Chapter: 8 Motions Solved Test Paper -03

1. Q. Derive equations of uniformly accelerated motion mathematically?

Ans: 1st Equation of Motion:

Let a body having initial velocity u and The velocity changes at a uniform rate a so that after time't` its final velocity becomes v.

Acceleration = change in velocity /time $\Rightarrow$ a = $\frac{v-u}{t}$ $\Rightarrow$ at = v - u $\Rightarrow$ v = u +at (i)

2nd Equation of Motion:

If the distance traveled by moving body in time 't' is 's' then the average velocity = (v + u)/2.

Distance traveled = Average velocity x time = $\frac{v+u}{2}\ x\ t$

Putting, v = u + at we get, S = $\frac{u+at+u}{2}\ x\ t$ $\Rightarrow$ S = $ut + \frac{1}{2}at^2$

3rd Equation of Motion

Distance traveled = Average velocity X time = $\frac{v+u}{2}\ x\ t$

Putting, t = $\frac{v-u}{a}$ $\Rightarrow$ S = $\frac{v+u}{2}\ x\ \frac{v-u}{a}$ $\Rightarrow$ S = $\frac{v^2-u^2}{2a}$ $\Rightarrow$ 2as = $(v^2 - u^2)$ $\Rightarrow$ $V^2 = u^2 + 2as$

2. Q. Derive equations of uniformly accelerated motion graphically?

Ans: Let a body moving under constant from A to B in time t.

The acceleration of the object = a = Slop of line AB

a = $\frac{Change\ invelocity}{timetaken}$ = $\frac{BD-CD}{OD-OE}$ = $\frac{V-u}{t}$ $\Rightarrow$ v = u + at

The distance s travelled by the object = S

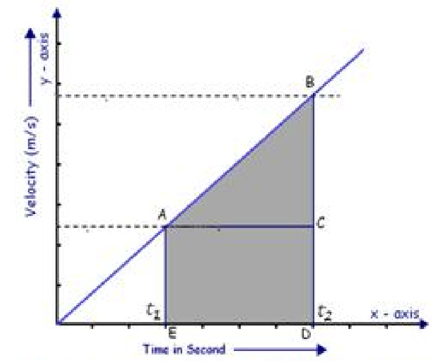
S = area trapezium OABC = $\frac{1}{2}\ [AE+BD]\ x\ ED$

S = $\frac{1}{2}\ x\ \frac{v+u}{2}\ x\ t$ ------------(ii)

Putting, v = u + at from (i) S = $\frac{u+at+u}{2}\ x\ t$ $\Rightarrow$ S = $ut + \frac{1}{2}at^2$

Putting in eq (ii) , t = $\frac{v-u}{a}$ $\Rightarrow$ S = $\frac{v+u}{2}\ x\ \frac{v-u}{a}$

$\Rightarrow$ S = $\frac{v^2-u^2}{2a}$ $\Rightarrow$ 2as = $(v^2 - u^2)$ $\Rightarrow$ $V^2 = u^2 + 2as$



velocity time graph of an object moving with uniform acceleration

3. Q.A train starting from rest attains a velocity of 72 km/ h in 5 minutes. Assuming that the acceleration is uniform, find (i) the acceleration and (ii) the distance travelled by the train for attaining this velocity.

Solution: u = 0 m/s; v = 72 km/h = 20 m/s and t = 5 minutes = 300 s

a =(v—u)/t =(20-0)/300= 1/15m/s^2

S = ut +1/2at^2 = (0 x 300) +1/2{1/15 x 300 x 300} = 3000 m

4. Q. A train is travelling at a speed of 90 km/h. Brakes are applied so as to produce a uniform acceleration of – 0.5 m/s^2. Find how far the train will go before it is brought to rest.

Solution: u = 90km/h = 90 x 5/18 = 25m/s; v = 0 m/s ; a = - 0.5 m/s^2

$v^2 = u^2 + 2as = 0^2 = 25^2 + 2 x (-0.5) x S$ $\Rightarrow$ S = 625 m

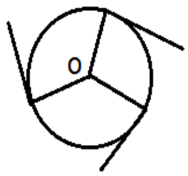
5. Q. A stone is thrown in a vertically upward direction with a velocity of 5 m/s. If the acceleration of the stone during its motion is 10 m/s^2 in the downward direction, what will be the height attained by the stone and how much time will it take to reach there?

Solution: u = 5m/s ; a = -10/s^2[a is - ve as it is downward]
Let the high attain by stone = h m and here v = 0 m/s
$v^2 = u^2 + 2as$ $0^2 = 5^2 + 2 \times (-10) \times S$ $\Rightarrow$ S =25/20 = 1.25 m $\Rightarrow$ Time taken =(v-u)/a= {0-5}/(-l0)=0.5sec.

6. Q. What is circular motion? Is circular motion an acceleration motion?

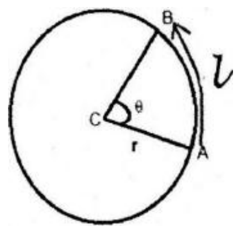
Ans: Motion of a body along a circular path is called a circular motion.
In circular motion a body moves with a velocity of constant magnitude along the circular path, the only change in his velocity is due to the change in the direction of motion. Therefore, circular motion is an acceleration motion.
As object moves in a circular path with uniform speed, its motion is called uniform circular motion.

7. Q. Take a piece of thread and tie a small piece of stone at one of its ends. Move the stone with constant speed by holding the thread at the other end. What will be the direction in which the stone moves after it is released.



Answer: If we release the thread, the stone moves along a straight line tangential to the circular path.

8. Q. Define terms (i) Angular displacement (ii) Angular velocity
Answer: **Angular displacement**: The angle subtended by a moving body at the centre of circular path in a given interval of time. It is represented by the symbol θ (theta).



Angular displacement $= \frac{length\ of\ arc}{r}$ $\Rightarrow \theta = \frac{\text{length of arc}(l)}{\text{r}}$

SI unit of angular displacement is radian $\Rightarrow$ Then, $\theta = \frac{l}{r}$ radians

Let Length of arc (l) = r $\Rightarrow$ θ = 1 radians

One radian is defined as the angle subtended at the centre of the circle by an arc equal in length to its radius.

Relation between θ and radian: Let a body completes 1 rotation then $\theta = 360^0$ and Length of arc $(l) = 2\pi r$

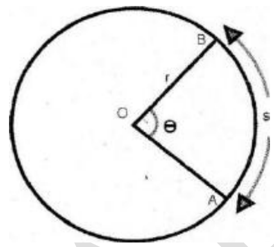
Angular displacement $= \frac{length\ of\ arc}{r}$ $\Rightarrow \theta = \frac{\text{length of arc}(l)}{\text{r}}$

$\Longrightarrow 360^0 = \frac{2\pi\,\text{r}}{\text{r}}$ radian $\Longrightarrow$ 1 radian $= \frac{360^0}{2\pi}$ = 57.3°

Angular velocity: The angular displacement per unit time is called the angular velocity. it is represented by the symbol ω (omega). **Angular velocity** $\boldsymbol{\omega} = \frac{\theta}{t}$

9. Q. Determine relation between linear velocity and Angular velocity?

Ans: Consider a body moving along the circumference of a circle of radius r with linear velocity v from A to B .
Let the body moves from A to B in a time t



Now, Linear velocity = $\frac{\text{displacement}}{\text{time}} \Rightarrow$ v = $\frac{s}{t}$ --------------- (i)

If θ is the angle subtended by an arc of length s and radius r.

Then θ = $\frac{s}{r}$ $\Rightarrow$ s = r θ-------------- (ii)

Substituting (ii) in (i), v = $\frac{\theta\ x\ r}{t}$

But , Angular velocity ω = $\frac{\theta}{t}$ $\Rightarrow$ v = ω r

Thus, Linear velocity = Radius of the circle x Angular velocity

10. Q. What do you mean by centripetal force and centrifugal force?

Answer: The constant force that acts on the body along the radius towards the centre and perpendicular to the velocity of the body is known as centripetal force,

Let us consider an object of mass m, moving along a circular path of radius r, with an angular velocity ω and linear velocity v. F = $\frac{mv^2}{r}$ $\Rightarrow$ Centripetal force, F = m r ω^2 [since v = ω r)

Examples

1. In the case of the stone tied to the end of a string and rotated in a circular path, the centripetal force is provided by the tension in the string.
2. When a car takes a turn on the road, the frictional force between the tyres and the road provides the centripetal force.
3. In the case of planets revolving round the sun or the moon revolves around the earth, the centripetal force is provided by the gravitational force of attraction between them.
4. For an electron revolving around the nucleus in a circular path, the electro static force of attraction between the electron and the nucleus provides the necessary centripetal force.

Centrifugal force: The force, which is equal in magnitude but opposite in direction to the centripetal force, is known as centrifugal force.

Examples: (i) while churning curd, butter goes to the side due to centrifugal force. (ii) A cyclist turning a corner leans inwards. Now the frictional force (centripetal force) is balanced by the centrifugal force (mv2)/r