CBSE Test Paper 05

Chapter 3 Motion in A Straight Line

1. Jules Verne in 1865 proposed sending people to the Moon by firing a space capsule from 220-m-long cannon with a final velocity of 10.97 km/s. What would have been the unrealistically large acceleration experienced by the space travelers during launch? **1**

   a. $2.74 \times 10^6\ m/s^2$
   b. $2.74 \times 10^5\ m/s^2$
   c. $3.74 \times 10^5\ m/s^2$
   d. $2.74 \times 10^3\ m/s^2$

2. Path length is a **1**

   a. tensor
   b. Derived unit
   c. scalar
   d. vector

3. Motion along a straight line is called _____. **1**

   a. parabolic motion
   b. circular motion
   c. oscillatory motion
   d. rectilinear motion

4. A truck accelerates at 1 m / sec^2 from rest. What is its velocity in m/s at a time of 2 sec? **1**

   a. 2
   b. 4
   c. 1
   d. 3

5. A stone thrown from the top of a building is given an initial velocity of 20.0 m/s

straight upward. Determine the time in seconds at which the stone reaches its maximum height. g =9.8 m / sec^2. **1**

a. 2.8
b. 2.04
c. 1.67
d. 2.7

6. For which condition, the magnitude of average velocity is equal to the average speed for a particular motion? **1**

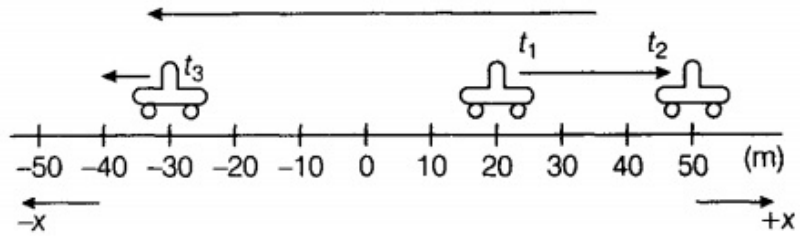
7. If the position of a particle at instant t is given by $x = 2t^3$, find the acceleration of the particle. **1**

8. The displacement - time graph of a particle is parallel to time - axis, what is the velocity of the particle? **1**

9. The displacement x of a particle moving in one dimension under the action of constant force is related to the time by the equation where x is in meters and t is in seconds. Find the velocity of the particle at **2**

i. t = 3s
ii. t = 6s.

10. For the motion shown in the figure, find the displacement of car between the time intervals t_1 and t_3. **2**



11. The displacement (in metre) of a particle moving along x-axis is given by $x = 18t + 15t^2$. Find the instantaneous velocity at t = 0 and t = 2 s. **2**

12. Two trains, each having a speed of 30 km/h, are headed towards each other on the same track. A bird that can fly 60 km/h flies off the front of one train when they were

60 km apart and heads directly to the other train. On reaching the train, the bird flies back to the first train.
What is the total distance the bird travels before the trains collide? **3**

13. A train takes 4 min to go between stations 2.25 km apart starting and finishing at rest. The acceleration is uniform for the first 40 s and the deceleration is uniform for the last 20 s.
Assuming the velocity to be constant for the remaining time, calculate the maximum speed, acceleration, and retardation, use the only graphical method. **3**

14. A bullet bike moving on a straight road at a speed of 120 kmph is made to stop by a police officer within a 100m distance. Calculate the retardation of the bike (assumed uniform) and the time it takes for the bike to stop? **3**

15. Two towns A and B are connected by a regular bus service with a bus leaving in either direction every T minutes. A man cycling with a speed of 20 km h^{-1} in the direction A to B notices that a bus goes past him every 18 min in the direction of his motion, and every 6 min in the opposite direction. What is the period T of the bus service and with what speed (assumed constant) do the buses ply on the road? **5**

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Answer

1. b. $2.74 \times 10^5\ m/s^2$

   Explanation: We know the equation of motion

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

   Given: v = 10.97 km/s = 10.97 x 10^3 m/s

   u = 0

   S = 220 m

   Acceleration $a = \frac{v^2-u^2}{2s}$ = $\frac{(10.97\times10^3)^2-(0)^2}{2\times220}$ = $\frac{(10.97\times10^3)^2}{440}$

   = 2.74 x 10^5 m/s^2

2. c. scalar

   Explanation: Path length has no particular direction and it depends upon the path chosen to reach the destination where displacement of the destination is absolute no matter what path is used to get there. So it is scaler.

3. d. rectilinear motion

   Explanation: Rectilinear motion is another name for straight-line motion. This type of motion describes the movement of a particle or a body. A body is said to experience rectilinear motion if any two particles of the body travel the same distance along two parallel straight lines.

4. a. 2

   Explanation: Initial velocity u = 0 m/s

   final velocity = v

   Time t = 2 s

   Acceleration a = 1 m/s^2

   We know, v = u + at

   $\Rightarrow v = 0 + 1 \times 2$

   $\Rightarrow$ v = 2 m/s

5. b. 2.04

   Explanation: Initial velocity u = 20.0 m/s

   At maximum height it ll stop

   So final velocity v = 0 m/s

   Acceleration due to gravity g = 9.8 m/s^2

   Time taken to reach maximum height = t

   We know v = u + at

   $\Rightarrow 0 = 20 + (-9.8)t$

   $\Rightarrow t = \frac{-20}{-9.8} = 2.04\ s$ [g is taken negative because it is in opposite direction of motion.]

6. When a particle is moving along a straight line with the fixed speed then magnitude of average velocity and average speed are same.

7. it is given that , x = 2t^3

   Differentiate w.r.t time we get

   velocity, $v = \frac{dx}{dt} = \frac{d(2t^3)}{dt}$ = 6t^2

   Differentiate again we have

   Acceleration, $a = \frac{dv}{dt} = \frac{d(6t^2)}{dt}$ = 12t.

8. In that situation the slope of the x-t graph will be zero, therefore the velocity of the particle is zero.

9. $t = \sqrt{x} - 3$

   $\sqrt{x} = t + 3$

   x = (t + 3)^2

   i. $v = \frac{dx}{dt} = 2(t + 3)$

      For t = 3 sec v = 2(3 + 3) = 12m/s

   ii. For t = 6 v = 2(6 + 3) = 18m/s

10. A car moving towards + x-axis. At time t_1 the initial position is at +20 m.

    It turns and starts moving towards - x-axis. At time t_3 , the final position is at -30 m.

    The displacement of car in (t_3 - t_1) interval Δ = - 30 - (+20) = - 50 m (negative sign

indicates displacement is towards - x-axis).

11. Displacement,

    $x = 18t + 15t^2$

    Instantaneous velocity is the derivative of displacement with respect to time

    $\mathbf{v}_i = \frac{d\mathbf{x}}{dt} = 18 + 30t$ (i)

    Instantaneous velocity

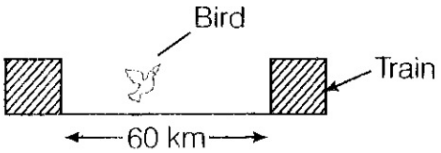
    at t = 0, put in (i)

    $v = 18 + 30 \times 0 = 18$ m/sec

    at t = 2 s, using equation (i)

    $v = 18 + 30 \times 2$

    = 78 m/s

12. 

    Here, It is given that, v_1 = 30 km/h, v_2 = 60 km/h and d = 60 km

    Therefore, v_1 = 30 km/h $= 30 \times \frac{5}{18} = 8.33\text{m/s}$

    and v_2 = 60 km/h $= 60 \times \frac{5}{18} = 16.67\text{m/s}$

    Also, d = 60 km = 60000 m (because 1km = 1000m)

    Since the trains will collide in the middle, we have

    Δx = 30 km

    When trains collide, $v = \frac{\Delta x}{\Delta t} \Rightarrow \Delta t = \frac{\Delta x}{v}$

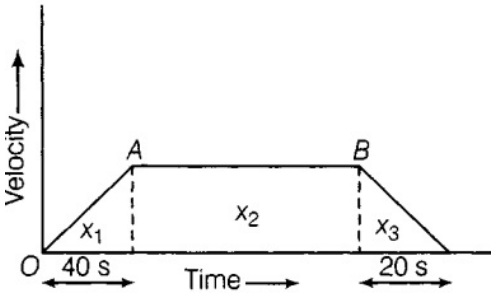
    $\therefore \quad \Delta t = \frac{30000}{8.33} = 3601$

    Now, $v = \frac{\Delta x}{\Delta t} = \Delta x = v\Delta t$

    $\therefore \quad \Delta x = (16.67\text{m/s})(3601)$

    $\approx$ 60028.67 m = 60 km

13. The motion of the train is shown in the following velocity-time graph.



Assume that v represents the maximum speed of the train. If x_1 be the distance covered during the first 40 seconds, then

$\frac{v}{2} \times 40 = x_1$ or $x_1 = 20v$

Since total time is 4 min (240 seconds) therefore, the time corresponding to velocity-time graph AB is (240 - 40 - 20) s i.e. 180 s. If x_2 be the distance covered during this time, then $x_2 = 180v$.

If x_3 be the distance covered during the last 20 s, then we have

$x_3 = \frac{v}{2} \times 20 = 10v$

Now, $x_1 + x_2 + x_3 = 20v + 180v + 10v$

$\Rightarrow$ 2250 = 210 v (given that distnace = 2.25 km = 2.25 $\times$ 1000 m = 2250 meters)

$\Rightarrow v = \frac{225}{21} ms^{-1} = 10.7$ m/s

Hence, the maximum speed = 10.7 m/s

Therefore, Acceleration = $\frac{v}{40} = \frac{10.7}{40} ms^{-2} = 0.2675\ ms^{-2}$

and Retardation = $\frac{v}{20} = \frac{10.7}{20} ms^{-2} = 0.535\ ms^{-2}$

14. Given,

Initial velocity of the bike, u = 120 km/h = 33.33 m/s

As bike stops, so final velocity v = 0

Distance taken to stop s = 100 m

Let, a be the retardation experienced by the bike.

From the equation of motion

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

$(0)^2 - 33.33^2 = 2 \times 100 \times a$

$a = -\frac{1111}{200}$ = - 5.55 m/s

Now, using the first equation of motion we get:

v = u + at

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

$t = \frac{0-33.33}{-5.55}$

= 6 sec.

15. Let speed of bus = V

relative speed when cyclist and bus both move same direction = (V - 20) km/h

We know ,

Distance = speed $\times$ time

A/C to question ,

Bus went past cyclist every 18 min when in the motion of his direction .

e.g distance covered by bus = (V-20) $\times$ 18/60 km

Every T time bus travels distance = VT

e.g. (V - 20) $\times$ 18/60 = VT ----------(1)

Similarly ,

Relative speed of bus when bus and cyclist move in opposite direction = (v+ 20) km/h

Bus went past every 6 min in opposite direction of his motion .

then,

(V + 20) $\times$ 6/60 = VT ----------(2)

Solve both equation ,

(V -20) $\times$ 18/60 =(V +20) $\times$ 6/60

$\Rightarrow$ 3V - 60 = V + 20

$\Rightarrow$ 2V = 80

$\Rightarrow$ V = 40 Km/h put equation (1)

(40 - 20) $\times$ 18/60 = 40 T

T = 6/40 hour = 9 min

Hence,

V= 40 km/h and T = 9 min