YAKEEN NEET 2.0

2026

Circular Motion

PHYSICS | KPP 25

By - Saleem Ahmed Sir

KPP / (H.W) Level - 1

Circular motion

1 A particle is revolving in a circle of radius 1m with an angular speed of 12 rad/s. At t = 0, it was subjected to a constant angular acceleration α and its angular speed increased to (480/π) rotation per minute (rpm) in 2 sec. Particle then continues to move with attained speed. Calculate

(i) angular acceleration of the particle,

(ii) tangential velocity of the particle as a function of time.

(iii) acceleration of the particle at t = 0.5 second and at t = 3 second

(iv) angular displacement at t = 3 second.

$R=1, \quad \omega_i = 12 \qquad \omega_f = \frac{480}{\pi} \times \frac{\pi}{30} = 16$

(1) $\omega = \omega_0 + \alpha t$

$16 = 12 + \alpha \times 2 \qquad \alpha = 2$

... चक्कर लगा रहा है। t = 0 पर इसे नियत कोणीय ... m तक बढ़ जाती है। अब कण इसी चाल से ...

(3) $a_t = r\alpha = 1 \times 2 = 2$

$a_c = \frac{v^2}{R} = \frac{(13)^2}{1} = 169$

$a_{net} = \sqrt{2^2 + (169)^2} = \checkmark$

$1\,rpm = \frac{\pi}{30}\,rad/sec.$

(2) $v = r\omega = r(\omega_i + \alpha t)$

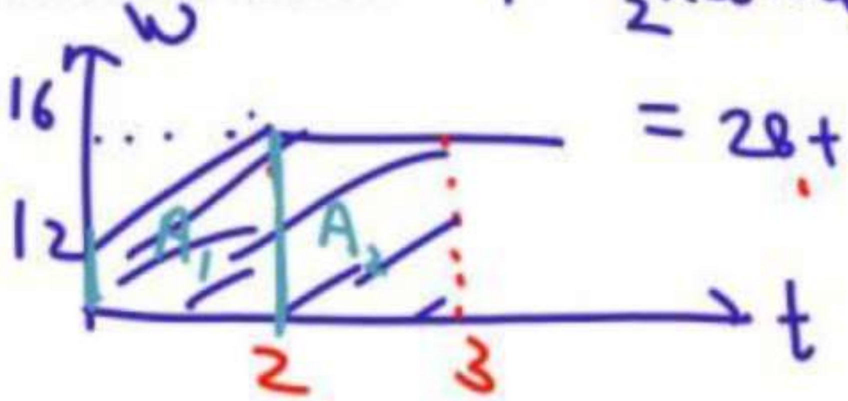
$\boxed{v = 12 + 2t}$

(ii) समय के फलन के रूप में कण का स्पर्शरिखीय वेग।

(iv) t = 3 s पर कोणीय विस्थापन।

$A_1 = \frac{1}{2} \times 28 \times 2 + 16$

$1\,rpm = \frac{2\pi}{60}\,rad$



$= 28 + 6 = 44$

Ans. (i) 2 rad/s²

(ii) 12+2t for t ≤ 2s, 16 for t ≥ 2s

(iii) $a = 169.01\ m/s^2$

(iv) 44 rad

(3) $t = 3$

$$a_t = 0$$

$$a_c = \frac{v^2}{R} = \frac{(16)^2}{1} = 256$$

$$a_{net} = \sqrt{a_t^2 + a_c^2} = 256$$

(2) A particle is travelling in a circular path of radius 4m. At a certain instant the particle is moving at 20m/s and its acceleration is at an angle of 37° from the direction to the centre of the circle as seen from the particle

H/w

(i) At what rate is the speed of the particle increasing? a_t

(ii) What is the magnitude of the acceleration?

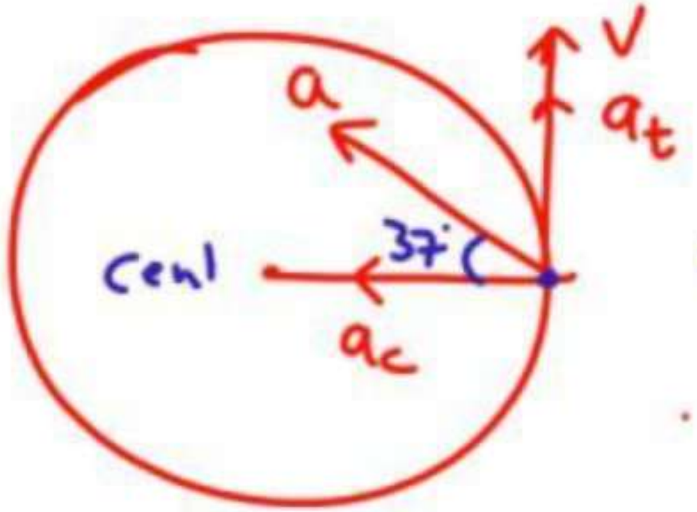
$R = 4,\ v = 20$ $\quad a_c = \frac{v^2}{R} = \frac{400}{4} = 100$

एक कण 4 m त्रिज्या वाले वृत्ताकार पथ में गति कर रहा है। किसी क्षण पर कण 20 m/s से गतिशील है। कण से देखने पर इस क्षण इसका त्वरण वृत्त के केन्द्र से 37° कोण पर है।

(i) कण की चाल किस दर से बढ़ रही है?

(ii) त्वरण का परिमाण ज्ञात कीजिए।

Ans. (i) 75m/s^2, (ii) 125m/s^2



$\tan 37 = \frac{a_t}{a_c}$

$\frac{3}{4} = \frac{a_t}{100}$ $\quad a_t = 75$

(ii) $a = \sqrt{a_t^2 + a_c^2} = \sqrt{(75)^2 + (100)^2} = \underline{125}$

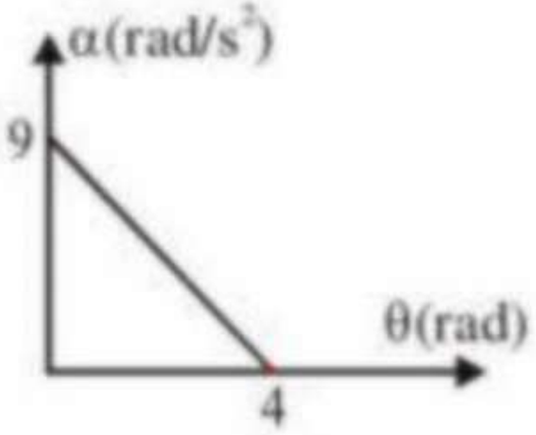
(3) A particle starts moving in a non-uniform circular motion, has angular acceleration as shown in figure. The angular velocity at the end of 4 radian is given by ω rad/s then find the value of ω.

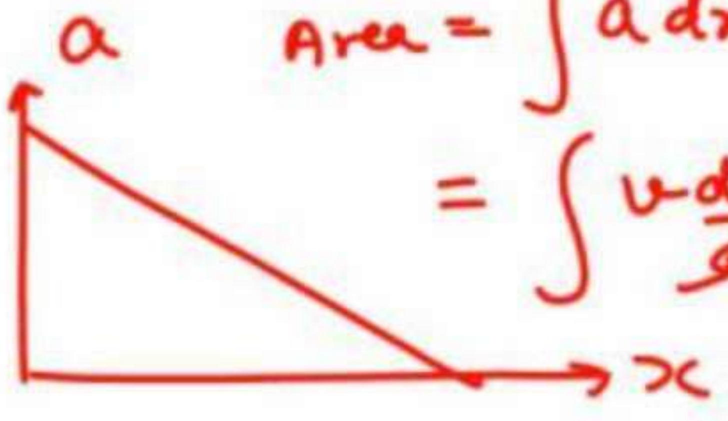
H/W

एक कण असमरूप वृत्ताकार गति कर रहा है, जिसका कोणीय त्वरण चित्रानुसार परिवर्तित हो रहा है। 4 रेडियन के बाद कोणीय वेग ω रेडियन/सेकण्ड हो तो ω का मान ज्ञात कीजिए।

$$\text{Area} = \int \alpha \, d\theta = \int \omega \frac{d\omega}{d\theta} \, d\theta$$

$$\frac{1}{2} \times 4 \times 9 = \frac{\omega^2}{2}$$





$$\text{Area} = \int a \, dx$$
$$= \int v \frac{dv}{\cancel{dx}} \cdot \cancel{dx}$$
$$\text{Area} = \int v \, dv = \frac{v^2}{2}$$

Ans. 6

$\omega^2 = 36 \qquad \omega = 6$

$\omega =$

4 A point P moves in counter clockwise direction on a circular path as shown in the figure. The movement of 'P' is such that it sweeps out a length $s = t^2 + 5$, where s is in metres and t is in seconds. The radius of the path is 20 m. The acceleration of 'P' when $t = 5\sqrt{\frac{3}{10}}$ seconds is nearly : $t^2 = 25 \times \frac{3}{10}$

एक बिन्दु P एक वृत्तीय पथ पर वामावर्ती दिशा में गतिशील है जैसा कि चित्र में दर्शाया गया है। 'P' की गति इस प्रकार है कि वह लम्बाई $s = t^2 + 5$ घेरता है, जहाँ s मीटर में है और t सैकण्ड में है। पथ की त्रिज्या 20 m है। जब $t = 5\sqrt{\frac{3}{10}}$ सेकण्ड है, तब 'P' का त्वरण लगभग है :-

distance $= t^2 + 5 = s$

diff. speed $= \frac{ds}{dt} = 2t$

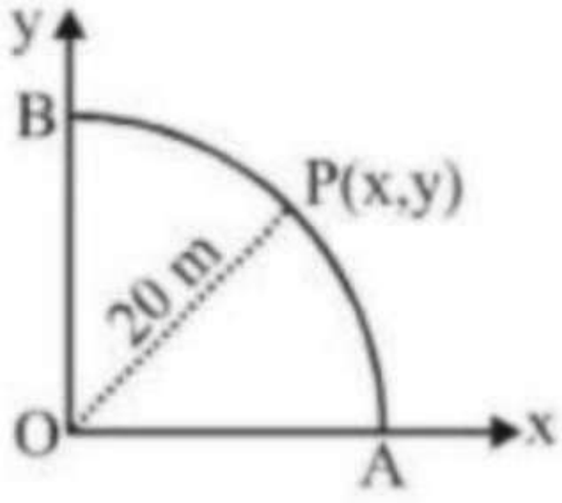
$a_t = 2$

$a_c = \frac{v^2}{R} = \frac{(2t)^2}{20} = \frac{t^2}{5} = \frac{25 \times 3}{5 \times 10} = \frac{3}{2}$

$a = \sqrt{a_t^2 + a_c^2} = \sqrt{2^2 + \left(\frac{3}{2}\right)^2}$

$= \sqrt{4 + \frac{9}{4}}$

$= \sqrt{\frac{25}{4}} = \frac{5}{2}$



(A) $2\ m/s^2$ (B) $1.5\ m/s^2$ (C) $2.5\ m/s^2$ (D) $3\ m/s^2$

Ans. (C)

5 A particle is moving in a circle :

(A) the resultant force on the particle must be towards the centre

(B) the cross product of the tangential acceleration and the angular velocity will be zero

(C) the direction of the angular acceleration and the angular velocity must be the same

(D) the resultant force may be towards the centre

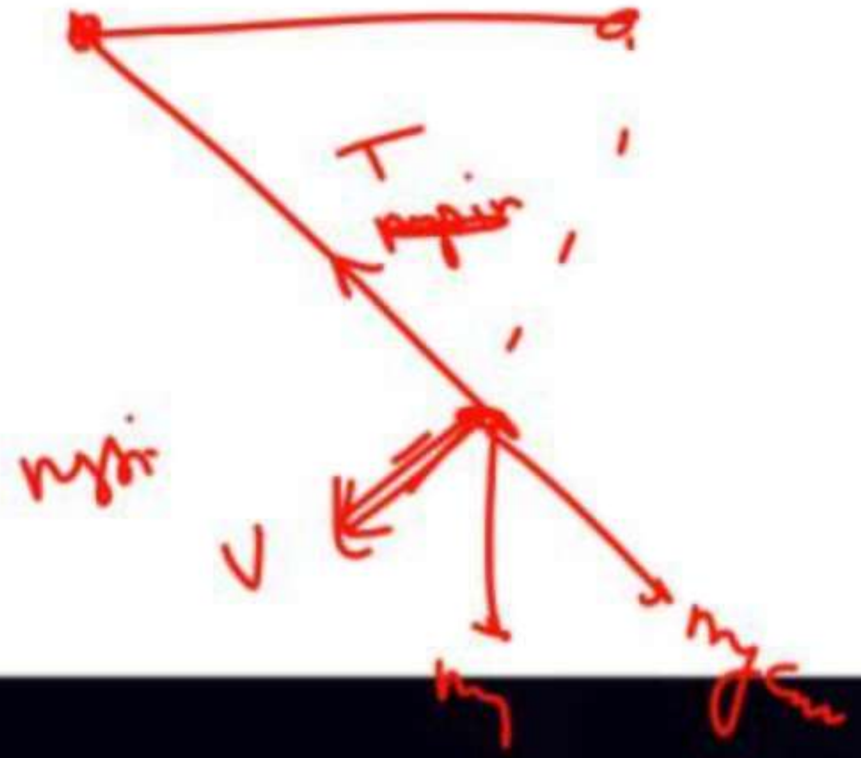
एक कण वृत्त में गति कर रहा है

(A) कण पर परिणामी बल केन्द्र की तरफ ही होगा

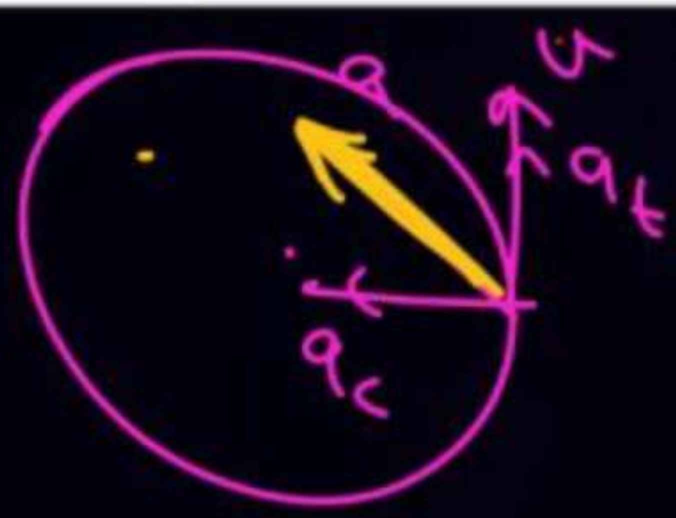
(B) स्पर्श रेखीय त्वरण तथा कोणीय वेग का वज्र गुणन शून्य होगा

(C) कोणीय त्वरण तथा कोणीय वेग की दिशा समान ही होगी

(D) परिणामी बल केन्द्र की तरफ हो सकता है



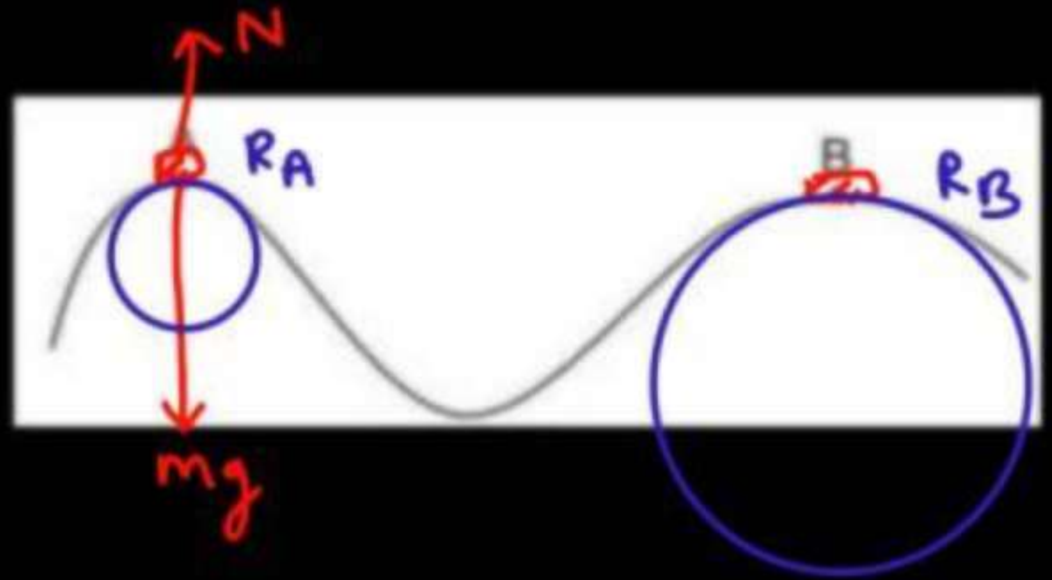
Ans. (D)



6

A car moves at a constant speed on a road as shown in figure (7-Q2). The normal force by the road on the car is N_A and N_B when it is at the points A and B respectively.

(a) $N_A = N_B$ (b) $N_A > N_B$ (c) $N_A < N_B$ (d) insufficient information to decide the relation of N_A and N_B.



$R_A \longrightarrow$ छोटा।

$$mg - N = \frac{mv^2}{R_A}$$

$$N_A = mg - \frac{mv^2}{R_A}$$

$$N_B = mg - \frac{mv^2}{R_B}$$

Ans : (c)

7

A particle is kept fixed on a turntable rotating uniformly. As seen from the ground the particle goes in a circle, its speed is 20 cm/s and acceleration is 20 cm/s^2. The particle is now shifted to a new position to make the radius half of the original value. The new values of the speed and acceleration will be

(a) 10 cm/s, 10 cm/s^2
(b) 10 cm/s, 80 cm/s^2
(c) 40 cm/s, 10 cm/s^2
(d) 40 cm/s, 40 cm/s^2.

$a_c = \frac{v^2}{R}$, $R = \frac{v^2}{a_c}$

$20 = \frac{(20)^2}{R} \Rightarrow \boxed{R = 20 \text{ cm}}$

$R_{new} = \frac{R}{2} = 10 = \frac{v^2}{a_c}$

Ans : (a)

8

A stone of mass m tied to a string of length l is rotated in a circle with the other end of the string as the centre. The speed of the stone is v. If the string breaks, the stone will move

(a) towards the centre (b) away from the centre

(c) along a tangent (d) will stop.

Ans : (c)

9

A coin placed on a rotating turntable just slips if it is placed at a distance of 4 cm from the centre. If the angular velocity of the turntable is doubled, it will just slip at a distance of

(a) 1 cm (b) 2 cm (c) 4 cm (d) 8 cm.

$$f_{max} = \mu mg = mr\omega^2$$

$$\omega \longrightarrow 2\omega$$

$$r \longrightarrow r/4$$

Ans : (a)

10

A particle moves in a circle of radius 1·0 cm at a speed given by $v = 2\cdot0\, t$ where v is in cm/s and t in seconds. (a) Find the radial acceleration of the particle at $t = 1$ s. (b) Find the tangential acceleration at $t = 1$ s. (c) Find the magnitude of the acceleration at $t = 1$ s.

Class

Ans : (a) 4.0 cm/s^2; (b) 2.0 cm/s^2; (c) $\sqrt{20}$ cm/s^2

11

Two cars having masses m_1 and m_2 move in circles of radii r_1 and r_2 respectively. If they complete the circle in equal time, the ratio of their angular speeds ω_1/ω_2 is

(a) m_1/m_2 (b) r_1/r_2 (c) m_1r_1/m_2r_2 (d) 1.

Time period $\longrightarrow$ Same.

$\omega \longrightarrow$ same

$$\omega = \frac{2\pi}{T}$$

Ans : (d)

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OBJECTIVE I

When a particle moves in a circle with a uniform speed

(a) its velocity and acceleration are both constant

(b) its velocity is constant but the acceleration changes

(c) its acceleration is constant but the velocity changes

(d) its velocity and acceleration both change.

Ans : (d)

(13)

A circular road of radius 50 m has the angle of banking equal to 30°. At what speed should a vehicle go on this road so that the friction is not used?

$$v = \sqrt{Rg\tan(\theta \pm \phi)}$$

put $\mu = 0,\ \phi = 0$

$$\tan\theta = \frac{v^2}{Rg}$$

$$\frac{1}{\sqrt{3}} = \frac{v^2}{50 \times 10}$$

$$v^2 = \frac{500}{\sqrt{3}} = \frac{5000}{17}$$

$$v \simeq \frac{10 \times 7}{4} \simeq \frac{35}{2} \simeq 17 \text{ Approx}$$

Ans : (17 m/s)

(14)

A park has a radius of 10 m. If a vehicle goes round it at an average speed of 18 km/hr, what should be the proper angle of banking ?

$16 \times \frac{5}{18} = 5\,m/s$

$\tan\theta = \frac{v^2}{Rg} = \frac{5 \times 5}{10 \times 10}$

Ans : $\tan^{-1}(1/4)$

(5)

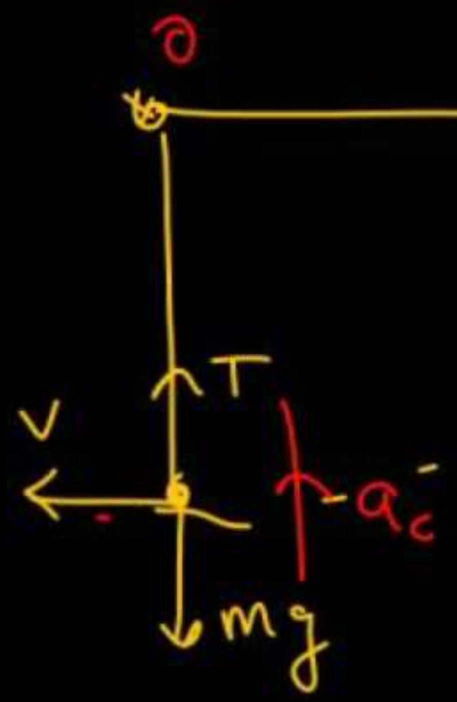
A scooter weighing 150 kg together with its rider moving at 36 km/hr is to take a turn of radius 30 m. What horizontal force on the scooter is needed to make the turn possible ?

$$F = \frac{mv^2}{R} = \frac{150 \times 100}{30}$$

Ans : 500 N

16

The bob of a simple pendulum of length 1 m has mass 100 g and a speed of 1·4 m/s at the lowest point in its path. Find the tension in the string at this instant.



$$T - mg = \frac{mv^2}{R}$$

Ans : 1.2 N

17

$R = 20$

. A turn of radius 20 m is banked for the vehicles going at a speed of 36 km/h. If the coefficient of static friction between the road and the tyre is 0·4, what are the possible speeds of a vehicle so that it neither slips down nor skids up ?

$$V_{max} = \sqrt{Rg\tan(\theta+\phi)}$$

$$\tan\phi = \mu$$

$$36 \times \frac{5}{18} = 10\,m/s$$

$$\tan\theta = \frac{V^2}{Rg} = \frac{10\times10}{20\times10} = \frac{1}{2}$$

$$= \sqrt{200 \quad \frac{.5+.4}{1-.5\times.4}}$$

$$= \sqrt{\frac{200\times .9}{.8}} = 3\times5 = 15\,m/s$$

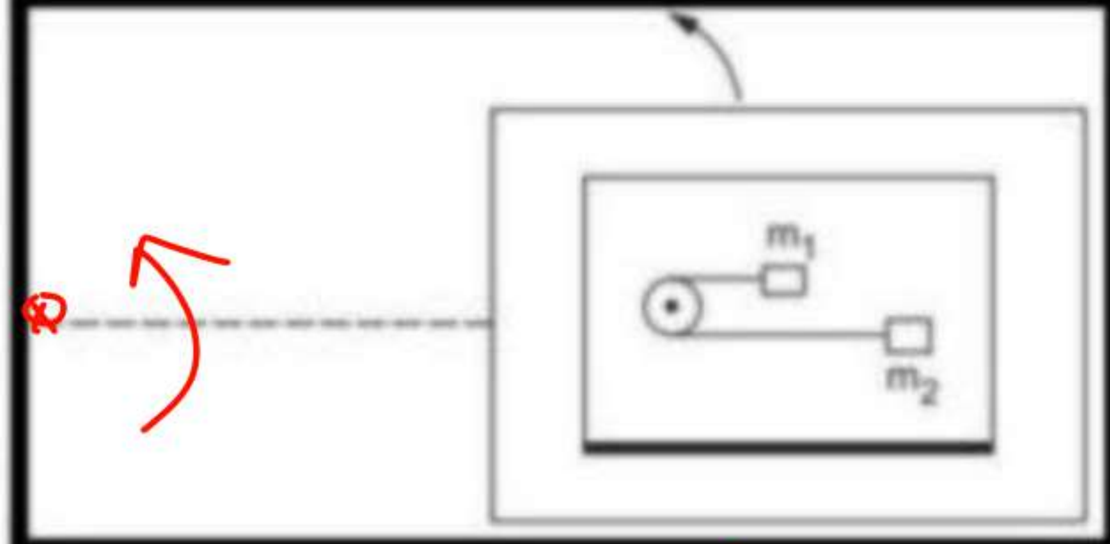
$$= 15\times\frac{18}{5}$$

$$= 54\,km/hr$$

Ans : Between 14.7 km/h and 54 km/hr

18

A table with smooth horizontal surface is placed in a cabin which moves in a circle of a large radius R (figure 7-E5). A smooth pulley of small radius is fastened to the table. Two masses m and $2m$ placed on the table are connected through a string going over the pulley. Initially the masses are held by a person with the strings along the outward radius and then the system is released from rest (with respect to the cabin). Find the magnitude of the initial acceleration of the masses as seen from the cabin and the tension in the string.



$$a = \frac{2mR\omega^2 - mR\omega^2}{3m} = \frac{R\omega^2}{3}$$

$$T = \frac{2 \times m \times 2m}{m + 2m} \times R\omega^2$$

Ans : $\frac{\omega^2 R}{3}, \frac{4}{3} m\omega^2 R$

(19)

. A particle is projected with a speed u at an angle θ with the horizontal. Consider a small part of its path near the highest position and take it approximately to be a circular arc. What is the radius of this circle? This radius is called the radius of curvature of the curve at the point.

Class

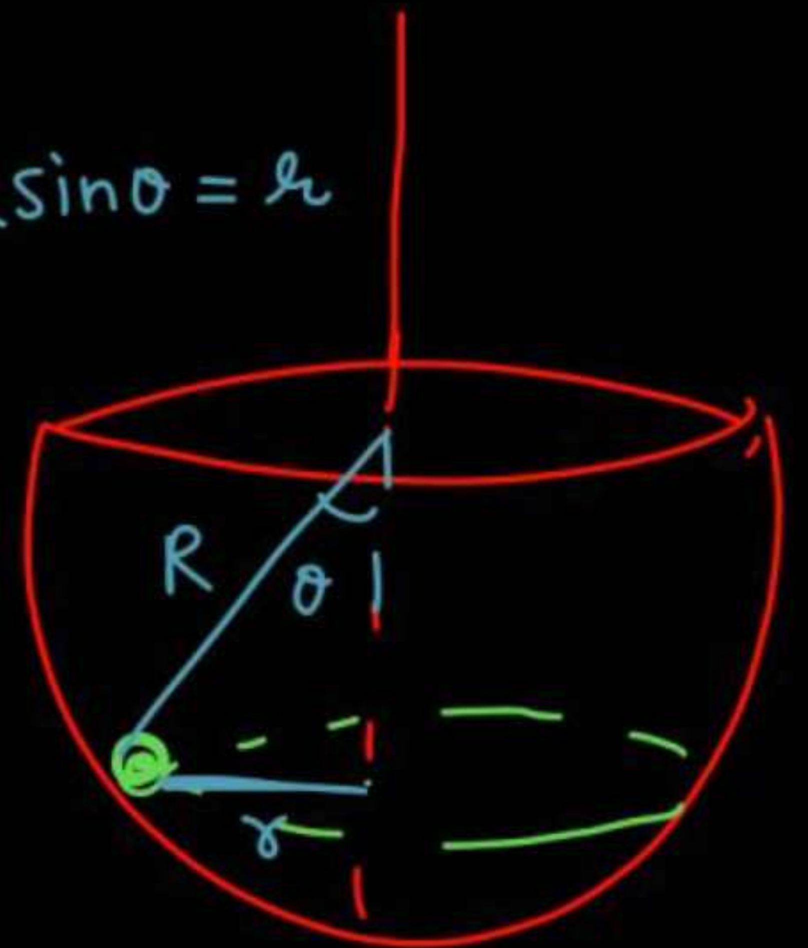
$$ROC = \frac{v^2}{a_N} = \frac{(u\cos\theta)^2}{g}$$

Ans : $\boxed{\dfrac{u^2\cos^2\theta}{g}}$

20

A hemispherical bowl of radius R is rotated about its axis of symmetry which is kept vertical. A small block is kept in the bowl at a position where the radius makes an angle θ with the vertical. The block rotates with the bowl without any slipping. The friction coefficient between the block and the bowl surface is μ. Find the range of the angular speed for which the block will not slip.

$R\sin\theta = r$



$$V_{max} = \sqrt{r g \tan(\theta+\phi)}$$

$$\omega = \frac{V}{r} = \sqrt{\frac{g\tan(\theta+\phi)}{r}} = \sqrt{\frac{g}{r}\cdot\frac{\tan\theta+\tan\phi}{1-\tan\theta\tan\phi}} = \sqrt{\frac{g}{R\sin\theta}\left(\frac{\tan\theta+\mu_s}{1-\mu_s\tan\theta}\right)}$$

Radius of circle

Ans : $\left[\frac{g(\sin\theta-\mu\cos\theta)}{R\sin\theta(\cos\theta+\mu\sin\theta)}\right]^{1/2}$ to $\left[\frac{g(\sin\theta+\mu\cos\theta)}{R\sin\theta(\cos\theta-\mu\sin\theta)}\right]^{1/2}$

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148. A coin is placed on a disc. The coefficient of friction between the coin and the disc is μ. If the distance of the coin from the center of the disc is r, the maximum angular velocity which can be given to the disc, so that the coin does not slip away, is:

[Main - Jan. 31, 2024 (I)]

(1) $\frac{\mu}{\sqrt{rg}}$ (2) $\sqrt{\frac{\mu g}{r}}$ $\mu mg = mR\omega^2$

(3) $\frac{\mu g}{r}$ (4) $\sqrt{\frac{r}{\mu g}}$

22

149. A coin placed on a rotating table just slips when it is placed at a distance of 1 cm from the centre. If the angular velocity of the table is halved, it will just slip when placed at a distance of ______ from the centre:

[Main - April 11, 2023 (I)]

(1) 2 cm (2) 1 cm

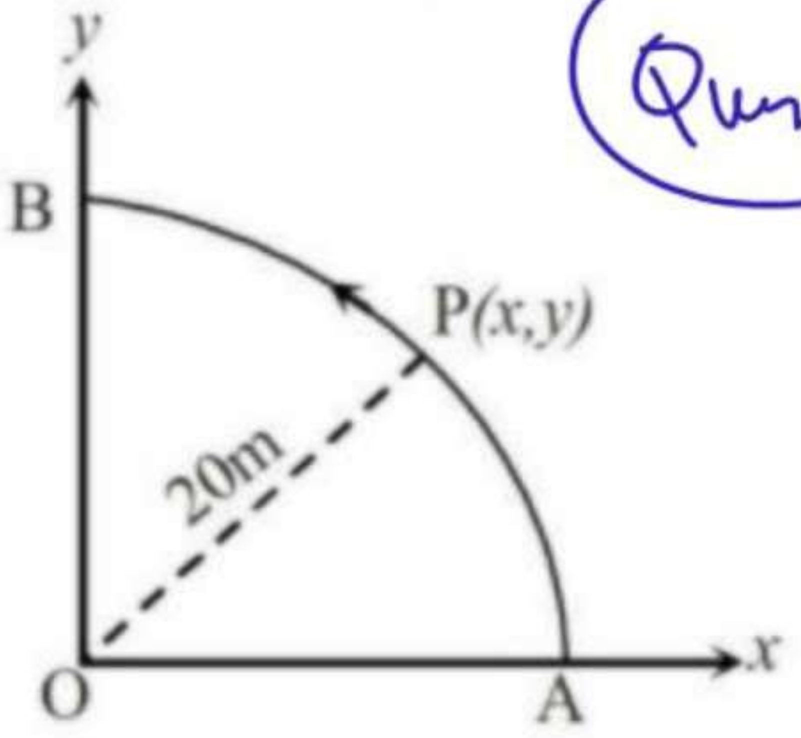
(3) 8 cm (4) 4 cm

146. A point P moves in counter-clockwise direction on a circular path as shown in the figure. The movement of 'P' is such that it sweeps out a length $s = t^3 + 5$, where s is in metres and t is in seconds. The radius of the path is 20 m. The acceleration of 'P' when $t = 2$ s is nearly. **[Main - 2010]**

23

H|W

Qun 4



(1) $13\ m/s^2$
(2) $12\ m/s^2$
(3) $7.2\ m/s^2$
(4) $14\ m/s^2$

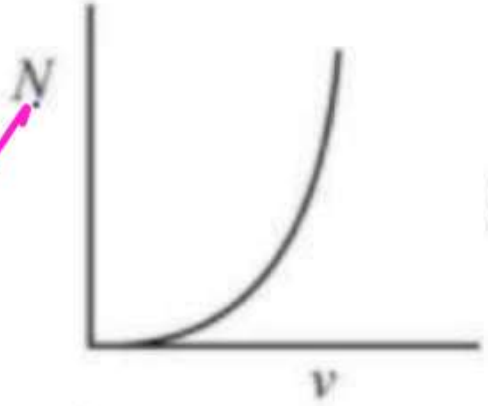
24

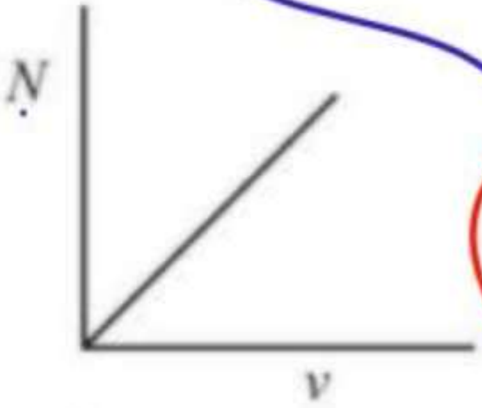
136. A smooth circular groove has a smooth vertical wall as shown in figure. A block of mass m moves against the wall with a speed v. Which of the following curve represents the correct relation between the normal reaction on the block by the wall (N) and speed of the block (v)?

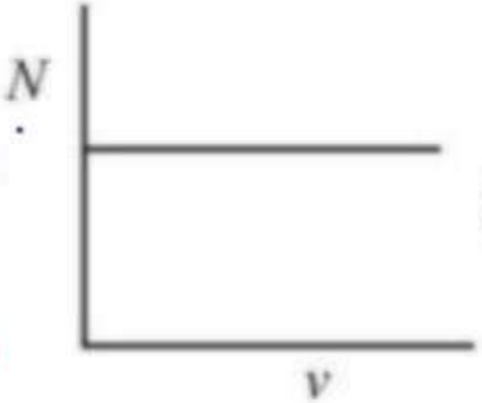
[Main - July 29, 2022 (I)]

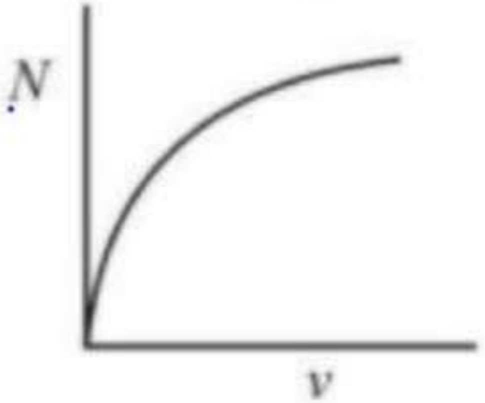
$N = \frac{mv^2}{R}$

$y = \frac{m}{R} x^2$

(1) 

(2) 

(3) 

(4) 

133. A car is moving on a horizontal curved road with radius 50 m. The approximate maximum speed of car will be, if friction between tyres and road is 0.34. [take $g = 10\ \mathrm{ms^{-2}}$]

[Main - Jan. 29, 2023 (I)]

(1) $3.4\ \mathrm{ms^{-1}}$ (2) $22.4\ \mathrm{ms^{-1}}$

(3) $13\ \mathrm{ms^{-1}}$ (4) $17\ \mathrm{ms^{-1}}$

24

b

$\mu mg = \frac{mv^2}{R}$

$V = \sqrt{\mu g R} = \sqrt{.34 \times 10 \times 50} = \sqrt{170}$

135. A car is moving with a constant speed of 20 m/s in a circular horizontal track of radius 40 m. A bob is suspended from the roof of the car by a massless string. The angle made by the string with the vertical will be: (Take $g = 10\ \text{m/s}^2$)

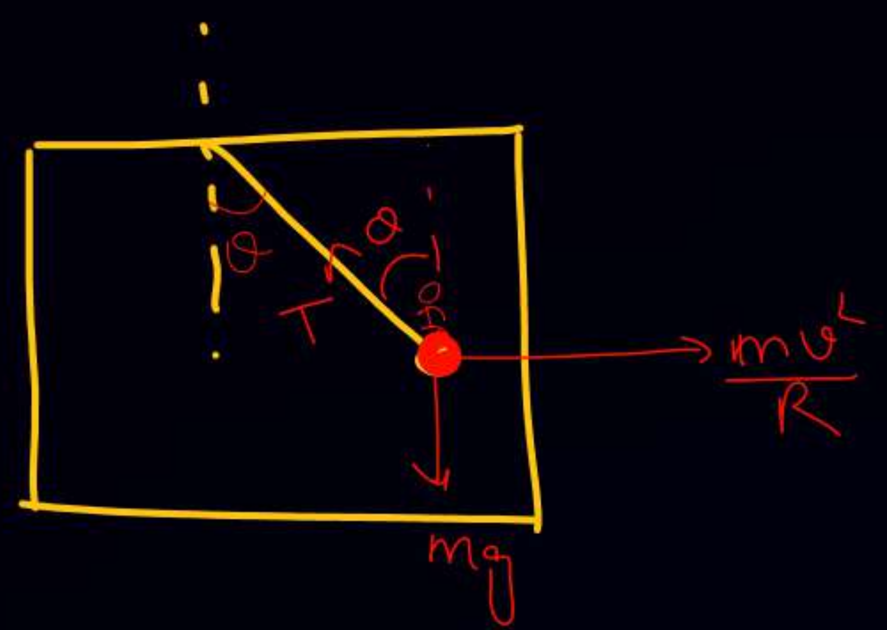
25

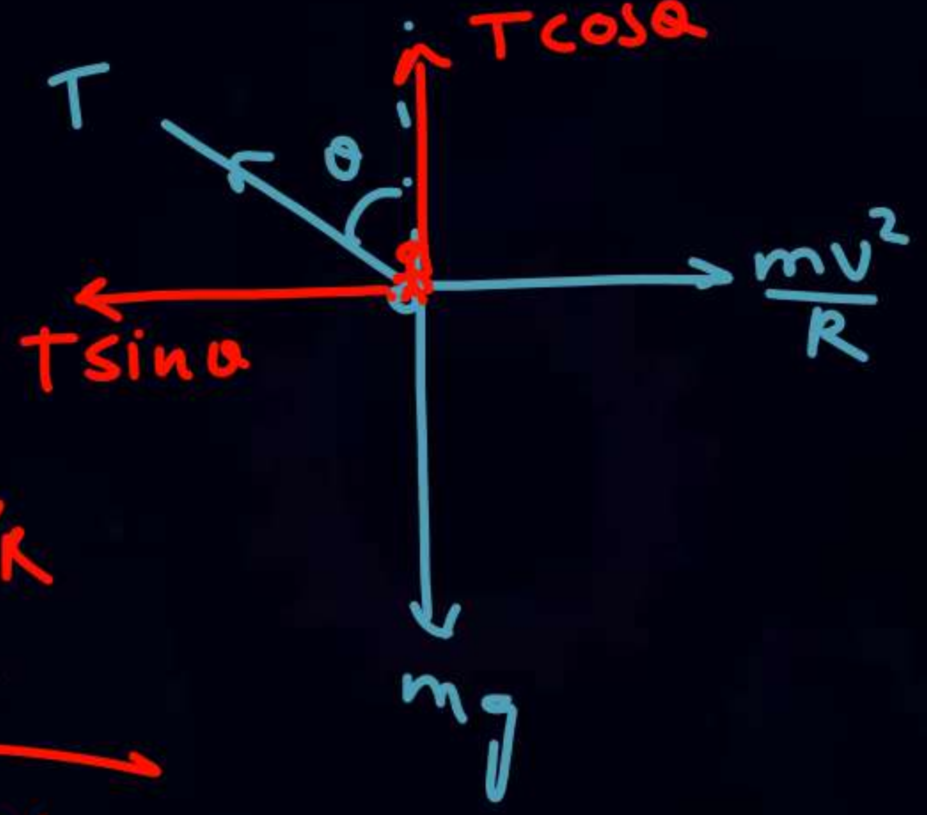
[Main - Jan. 25, 2023 (I)]

(1) $\pi/6$ (2) $\pi/2$

$\tan\theta = \frac{v^2}{Rg}$

(3) $\pi/4$ (4) $\pi/3$





$$T\sin\theta = mv^2/R$$
$$T\cos\theta = mg$$

$$\tan\theta = v^2/Rg$$

131. A vehicle of mass 200 kg is moving along a levelled curved road of radius 70 m with angular velocity of 0.2 rad/s. The centripetal force acting on the vehicle is: [Main - April 13, 2023 (I)]

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(1) 560 N
(2) 2800 N
(3) 14 N
(4) 2240 N

$mR\omega^2 = 200 \times 70 \times (.2)^2$

127. A ball of mass 0.5 kg is attached to a string of length 50 cm. The ball is rotated on a horizontal circular path about its vertical axis. The maximum tension that the string can bear is 400 N. The maximum possible value of angular velocity of the ball in rad/s is: **[Main - Feb. 1, 2024 (I)]**

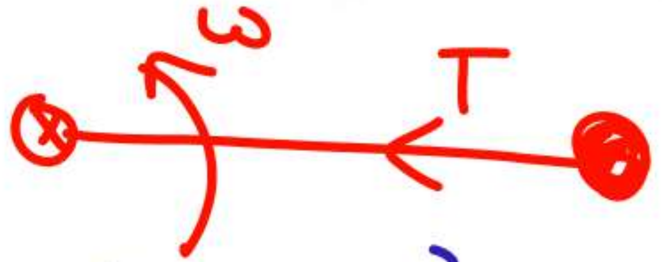
(27)

$T = mR\omega^2$

$400 = \frac{1}{2} \times \frac{1}{2} \omega^2$

(1) 1600 (2) 40

(3) 1000 (4) 20



$T = mr\omega^2$

125. A car of 800 kg is taking turn on a banked road of radius 300 m and angle of banking 30°. If coefficient of static friction is 0.2 then the maximum speed with which car can negotiate the turn safely: ($g = 10\ m/s^2$, $\sqrt{3} = 1.73$)

28

[Main - April 6, 2024 (II)]

(1) 70.4 m/s $V_{max} = \sqrt{Rg \tan(\theta + \phi)}$

(2) 51.4 m/s

(3) 264 m/s

(4) 102.8 m/s

CIRCULAR MOTION, BANKING OF ROAD

123. A car of mass 'm' moves on a banked road having radius 'r' and banking angle θ. To avoid slipping from banked road, the maximum permissible speed of the car is v_0. The coefficient of friction μ between the wheels of the car and the banked road is

29

[Main - Jan. 24, 2025 (I)]

(1) $\mu = \dfrac{v_0^2 + rg\tan\theta}{rg - v_0^2\tan\theta}$

(2) $\mu = \dfrac{v_0^2 + rg\tan\theta}{rg + v_0^2\tan\theta}$

(3) $\mu = \dfrac{v_0^2 - rg\tan\theta}{rg + v_0^2\tan\theta}$

(4) $\mu = \dfrac{v_0^2 - rg\tan\theta}{rg - v_0^2\tan\theta}$

$\tan\phi = \mu_s$

$V_{max} = \sqrt{Rg\tan(\theta+\phi)}$

$V_0^2 = Rg\,\dfrac{\tan\theta + \mu}{1 - \tan\theta . \mu}$

$V_0^2 - V_0^2\mu . \tan\theta = Rg\tan\theta + \mu Rg$

$V_0^2 - Rg\tan\theta = \mu(Rg + V_0^2\tan\theta)$

30

QUESTION

A particle of mass m is fixed to one end of a light spring having force constant k and unstretched length l. The other end is fixed. The system is given an angular speed ω about the fixed end of the spring such that it rotates in a circle in gravity free space. Then the stretch in the spring is:

[JEE Main - 2020]

(1) $\dfrac{ml\omega^2}{k+m\omega^2}$

(2) $\dfrac{ml\omega^2}{k-m\omega^2}$ ✓

(3) $\dfrac{ml\omega^2}{k-m\omega}$

(4) $\dfrac{ml\omega^2}{k+m\omega}$

$$kx = m(l+x)\omega^2$$

$$kx = ml\omega^2 + mx\omega^2$$

$$x(k-m\omega^2) = ml\omega^2$$

Ans : (2)

31

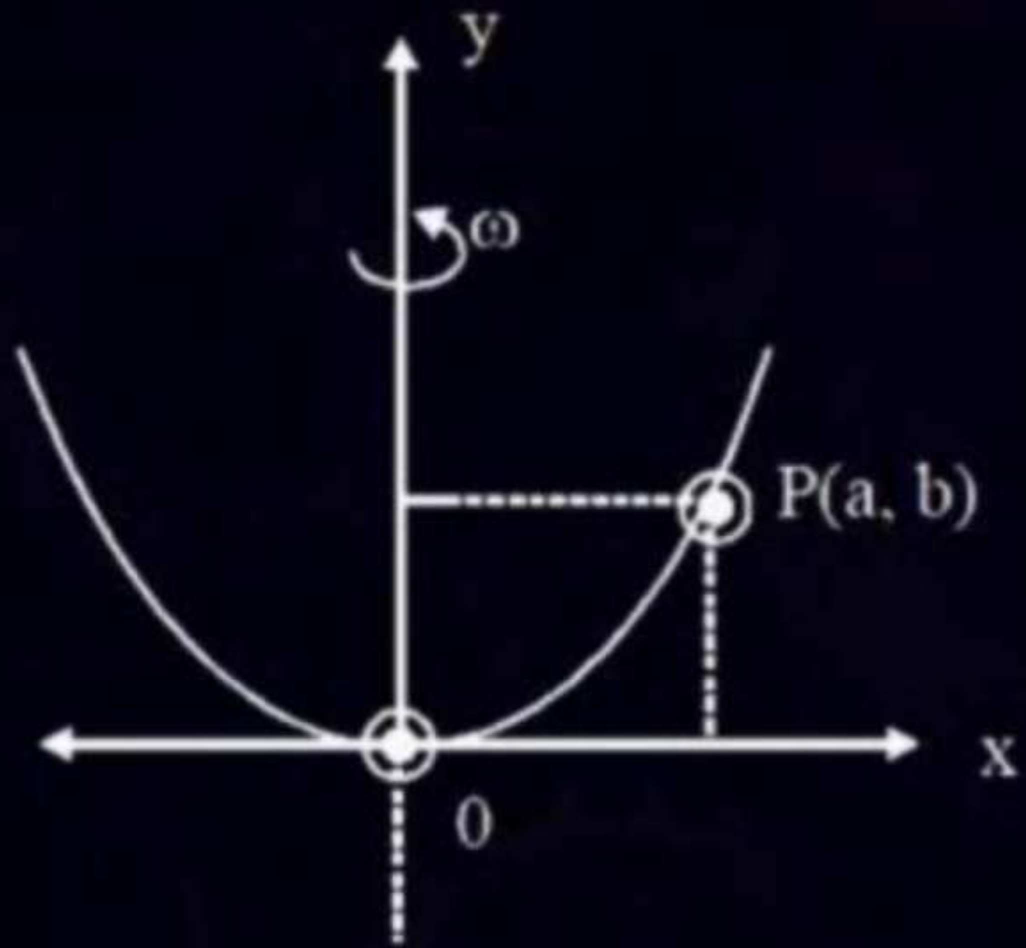
QUESTION

$\frac{g\tan\theta}{a} = \omega^2 = \frac{g}{\cancel{a}} 8C\cancel{x}$ $\tan\theta = \frac{dy}{dx} = 8Cx$ $x = a$

A bead of mass m stays at point P(a, b) on a wire bent in the shape of a parabola $y = 4Cx^2$ and rotating with angular speed ω (see figure). The value of ω is (neglect friction):

$\cancel{m}g\sin\theta = \cancel{m}a\omega^2\cos\theta$

[JEE Main - 2020]



(1) $\sqrt{\frac{2gC}{ab}}$

(2) $2\sqrt{2gC}$

(3) $\sqrt{\frac{2g}{c}}$

(4) $2\sqrt{gC}$

Ans : (2)

QUESTION

E-R

$T = \frac{\text{Dist.}}{\text{speed}} = \frac{2\pi R}{v}$

A particle is moving with uniform speed along the circumference of a circle of radius R under the action of a central fictitious force F which is inversely proportional to R^3. Its time period of revolution will be given by: **[JEE Main - 2021]**

1. $T \propto R^2$
2. $T \propto R^{3/2}$
3. $T \propto R^{5/2}$
4. $T \propto R^{4/3}$

$F = \frac{K}{R^3} = \frac{mv^2}{R}$

$v^2 = \frac{K}{mR^2}$

$v = \frac{K'}{R}$

$T = \frac{2\pi R}{v} = \frac{2\pi R}{K'/R} = \frac{2\pi}{K'} R^2$

Ans : (1)

33

QUESTION

$$N = mR\omega^2 = mR\left(\frac{2\pi}{T}\right)^2 = \frac{200}{1000} \times \frac{20}{100} \times \frac{4\pi^2}{(40)^2}$$

A block of 200 g mass moves with a uniform speed in a horizontal circular groove, with vertical side walls of radius 20 cm. If the block takes 40 s to complete one round, the normal force by the side walls of the groove is: **[JEE Main - 2021]**

$$T = 40 = \frac{2\pi R}{V}$$

$$V = \frac{2\pi R}{40}$$

(1) 0.0314 N

(2) 9.859×10^{-2} N

(3) 6.28×10^{-3} N

(4) 9.859×10^{-4} N

$$N = \frac{mV^2}{R}$$

$$= \frac{\cancel{200}}{\cancel{1000}} \times \frac{4\pi^2 R^{\cancel{2}}}{1600 \times \cancel{R}}$$

$$= \frac{R}{200} = \frac{\cancel{20}}{100 \times \cancel{200}_{10}} = \frac{1}{1000}$$

$$10 \times 10^{-4} = 10^{-3}$$

Ans : (4)

34

QUESTION

$\tan(\theta+\phi) = \frac{1+.2}{1-1\times.2} = \frac{1.2}{.8} = \frac{3}{2}$

$a_t = 0$

$\theta = 0$

Statement I: A cyclist is moving on an unbanked road with a speed of 7 kmh^{-1} and takes a sharp circular turn along a path of radius of 2 m without reducing the speed. The static friction coefficient is 0.2. The cyclist will not slip and pass the curve ($g = 9.8\ m/s^2$)

$V_{max} = \sqrt{\mu g R} = \sqrt{.2\times9.8\times2} = \frac{1}{10}\times2\times9.9 = 1.98$

Statement II: If the road is banked at an angle of 45°, cyclist can cross the curve of 2 m radius with the speed of 18.5 kmh^{-1} without slipping.

In the light of the above statements, choose the correct answer from the options given below. **[JEE Main – 2021]**

$V_{max} = \sqrt{Rg\tan(\theta+\phi)} = \sqrt{\cancel{2}\times9.8\times\frac{3}{\cancel{2}}} = 5.5$

$7\frac{km}{hr} = 7\times\frac{5}{18} = \frac{35}{18}$

$= 1.9$

$\frac{5}{18}\times18.5 = 5.1$

1. Statement I is incorrect and statement II is correct
2. Statement I is correct and statement II is incorrect
3. Both statement I and statement II are false
4. Both statement I and statement II are true

Ans : (4)

35

QUESTION

A modern grand-prix racing car of mass m is travelling on a flat track in a circular arc o radius R with a speed v. If the coefficient of static friction between the tyres and the track is μ_s, then the magnitude of negative lift F_L acting downwards on the car is (Assume forces on the four tyres are identical and g = acceleration due to gravity)

[JEE Main - 2021]

$$\mu N = \frac{mv^2}{R}$$

(1) $m\left(\frac{v^2}{\mu_s R} + g\right)$

(2) $m\left(\frac{v^2}{\mu_s R} - g\right)$

(3) $m\left(g - \frac{v^2}{\mu_s R}\right)$

(4) $-m\left(g + \frac{v^2}{\mu_s R}\right)s$

$$\mu(mg + F_L) = \frac{mv^2}{R}$$

$$F_L = \frac{mv^2}{R\mu} - mg$$

$$= m\left(\frac{v^2}{R\mu} - g\right)$$

Ans : (

36

QUESTION

$f = \mu N$

The normal reaction 'N' for a vehicle of 800 kg mass, negotiating a turn on a 30° banked road at maximum possible speed without skidding is ______ $\times 10^3$ kg m/s^2.

$\mu = .2$

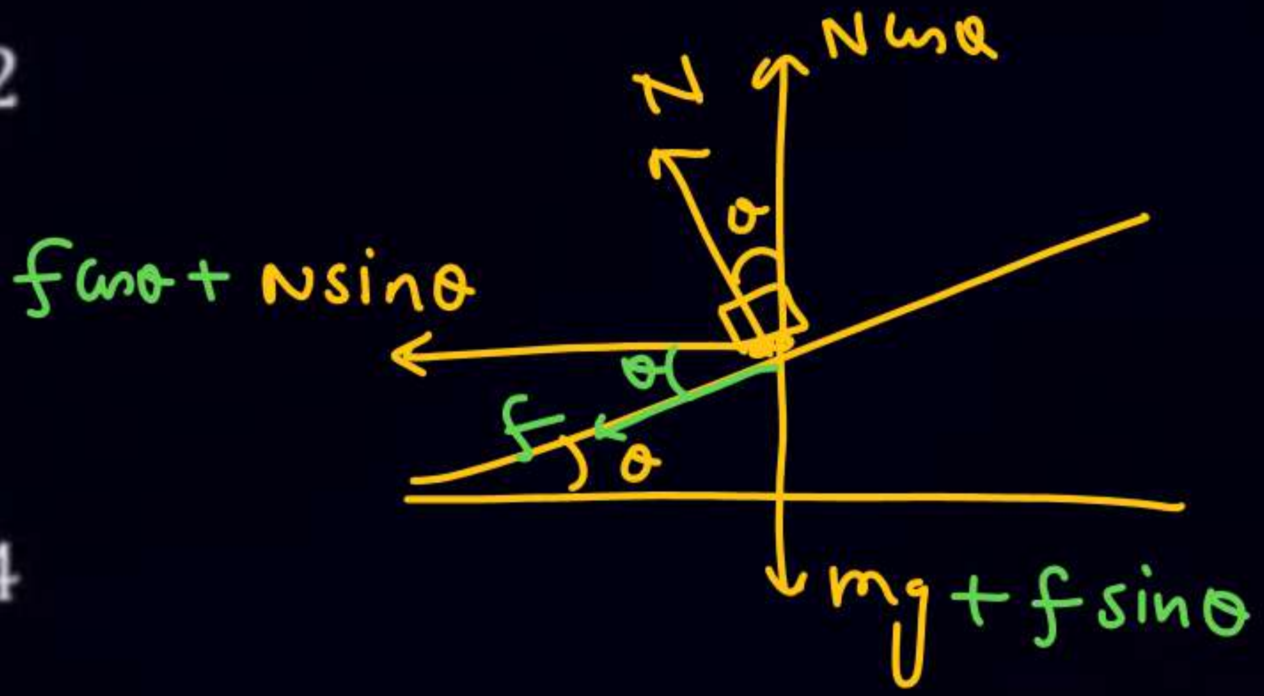
[JEE Main - 2021]

(1) 10.2

(2) 7.2

(3) 12.4

(4) 6.96



$N\cos\theta = mg + f\sin\theta$

$N\cos\theta = mg + \mu N\sin\theta$

$N(\cos\theta - \mu\sin\theta) = mg$

$N = \dfrac{mg}{\cos\theta - \mu\sin\theta} = \dfrac{8000}{\frac{\sqrt{3}}{2} - .2\times\frac{1}{2}}$

$= \dfrac{16\cancel{000}}{1.53}\times 10^3$

1.73
0.2

Ans : (1)

37

QUESTION

A body rotating with an angular speed of 600 rpm is uniformly accelerated to 1800 rpm in 10 sec. The number of rotations made in the process is. [JEE Main - 2021]

$\omega_i = 600 \times \pi/30$

$\omega_f = 1800 \times \pi/30$

$t = 10$

$\omega_f = \omega_i + \alpha t$

$\alpha = \checkmark$

$\theta = \omega_i t + \frac{1}{2}\alpha t^2$

Ans $\frac{\theta}{2\pi}$.

Ans : (200)

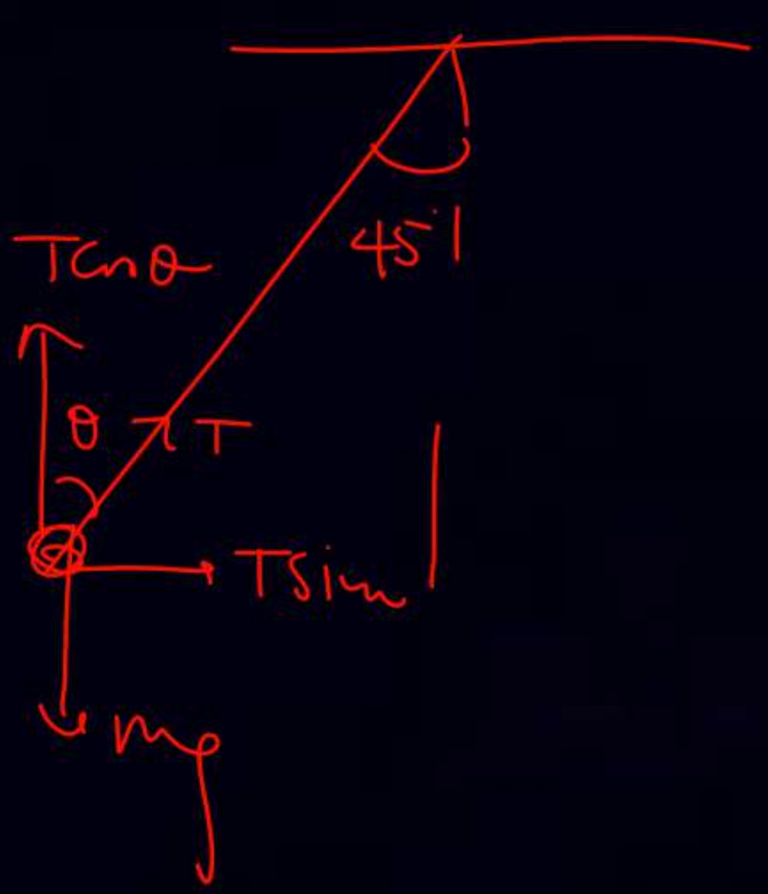
38

QUESTION

Conical

A particle of mass m is suspended from a ceiling through a string of length L. The particle moves in a horizontal circle of radius r such that $r = \frac{L}{\sqrt{2}}$. The speed of particle will be:

[JEE Main - 2021]



$\tan\theta = \frac{v^2}{Rg}$

$1 = \frac{v^2}{rg}$

(1) $\sqrt{rg}$

(2) $\sqrt{2rg}$

(3) $2\sqrt{rg}$

(4) $\sqrt{\frac{rg}{2}}$

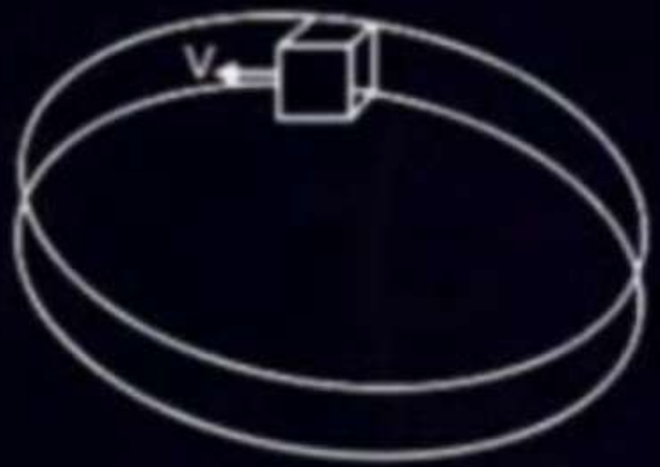
Ans : (1)

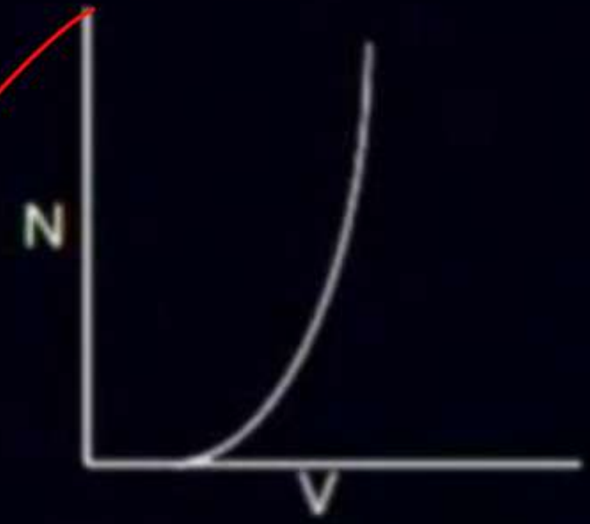
39

QUESTION

A smooth circular groove has a smooth vertical wall as shown in figure. A block of mass m moves against the wall with a speed v. Which of the following curve represents the correct relation between the normal reaction on the block by the wall (N) and speed of the block (V)?

[JEE Main - 2022]



(1)


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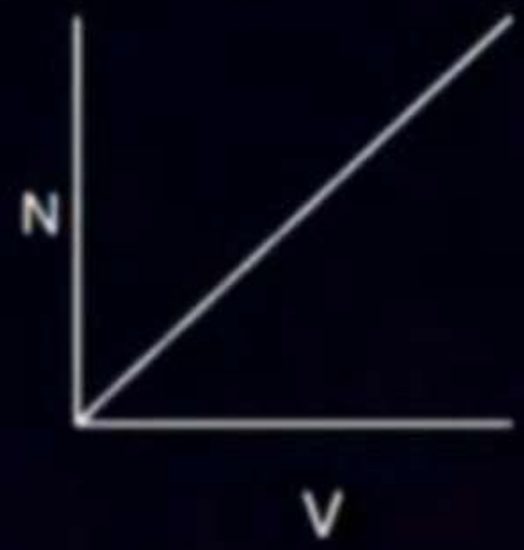

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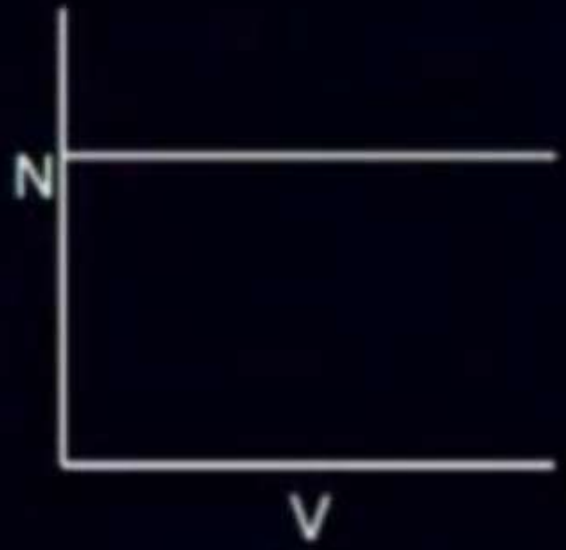

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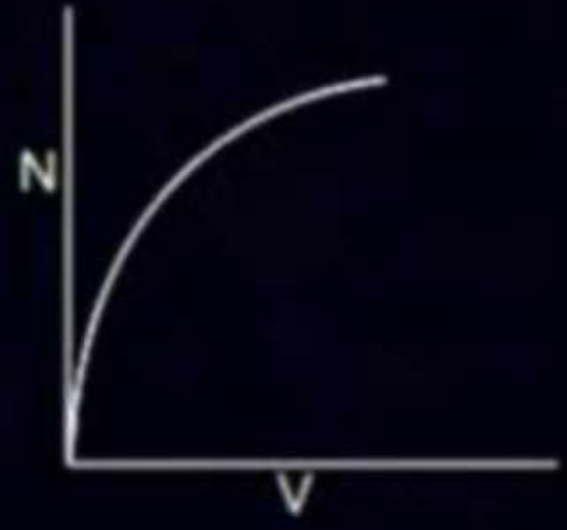


Ans : (1)

40

QUESTION

याद है

A particle of mass m is moving in a circular path of constant radius r such that its centripetal acceleration (a) is verying with time t as $a = k^2r^2t$ where k is constant. The power delivered to the particle by the force acting on it is given as: **[JEE Main - 2022]**

Work Power Energy

1. zero
2. $mk^2r^2t^2$
3. mk^2r^2t
4. mk^2rt

Ans : (3)

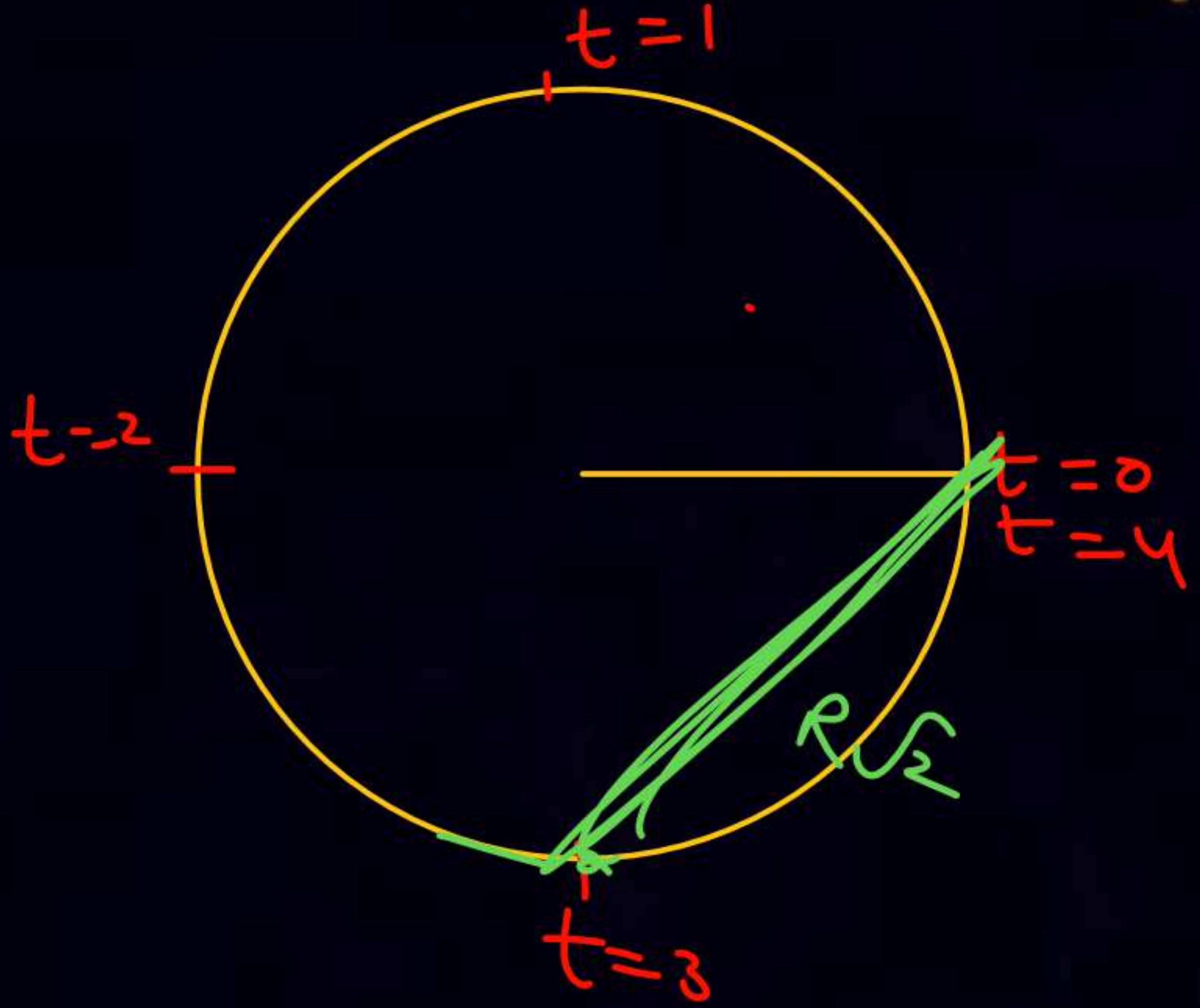
41

QUESTION

A body is moving with constant speed, in a circle of radius 10 m. The body completes one revolution in 4 s. At the end of 3rd second, the displacement of body (in m) from its starting point is:

[31 Jan, 2023 (shift-II)]

$T = 4\,sec$



(1) 30

(2) 15π

(3) 5π

(4) $10\sqrt{2}$

Ans : (4)

42

QUESTION

A particle is moving with constant speed in a circular path. When the particle turns by an angle 90°, the ratio of instantaneous velocity to its average velocity is $\pi : x\sqrt{2}$. The value of x will be:

[06 April, 2023 (shift-I)]

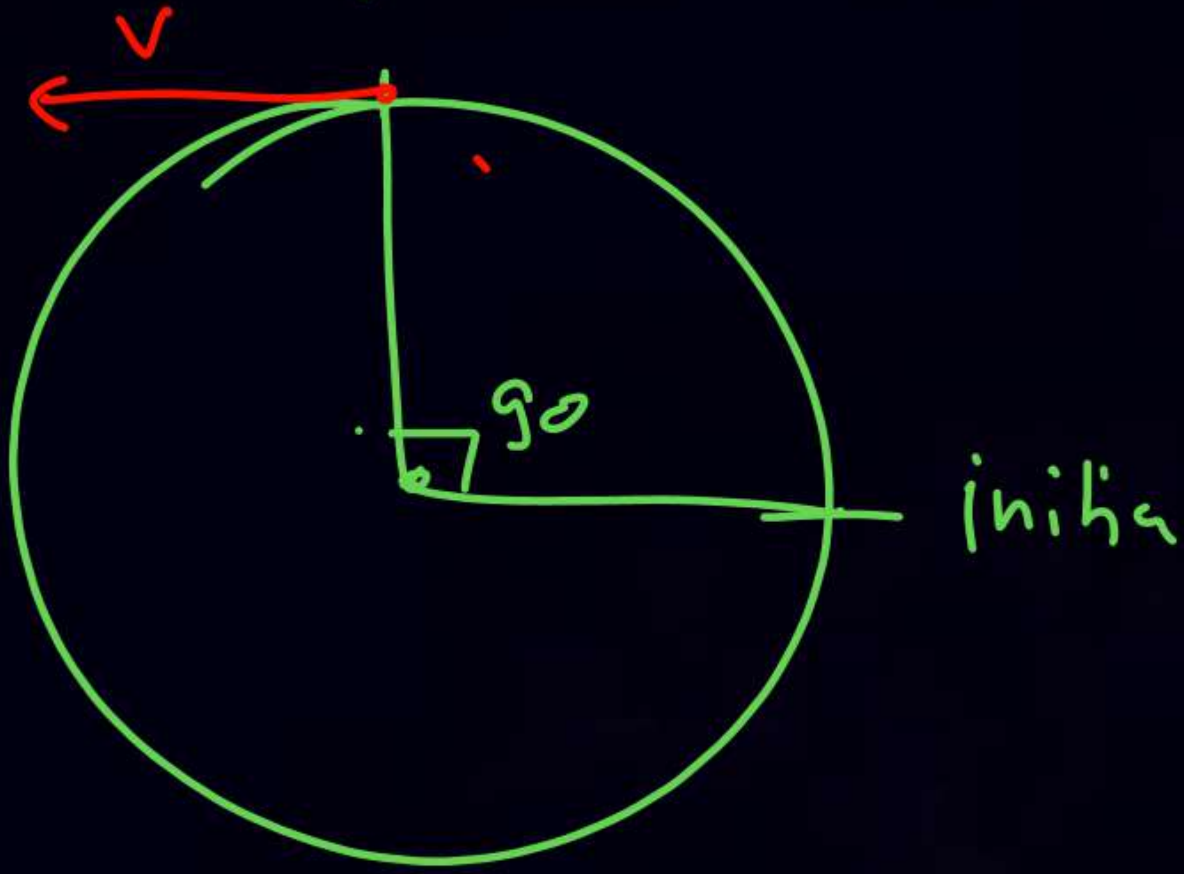
Find

(1) 2 ✓

(2) 5

(3) 1

(4) 7



$$\frac{VT}{R\sqrt{2}\times 4}$$

$$= \frac{V}{R\sqrt{2}\times 4}\times\frac{2\pi R}{V}$$

$$= \frac{2\pi}{4\sqrt{2}} = \frac{\pi}{2\sqrt{2}}$$

Ans : (1)

43

QUESTION

A car is moving on a circular path of radius 600 m such that the magnitudes of the tangential and centripetal acceleration are equal. Time taken by the car to complete first quarter of revolution, if it is moving with an initial speed of 54 km/hr is $t\left(1 - e^{-\pi/2}\right)$s. The value of t is:

[29 Jan, 2023 (shift-II)]

15 m/s

$$\frac{v^2}{R} = \frac{d\overset{\text{speed}}{v}}{dt}$$

Ans : (40)

$$a_c = a_t$$

$$\frac{V^2}{R} = \frac{dv}{dt}$$

$$\int_{15}^{V} \frac{dv}{V^2} = \int_0^t \frac{dt}{R}$$

$$-\frac{1}{V}\Big|_{15}^{V} = \frac{t}{R}$$

$$\frac{1}{V} - \frac{1}{15} = -\frac{t}{R}$$

$$\frac{1}{V} = \frac{1}{15} - \frac{t}{R}$$

$$\frac{dt}{ds} = \frac{1}{15} - \frac{t}{600} = \frac{40-t}{600}$$

$$\int_0^t \frac{dt}{40-t} = \int_0^{\frac{2\pi R}{4}} \frac{ds}{600}$$

$$-\ln\left(\frac{40-t}{40}\right) = \frac{2\pi \cancel{R}}{4 \times \cancel{600}}$$

$$\ln\left(\frac{40-t}{40}\right) = -\frac{\pi}{2}$$

$$\left(1 - \frac{t}{40}\right) = e^{-\pi/2}$$

$$t = \left(1 - e^{-\pi/2}\right) \times 40$$

44

QUESTION

A stone tied to 180 cm long string at its end is making 28 revolutions in horizontal circle in every minute. The magnitude of acceleration of stone is $\frac{1936}{x}$ ms^{-2}. The value of x ______. (Take $\pi = \frac{22}{7}$)

[30 Jan, 2023 (shift-II)]

$1\ min \longrightarrow 28\ rev$

$\omega = 28 \times \frac{\pi}{30}$

$R\omega^2$

Ans : (125)

45

QUESTION

A coin placed on a rotating table just slips when it is placed at a distance of 1 cm from the center. If the angular velocity of the table in halved, it will just slip when placed at a distance of from the centre:

[11 April, 2023 (shift-I)]

(1) 2 cm

(2) 1 cm

(3) 8 cm

(4) 4 cm

Ans : (4)

46

QUESTION

A small block of mass 100 g is tied to a spring of spring constant 7.5 N/m and length 20 cm. The other end of spring is fixed at a particular point A. If the block moves in a circular path on a smooth horizontal surface with constant angular velocity 5 rad/s about point A, then tension in the spring is: [06 April, 2023 (shift-I)]

$$F_{sp} = kx = m(l+x)\omega^2$$

(1) 1.5 N

(2) 0.75 N

(3) 0.25 N

(4) 0.50 N

Ans : (2)

47

QUESTION

A car is moving on a horizontal curved road with radius 50 m. The approximate maximum speed of car will be, if friction coefficient between tyres and road is 0.34. [Take $g = 10\ ms^{-2}$]

[29 Jan, 2023 (shift-I)]

(1) $3.4\ ms^{-1}$

(2) $22.4\ ms^{-1}$

(3) $13\ ms^{-1}$

(4) $17\ ms^{-1}$

Ans : (3)

48

QUESTION

A body of mass 200 g is tied to a spring of spring constant 12.5 N/m, while the other end of spring is fixed at point O. If the body moves about O in a circular path on a smooth horizontal surface with constant angular speed 5 rad/s, then the ratio of extension in the spring to its natural length will be: [24 Jan, 2023 (shift-II)]

$\frac{x}{l} = y$

(1) 1 : 2

(2) 1 : 1

(3) 2 : 3

(4) 2 : 5

$$F_{sp} = kx = m(l+x)\omega^2$$

$$k\left(\frac{x}{l}\right) = m\left(1+\frac{x}{l}\right)\omega^2$$

$$12.5 \times y = \frac{2}{10}(1+y)25$$

Ans : (3)

49

QUESTION

A vehicle of mass 200 kg is moving along a levelled curved road of radius 70 m with angular velocity of 0.2 rad/s. The centripetal force acting on the vehicle is:

[13 April, 2023 (shift-II)]

$$\frac{2\cancel{00} \times 70 \times 4}{\cancel{100}}$$

(1) 560 N

(2) 2800 N

(3) 14 N

(4) 2240 N

Ans : (1)

50

QUESTION

A car is moving with a constant speed of 20 m/s in a circular horizontal track of radius 40 m. A bob is suspended from the roof of the car by a massless string. The angle made by the string with the vertical will be:

(Take $g = 10\ m/s^2$) [25 Jan, 2023 (shift-I)]

$$\tan\theta = \frac{v^2}{Rg}$$

(1) $\pi/6$

(2) $\pi/2$

(3) $\pi/4$

(4) $\pi/3$

Ans : (3)

THANK
YOU