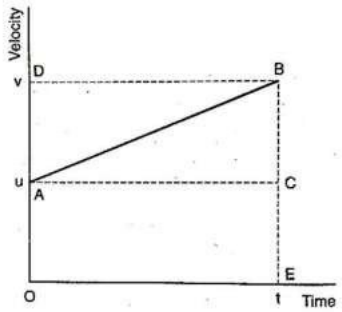
CLASS NOTES	
Class : IX	**Topic:** **Derivation of Equations of Motion by Graphical Method,** **Circular Motion,** **In-text Question.**
Subject: Physics	

Derivation of Equations of Motion by Graphical Method:

In this topic we shall discuss on the method of derivation of three equations of motion. Equations of motion describe the behaviour of a physical system in terms of its motion as a function of time. These equations are valid only when the acceleration is constant or uniform.

1. First Equation of Motion (Equation for velocity time relation):

Let us consider V – T graph for a body moving under uniform acceleration and as a result of the acceleration, its velocity increases from *u* to *v* in time *t*.



The slope of the V – T graph gives the acceleration of the moving object.

Therefore, $\text{Acceleration} = \text{slope of AB} = \frac{BC}{CA}$

$= \frac{BE-CE}{CA}$

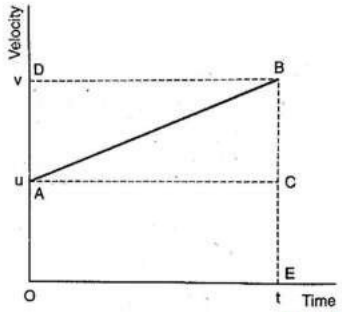
Or, $a = \frac{v-u}{t}$

Or, $v - u = at$

Or, $v = u + at$ ----------(1)

2. Second Equation of Motion (Equation for position time relation):

Let us consider V – T graph for a body moving under uniform acceleration and as a result of the acceleration, its velocity increases from *u* to *v* in time *t*.



As we know that the distance travelled s in time t is given by the area enclosed by the v – t graph and the time axis.

Therefore, $distance\ travelled, s = area\ of\ trapezium\ ABEO$

$= area\ of\ rectangle\ ACEO + area\ of\ triangle\ ABC$

$= (OA \times OE) + \frac{1}{2} \times AC \times BC$

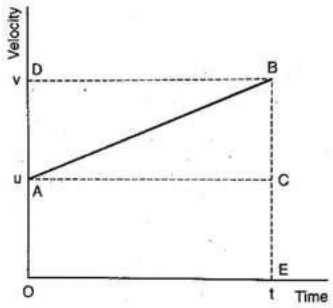
$= ut + \frac{1}{2} \times t \times (v - u)$

$= ut + \frac{1}{2} \times t \times at$ [from eqⁿ (1), $v - u = at$]

Or, $\boxed{s = ut + \frac{1}{2}at^2}$ ---------- (2)

3. Third Equation of Motion (equation for position velocity relation):

Let us consider V – T graph for a body moving under uniform acceleration and as a result of the acceleration, its velocity increases from *u* to *v* in time *t*.



In this case also we have to find the distance travelled by the body.

Therefore, $distance\ travelled, s = area\ of\ trapezium\ ABEO$

$= \frac{1}{2} \times (sum\ of\ the\ parallel\ sides) \times height$

$= \frac{1}{2} \times (OA + BE) \times OE$

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

$= \frac{1}{2} \times (v + u) \times \frac{(v-u)}{a}$ [from eqⁿ (1), $t = \frac{(v-u)}{a}$]

Or, $2as = v^2 - u^2$

Or, $\boxed{v^2 = u^2 + 2as}$ ---------- (3)