Subject - Physics

Chapter-1 (Motion)

- **Acceleration** :- Acceleration of a body is defined as the rate of changes of its velocity with time.

$$\text{Acceleration} = \frac{\text{Change in velocity}}{\text{Time taken for change}}$$

$$\text{Acceleration} = \frac{\text{Find velocity} - \text{Initial Velocity}}{\text{Time taken}}$$

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

a = Acceleration
v = Final velocity
u = Initial velocity
t = Time taken

Note:- (i) Acceleration is a vector quantity.
(ii) The SI unit of acceleration is m/sec^2.
(iii) When a body is moving with uniform velocity, its acceleration will be zero.

Uniform Acceleration :- A body has a uniform acceleration if it travels in a straight line and its velocity increases by equal amounts in equal intervals of time.

* The velocity - time - graph of a body having uniformly accelerated motion is a straight ~~time~~ line.

Non-Uniform Acceleration :- A body has a non-uniform acceleration if its velocity increases by unequal amounts in equal intervals of time.

"—— A body has a non-uniform acceleration if its velocity changes at a non-uniform rate."

- **Retardation (Deceleration/Negative acceleration) :-**

(i) If the velocity of a body decreases, the acceleration is negative.

(ii) Retardation is measured in the same way as acceleration, that is, retardation is equal to change in velocity per unit time.

$$\text{Retardation } (a) = \frac{\text{Change in velocity}}{\text{Time taken}}$$

(iii) Negative value of acceleration shows that the velocity of the body is decreasing.

- **Average Velocity :-**

$$\text{Average velocity } (\bar{v}) = \frac{\text{Initial velocity} + \text{Final velocity}}{2}$$

$$\boxed{\bar{v} = \frac{u+v}{2}}$$

- Equation of uniformly accelerated motion :-

There are three equations of motion —

(i) First equation of Motion

(ii) Second equation of motion

(iii) Third equation of motion.

(i) First Equation of Motion –

It gives the velocity acquired by a body in time 't'.

First equation of motion —

Let a = acceleration of body

t = time taken

v = Final velocity

u = Initial velocity

we know that

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

$$\Rightarrow \boxed{v = u+at} \quad \text{.....} \quad (1)$$

(ii) Second Equation of motion –

It gives the distance travelled by a body in time 't'.

Let s = distance travelled

t = Time taken

v = Final velocity

u = Initial velocity

a = acceleration

we know that,

Average velocity $= \frac{v+u}{2}$

$\Rightarrow \quad \frac{\text{Distance travelled}}{\text{Time taken}} = \frac{v+u}{2}$

$$\frac{s}{t} = \frac{u+v}{2} \quad \Rightarrow \quad s = \left(\frac{u+v}{2}\right) \times t$$

from eqn ① we get, $v = u+at$

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

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

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

$$\boxed{s = ut + \frac{1}{2}at^2} \quad \text{---------- ②}$$

(iii) Third equation of motion :-

It gives the velocity acquired by a body in travelling a distance.

Let, $s = ut + \frac{1}{2}at^2$ [from eq: ②] ------ (i)

we have, $v = u+at$ ------ (ii)

$\Rightarrow \quad at = (v-u)$

$$t = \left(\frac{v-u}{a}\right)$$

From equation (ii)

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

$$\Rightarrow s = \frac{uv-u^2}{a} + \frac{1}{2}\frac{a(v^2+u^2-2uv)}{a^2}$$

$$\Rightarrow s = \frac{uv-u^2}{a} + \frac{v^2+u^2-2uv}{2a}$$

$$\Rightarrow s = \frac{2uv-2u^2+v^2+u^2-2uv}{2a}$$

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

$$\Rightarrow 2as = v^2-u^2$$

$$\Rightarrow \boxed{v^2 = u^2+2as}$$

Note :- (i) If a body starts from rest its initial velocity, $u=0$

(ii) If a body comes to rest, final velocity, $v=0$

(iii) If a body moves with uniform velocity then acceleration, $a=0$

Questions

Que 1. A driver decreases the speed of a car from 25 m/s to 10 m/s in 5 second. Find the acceleration of the car.

Que 2. A train travels the first 15 km at a uniform speed 30 km/h, the next 75 km at a uniform speed of 50 km/h and the last 10 km at a uniform speed of 20 km/h. Calculate the average speed for the entire train journey.

Que 3. A scooter acquires a velocity of 36 km/h in 10 seconds just after the start. Calculate the acceleration of the scooter.

Que 4. A car travelling at 20 km/h speeds up to 60 km/h in 6 second. What is the acceleration?

Que 5. A bus was moving with a speed of 54 km/h. On applying brakes its stopped in 8 seconds. Calculate the acceleration.

Que 6. Derive the formula,

$$v = u + at.$$

Que 7. What is meant by term 'Acceleration'.?

Que 8. What is difference between speed and velocity?