RADIANT 2026

Physics

Motion In One Dimension

Lecture - 06

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Topics *to be covered*

1. Acceleration-time graph

2) Equations of motion

Recap *of previous lecture*

1. Displacement-time graph
2. Velocity-time graph

Equation of Motion

(i) $v = u + at$

(ii) $s = ut + \frac{1}{2}at^2$

(iii) $v^2 = u^2 + 2as$

(i) $v = u + at$

$$acc = \frac{\text{Change in Velocity}}{\text{time}}$$

$$a = \frac{\text{final velocity} - \text{Initial Velocity}}{\text{time}}$$

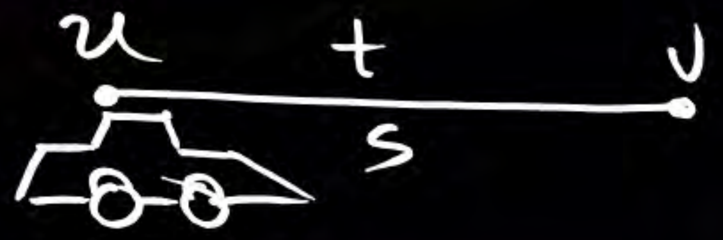
$$a = \frac{V - u}{t}$$

$$at = V - u$$

$$\boxed{at + u = v}$$

$$S = ut + \frac{1}{2}at^2$$

Average Velocity = $\frac{\text{Initial Velocity} + \text{final Velocity}}{2}$



$$V_{av} = \frac{u + v}{2}$$

Velocity

$$V_{av} = \frac{s}{t}$$

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

$\because v = u + at$

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

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

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

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

$$V^2 = u^2 + 2as$$

Average velocity

$$V_{av} = \frac{u+V}{2} \quad \text{.....(i)}$$

Velocity

$$V_{av} = \frac{s}{t} \quad \text{.....(ii)}$$

Compare (i) & (ii)

$$\frac{s}{t} = \frac{V+u}{2}$$

$$s = t\left[\frac{V+u}{2}\right]$$

$$V = u + at$$

$$V - u = at$$

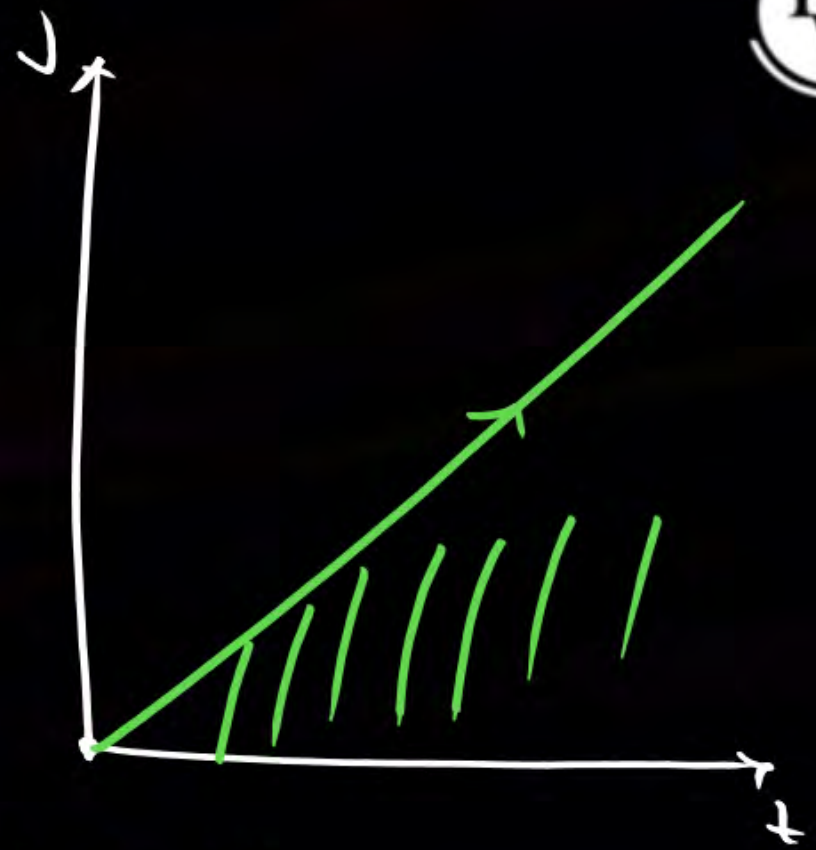
$$\boxed{\frac{V-u}{a} = t}$$

$$s = \left[\frac{V-u}{a}\right]\left[\frac{V+u}{2}\right]$$

$$s = \frac{V^2 - u^2}{2a}$$

$$2as = V^2 - u^2$$

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



A → v

B → s

C → a


u
v
t=0
t

(i) $v = u + at$

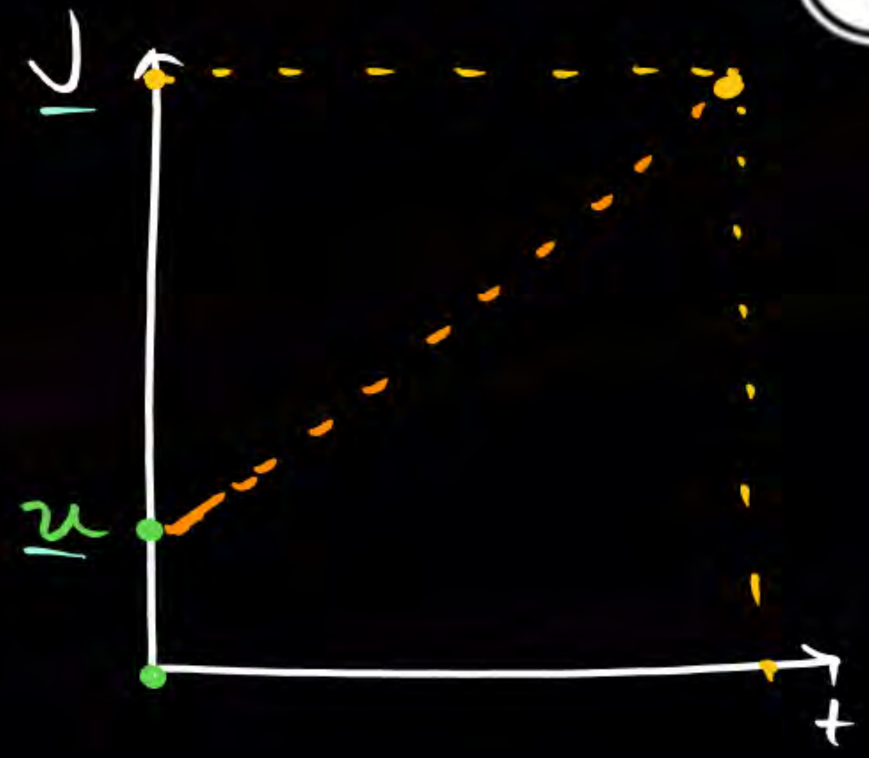
$$\text{Slope} = \frac{\text{Change in } y}{\text{Chang in } x}$$

$$a = \frac{v - u}{t - 0}$$

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

$$at = v - u$$

$$\boxed{at + u = v}$$

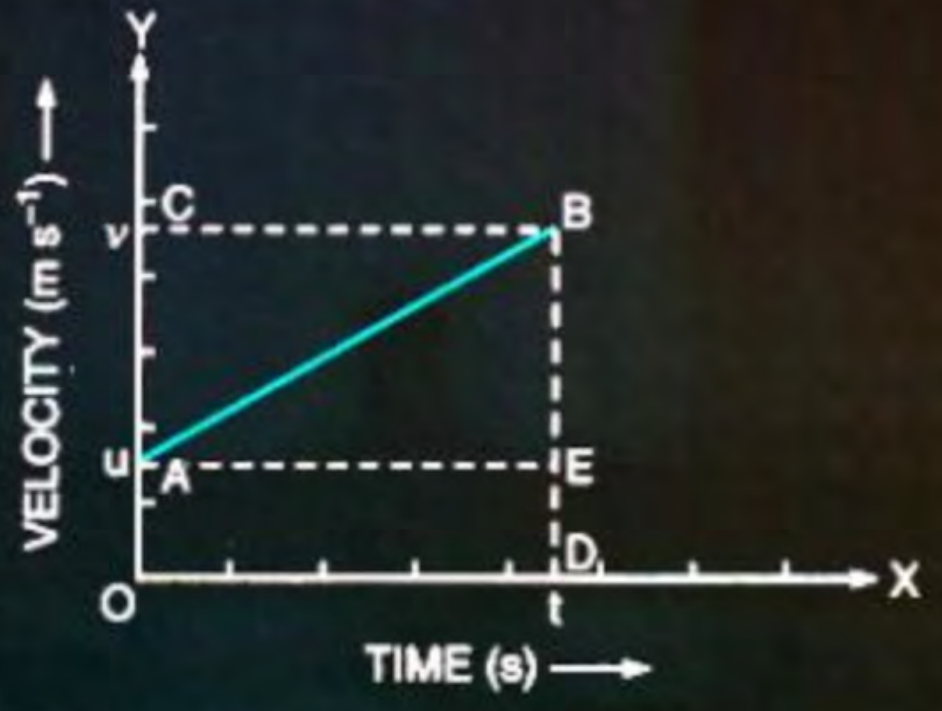


(i) Acceleration a = slope of the line AB

or $a = \frac{EB}{AE} = \frac{AC}{OD} = \frac{OC-OA}{OD} = \frac{v-u}{t}$

or $at = v - u$ (i)

or $v = u + at$



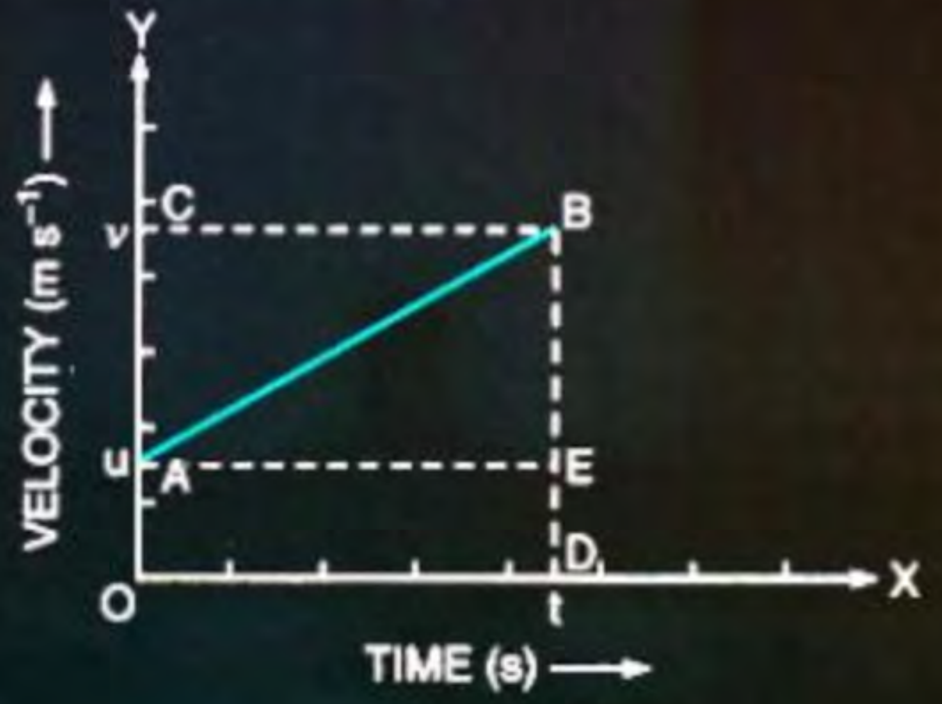
(ii) The distance S travelled in time t

= area of the trapezium OABD

= area of recyangle OABD + area of triangle ABE

or $S = OA \times OD + \frac{1}{2} \times BE \times AE$

$= u \times t + \frac{1}{2} \times (v - u) \times t$ (ii)



But from eqn (ii), $v - u = at$

∴ From eqn. (iii),

$$S = ut + \frac{1}{2}at^2$$ (iii)

$S = ut + \frac{1}{2}at^2$

area = □ OABC + △ BCE

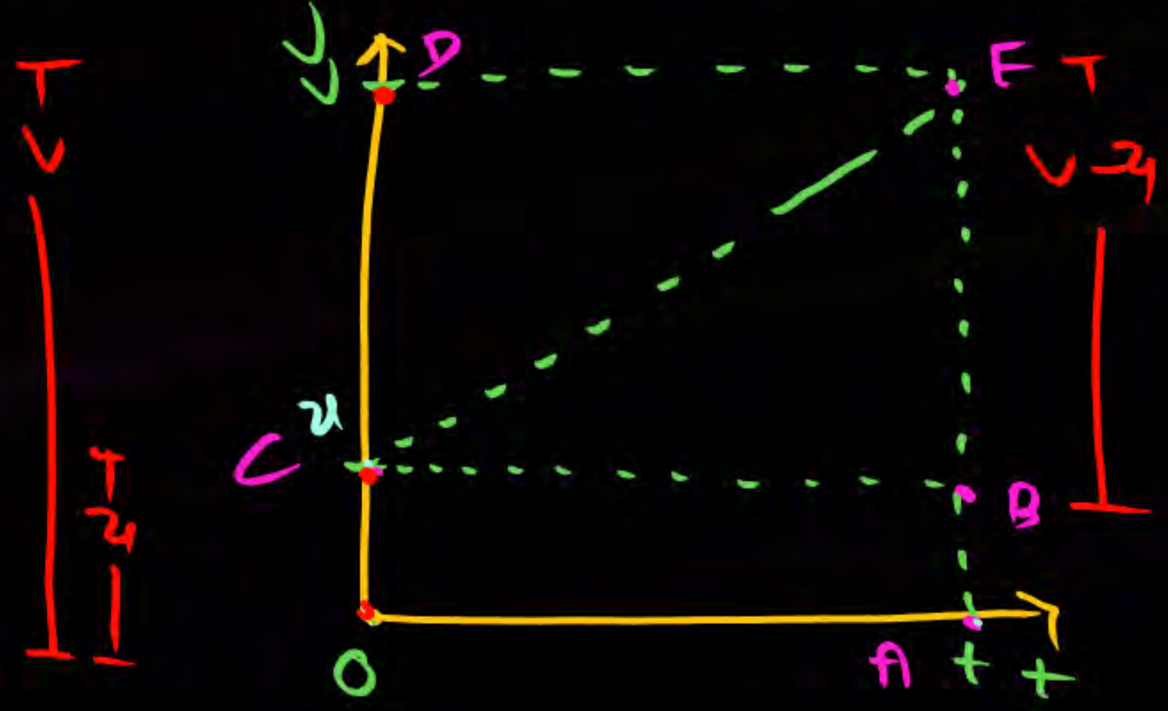
$S = ut + \frac{1}{2} t [v - u]$

$\because v = u + at$

$v - u = at$

$S = ut + \frac{1}{2} t \, at$

$$S = ut + \frac{1}{2}at^2$$



$t = 0$ t

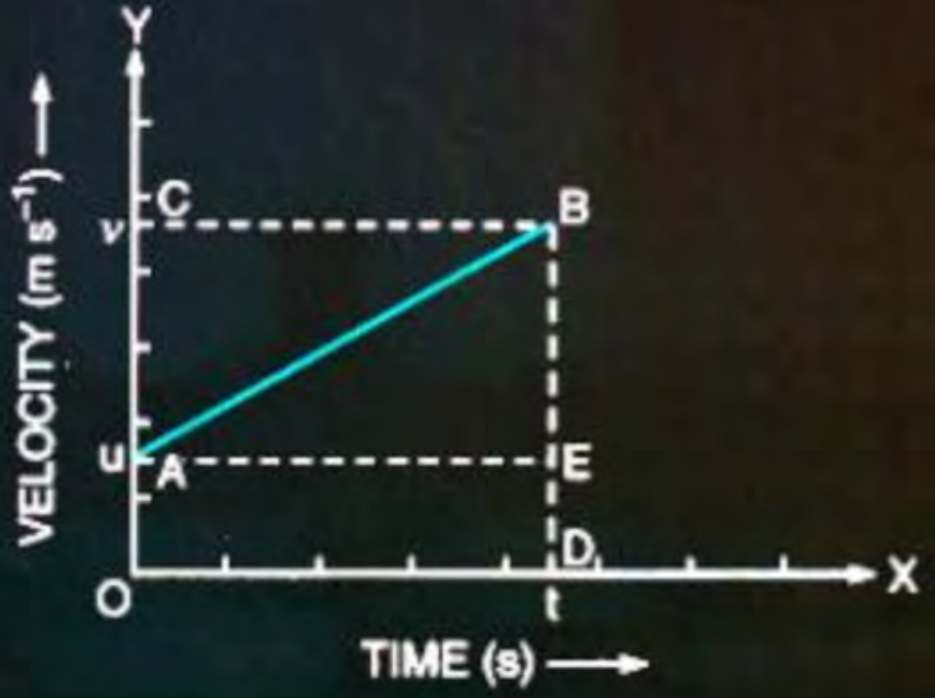
u v

(iii) The distance S travelled in time t

= area of the trapezium OABD

or $s = \frac{1}{2}(OA + DB) \times OD$

or $s = \frac{1}{2}(u + v) \times t$ ...(iv)



From eqn . (ii), $t = \frac{v-u}{a}$

∴ From eqn (iv),

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

or $2\,a\,S = v^2 - u^2$

or $v^2 = u^2 + 2aS$ ...(v)

$V^2 = u^2 + 2as$

area = OBECO

$S = \frac{1}{2}$ [sum of ‖ sides] × distance

$S = \frac{1}{2}[u+v] \times t$

$\because V = u + at$

$V - u = at$

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

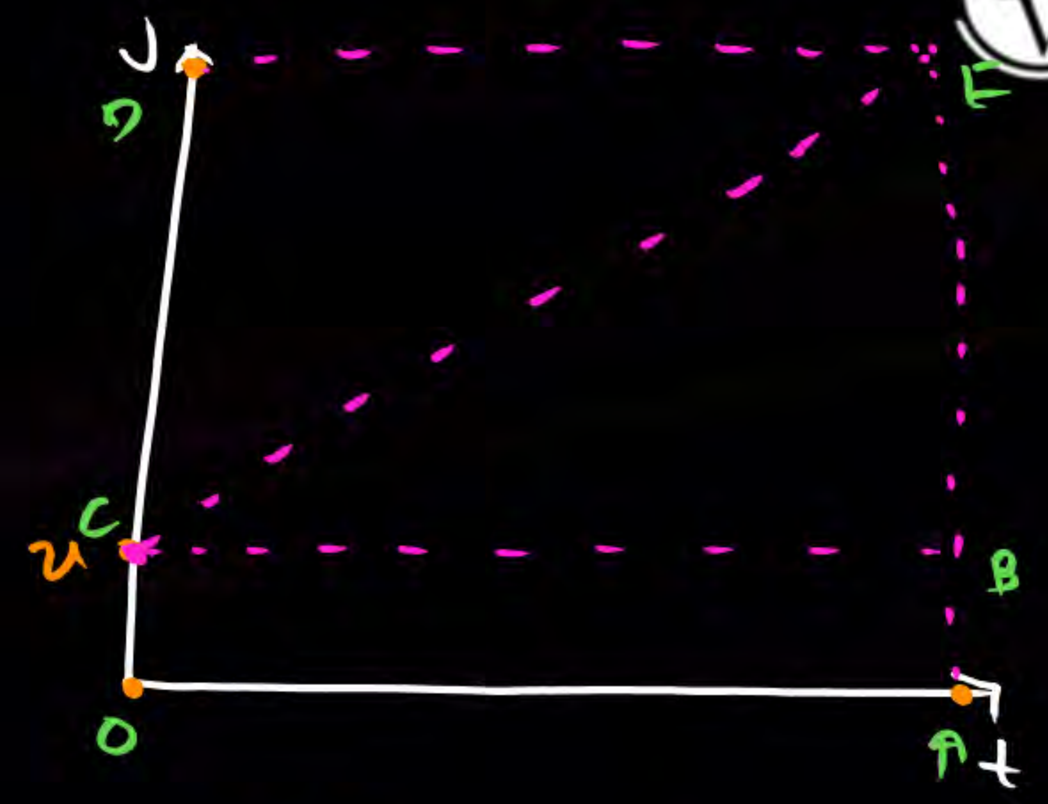
$S = \frac{1}{2}[V+u]\left[\frac{V-u}{a}\right]$

$= \frac{(V+u)(V-u)}{2a}$

$S = \frac{V^2 - u^2}{2a}$

$2as = V^2 - u^2$

$$2as + u^2 = V^2$$



$t = 0$ | t
u | V

Starts from rest

$u=0$

$V = at$

$S = \frac{1}{2}at^2$

$V^2 = 2as$

$V = u + gt$

$V^2 = u^2 + 2gh$

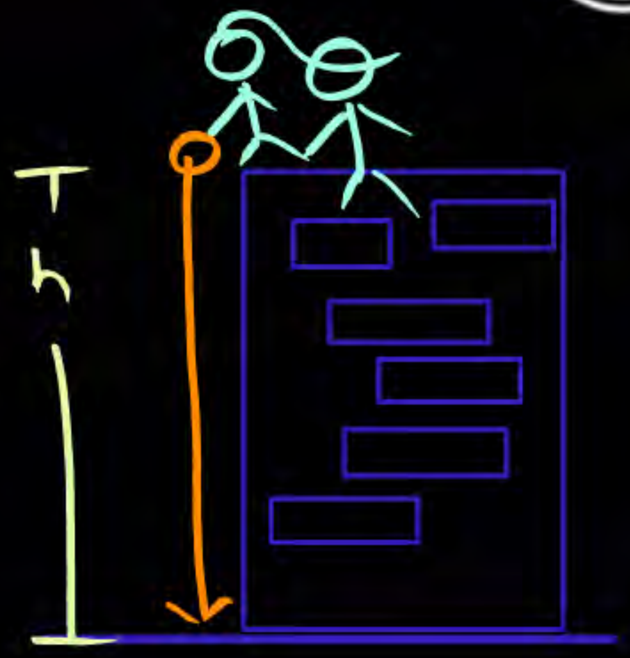
$H = ut + \frac{1}{2}gt^2$

$a = -g$

$V = u - gt$

$V^2 = u^2 - 2gh$

$H = ut - \frac{1}{2}gt^2$



$a = g$


Thank You