Physics Notes

BY

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Class:10+1
Unit: II
Topic: Kinematics

SYLLABUS: UNIT-II-B

Frame of reference. Motion in a straight line: Position-time graph, speed and velocity, Uniform and non-uniform motion, average speed and instantaneous velocity.
Uniformly accelerated motion, velocity-time, position-time graphs, relations for uniformly accelerated motion (graphical treatment).
Elementary concept of differentiation and integration for describing motion.
Scalar and vector quantities: Position and displacement vectors, general vectors and notation, equality of vectors, multiplication of vectors by a real number; addition and subtraction of vectors. Relative velocity.
Unit vector; Resolution of a vector in a plane – rectangular components, Motion in a plane, Cases of uniform velocity and uniform acceleration-projectile motion. Uniform circular motion.

Q.1. a) Define acceleration. What are its units & dimensions?
b) Explain the following:

I) Uniform acc.
Ii) Average acc.
Iii) Variable acc.
Iv) Instantaneous acc.

Ans.**a)** **Acceleration**:-

Acceleration is defined as time rate of change of velocity of object.

acc. $= \frac{change\ of\ velocity}{change\ in\ time}$

Units:- m/sec^2

Dimensions: $[acc] = \frac{L}{T^2} = [M^0 L^1 T^{-2}]$

b)i) **Uniform Acceleration**:-

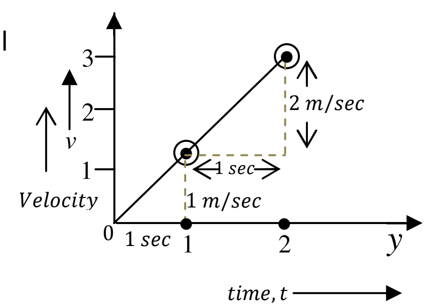
Acceleration when velocity changes by equal amount in equal interval of time.

Example:- free fall of object

acc. $= \frac{9.8m}{sec^2} = \frac{9.8m/sec}{1\ sec}$

ii) **Variable Acceleration**:-

Acceleration when velocity changes by unequal interval time.



Example:- $a_{oA} = \frac{\Delta V_{oA}}{\Delta V_{oA}} = \frac{1m/sec}{sec} = 1m/sec^2$

$acc_{AB} = \frac{\Delta V_{AB}}{\Delta V_{AB}} = \frac{2m/sec}{sec} = 2m/sec^2$

acc. is slope of velocity – time graph.

iii)**Average Acceleration**:-

Average acceleration is ratio of change in velocity to change in time

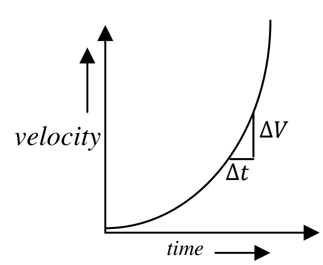
$\frac{change\ of\ velocity}{total\ change\ in\ time}$

iv) **Instantaneous Acceleration**:-

acc. = limit $\Delta t \to 0$ $\frac{\Delta V}{\Delta t}$

$= \frac{dV}{dt}$

$acc_{inst.}$ is slope of $v - t$ graph.



Q.2. Draw velocity time graph for

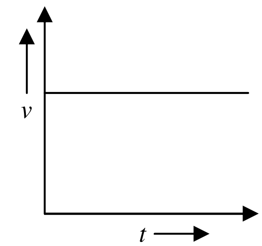
a) Zero acceleration
b) Non zero constant acceleration
c) Increasing acceleration
d) Decreasing acceleration
e) –ve acceleration

Ans.a) **<u>Zero acceleration</u>**:-

acc → $\frac{dV}{dt}$

slope of $v - t$ graph

slope = $\frac{dV}{dt}$ = 0

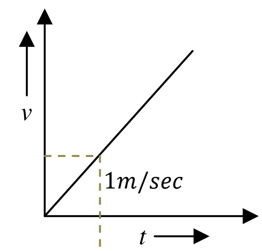


b) **<u>Non zero constant acceleration</u>**:-

slope = $\frac{dV}{dt}$

= $\frac{1m/sec}{sec}$

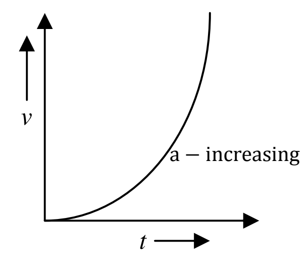
= $1m/sec^2$



a) **<u>Increasing acceleration</u>**:-

acc = $\frac{dV}{dt}$, slope of velocity-time graph.

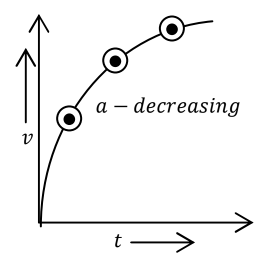
Slope of velocity-time graph is increasing



b) **<u>Decreasing acceleration</u>**:-

acc = $\frac{dV}{dt}$

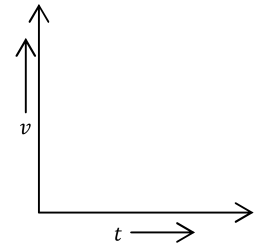
Slope of velocity-time graph is decreasing



c) **<u>–*ve* acceleration</u>**:-

acc = $\frac{dV}{dt}$ is -*ve*

It means velocity decreases with time. It means braking.



Q.3. Prove equations of Uniform acc. Motion using calculus (Diff. integration)

i) $v = u + at$

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

iii) $v^2 - u^2 = 2.a.s$

Ans. **$v = u + at$:-**

acc = a (constant)

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

$dv = a.dt$

Integrating both sides

$\int dv = \int a.dt$

$= a.dt$

$\int_u^v dv = a\int_0^t at$

$|v|_u^v = a\,|t|_0^t$

$v - u = a(t-0)$

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

$s = ut + \frac{1}{2}at^2$:-

$v = u + at$

$\frac{ds}{dt} = u + at$

$\int ds = \int V\,dt + \int at\,dt$

Integrating both sides

$\int_0^s ds = \int_0^t v.dt + a\int_0^t dt$

$|S|_0^S = u|t|_0^t + a.\left|\frac{t^2}{2}\right|_0^t$

$s - 0 = u(t-0) + \frac{1}{2}a\,(t^2 - 0^2)$

$s = ut\,\frac{1}{2}at^2$

$$\boxed{s = u.t + \frac{1}{2}a.t^2}$$

$v^2 - u^2 = 2.a.s$:-

acc = a

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

$\frac{dV}{dt} \times \frac{ds}{ds} = a$

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

$v.dv = a\,ds$

Integrating both sides

$\int v.dv = \int a.ds$

$\int_u^v v.dv = a.\int_0^s ds$

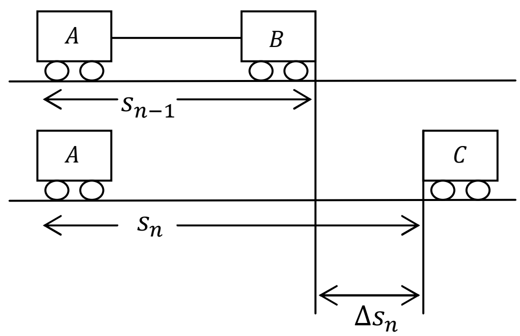
$\left|\frac{v^2}{2}\right|_u^v = a(s-0)$

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

$$\boxed{v^2 - u^2 = 2.a.s}$$

Q.4. **Derive formula for distance covered by a particle in n^{th} second.**

Ans. This is for $(n + 1)^{th}$



Now for (n^{th}) second

Distance covered in n seconds, $S_n = u.n + \frac{1}{2} a.n^2$

Distance covered in (n-1) seconds, $S_{n-1} = u.(n-1) + \frac{1}{2} a.(n-1)^2$

$\Delta s_n = s_n - s_{n-1}$

$= \left[u.n + \frac{1}{2} a.n^2\right] - \left[u(n-1) + \frac{1}{2} a(n-1)^2\right]$

$= \left[\cancel{u}n + \frac{1}{2} a.n^2\right] - \left[\cancel{u}n + u - \frac{1}{2} a(n^2 + 1 - 2n)\right]$

$= u - \frac{a}{2} + a.n$

$$\boldsymbol{\Delta s_{nth} = u + \frac{a}{2}(2.n - 1)}$$

Example:- Find distance covered by free fall particle in 5th second when dropped from rest?

Solution:- $\Delta s_5 = s_5 - s_4$

$= u + \frac{g}{2}(2 . 5 - 1)$

$= 0 + \frac{10}{2}(9)$

$= 45$