IMPORTANT QUESTIONS CLASS – 11 PHYSICS
CHAPTER – 2 MOTION IN A STRAIGHT LINE

Question 1.
A rocket is fired vertically from the ground. It moves upwards with a constant acceleration of 10 ms^{-2} for the 30s after which the fuel is consumed. After what time from the instant of firing, the rocket will attain the maximum height? Take g = 10ms^{-2}.

Answer:
Here, a = g = 10ms^{-2} for t = 30s
∴ u = 0 for first part of the motion
v = velocity attained by the rocket after 30s = ?

∴ using the relation,
v = u + at ...(1)
we get v = 0 + 10 × 30
= 300 ms^{-1}

for second part of motion,
u = v = 300 ms^{-1}
v_1 = final velocity = 0

Let t1 be the time of journey for this part of the motion,
∴ from equation (1), we get
0 = 300 – 10 × t_1

Let T = total time of flight in which the rocket attains maximum height,
T = t + t_1
= 30 + 30
= 60 second.

Question
On a foggy day, two car drivers spot each other when they are just 80 m apart. They were travelling at 72 km h^{-1} and 60 km h^{-1} respectively. Both of them simultaneously apply brakes which retard both the cars at 5ms-2. Tell whether they will avert a collision or not?
Answer:
Here, let u, and u2 be the initial velocities of the two cars.

$\therefore \quad u_1 = 72 \text{ kmh}^{-1} = 72 \times \frac{5}{18} = 20 \text{ ms}^{-1}$

and $u_2 = 60 \text{ kmh}^{-1} = 60 \times \frac{5}{18} = \frac{50}{3} \text{ ms}^{-1}$

a = retardation = -5 ms^{-2}

If S1 and S2 be the distances covered by the two cars before coming to rest (i.e. v = 0), then
using the relation,

$v^2 - u^2 = 2as$, we get

for 1st car, $0 - 20^2 = 2(-5)S_1$

or $S_1 = \frac{-400}{-10} = 40 \text{ m}$

and for 2nd car,

$0 - \left(\frac{50}{3}\right)^2 = 2(-5)S_2$

or $S_2 = \frac{-\left(\frac{50}{3}\right)^2}{-10} = \frac{2500}{90}$

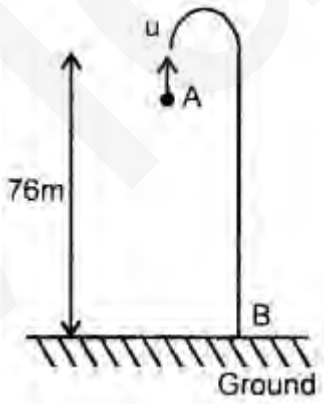
or $S_2 = 27.7 \text{ m}.$

If S be the total distance covered by two cars before coming to rest, then
$S = S_1 + S_2 = 40 + 27.7 = 67.7$ m.

Also $S_1 = 80$ m.
Now clearly the total distance covered by the cars before coming to rest is less than 80 m, so the collision will be averted.

Question 2.
A stone is dropped from a rising balloon at a height of 76 m above the ground and reaches the ground in 6s. What was the velocity of the balloon when the stone was dropped?

Answer:
Let u be the velocity of the balloon in an upward direction at the point
A = initial velocity of stone in an upward direction.



The stone rises to the top, comes to rest and then it starts coming back to the ground to hit B.

Let us take A as origin :
∴ Net vertical distance covered by the stone, y = – 76 m.
a = – g = – 9.8 ms^{-2}
(Here y and acc. are taken as -ve because they are in a downward direction w.r.t. A)

$$t = 6s$$

Using the relation, $S = ut + \frac{1}{2}at^2$

We get, $-76 = u \times 6 - \frac{1}{2} \times 9.8 \times 6^2$

$$= 6u - 4.9 \times 36$$

or $u = \frac{176.4 - 76}{6} = \frac{100.4}{6}$

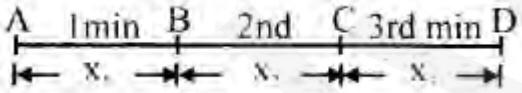
or $u = 16.7\ ms^{-1}$.

Question 3.

A car moves at a velocity of 2.24 km h^{-1} in the first minute, at 3.60 km h^{-1} in the second minute and at 5.18 km h^{-1} in the third minute. Calculate the average velocity in these three minutes.

Answer:

Let x_1, x_2 and x_3 be the displacements of car in 1 st, 2nd and 3rd minutes respectively and let v_1, v_2 and v_3 be the velocities of these time intervals,



$\therefore v_1 = 2.24\ kmh^{-1}$, $v_2 = 3.60\ kmh^{-1}$, $v_3 = 5.18\ kmh^{-1}$

time intervals = $t_1 = t_2 = t_3 = 1$ minute = 160 h

$$\therefore \quad x_1 = v_1t_1 = 2.24 \times \frac{1}{60}\ km$$

$$x_2 = v_2t_2 = \frac{3.60}{60}\ km$$

and $$x_3 = v_3t_3 = \frac{5.18}{60}\ km$$

If x be the total displacement, then

$$x = x_1 + x_2 + x_3$$

$$= \frac{2.24}{60} + \frac{3.60}{60} + \frac{5.18}{60}$$

$$= \frac{11.02}{60}\text{ km}$$

and total time = $t = t_1 + t_2 + t_3$

$$= 1 + 1 + 1 = 3 \text{ minute} = \frac{3}{60}\text{h}$$

If v be the average velocity in these 3 minutes, then

$$v = \frac{x}{t} = \frac{\frac{11.02}{60}}{\frac{3}{60}}$$

$$= \frac{11.02}{3}\text{ kmh}^{-1} = 3.67 \text{ kmh}^{-1}.$$

Question 4.

A man is walking due East at the rate of 3 km h^{-1}. Rain appears to fall down vertically at the rate of 3 km h^{-1}. Find the actual velocity and direction of the rainfall.

Answer:

Let a = angle made by the rainfall with the vertical

Velocity of man represented by OA due East = 3 km h^{-1}

As rain appears to fall vertically downward, so OB = 3 km h^{-1} represents the velocity of rain w.r.t. man. The actual velocity of rainfall is represented by OC and is given by

$$OC = \sqrt{OA^2 + OB^2}$$

$$= \sqrt{9+9} = 3\sqrt{2} \text{ kmh}^{-1}$$

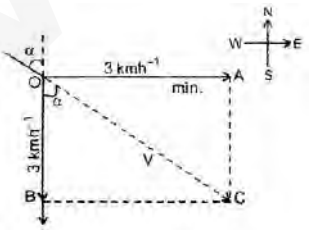
Direction of rainfall :

In rt. ∠d ΔOCB,

$$\tan\alpha = \frac{BC}{OB} = \frac{3}{3} = 1$$

$$\therefore \quad \alpha = 45^\circ$$

Thus the rain is actually falling at 32–√ km h^{-1} at an angle of 45° west of the vertical.



Question 5.

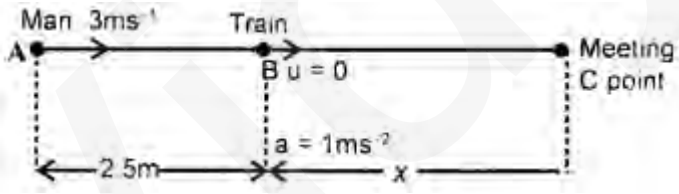
A car starting from rest and moving with uniform acceleration possesses average velocities 5 ms^{-1}, 10 ms^{-1} and 15 ms^{-1} in the first, second and third seconds. What is the total r distance covered by the car in these three seconds?

Answer:
Here, let v_1, v_2 and v_3 be the average velocities of 1st, 2nd and 3rd secs, respectively.
$\therefore v_1 = 5\ ms^{-1}, v_2 = 10\ ms^{-1}, v_3 = 15\ ms^{-1}$
$t_1 = t_2 = t_3 = 1\ s$ = time intervals

If x_1, x_2 and x_3 be the distances covered in these seconds resp., then

$x_1 = v_1 t_1 = 5 \times 1 = 5m$
$x_2 = v_2 t_2 = 10 \times 1 = 10\ m$
and $x_3 = v_3 t_3 = 15 \times 1 = 15\ m$
Let x = total distance covered
$\therefore x = x_1 + x_2 + x_3$
$= 5 + 10 + 15$
$= 30\ m.$

Question 6.
A person is running at a maximum speed of 3 ms-1 along the length of a train to catch hold of the door of a compartment. When he is just 2.5 m from the door, the train steams off with an acceleration of 1 ms^{-2}. Find how long it takes him to catch the door?
Answer:



Here, let $u_1 = 3\ m\ s^{-1}$, be the initial speed of man at point A.
For train $x_1 = 2.5$ m = distance of the train from man.
$u = 0$, a = acceleration of train = $1\ ms^{-2}$

Let C be their meeting point after a time t.
If BC = x, then usirig the relation,
S = ut + 12 at2, we get

For train, $x = 0 + 12 \times 1 \times t^2 = 0.5t^2$ ... (1)
For man, using the relation,

$$x = ut, \text{ we get}$$
$$x + 2.5 = u_1 t = 3t \quad \ldots (2)$$

$\therefore$ From (1) and (2), we get

$$0.5t^2 + 2.5 = 3t$$
$$\text{or} \quad 0.5t^2 - 3t + 2.5 = 0$$
$$\text{or} \quad t^2 - 6t + 5 = 0$$
$$\text{or} \quad (t - 5)(t - 1) = 0$$
$$\therefore \text{either } t - 1 = 0 \text{ or } t - 5 = 0$$

$\therefore$ t = 1, 5 i.e. he will catch the door first after Is and then after 5s.
t = 1s.

Question 7.
The displacement of a body along the x-axis changes according to the relation: $x = 20 - 15t + 4t^2$, where x is in metres, t in seconds. Determine its position, velocity and acceleration at t = O.

Answer:
Here, $x = 4t^2 - 1\,5t + 20$ ... (1)
$v = dxdt = 4.2t - 15 = 8t - 15$ ...(2)

Also a = dvdt = 8
At t = 0, the position (x), velocity (y) and acceleration (a) are given by
$x = 4.0 - 15 \times 0 + 20 = 20$ m
$v = 8 \times 0 - 15 = -15 ms^{-1}$
and $a = 8\ ms^{-2}$.

Question 25.
A body undergoes a uniformly accelerated motion. Its velocity after 5 seconds is 25 ems and after 8 seconds it is 34 cms'. Calculate the distance covered in the 12th second.
Answer:
Let u and a be the initial speed and acceleration of the body.
Let v_1 and v_2 be its velocities after 5s and 8s respectively

$\therefore \quad v_1 = 25\ cms^{-1}, v_2 = 34\ cms^{-1}$
$t_1 = 5s, t_2 = 8s.$
$\therefore$ using the relation, $v = u + at$, we get
$$25 = u + 5a \quad \ldots (1)$$
and
$$34 = u + 8a \quad \ldots (2)$$
From (1) and (2), we get
$$34 = 25 - 5a + 8a$$
$$\text{or} \quad 34 - 25 = 3a$$
$$\therefore \quad 3a = 9$$
$$\text{or} \quad a = 3\ cms^{-2} \quad \ldots (3)$$
From (1) and (3), we get
$$25 = u + 5 \times 3$$
$$\text{or} \quad u = 10\ cms^{-1} \quad \ldots (4)$$

Let S_nth be the distance covered in the 12th second.

Using the relation,

$$S_n\text{th} = u + \frac{a}{2}(2n - a)$$

We get,

$$S_{12}\text{th} = 10 + \frac{3}{2}(2 \times 12 - 1)$$

$$= 10 + \frac{3}{2} \times 23$$

$$= 10 + 34.5 = 44.5 \text{ cm}.$$

Value-Based Type:

Question 8.
On a two-lane road, there are hoardings hanged on the electric poles "Save Energy". If car a is travelling at a speed of 54 km h1 and car 'B' moves with 90 km h^{-1} from the opposite direction.
Now, answer these questions:
(a) Which values are depicted in the above problem? Write down the four ways by which the energy can be saved.

Answer:
Save energy to save our environment.

The four ways to save energy are as under :

1. By using CFLs, switching off appliances when not in use.
2. Saving water by using it efficiently.
3. Using solar energy.
4. By using public transport.

(b) Write a slogan on "save energy".
Answer:
Try to switch of the fans and lights when you are not using it. Use limited non renewable sources of energy.

(c) Find the velocity of B with respect to A? Also, find the velocity of the ground with respect to B?

Solution:

$V_A = +54 \text{ km h}^{-1} = 15 \text{ ms}^{-1}$

$V_B = 90 \text{ km h}^{-1} = -25 \text{ ms}^{-1}$

(Takingthe velocity of car A positive N v and car B negative)

∴ Relative velocity of B with respect to A

$= V_B - V_A = -25 - 15 = -40 \text{ ms}^{-1}$

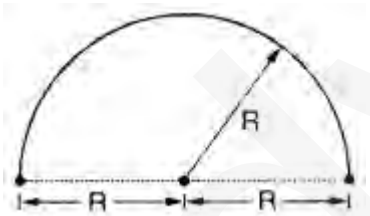
i.e. the car Boppers to A to move with a speed 40 ms-1 from opposite direction.

Relative velocity of ground w.r.t B = $0 - V_B = 0 - (-25)$

$= 25 \text{ ms}^{-1}$

Question 9.

A candle march was organized by an NGO. The theme of the candle march was "No use of non-biodegradable products". The organizer made a semicircular track of radius R on which peoples have to run taking a poster in their hands. If Mahesh travelled from A to B in time t with constant speed, then answer the following:



(i) Why should non-biodegradable products not be used?

Justify your answer.

Answer:

Biodegradable products are reusable and cause less pollution.

So, non-biodegradable products must be avoided.

(ii) Find the

(a) Displacement

Answer:

Displacement = minimum distance between initial and final point = AB = 2 R

(b) Average speed

Answer:

$$\text{Average Speed, } V = \frac{\text{Distance}}{\text{Time}} = \frac{\pi R}{t}$$

(c) Average velocity

Answer:

$$\text{Average velocity} = \frac{\text{Displacement}}{\text{Time}} = \frac{2R}{t}$$

(d) Average acceleration

Answer:

$$\text{Average acceleration} = \frac{\text{Change in velocity}}{\text{Time taken}} = \frac{2V}{t}$$

$$= \frac{2 \times \left(\frac{\pi R}{t}\right)}{t} = \frac{2\pi R}{t^2}$$

Question 10.

In sports day activities of a public school, the lines were drawn with chalk powder. Gagan an athlete runs a distance of 1500 m in the following manner, (i) Starting from rest, he accelerates himself uniformly at 2ms_1, till he covers a distance of 900 m. (ii) He then runs the remaining distance of 600 m at the uniform speed developed.

(i) Which value is depicted in the above problem?

Answer:

Importance of sports activities.

(ii) Do you think that sports activities are important in day-to-day life?

Answer:

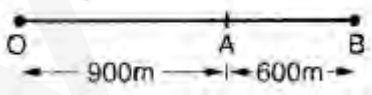
Yes, sports activities are very much important in day-to-day life as

(a) It gives break from regular life

(b) It improves physical strength

(c) It relaxes our mind and body

(d) It helps to concentrate on other works



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(iii) Calculate the time taken by the athlete to cover the two parts of the distance covered.

Answer:

Let the athlete run from O to B Here, OB = 1500 m, OA = 900 m, AB = 600 m

Case I: From O to A

$u = 0, a = 2\ m/s^2,$

$S = 900\ m, t = t_1 = ?$

$V = ?$

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

$\Rightarrow 900 = 0 \times t + \frac{1}{2} \times 2 \times t^2 \quad \Rightarrow t_1 = 30\ S$

Now, $V = u = at_1 = 0 + 2 \times 30 = 60\ m/s.$

Case II : Taking motion of athelete from A to B u = 60 m/s, S = 600m, a = 0 (∵ Speed is uniform or constant)

$t = t_2 = ?$

$$\therefore \quad S = u t_2 + \frac{1}{2} a t_2^2$$

$$600 = 60 \times t_2 + \frac{1}{2} \times 0 (t_2)^2$$

$$\Rightarrow \quad t_2 = \frac{600}{60} = 10 \text{ S.}$$