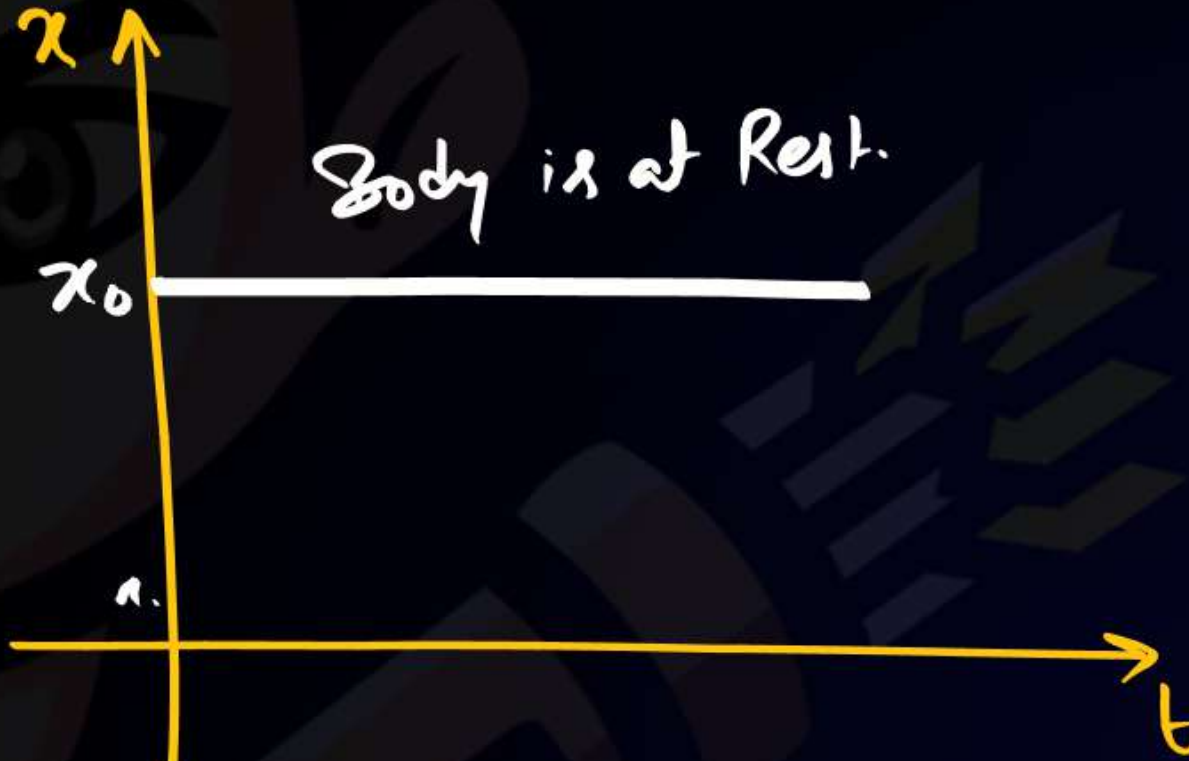
3 D

4 A

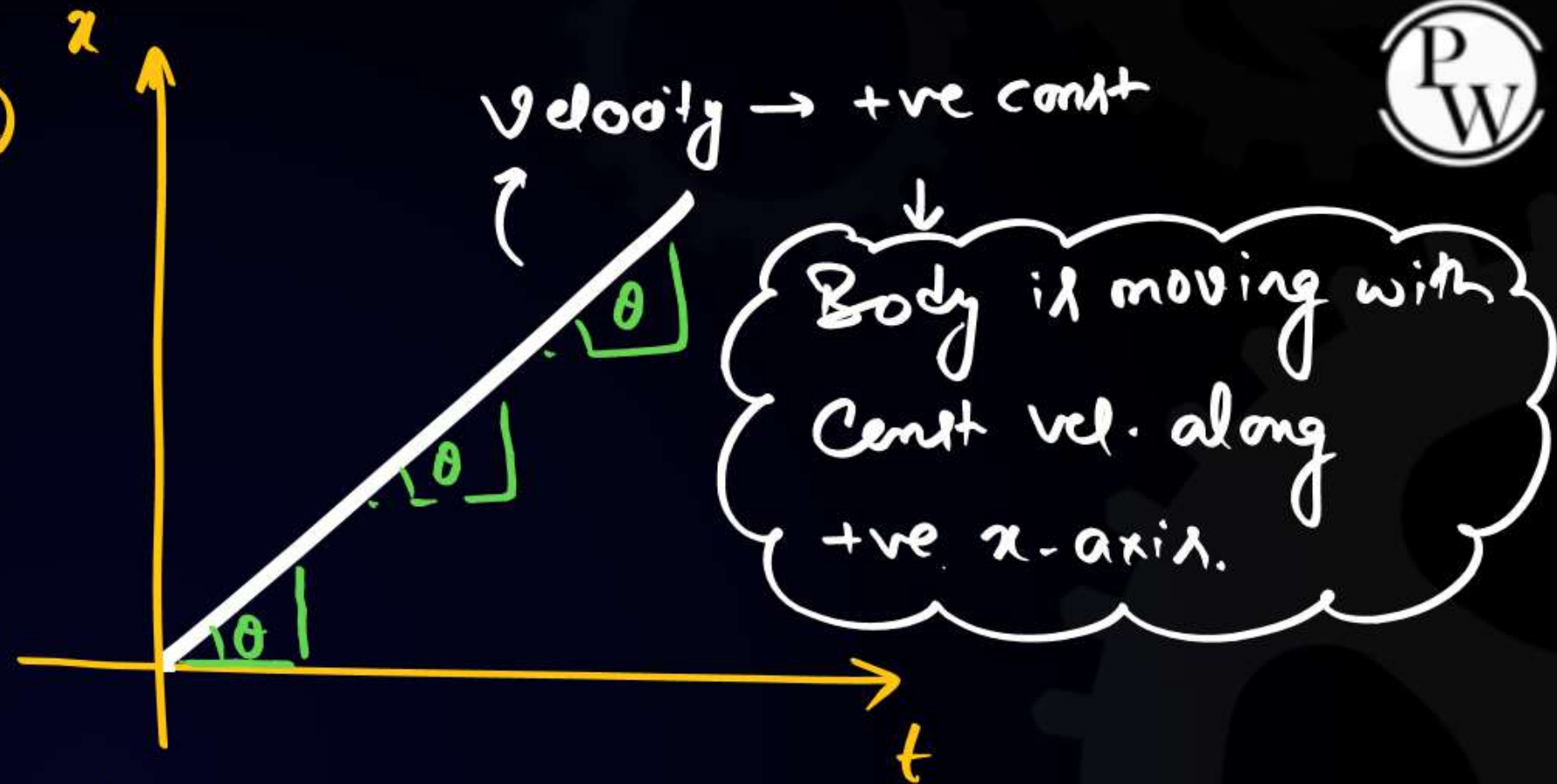




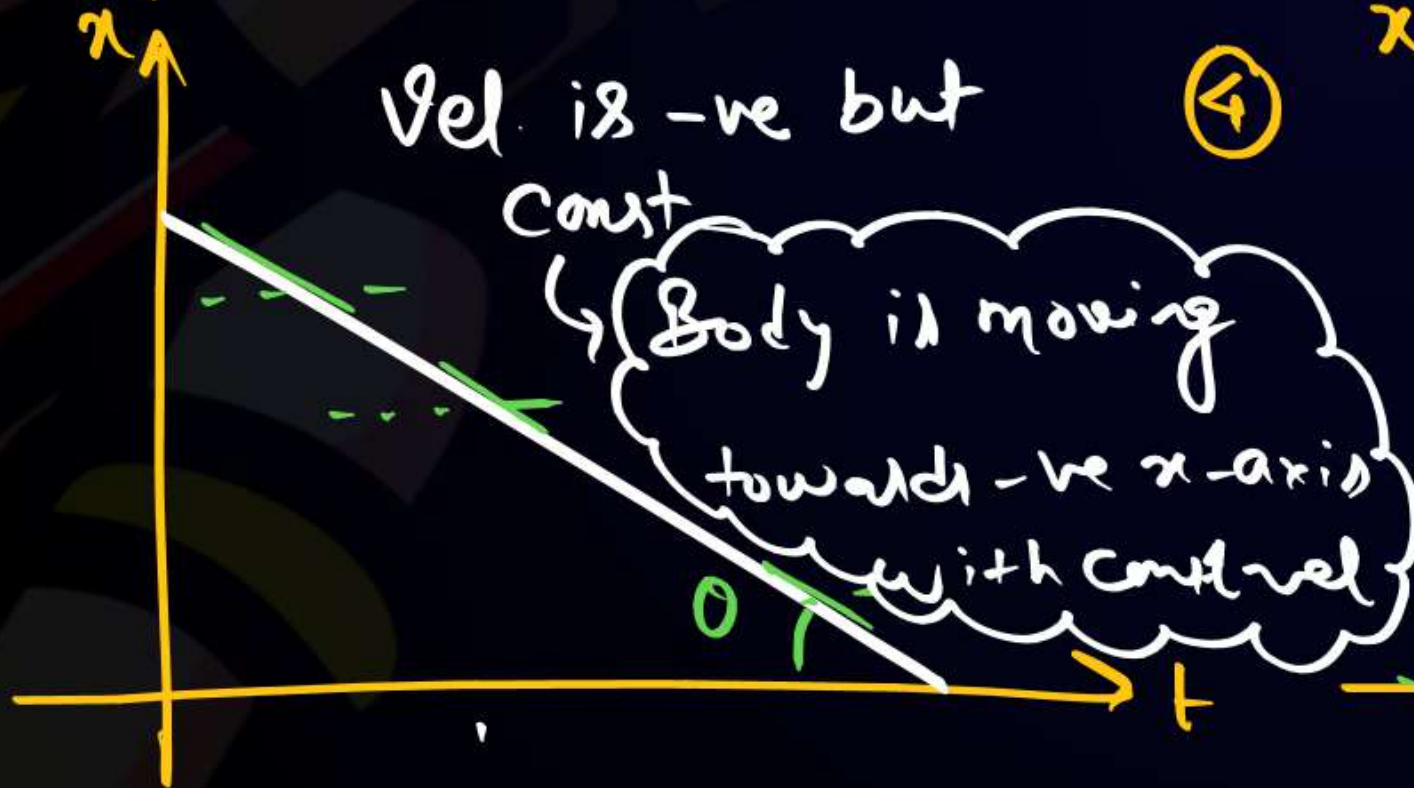
①



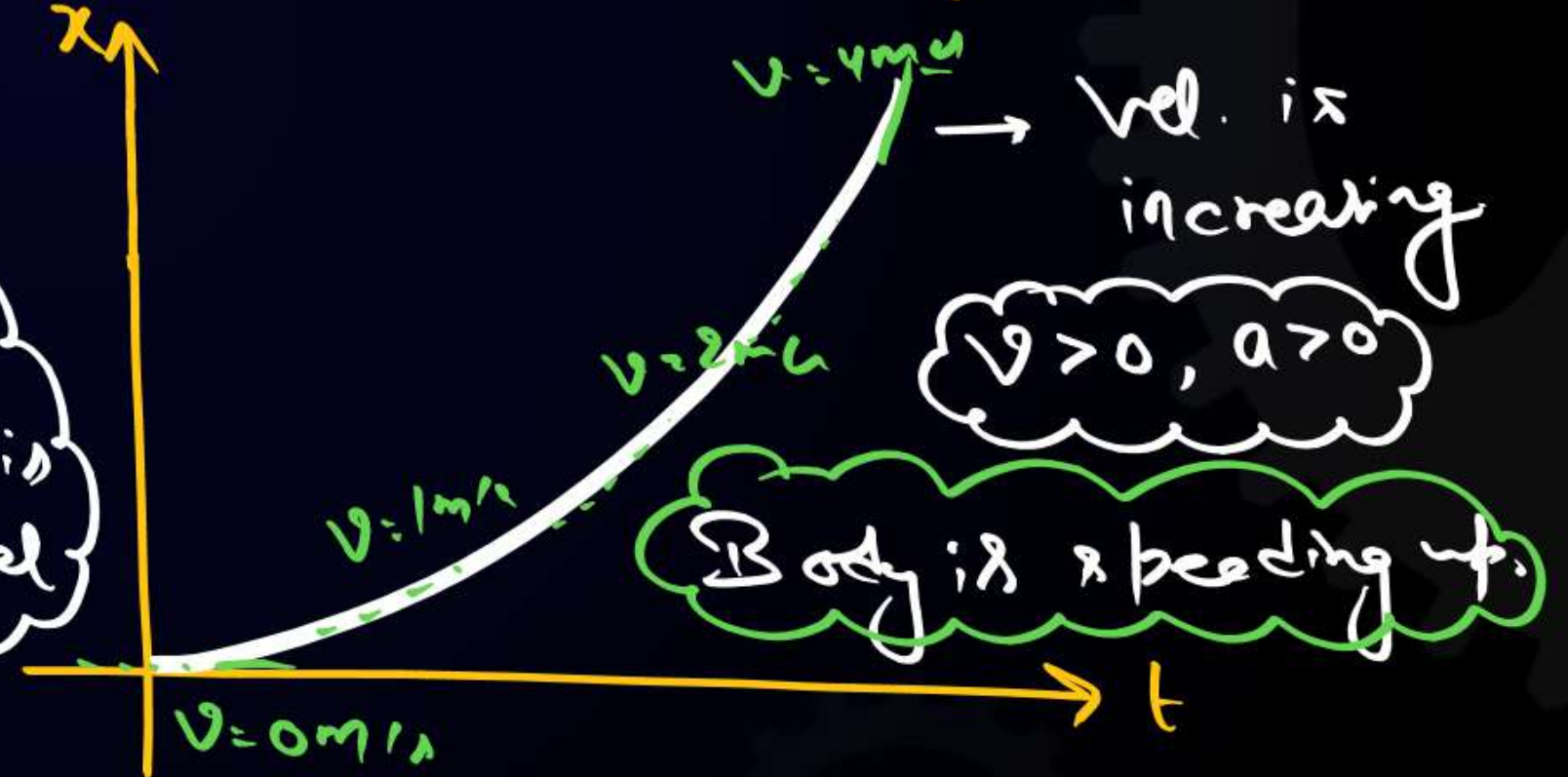
②



③



④

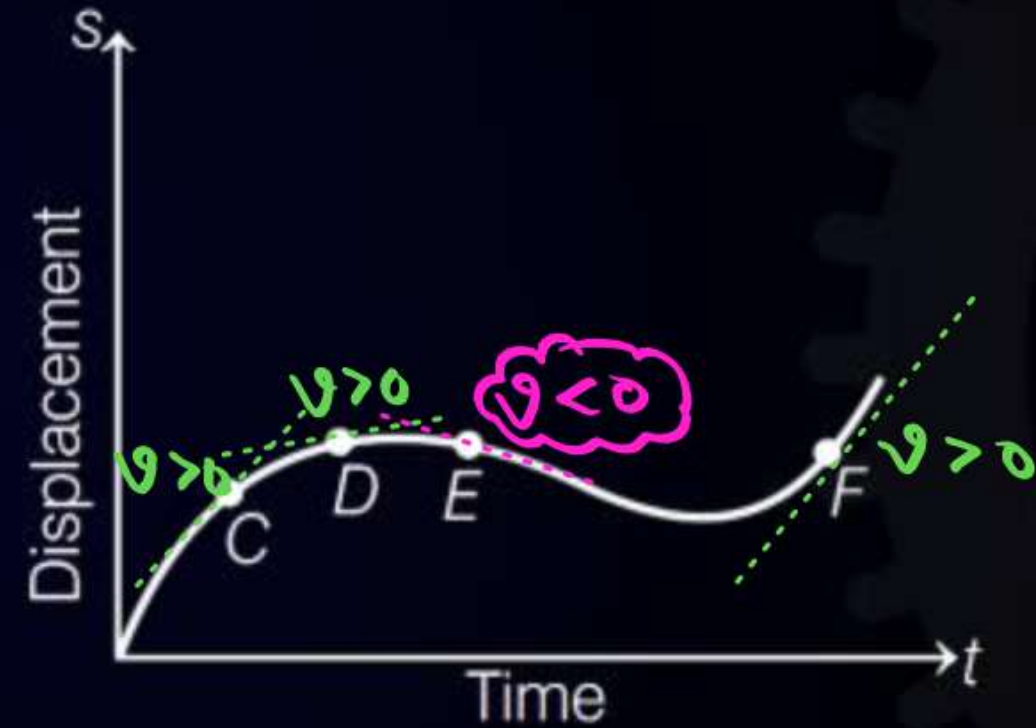


Question



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

- ☐ 1 D
- ☐ 2 F
- ☐ 3 C
- ☒ 4 E



Question

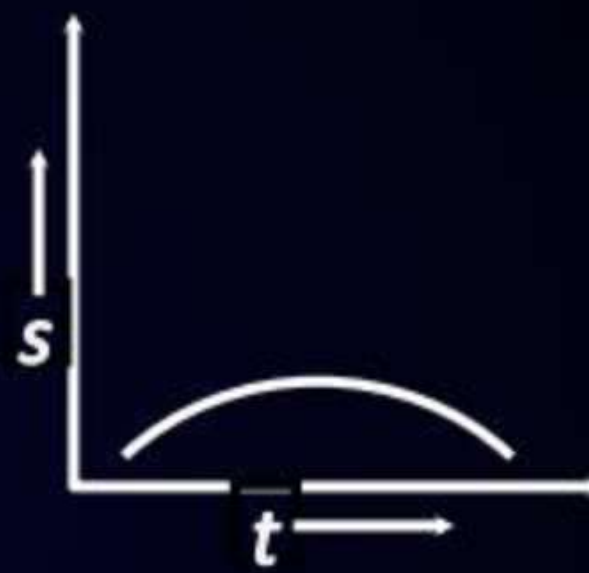
JH.W

Which of the following graph represents uniform motion

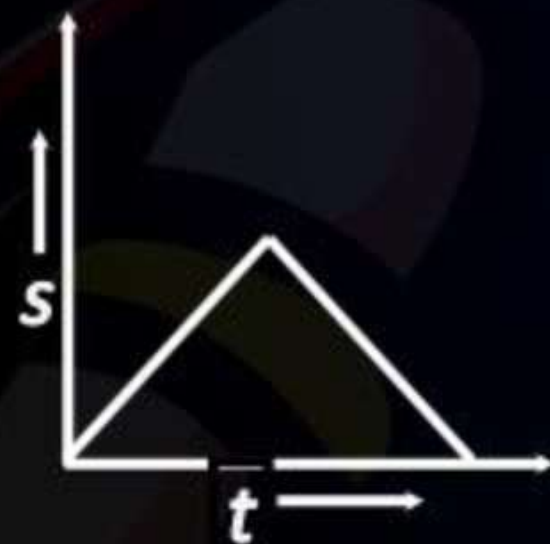
1



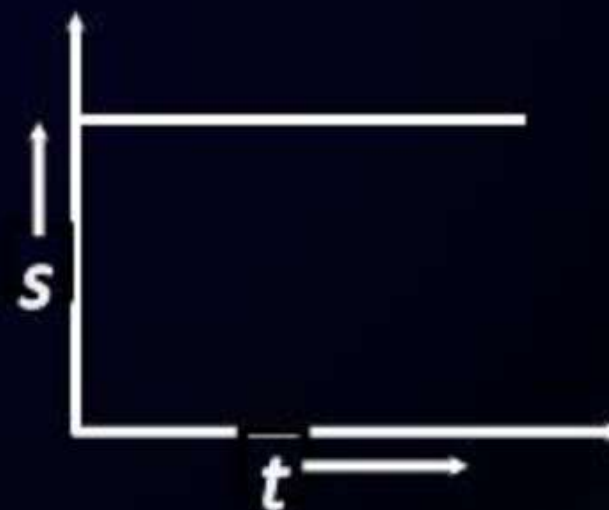
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3

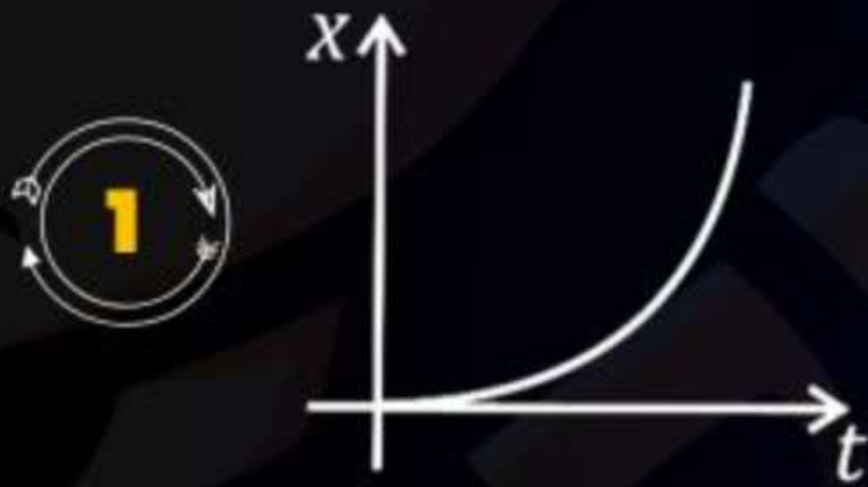


4



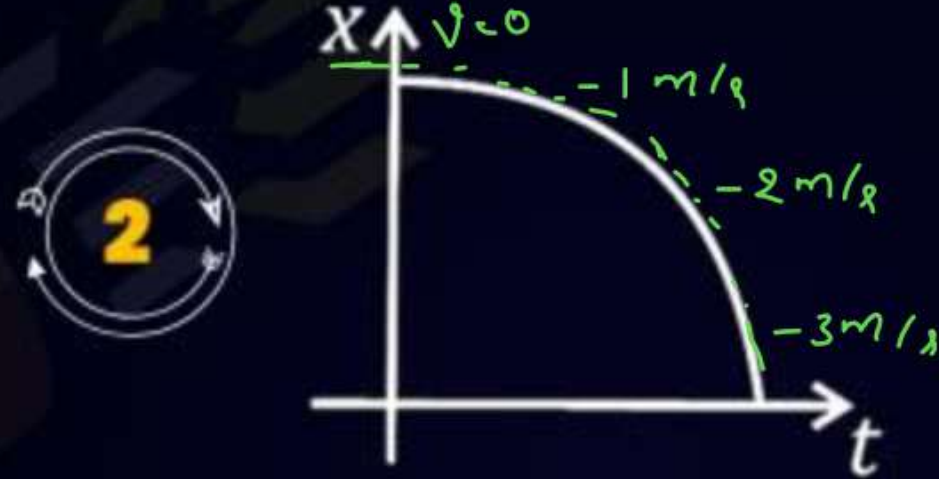
Question

Identify acceleration & retardation of body from following x-t graphs-

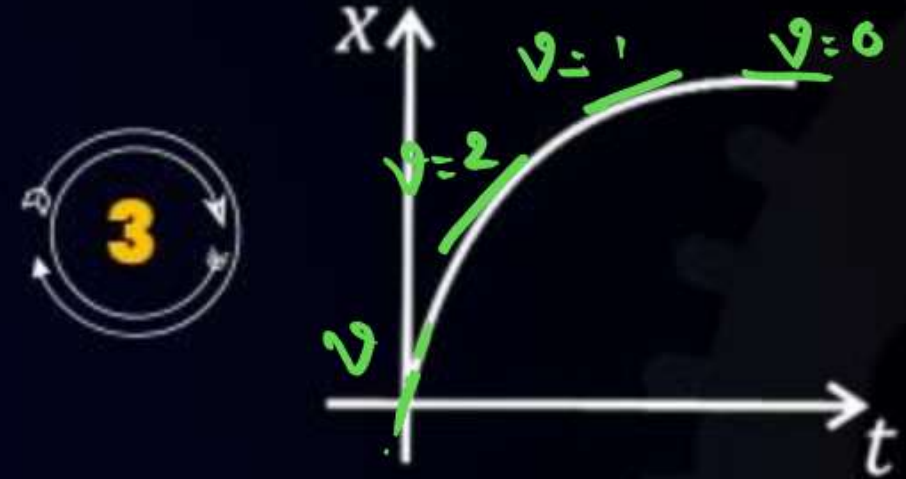


Acc.
Motion

Vel. → +ve
↓
vel. बढ़ रही है
↓
acc. → +ve



vel. → -ve
↓
vel. कम हो रही है
↓
acc. → -ve
→ Accelerated Motion



vel. → +ve
↓
vel. कम हो रही है
↓
acc. → -ve
→ Retardation

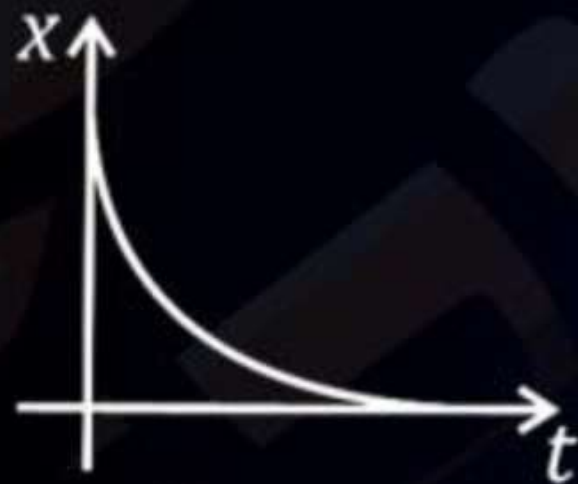
Question

H.W

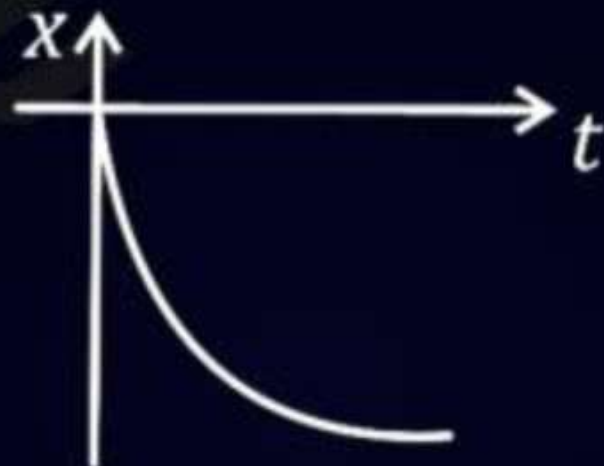


Identify acceleration & retardation of body from following $x-t$ graphs-

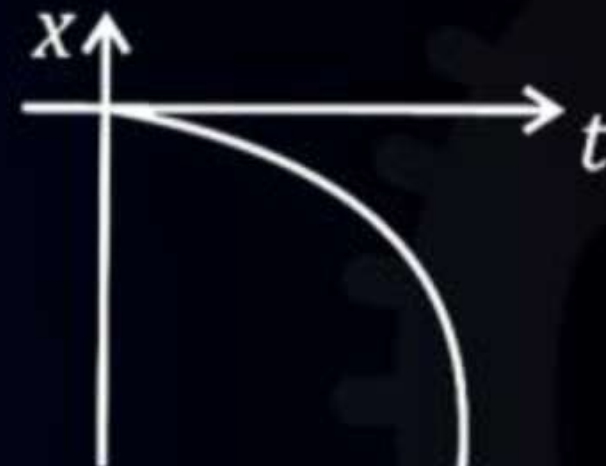
4



5



6



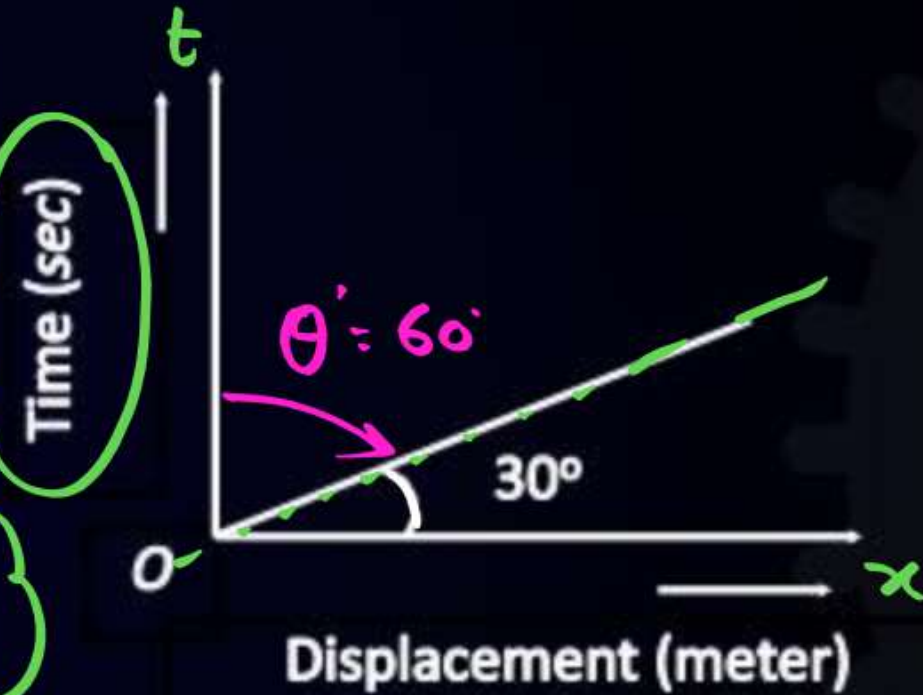
Question

From the following displacement-time graph find out the velocity of a moving body

Common Mistake →

$$\tan \theta = v = \tan 30 = \frac{1}{\sqrt{3}}$$

$$Vel = \tan \theta' = \tan 60 = \sqrt{3}$$



1 $\frac{1}{\sqrt{3}}$ m/s

2 3 m/s

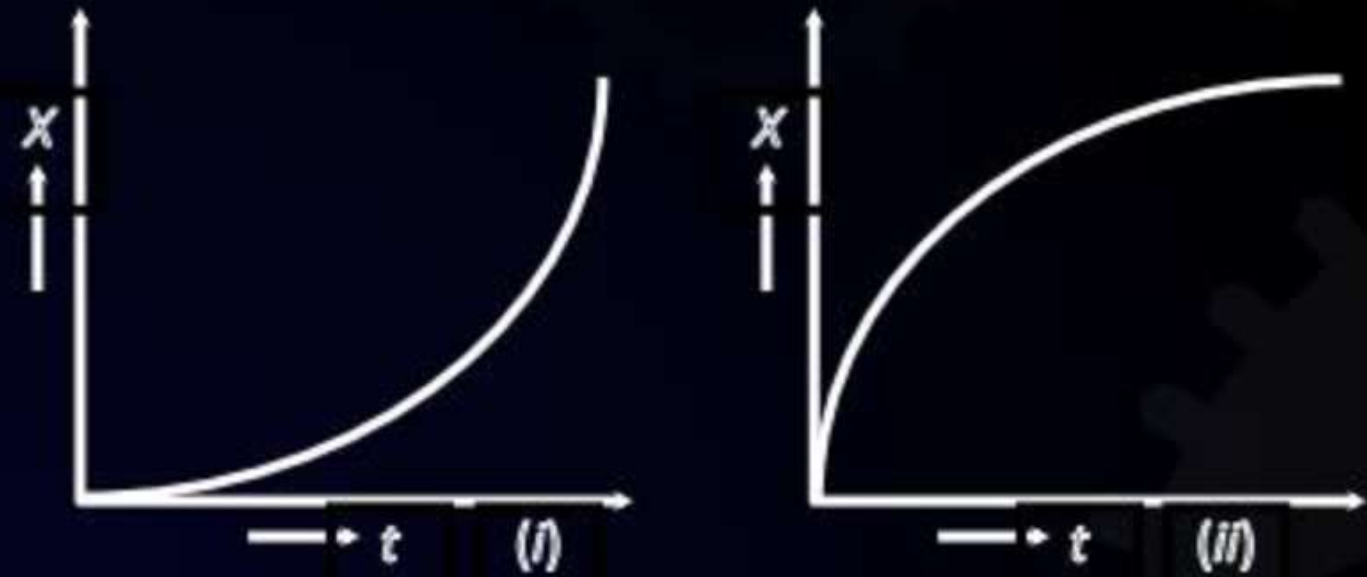
3 $\sqrt{3}$ m/s

4 $\frac{1}{3}$

Question



Figures (i) and (ii) below show the displacement-time graphs of two particles moving along the x-axis. We can say that



- 1 Both the particles are having a uniformly accelerated motion
- 2 Both the particles are having a uniformly retarded motion
- 3 Particle (i) is having a uniformly accelerated motion while particle (ii) is having a uniformly retarded motion
- 4 Particle (i) is having a uniformly retarded motion while particle (ii) is having a uniformly accelerated motion

Question



The displacement of a particle as a function of time is shown in the figure. The figure shows that

- 1 The particle starts with certain velocity but the motion is retarded and finally the particle stops
- 2 The velocity of the particle is constant throughout
- 3 The acceleration of the particle is constant throughout.
- 4 The particle starts with constant velocity, then motion is accelerated and finally the particle moves with another constant velocity



Question (Homework)



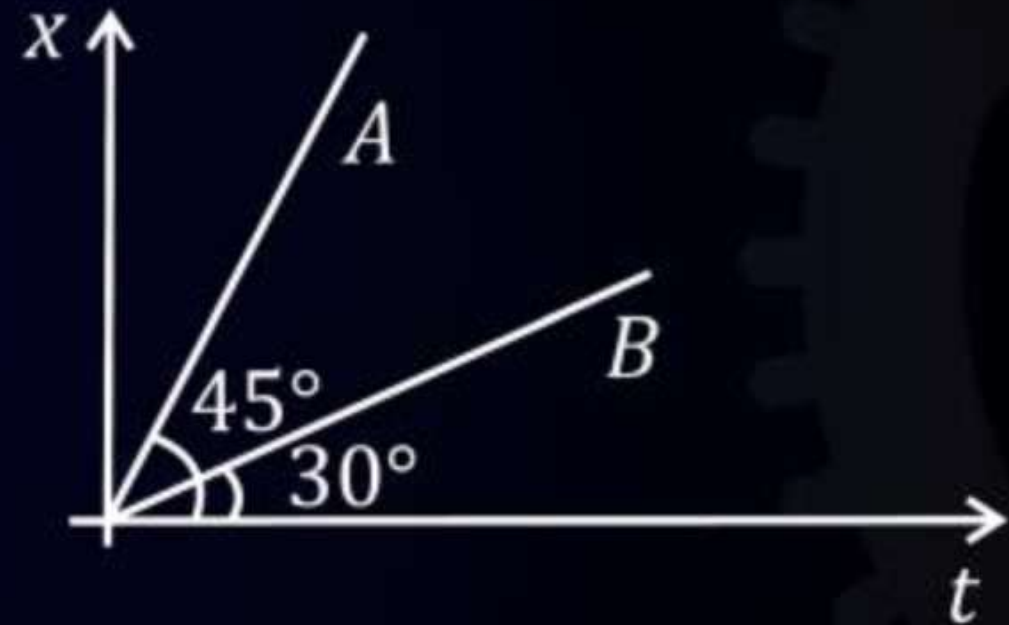
Find the ratio of velocities if displacement-time graphs of two bodies are represented by given straight line.

1 $\sqrt{3} : 1$

2 $3 : 1$

3 $2 : 1$

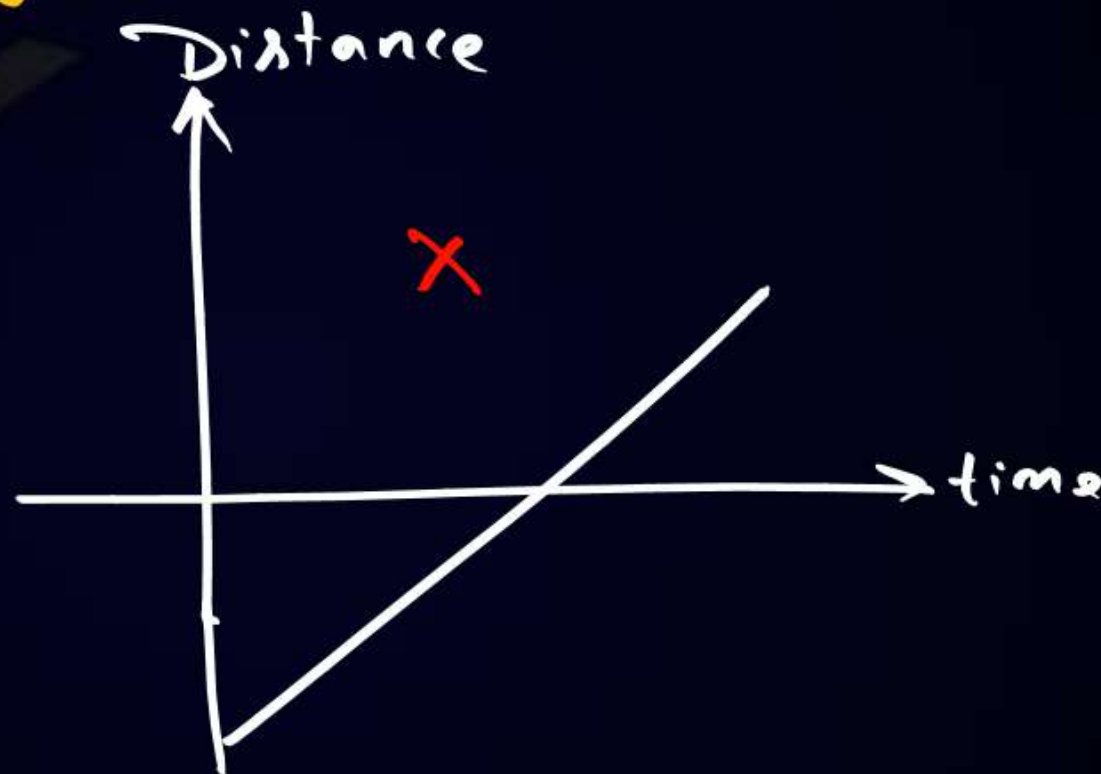
4 None of these





Distance-Time Graph

⇒ Distance-time graph kabhi x-axis ke neeche nahi ja sakta hai.



→ Dist. - time graph hamesha ya to badhega ya const. rahega. (kabhi bhi distance kam nahi hoga)



Thukega nahi

Question

NCERT



Look at the graph (1) to (4) carefully and state, with reasons, which of these cannot possibly represent one-dimensional motion of a particle.

Not Possible.

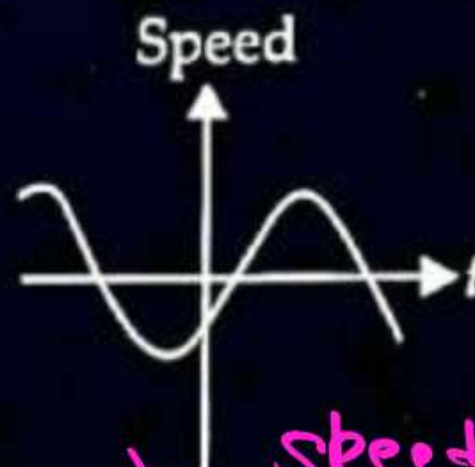


(i)



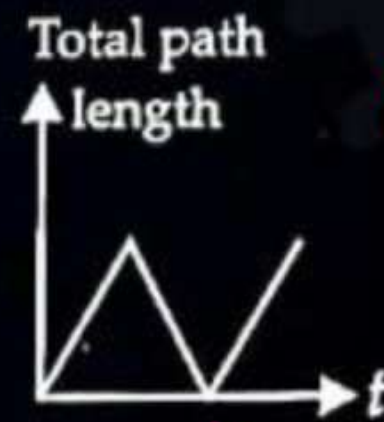
(ii)

A body cannot have two vel at same time.



(iii)

Speed ≥ 0 .



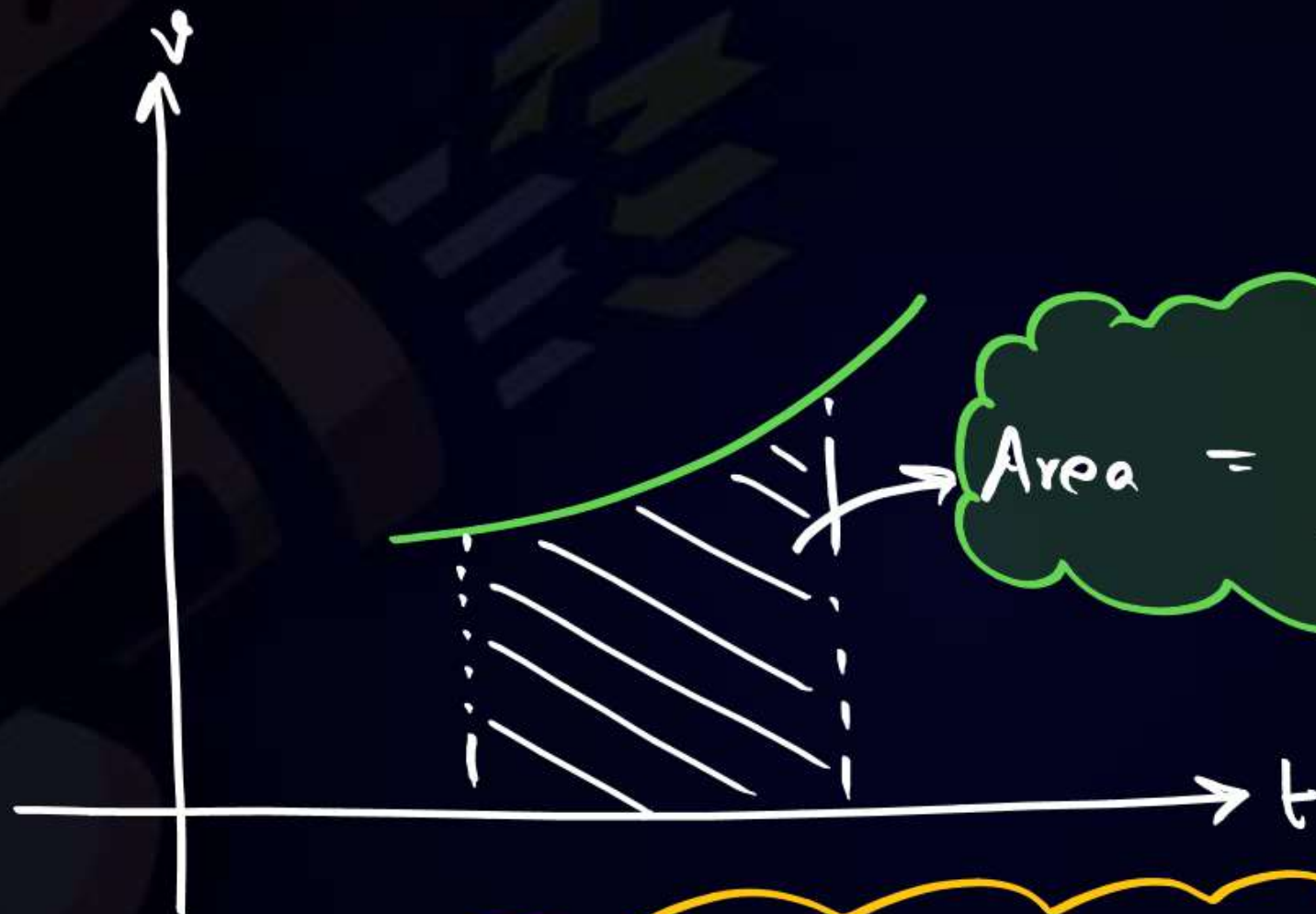
(iv)

path length can never decrease.



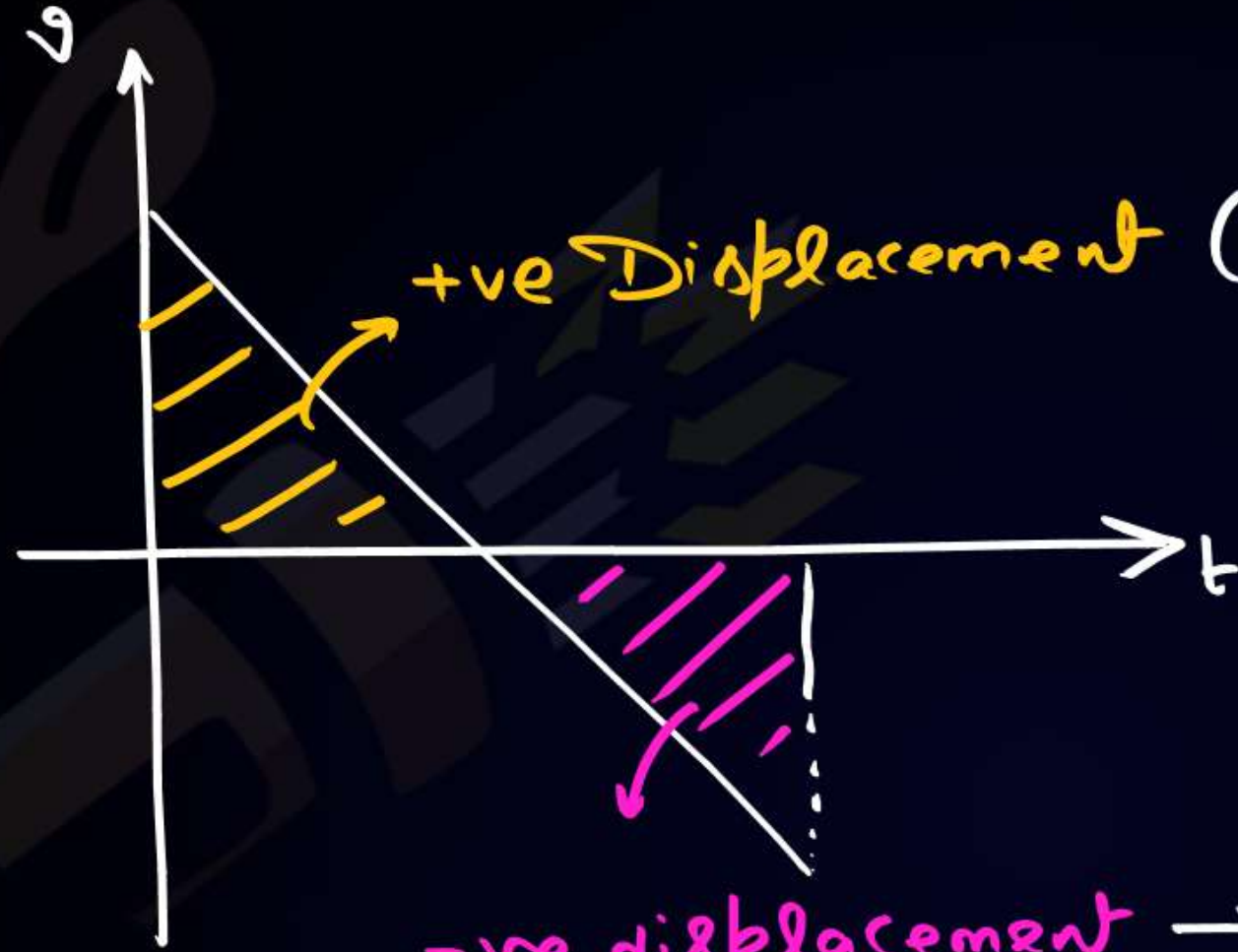
Velocity-Time Graph

$$\int \left(\frac{dx}{dt} \right) dt = \int dx$$



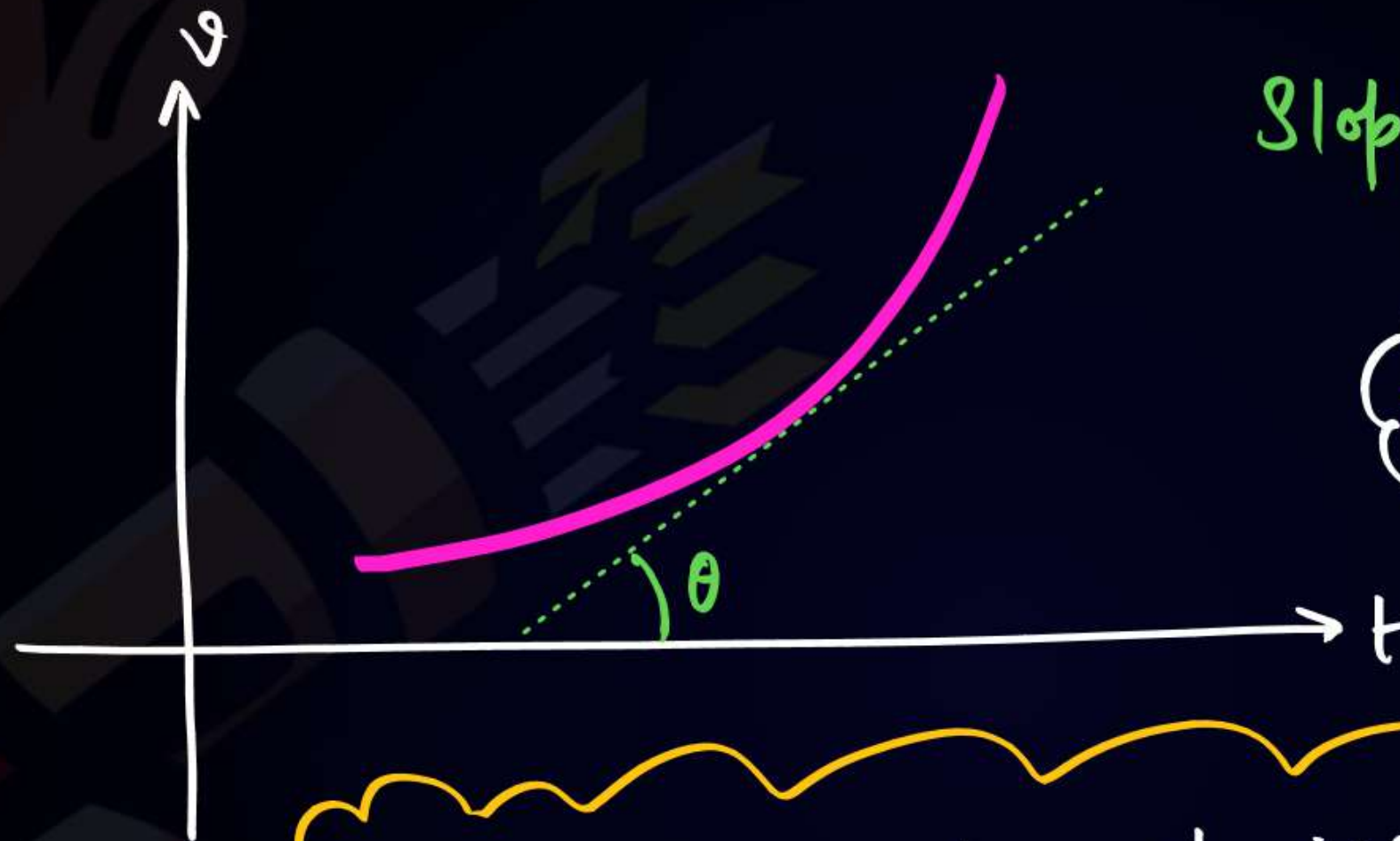
$$\text{Area} = \int v dt = \text{Displacement}$$

v-t graph ka area total displacement deta hai.



+ve Displacement (Body +ve x -axis ki taraf ja rahi hai)

-ve displacement \rightarrow (Body -ve x -axis ki taraf ja rahi hai)



Slope of tangent drawn
on v-t curve -

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

⇒ v-t curve par tangent instantaneous acceleration
deta hai.

Q.

JEE Mains 2020

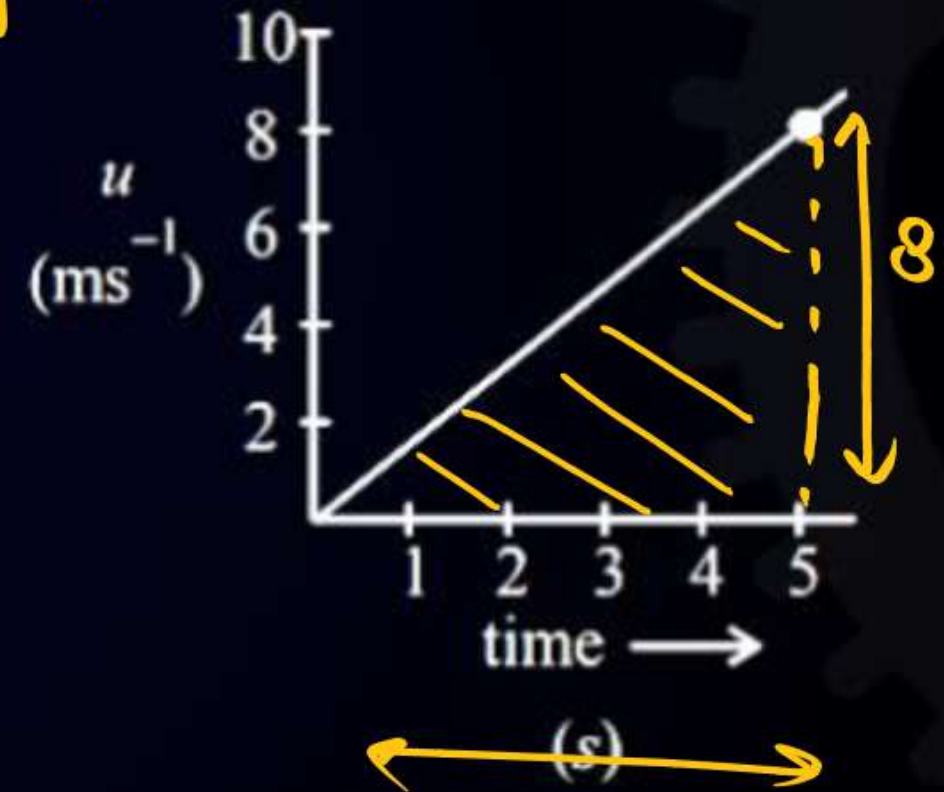


The speed versus time graph for a particle is shown in the figure. The distance travelled (in m) by the particle during the time interval $t = 0$ to $t = 5$ s will be _____.

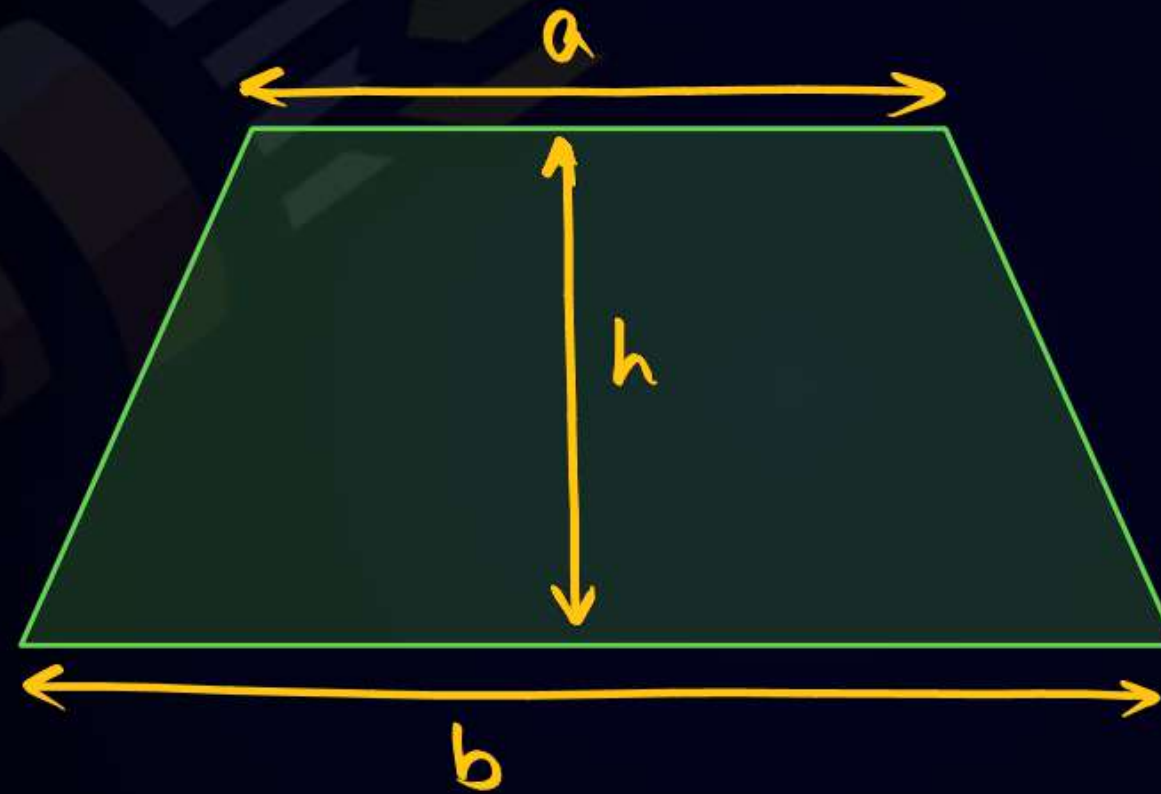
Distance = Area under speed-time graph

$$= \frac{1}{2} \times 5 \times 8$$

$$= 20m$$



Area of trapezium



$$\text{Area} = \underbrace{\left(\frac{a+b}{2} \right)}_{\text{Avg. of } \parallel \text{ sides}} h$$

Q.

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$v-t$ curve का area displacement देता है position नहीं देता



A particle starts from the origin at time $t = 0$ and moves along the positive X -axis. The graph of velocity with respect to time is shown in figure. What is the position of the particle at time $t = 5s$?

1 6 m

2 3 m

3 10 m

4 9 m

Disp. = Area (shaded)

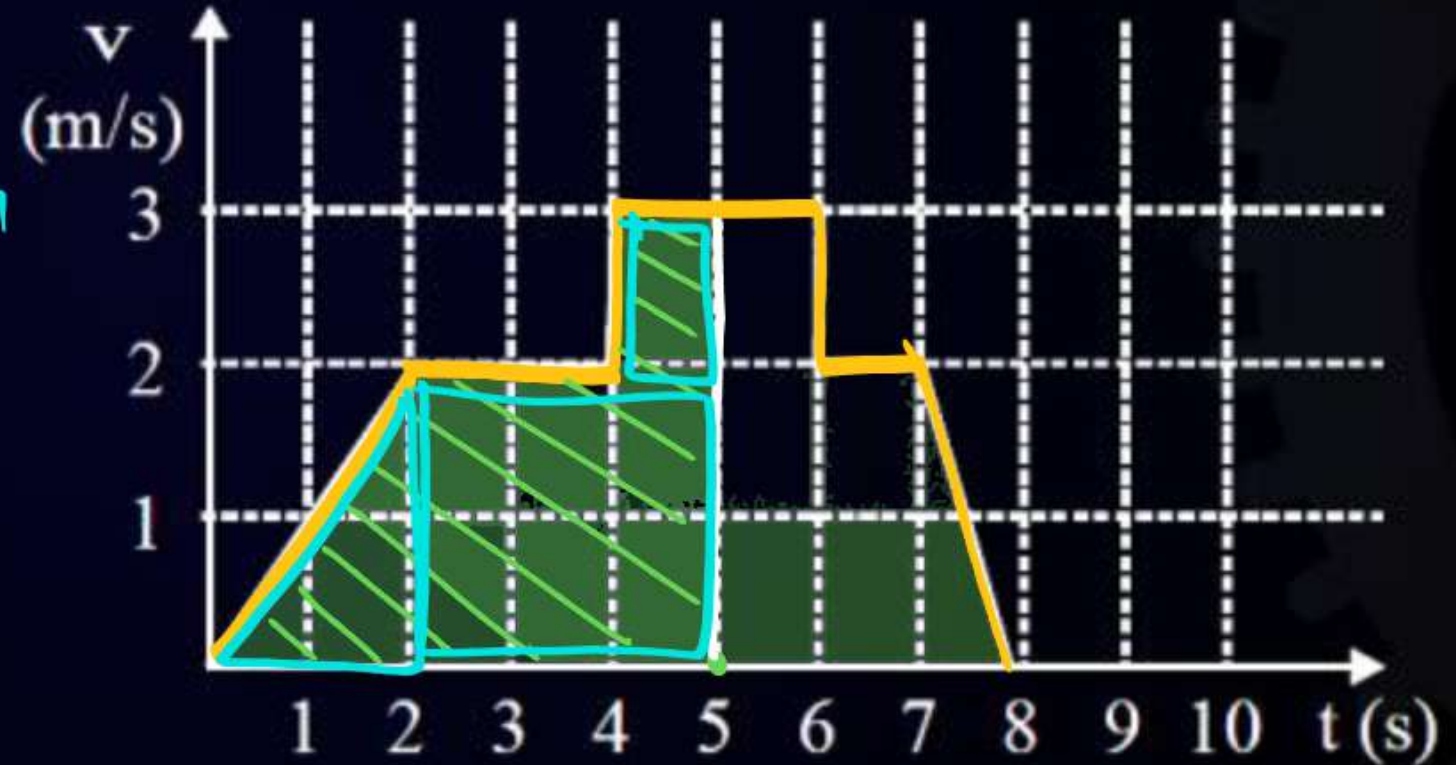
$$= \frac{1}{2} \times 2 \times 2 + 3 \times 2 + 1 \times 1$$

$$= 2 + 6 + 1$$

$$x_f - x_i = 9 \text{ m}$$

$$x_f - 0 = 9$$

$$x_f = 9 \text{ m}$$



Marathon Question



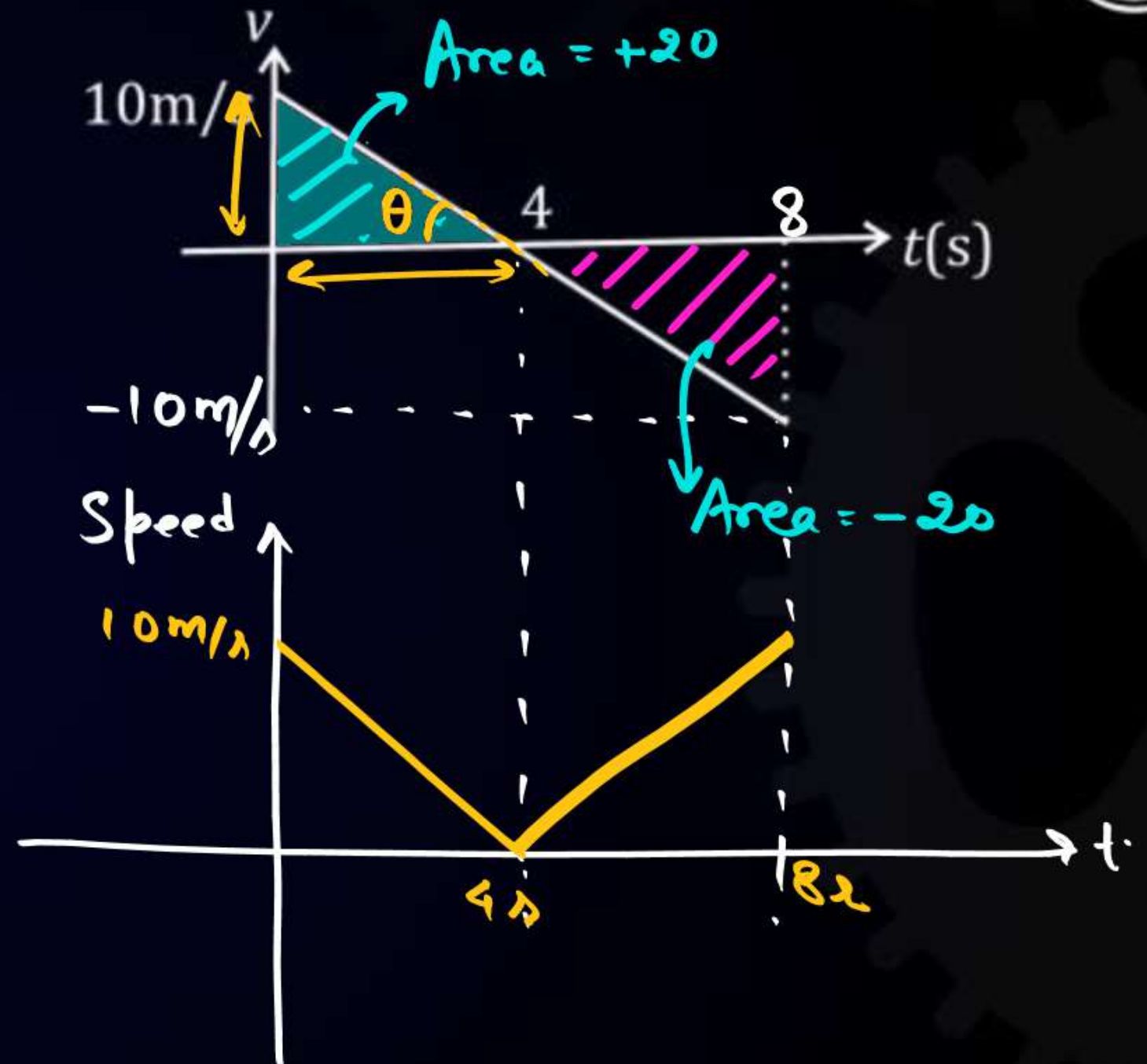
1. Find acceleration = ? = -2.5 m/s^2
2. Displacement between $t = 0$ & $t = 4 \text{ s}$
3. Displacement between $t = 0$ & $t = 8 \text{ s}$.
4. Distance between $t = 0$ & $t = 8 \text{ s}$.

$$1) a = -\frac{10}{4} = -2.5 \text{ m/s}^2$$

$$2) \text{Disp.} = \frac{1}{2} \times 4 \times 10 = 20 \text{ m.}$$

$$3) \text{Disp.} = 0$$

$$4) \text{Dist.} = 20 + 20 = 40 \text{ m.}$$

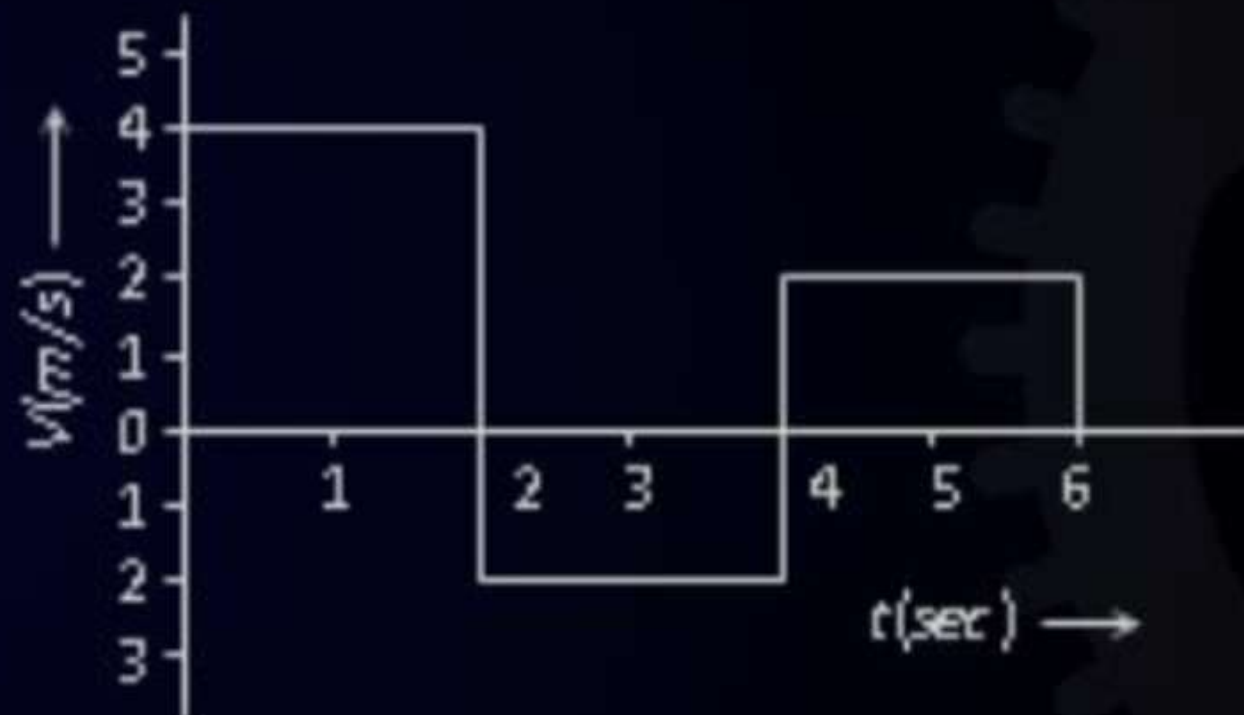


Question



The velocity-time graph of a body moving in a straight line is shown in the figure. The displacement and distance travelled by the body in 6 sec are respectively

- 1 8 m, 16 m
- 2 16 m, 8 m
- 3 16 m, 16 m
- 4 8 m, 8 m

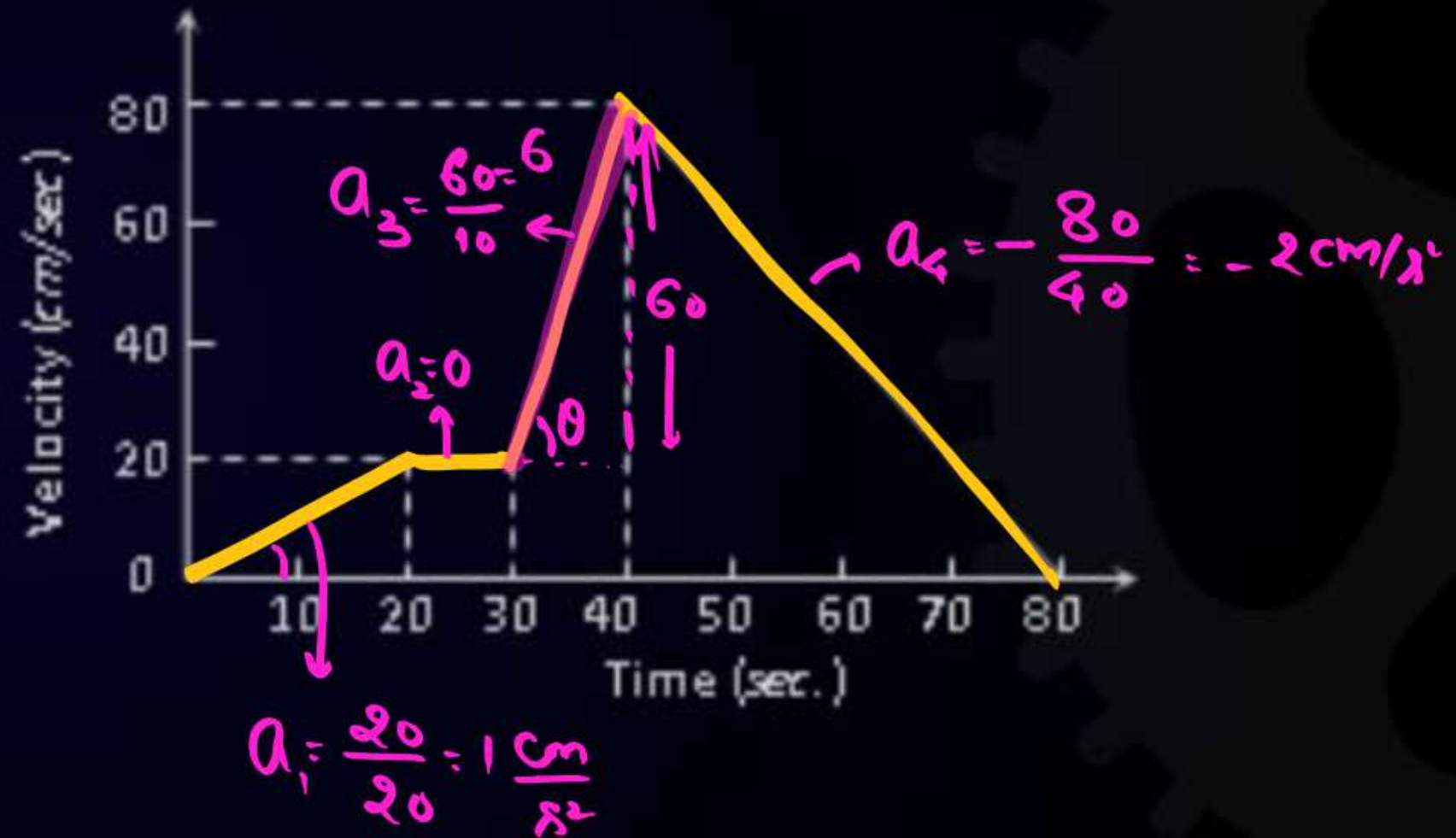


Question



The $v - t$ graph of a moving object is given in figure. The maximum acceleration is

- 1 1 cm/sec^2
- 2 2 cm/sec^2
- 3 3 cm/sec^2
- 4 6 cm/sec^2



Question (Homework)

JH.W3



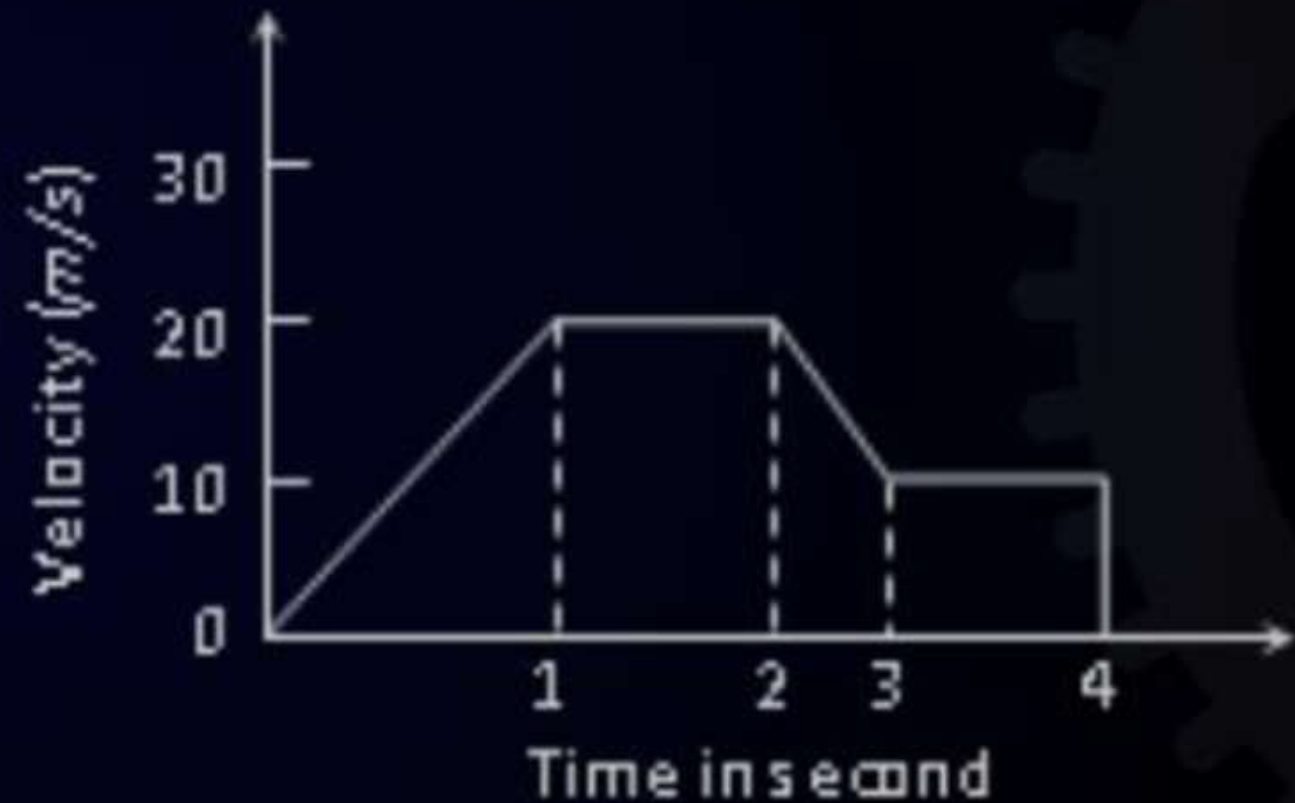
The variation of velocity of a particle with time moving along a straight line is illustrated in the following figure. The distance travelled by the particle in four seconds is

1 60 m

2 55 m

3 25 m

4 30 m



Q.

JEE Mains 2020

H.W.



The velocity (v) and time (t) graph of a body in a straight line motion is shown in the figure. The point S is at 4.333 seconds. The total distance covered by the body in 6 s is:

1

 $37/3 \text{ m}$

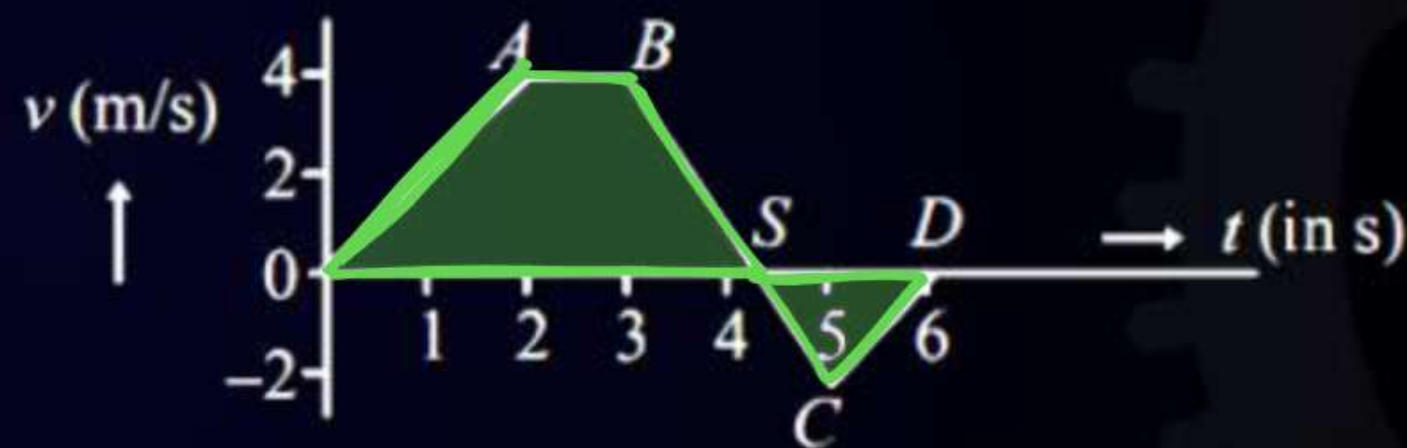
2

 12 m

3

 11 m

4

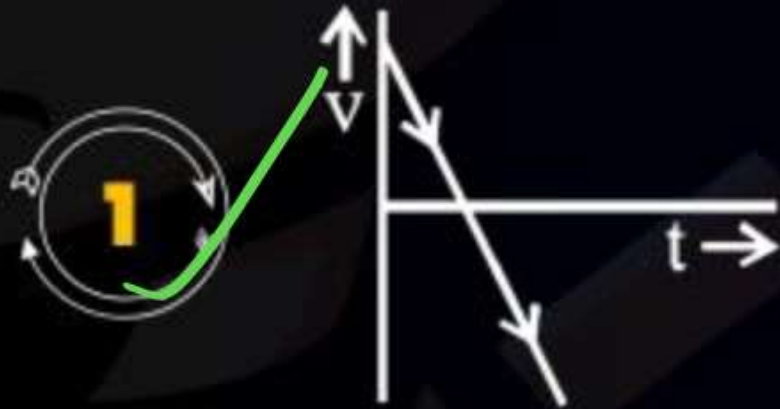
 $49/4 \text{ m}$ 

Q.

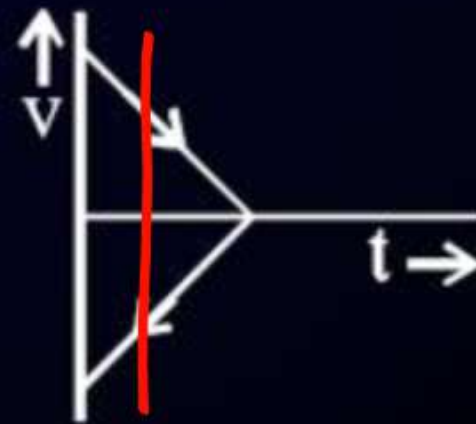
JEE Mains 2017

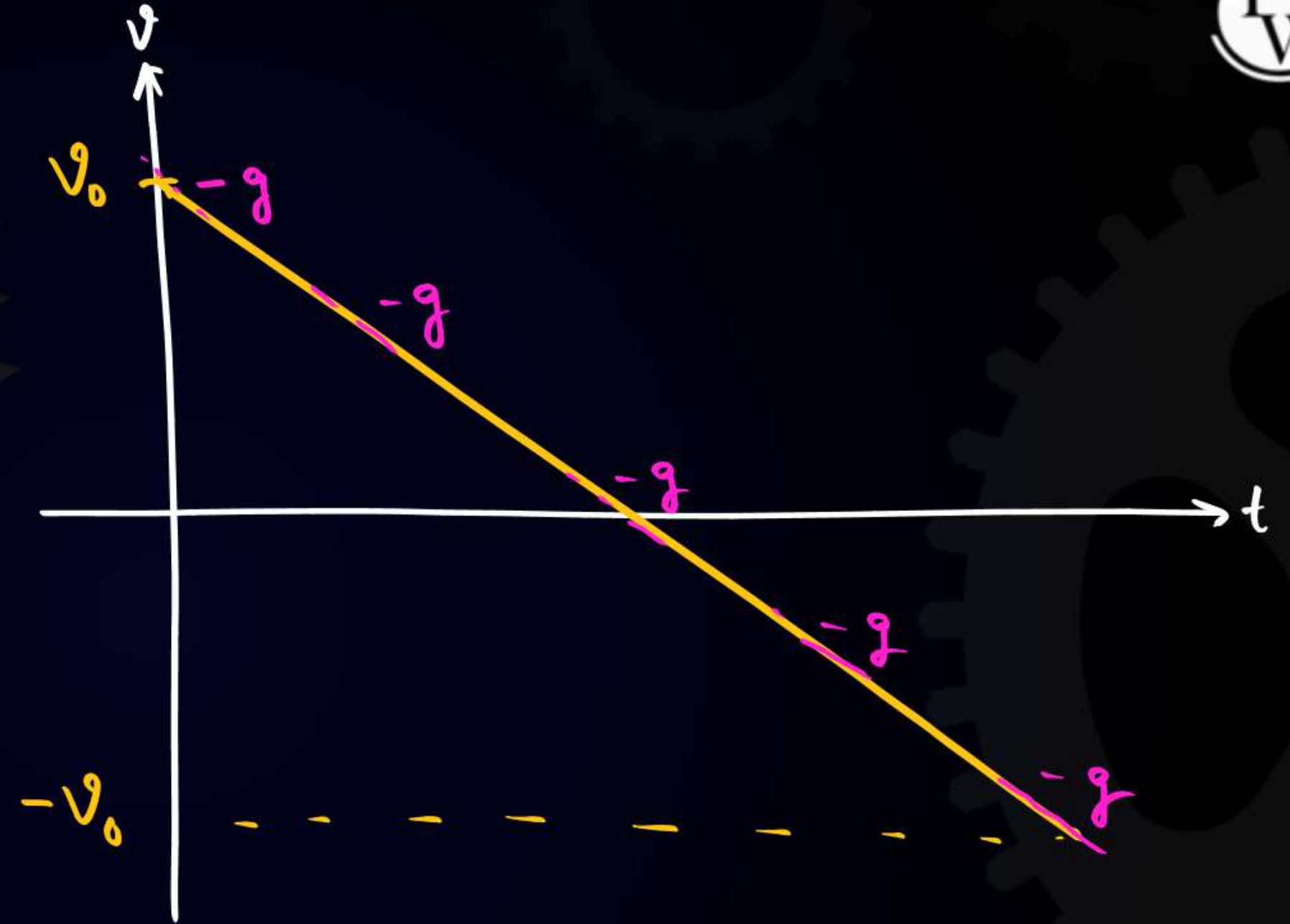
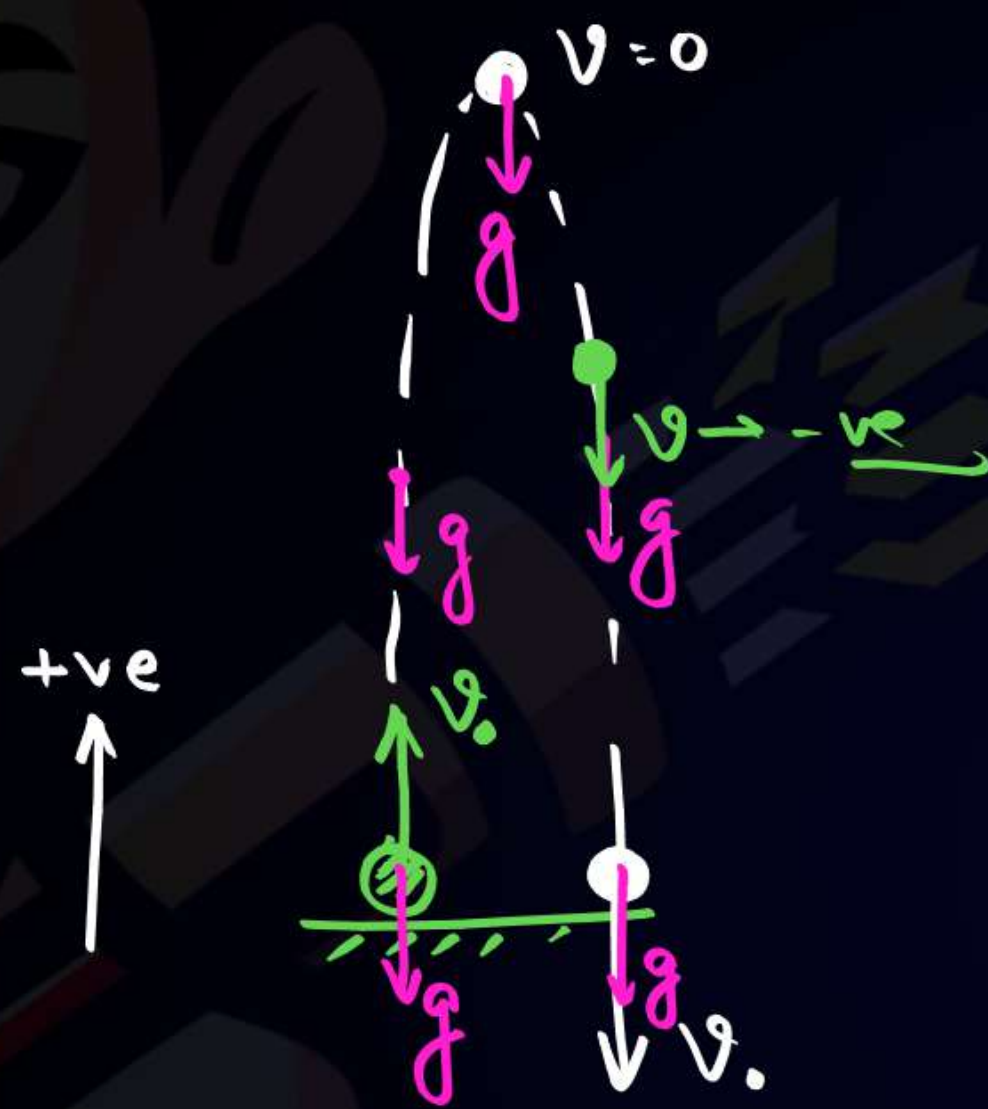


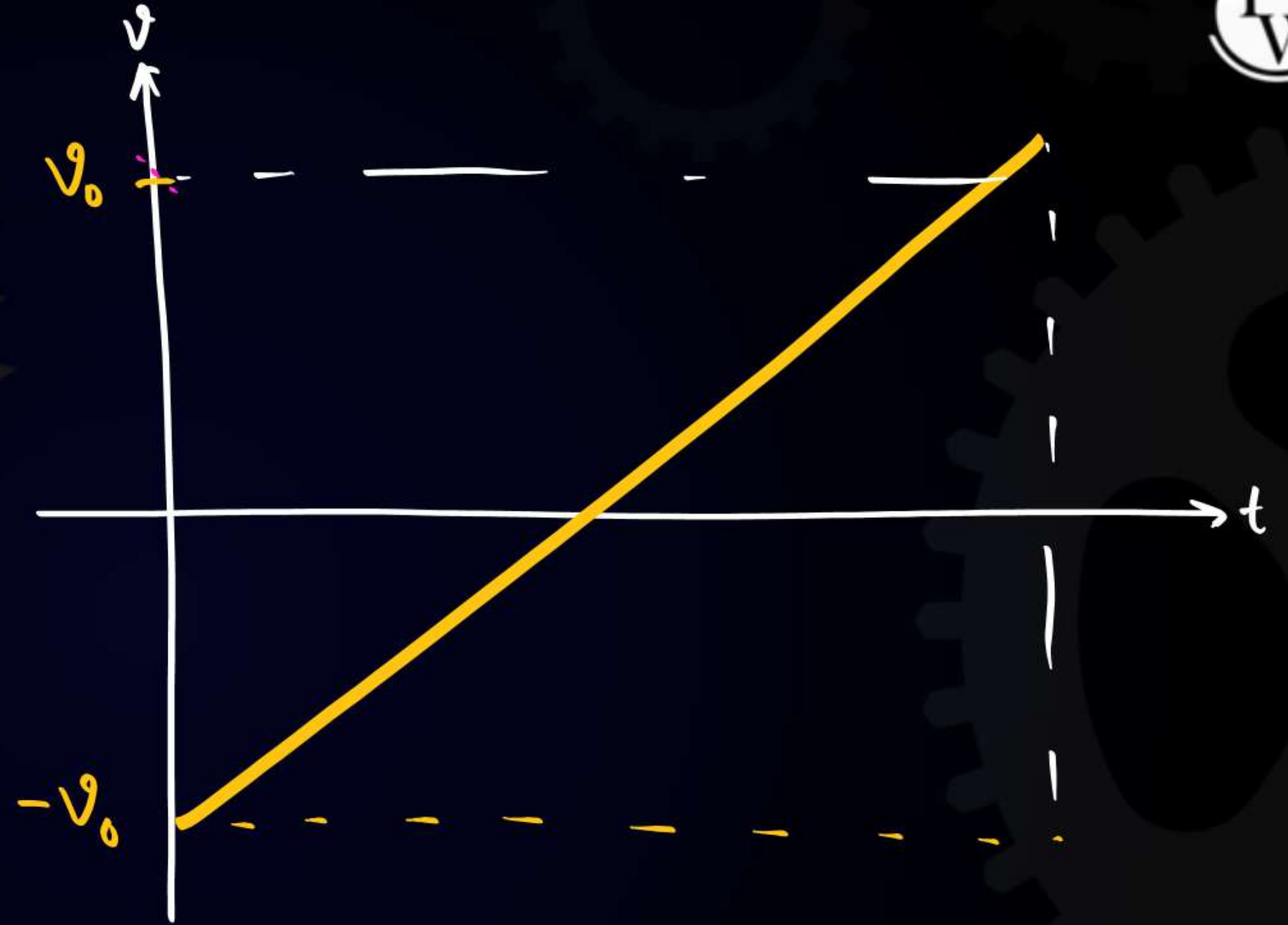
A body is thrown vertically upwards. Which one of the following graphs correctly represent the velocity vs time ? [Main 2017]



+ve
-ve







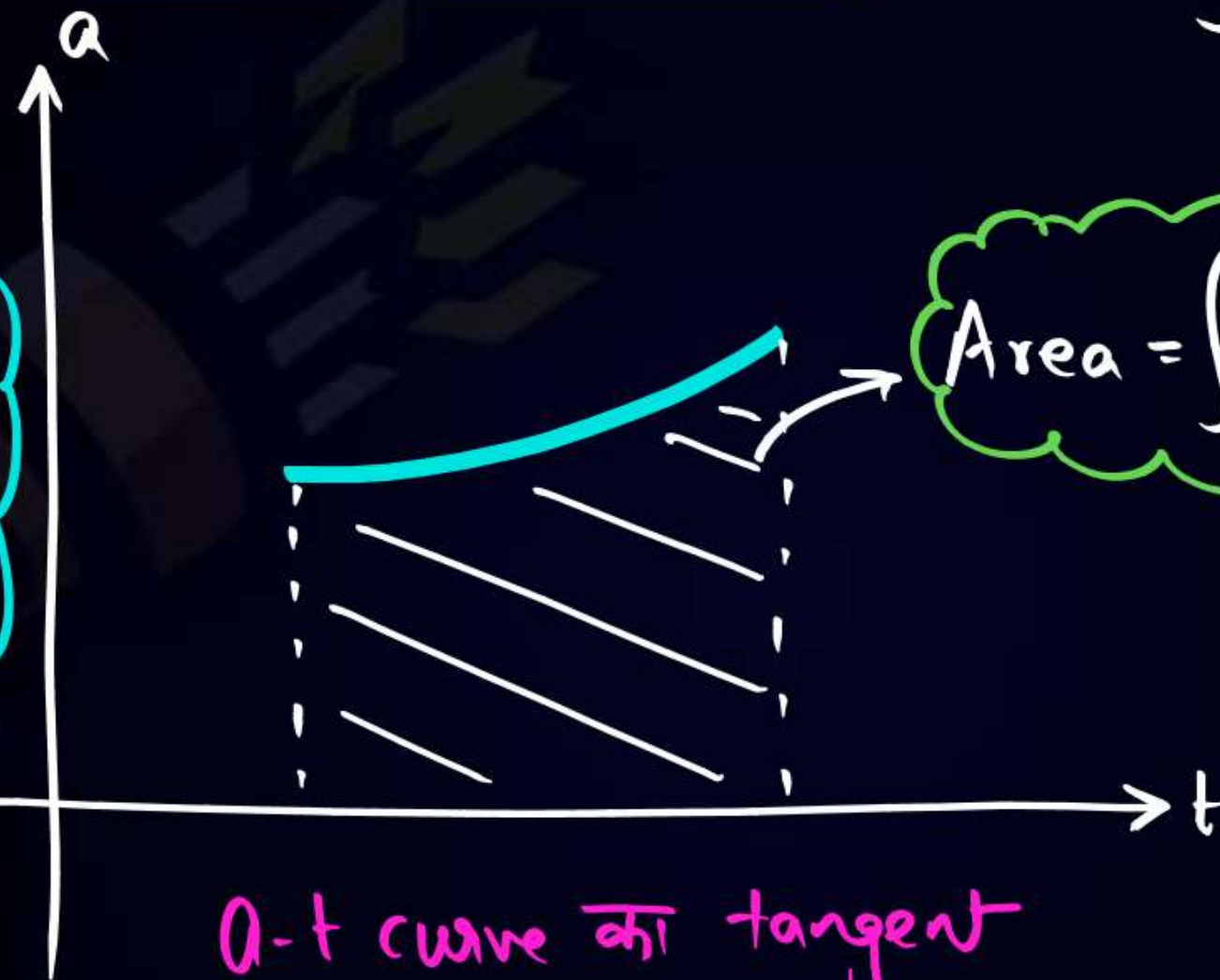


Acceleration-Time Graph



$$\int \left(\frac{dv}{dt} \right) dt = \int dv = \Delta v$$

Acc.-time graph का area velocity नहीं देता है बल्कि change in vel देता है।



a-t curve का tangent हमारे किसी काम का नहीं है।

$$\text{Area} = \int a dt = \Delta v$$

Area under a-t curve gives change in velocity and not velocity.

Question



Initially the body is moving with velocity 2 m/s from origin towards +ve x-axis.

Find

- Velocity of body at (i) $t = 2\text{s}$, (ii) $t = 4\text{s}$, (iii) $t = 5\text{s}$.
- Average acceleration between (i) $t = 0$ & $t = 2\text{s}$, (ii) $t = 0$ & $t = 5\text{s}$.

$$2) (i) a_{avg} = \frac{v_f - v_i}{t_f - t_i}$$

$$= \frac{12 - 2}{2 - 0}$$

$$= 5 \text{ m/s}^2$$

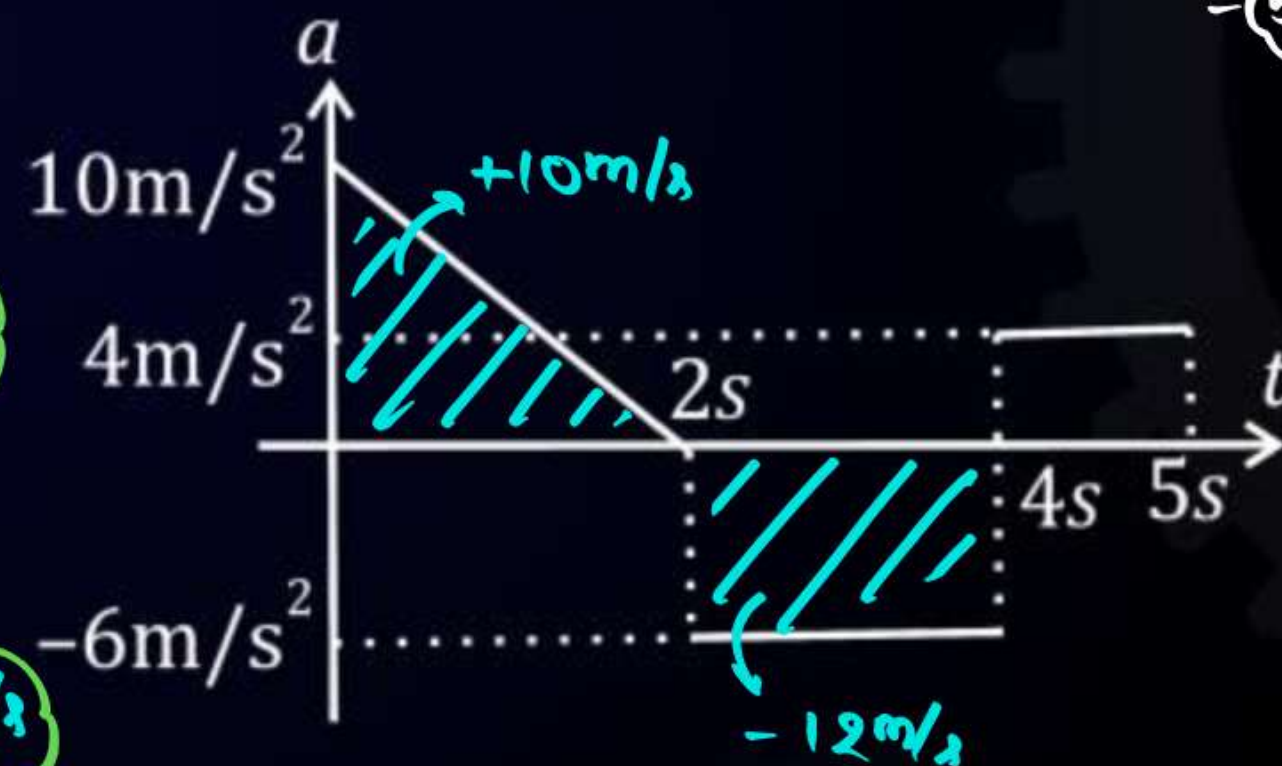
$$1) (i) \Delta v = \frac{1}{2} \times 2 \times 10 = 10 \text{ m/s}$$

$$\Rightarrow v_f - v_i = 10$$

$$\Rightarrow v_{t=2} - 2 = 10 \Rightarrow v_{t=2} = 12 \text{ m/s}$$

$$(ii) v_{t=4} - v_{t=0} = +10 - 12$$

$$v_{t=4} - 2 = -2 \Rightarrow v_{t=4} = 0 \text{ m/s}$$



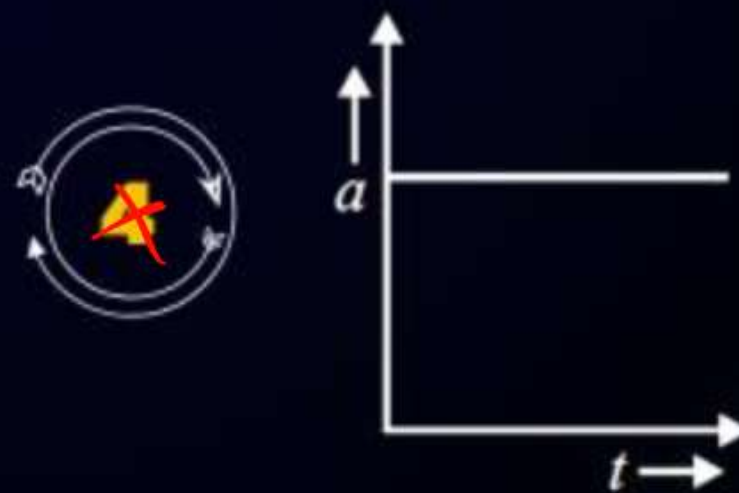
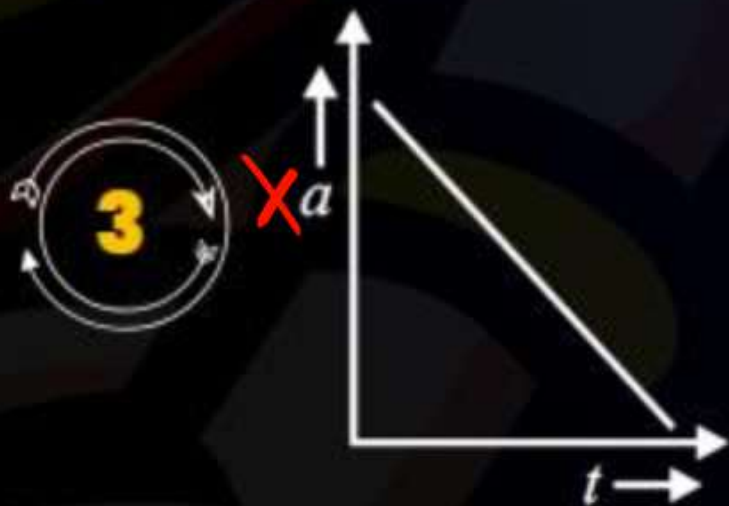
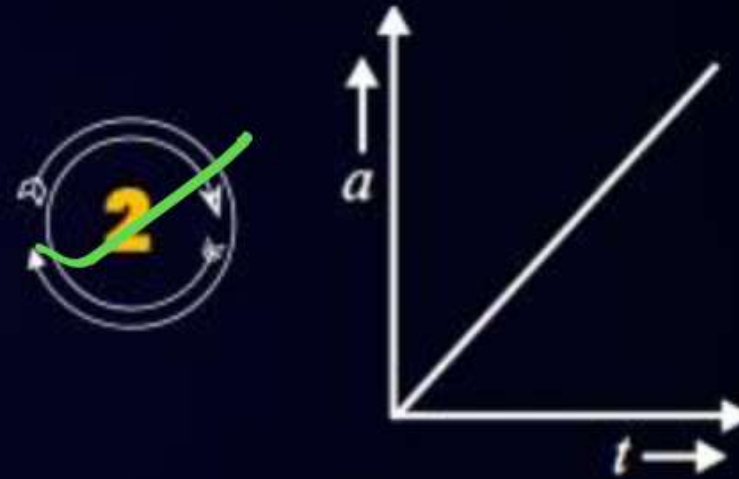
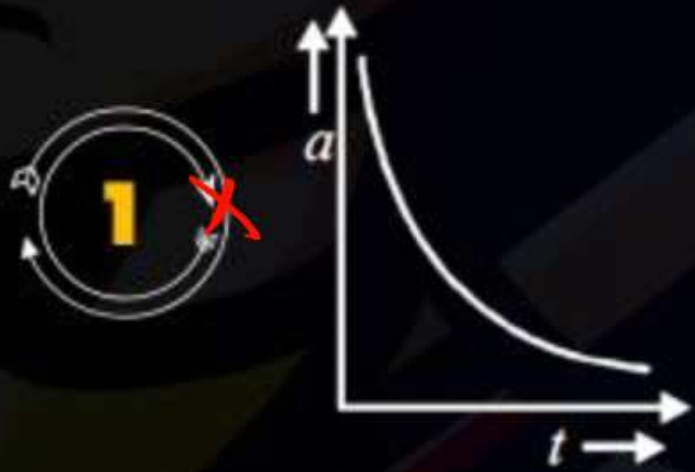
Q.

JEE Mains 2012



The distance travelled by a body moving along a line in time t is proportional to t^3 .
The acceleration-time (a, t) graph for the motion of the body will be

$$\begin{aligned}x &\propto t^3 \\x &= kt^3 \\v &= 3kt^2 \\a &= 6kt \\a &\propto t\end{aligned}$$



Q.

IIT JEE - 2004



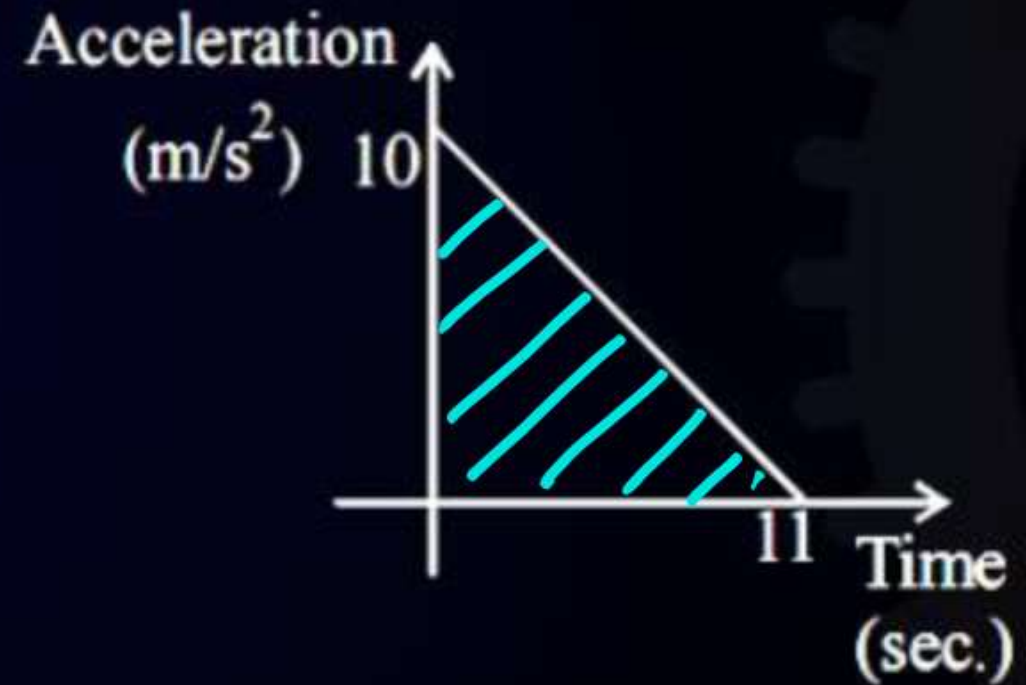
A body starts from rest at time $t = 0$, the acceleration time graph is shown in the figure. The maximum velocity attained by the body will be

$$\text{Area } a = \Delta v_{\text{max}} = \frac{1}{2} \times 11 \times 10 = 55 \text{ m/s}$$

$$v_f - v_i = 55$$

$$v_f - 0 = 55$$

$$v_f = 55 \text{ m/s}$$



1

110 m/s

2

55 m/s

3

650 m/s

4

550 m/s

Q.

JEE Mains 2019



A particle starts from origin O from rest and moves with a uniform acceleration along the positive x -axis. Identify all figures that correctly represents the motion qualitatively (a = acceleration, v = velocity, x = displacement, t = time)

1

(B), (C)

2

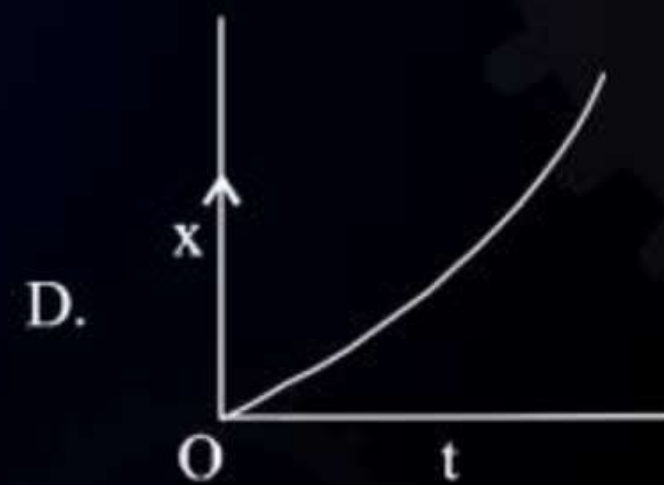
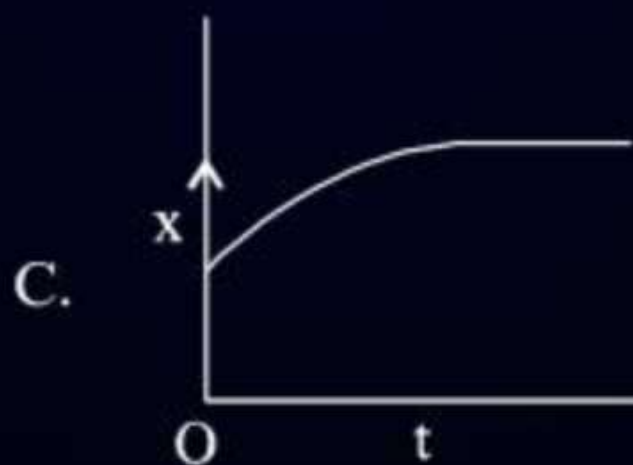
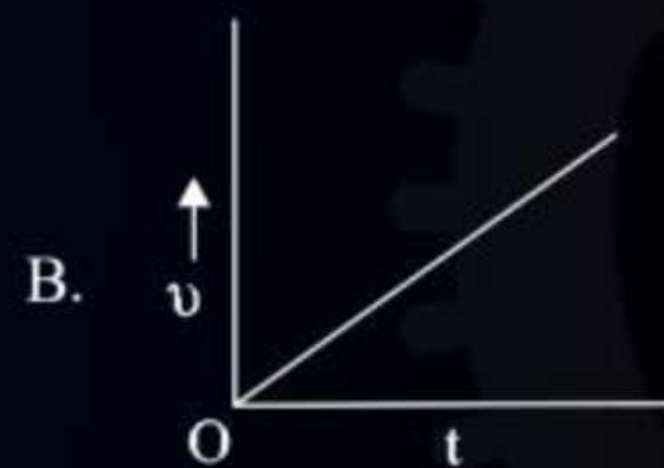
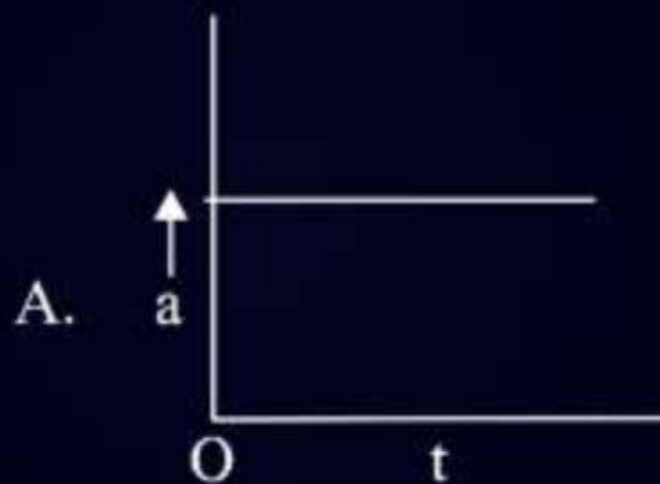
(A)

3

(A), (B), (C)

4

(A), (B), (D)

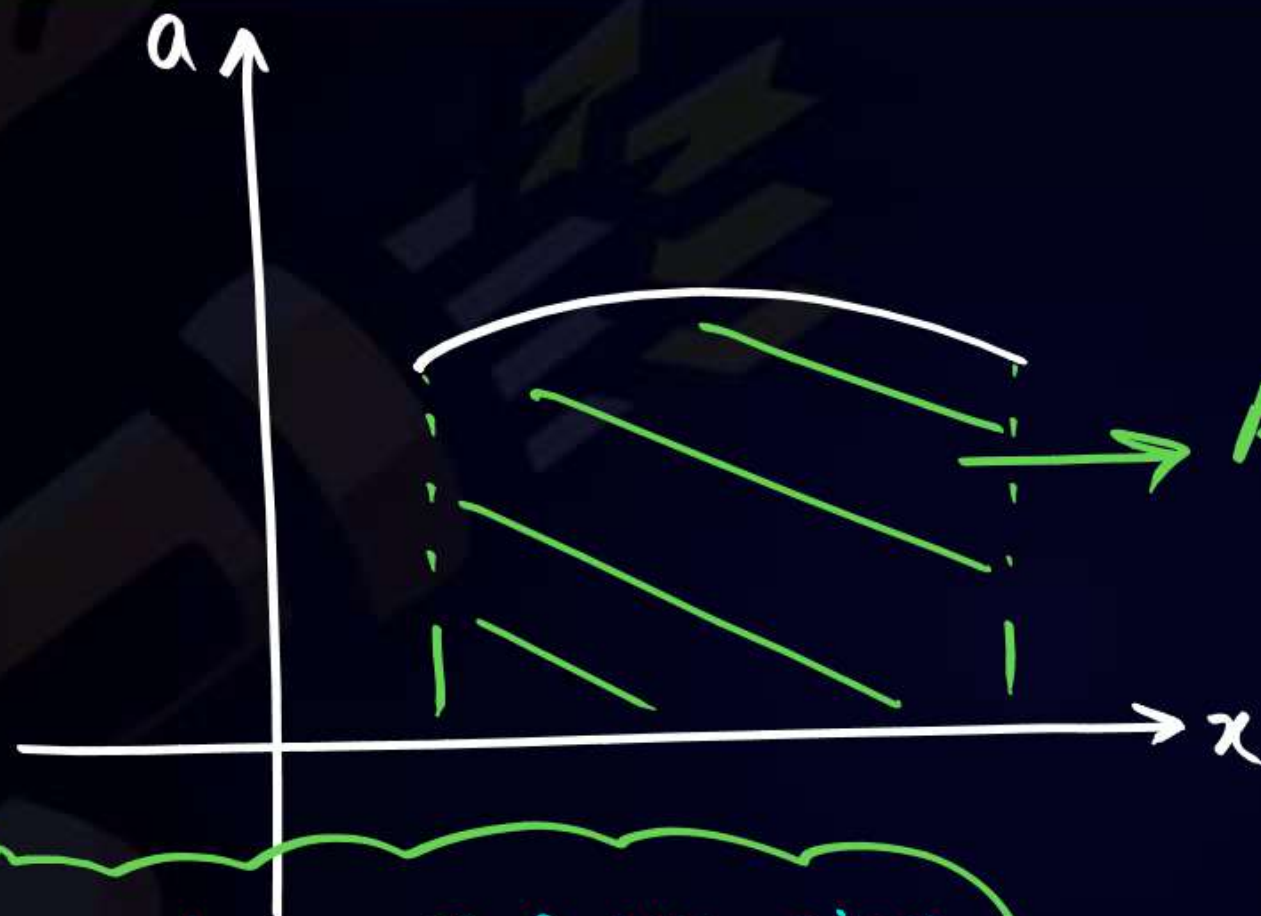




Acceleration – Position Graph



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



$$\text{Area} = \int a dx$$

$$= \int \left(\frac{v dv}{dx} \right) dx$$

$$= \int_u^v v dv$$

$$= \frac{v^2 - u^2}{2}$$

Area under a-x curve gives

$$\frac{v^2 - u^2}{2}$$

Question



Find vel. of body at $x = 4$ if at $x = 0$, $u = 0$.

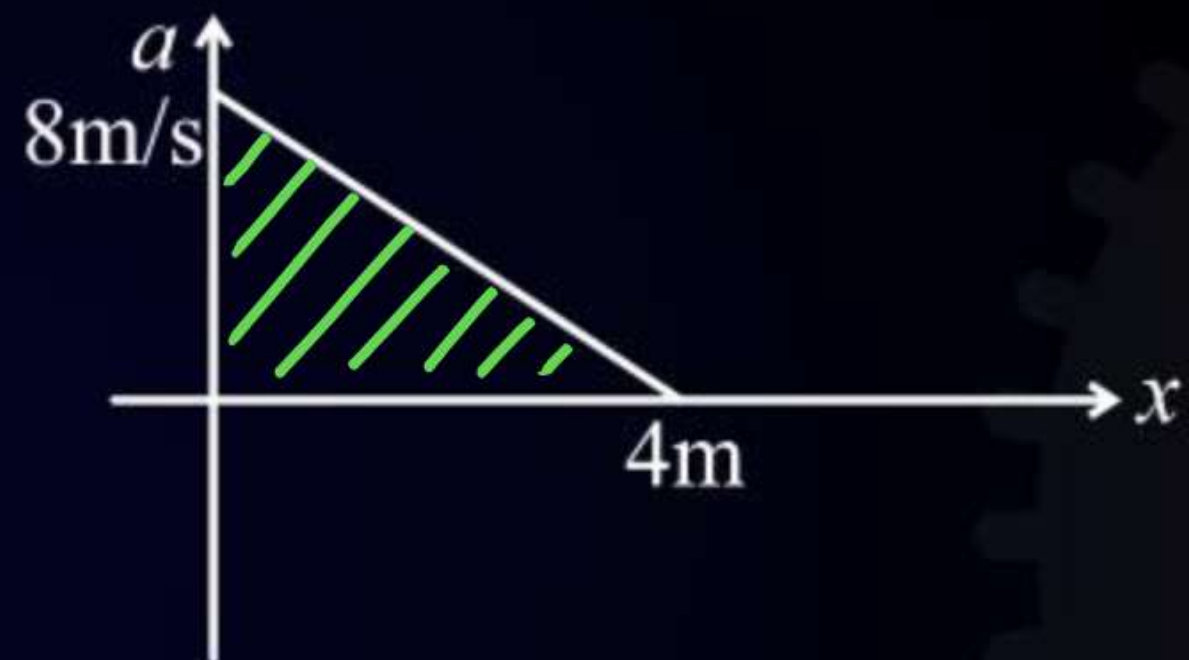
$$\text{Area} = \frac{1}{2} \times 4 \times 8$$

$$\frac{v^2 - u^2}{2} = 16$$

$$\Rightarrow \frac{v^2 - 0^2}{2} = 16$$

$$\Rightarrow v = \sqrt{32}$$

$$v = 4\sqrt{2} \text{ m/s}$$



Q.

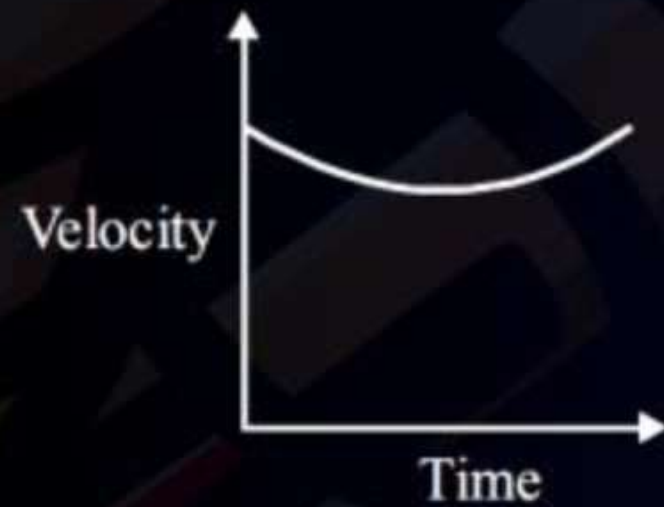
JEE Mains 2017

H.W

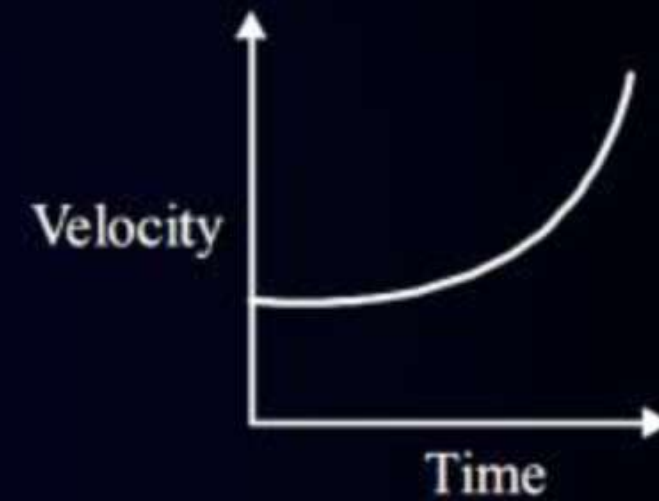


Which graph corresponds to an object moving with a constant negative acceleration and a positive velocity?

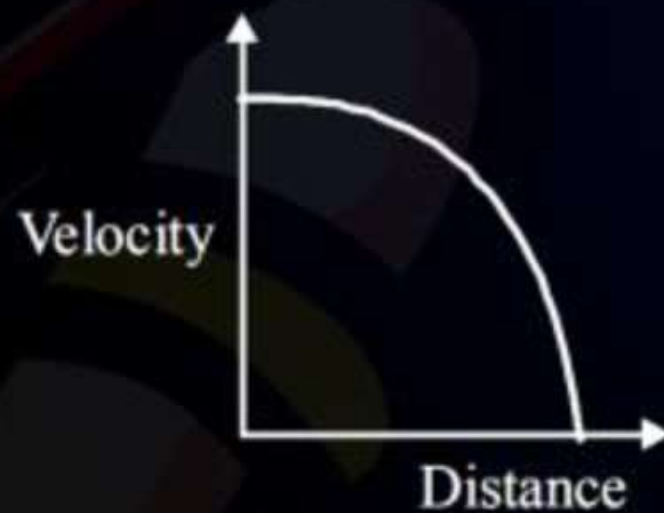
1



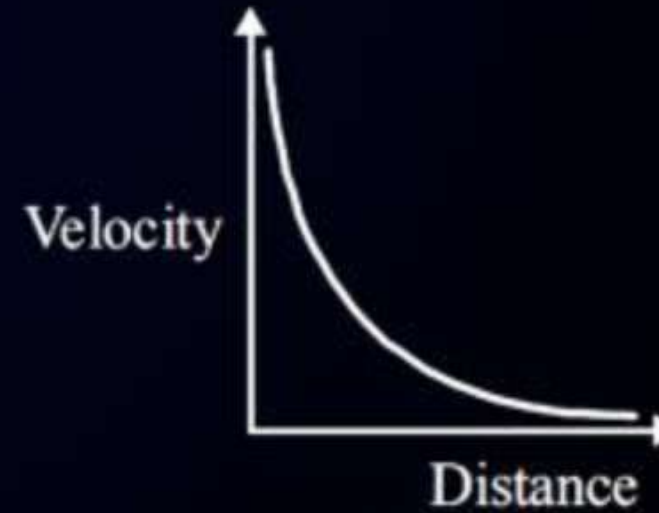
2



3



4





Homework



DPP:
MODULE:

DPP-6

Chapter- Motion in a Straight Line

EXERCISE-1: 37-47

THANK YOU

