Important snaps by Team PIS Class- IX

SUBJECT: PHYSICS

BOOKS : SCIENCE NCERT

TEACHER: MR. BHUPENDER

Chapter 8 MOTION

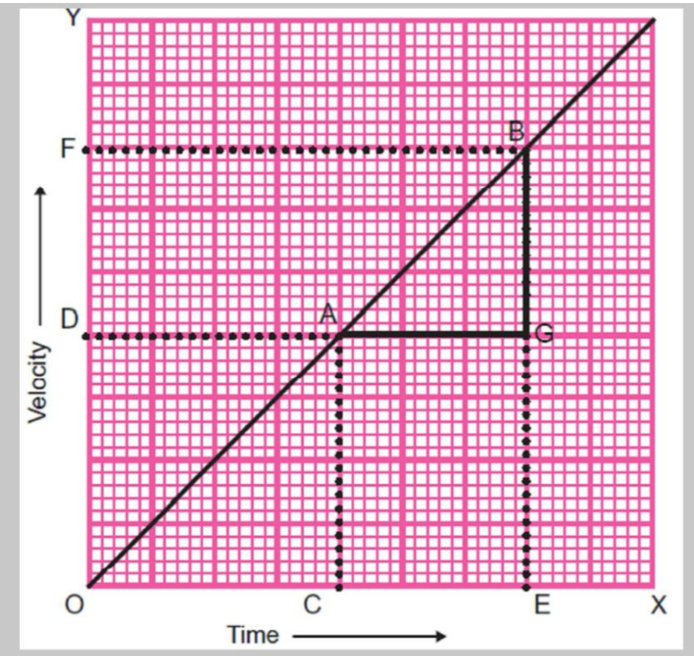
- **Q1. Derive following equations of motion using V-T graph**

(1) $v=u+at$

(2) $S=ut+1/2at^2$

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

- **A.** **EQUATION FOR VELOCITY-TIME RELATION**
In the graph, AC gives the initial velocity (u). BE gives the final velocity (v). CE represents the time taken t. DF gives the change in velocity.



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

$$\Rightarrow a=\frac{DF}{CE}=\frac{OF-OD}{OE-OC}$$

But OE – OC = t

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

$$\Rightarrow v-u=at \text{ ...... (i)}$$

$$\Rightarrow v=u+at \text{ ......(I)}$$

Chapter 8 MOTION CONT.

EQUATION FOR POSITION-VELOCITY RELATION

Let ‘s’ be the displacement of the body in a time t.

In the graph, Displacement = Area CABE

s = Area of the rectangle CAGE + Area of the triangle ABG.

$s = AC \times CE + \frac{1}{2} (AG \times GB)$

Here AC = u

CE = t

AG = t

GB = v – u = at [from(i)]

$s = ut + \frac{1}{2} \times t \times at$

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

EQUATION FOR POSITION-TIME RELATION

In the graph, Displacement = Area of the trapezium CABE

$s = \frac{1}{2} (AC+EB) \times CE$

Here AC = u, EB = v, CE = t

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

From (i), we have $t = \frac{v-u}{a}$

Substituting the value of t,

$$s = \frac{u+v}{2} \times \frac{v-u}{a}$$

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

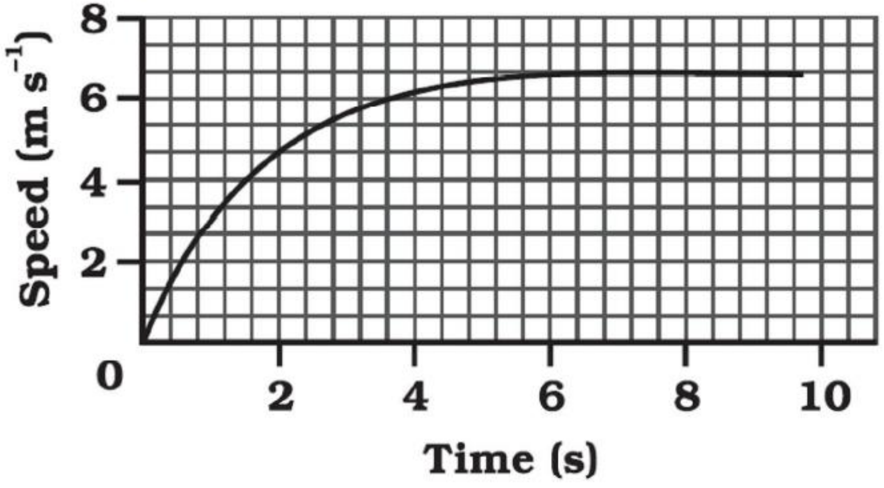
$$\Rightarrow v^2 - u^2 = 2as$$

$v^2 = u^2 + 2as$ ……………..(III)

(I), (II) and (III) are the equations of motion.

Chapter 8 MOTION CONT.

- **Q2** The speed-time graph for a car is shown is Fig. 8.12.

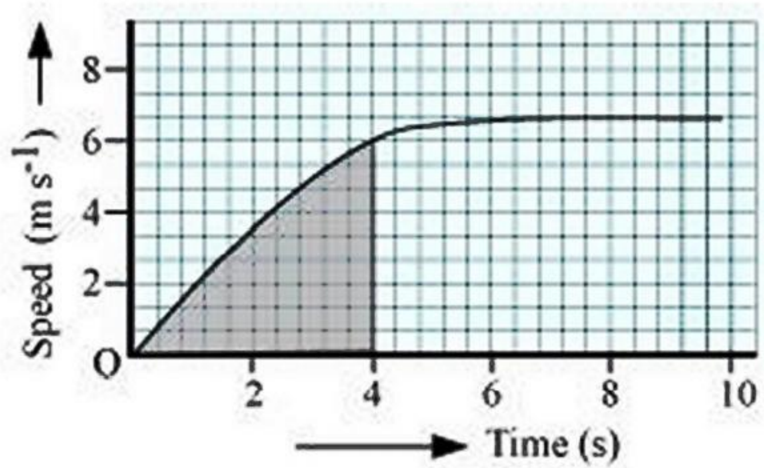


(a) Find how far does the car travel in the first 4 seconds. Shade the area on the graph that represents the distance travelled by the car during the period.
(b) Which part of the graph represents uniform motion of the car?

Chapter 8 MOTION CONT.

- **A** (a)

The shaded area which is equal to $\frac{1}{2} \times 4 \times 6 = 12m$ represents the distance travelled by the car in the first 4 s.



(b) The part of the graph in red colour between time 6 s to 10 s represents uniform motion of the car.

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Chapter 9 FORCE AND LAWS OF MOTIO

- **Q1 State and Prove the law of conservation of momentum by taking an example of collision of two objects of different masses.**
- A Law of Conservation of Momentum – The sum of momenta of two objects remains same even after collision.
  In other words, the sum of momenta of two objects before collision and sum of momenta of two objects after collision are equal.
  Mathematical Formulation of Conservation of Momentum:
  Suppose that, two objects A and B are moving along a straight line in same direction and the velocity of A is greater than the velocity of B.

Chapter 9 FORCE AND LAWS OF MOTION CONT.

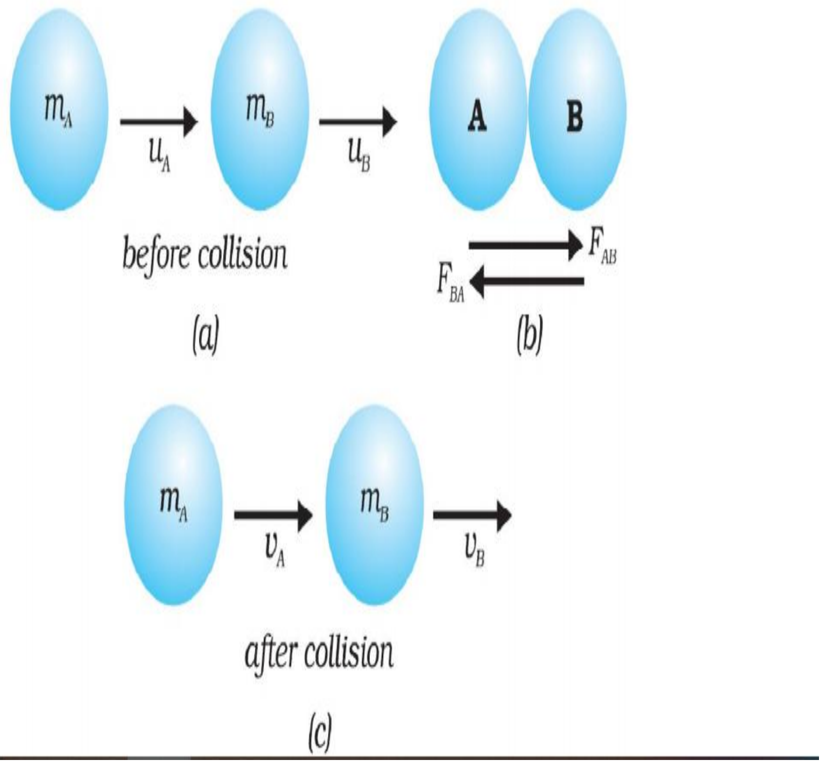
Let the initial velocity of A=u_A
Let the initial velocity of B= u_B
Let the mass of A= m_A
Let the mass of B–m_B
Let both the objects collide after some time and collision lasts for ' t' second.
Let the velocity of A after collision= v_A

Let the velocity of B after collision= v_B

We know that, Momentum – Mass x Velocity
Therefore,
Momentum of A (F_A) before collision = m_A x u_A
Momentum of B (F_B) before collision = m_B x u_B
Momentum of A after collision = m_A x v_A
Momentum of B after collision = m_B x v_B

Now, we know that Rate of change of momentum = mass x rate of change in velocity

$$\Rightarrow \text{Rate of change of momentum} = \text{mass} \times \frac{\text{Change in velocity}}{time}$$



Chapter 9 FORCE AND LAWS OF MOTION CONT.

Therefore, rate of change of momentum of A during collision, $F_{AB} = m_A\left(\frac{v_A - u_A}{t}\right)$

Similarly, the rate of change of momentum of B during collision, $F_{BA} = m_B\left(\frac{v_B - u_B}{t}\right)$

Since, according to the Newton's Third Law of Motion, action of the object A (force exerted by A) will be equal to reaction of the object B (force exerted by B). But the force exerted in the course of action and reaction is in opposite direction.

Therefore,

$$F_{AB} = -F_{BA}$$

$$or, m_A\left(\frac{v_A - u_A}{t}\right) = -m_B\left(\frac{v_B - u_B}{t}\right)$$

$$\Rightarrow m_A(v_A - u_A) = -m_B(v_B - u_B)$$

$$\Rightarrow m_A v_A - m_A u_A = -m_B v_B + m_B u_B$$

$$\Rightarrow m_A v_A + m_B v_B = m_A u_A + m_B u_B \quad \ldots\ldots\ldots\ldots\ldots\ldots \text{(i)}$$

Chapter 9 FORCE AND LAWS OF MOTION CONT.

- **Q2. State and prove Newton's second law of motion**
- **A** Newton's second Law of Motion states that The rate of change of momentum is directly proportional to the force applied in the direction of force.

For example; when acceleration is applied on a moving vehicle, the momentum of the vehicle increases and the increase is in the direction of motion because the force is being applied in the direction of motion. On the other hand, when brake is applied on the moving vehicle, the momentum of the vehicle decreases and the decrease is in the opposite direction of motion because the force is being applied in the opposite direction of motion.

Mathematical formulation of Newton's Second Law of Motion:

Let mass of an moving object = m.
Let the velocity of the object changes from 'u' to 'v' in the interval of time 't'.
This means,
Initial velocity of the object = u.
Final velocity of the object = v.
We know that momentum (p) = Mass x velocity
Therefore,
Momentum (p) of the object at its initial velocity u = m x u = mu
Momentum (p) of the object at its final velocity v = m x v = mv
The change in momentum = mv – mu

$$\text{Rate of change of momentum} = \frac{mv - mu}{t} \quad \ldots\ldots\ldots\ldots\ldots\ldots \text{(i)}$$

Chapter 9 FORCE AND LAWS OF MOTION CONT.

According to the Newton's Second Law of motion force is directly proportional to the rate of change of momentum.

This means, Force ∝ Rate of change of moentum

After substituting the value of rate of change of momentum from equation (i) we get.

$$Force \propto \frac{mv - mu}{t}$$

$$\Rightarrow F \propto \frac{m(v-u)}{t}$$

$$\Rightarrow F \propto ma\left(\because a = \frac{v-u}{t}\right)$$

$$\Rightarrow F = k.ma \quad \ldots\ldots\ldots\ldots\ldots\ldots \textbf{(ii)}$$

where, k is proportionality constant.

Since, 1 unit force is defined as the mass of 1kg object produces the acceleration of $1m/s^2$

Therefore, 1 unit of Force = k x 1 kg x $1m/s^2$

Thus k = 1.

Chapter 9 FORCE AND LAWS OF MOTION CONT.

By substituting the value of 'k = 1' in equation (ii) we get

F = m.a ………………. (iii)

⇒ Force = mass × acceleration

Thus Newton's Second Law of Motion gives the relation between force, mass and acceleration of an object.

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CHAPTER -10 GRAVITATION

- **Q1** What are the differences between the mass of an object and its weight?

Ans.

Mass	**Weight**
Mass is the quantity of matter contained in the body.	Weight is the force of gravity acting on the body.
It is the measure of inertia of the body.	It is the measure of gravity.
Mass is a constant quantity.	Weight is not a constant quantity. It is different at different places.
It only has magnitude.	It has magnitude as well as direction.
Its SI unit is kilogram (kg).	Its SI unit is the same as the SI unit of force, i.e., Newton (N).

CHAPTER -10 GRAVITATION CONT.

- **Q2** What happens to the force between two objects, if
  (i) the mass of one object is doubled?
  (ii) the distance between the objects is doubled and tripled?
  (iii) the masses of both objects are doubled?
  Ans. According to the universal law of gravitation, the force of gravitation between two objects is given by: $F = \frac{Gm_1m_2}{r^2}$
  (i) F is directly proportional to the masses of the objects. If the mass of one object is doubled, then the gravitational force will also get doubled.
  (ii) F is inversely proportional to the square of the distances between the objects. If the distance is doubled, then the gravitational force becomes one-fourth of its original value. Similarly, if the distance is tripled, then the gravitational force becomes one-ninth of its original value.
  (iii) F is directly proportional to the product of masses of the objects. If the masses of both the objects are doubled, then the gravitational force becomes four times the original value.

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Chapter 11 WORK ENERGY AND POWER

- **Q1 Derive an expression of potential energy of a body at h height above the ground level**
- **Ans**

EXPRESSION FOR POTENTIAL ENERGY OF A BODY ABOVE THE GROUND LEVEL

Work is done in raising an object from the ground to certain height against the gravity is stored in the body as a potential energy.

Consider an object of mass m. It is raised through a height h from the ground. Force is needed to do this.

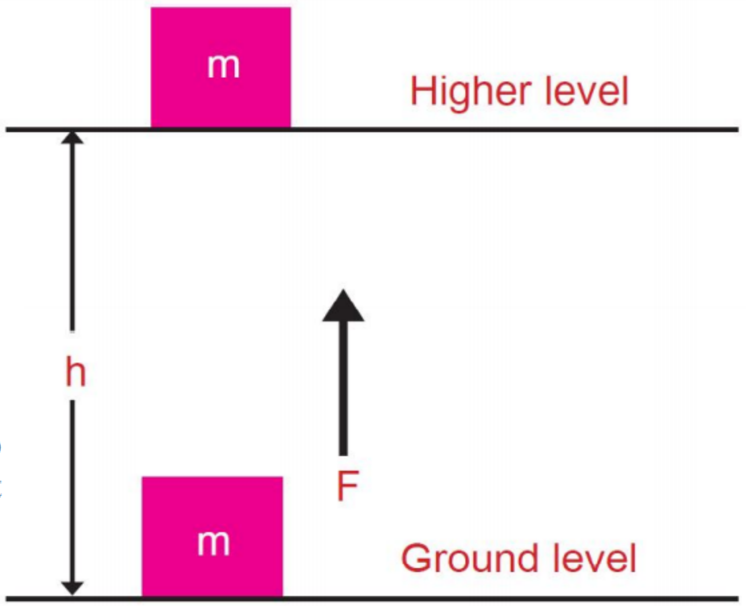
Chapter 11 WORK ENERGY AND POWER CONT.

The downward force acting on the body due to gravity = mg.
The work has to be done to lift the body through a height h against the force of gravity as shown in above figure.
The object gains energy to do the work done (w) on it.
work done = force x displacement

$w = F \times h$

$w = mgh$ [Since F=ma and a=g, therefore F=mg]

Work done is equal to potential energy of an object.



$$E_p = mgh.$$

NOTE: The potential energy of an object at a height depends on the ground level or the zero level you choose. An object in a given position can have a certain potential energy with respect to one level and a different value of potential energy with respect to another level.

Chapter 11 WORK ENERGY AND POWER CONT.

- Q2. **Calculate the work required to be done to stop a car of 1500 kg moving at a velocity of 60 km/h?**

  Ans: Kinetic energy, $E_k = \frac{1}{2}mv^2$

  Where, Mass of car, m = 1500 kg

  Velocity of car, v = 60 km/h $= 60 \times \frac{5}{18} ms^{-1}$

  $\therefore E_k = \frac{1}{2} \times 1500 \times \left(60 \times \frac{5}{18}\right)^2 = 20.8 \times 10^4 J$

  Hence, 20.8 × 104 J of work is required to stop the car.

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