

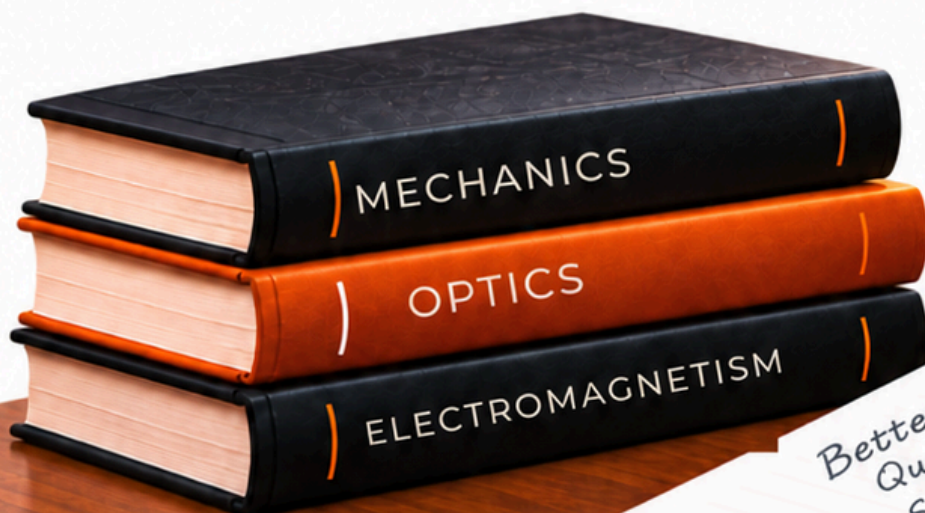
JEE Main Physics

Dynamics of uniform circular motion and centripetal force PYQ

$$F = ma$$



$$v = u + at$$



Better
Questions
Stronger
Concepts
Brighter Future

Subject: Physics

Years: 2026-2002

Total Questions: 53

About this PYQ collection

What is inside

A complete topic-wise set of **53 previous year questions** on **Dynamics of uniform circular motion and centripetal force** from **JEE Main (2026-2013)** and its predecessor **AIEEE (2012-2002)**, across **15 exam years**. **46 questions** are from 2019 onwards, so most of the set reflects the recent NTA pattern.

Questions are arranged to reduce unused page space, with newest-first priority and continuous numbering from 1. Each carries an exam date and shift tag to trace the original paper.

Topic-wise questions

TOPIC	QS	%
Dynamics of uniform circular motion and centripetal force	53	100%

Question types

TYPE	QS	%
Single-correct MCQ	48	91%
Numerical value	5	9%

Numerical-value questions have no options; all 5 are from 2021 onwards.

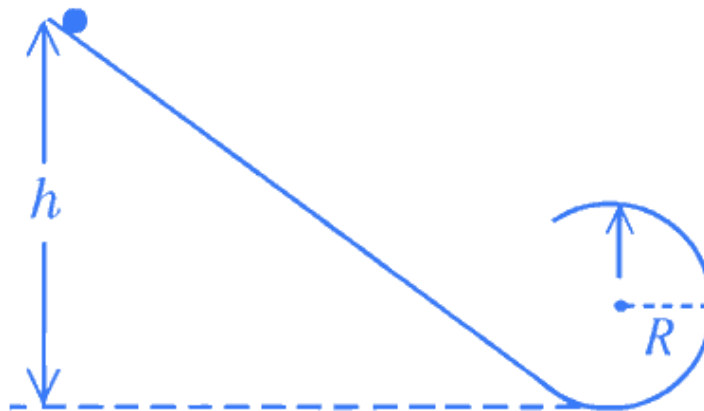
How these questions help you

- **Know where the marks are:** dynamics of uniform circular motion and centripetal force make up **53 of 53 questions (about 100%)**.
- **Build speed and accuracy:** practice the concepts and question styles used in previous papers.
- **Learn the patterns:** the same question styles return year after year.
- **Strengthen other chapters:** these concepts support further study in Physics.

Questions – Dynamics of uniform circular motion and centripetal force

1. A car moving with a speed of 54 km/h takes a turn of radius 20 m . A simple pendulum is suspended from the ceiling of the car. Determine the angle made by the string of the pendulum with the vertical during the turning. (Take $g = 10 \text{ m/s}^2$) (8 Apr 2026 | Shift 2)
- (A) $\tan^{-1}(0.5)$ (B) $\tan^{-1}(0.75)$
(C) $\tan^{-1}(1.125)$ (D) $\tan^{-1}(0.25)$

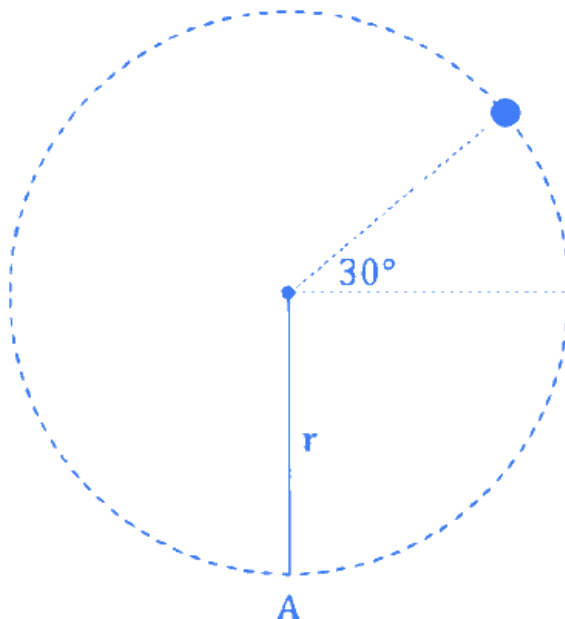
2. A smooth inclined plane ends in a vertical circular loop, as shown in the figure. A small body is released from height h as shown. If the body exerts a force of three times its weight on the plane at the highest point of circle then the height $h = \alpha R$. The value of α is ____



(6 Apr 2026 | Shift 1)

- (A) 2 (B) 4
(C) 3 (D) 6
3. A 0.5 kg mass is in contact against the inner wall of a cylindrical drum of radius 4 m rotating about its vertical axis. The minimum rotational speed of the drum to enable the mass to remain stuck to the wall (without falling) is 5 rad/s. The coefficient of friction between the drum's inner wall surface and mass is _____. (Take $g = 10 \text{ m/s}^2$) (2 Apr 2026 | Shift 2)
- (A) 0.1 (B) 0.5
(C) 0.7 (D) 0.3

4. In case of vertical circular motion of a particle by a thread of length r if the tension in the thread is zero at an angle 30° shown in figure, the velocity at the bottom point (A) of the circular path is (g = gravitational acceleration)



(24 Jan 2026 | Shift 2)

- (A) $\sqrt{\frac{7}{2}gr}$ (B) $\sqrt{4gr}$
 (C) $\sqrt{\frac{5}{2}gr}$ (D) $\sqrt{5gr}$

5. A body of mass 'm' connected to a massless and unstretchable string goes in vertical circle of radius 'R' under gravity g . The other end of the string is fixed at the center of circle. If velocity at top of circular path is $n\sqrt{gR}$, where, $n \geq 1$, then ratio of kinetic energy of the body at bottom to that at top of the circle is :

(29 Jan 2025 | Shift 1)

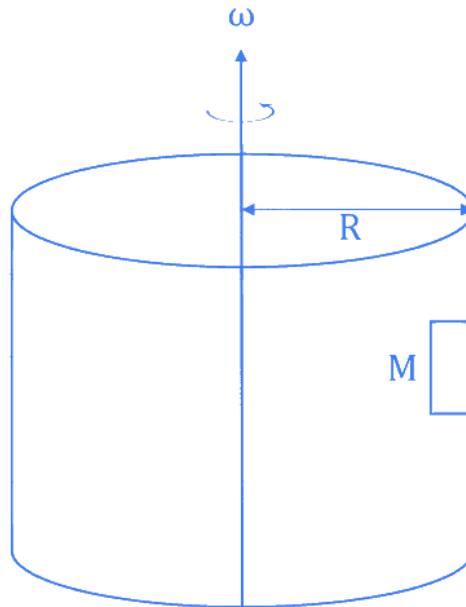
- (A) $\frac{n^2+4}{n^2}$ (B) $\frac{n+4}{n}$
 (C) $\frac{n^2}{n^2+4}$ (D) $\frac{n}{n+4}$

6. 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

(24 Jan 2025 | Shift 1)

- (A) $\mu = \frac{v_0^2 + rg \tan \theta}{rg + v_0^2 \tan \theta}$ (B) $\mu = \frac{v_0^2 - rg \tan \theta}{rg - v_0^2 \tan \theta}$
 (C) $\mu = \frac{v_0^2 - rg \tan \theta}{rg + v_0^2 \tan \theta}$ (D) $\mu = \frac{v_0^2 + rg \tan \theta}{rg - v_0^2 \tan \theta}$

7. A large drum having radius R is spinning around its axis with angular velocity ω , as shown in figure. The minimum value of ω so that a body of mass M remains stuck to the inner wall of the drum, taking the coefficient of friction between the drum surface and mass M as μ , is :



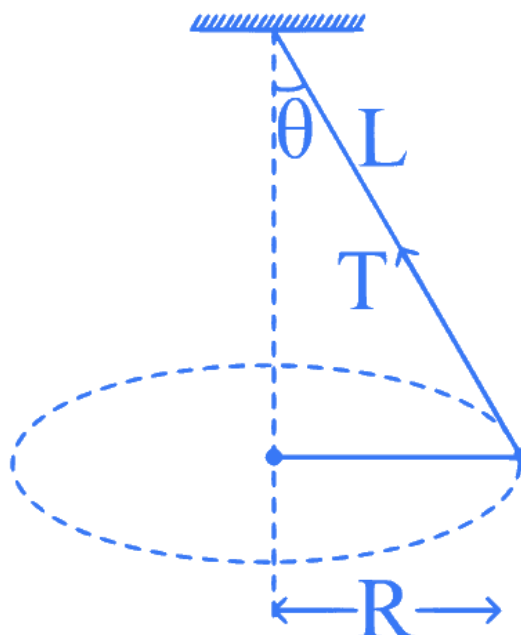
(21 Jan 2026 | Shift 2)

- (A) $\sqrt{\frac{2g}{\mu R}}$ (B) $\sqrt{\frac{g}{2\mu R}}$
 (C) $\sqrt{\frac{\mu g}{R}}$ (D) $\sqrt{\frac{g}{\mu R}}$

8. A tube of length 1 m is filled completely with an ideal liquid of mass $2M$, and closed at both ends. The tube is rotated uniformly in horizontal plane about one of its ends. If the force exerted by the liquid at the other end is F then angular velocity of the tube is $\sqrt{\frac{F}{\alpha M}}$ in SI unit. The value of α is _____. (22 Jan 2025 | Shift 2)

9. 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: ($g = 10 \text{ m/s}^2$, $\sqrt{3} = 1.73$) (6 Apr 2024 | Shift 2)
- (A) 51.4 m/s (B) 102.8 m/s
 (C) 70.4 m/s (D) 264 m/s

10.



A string of length L is fixed at one end and carries a mass of M at the other end. The mass makes $\left(\frac{3}{\pi}\right)$ rotations per second about the vertical axis passing through end of the string as shown. The tension in the string is _____ ML. (24 Jan 2025 | Shift 2)

11. 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, : (1 Feb 2024 | Shift 1)

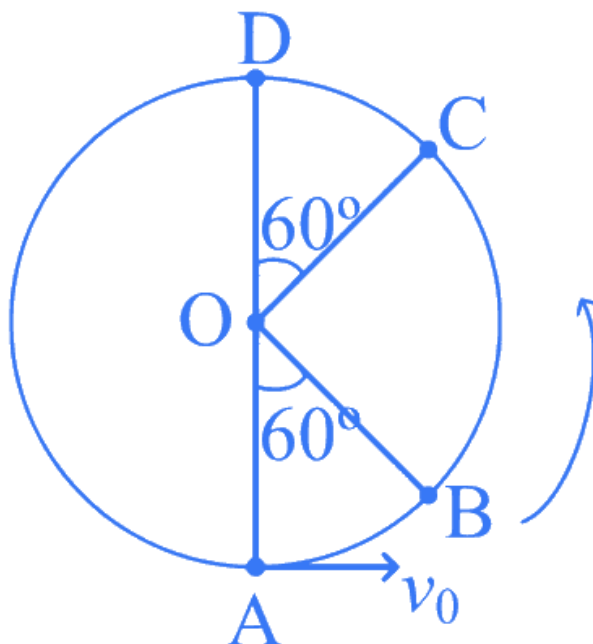
- (A) 1600 (B) 20
(C) 40 (D) 1000

12. 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 : (31 Jan 2024 | Shift 1)

- (A) $\sqrt{\frac{r}{\mu g}}$ (B) $\sqrt{\frac{\mu g}{r}}$
(C) $\frac{\mu g}{r}$ (D) $\frac{\mu}{\sqrt{r g}}$

13. A curved in a level road has a radius 75 m. The maximum speed of a car turning this curved road can be 30 m/s without skidding. If radius of curved road is changed to 48 m and the coefficient of friction between the tyres and the road remains same, then maximum allowed speed would be _____ m/s. (25 Jun 2022 | Shift 2)

14. A bob of mass m is suspended at a point O by a light string of length l and left to perform vertical motion (circular) as shown in figure. Initially, by applying horizontal velocity v_0 at the point 'A', the string becomes slack when the bob reaches at the point 'D'. The ratio of the kinetic energy of the bob at the points B and C is _____.



(22 Jan 2025 | Shift 1)

- (A) 4 (B) 1
(C) 2 (D) 3

15. If the radius of curvature of the path of two particles of same mass are in the ratio 3 : 4, then in order to have constant centripetal force, their velocities will be in the ratio of :

(29 Jan 2024 | Shift 1)

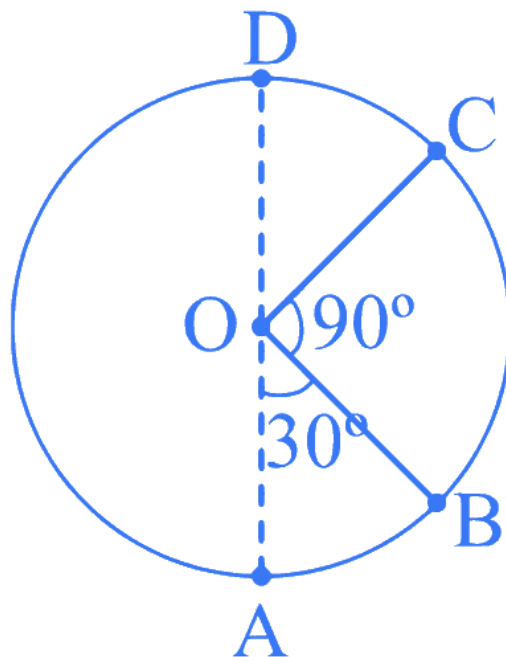
- (A) $1 : \sqrt{3}$ (B) $2 : \sqrt{3}$
(C) $\sqrt{3} : 2$ (D) $\sqrt{3} : 1$

16. A stone of mass 900 g is tied to a string and moved in a vertical circle of radius 1 m making 10 rpm. The tension in the string, when the stone is at the lowest point is (if $\pi^2 = 9.8$ and $g = 9.8 \text{ m/s}^2$) :

(29 Jan 2024 | Shift 2)

- (A) 17.8 N (B) 97 N
(C) 9.8 N (D) 8.82 N

17. A body of mass 100 g is moving in circular path of radius 2 m on vertical plane as shown in figure. The velocity of the body at point A is 10 m/s. The ratio of its kinetic energies at point B and C is :



(Take acceleration due to gravity as 10 m/s^2)

(22 Jan 2025 | Shift 2)

- (A) $\frac{3-\sqrt{2}}{2}$ (B) $\frac{2+\sqrt{3}}{3}$
(C) $\frac{2+\sqrt{2}}{3}$ (D) $\frac{3+\sqrt{3}}{2}$

18. A train is moving with a speed of 12 m/s on rails which are 1.5 m apart. To negotiate a curve radius 400 m, the height by which the outer rail should be raised with respect to the inner rail is (Given, $g = 10 \text{ m/s}^2$) :

(27 Jan 2024 | Shift 1)

- (A) 6.0 cm (B) 5.4 cm
(C) 4.8 cm (D) 4.2 cm

19. 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:

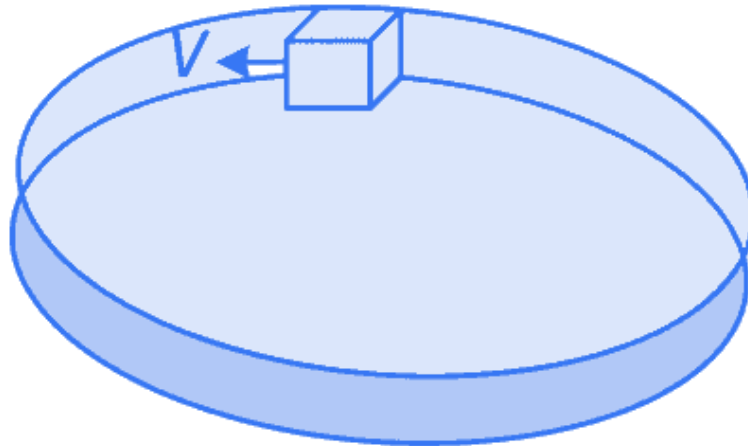
(13 Apr 2023 | Shift 2)

- (A) 560 N (B) 14 N
(C) 2800 N (D) 2240 N

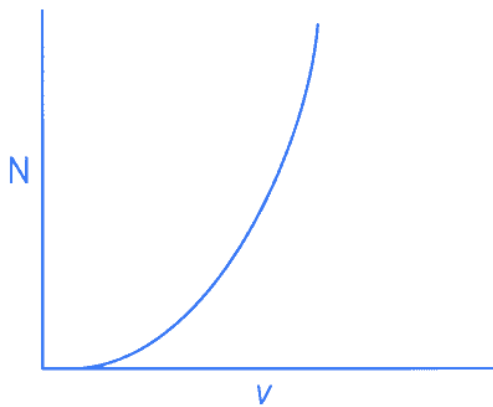
20. A coin placed on a rotating table just slips when it is placed at a distance of 1 cm from the center. If the angular velocity of the table is halved, it will just slip when placed at a distance of _____ from the centre : (11 Apr 2023 | Shift 1)
- (A) 1 cm (B) 8 cm
(C) 4 cm (D) 2 cm
-
21. A small 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 - (6 Apr 2023 | Shift 1)
- (A) 0.50 N (B) 1.5 N
(C) 0.75 N (D) 0.25 N
-
22. A child of mass 5 kg is going round a merry-go-round that makes 1 rotation in 3.14 s. The radius of the merry-go-round is 2 m. The centrifugal force on the child will be (6 Apr 2023 | Shift 2)
- (A) 50 N (B) 80 N
(C) 100 N (D) 40 N
-
23. A stone of mass 1 kg is tied to end of a massless string of length 1 m. If the breaking tension of the string is 400 N, then maximum linear velocity, the stone can have without breaking the string, while rotating in horizontal plane, is : (31 Jan 2023 | Shift 2)
- (A) 20 ms^{-1} (B) 40 ms^{-1}
(C) 400 ms^{-1} (D) 10 ms^{-1}
-
24. 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 $g = 10 \text{ ms}^{-2}$] (29 Jan 2023 | Shift 1)
- (A) 3.4 ms^{-1} (B) 13 ms^{-1}
(C) 22.4 ms^{-1} (D) 17 ms^{-1}
-
25. A pendulum of length 2 m consists of a wooden bob of mass 50 g. A bullet of mass 75 g is fired towards the stationary bob with a speed v . The bullet emerges out of the bob with a speed $\frac{v}{3}$ and the bob just completes the vertical circle. The value of v is _____ ms^{-1} . (if $g = 10 \text{ m/s}^2$). (27 Jun 2022 | Shift 1)

26. 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 Jan 2023 | Shift 1)
- (A) $\frac{\pi}{2}$ (B) $\frac{\pi}{6}$
(C) $\frac{\pi}{4}$ (D) $\frac{\pi}{3}$
-
27. A body of mass 200g 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 2)
- (A) 1 : 2 (B) 2 : 3
(C) 2 : 5 (D) 1 : 1
-
28. One end of a massless spring of spring constant k and natural length l_0 is fixed while the other end is connected to a small object of mass m lying on a frictionless table. The spring remains horizontal on the table. If the object is made to rotate at an angular velocity ω about an axis passing through fixed end, then the elongation of the spring will be : (27 Jun 2022 | Shift 2)
- (A) $\frac{k - m\omega^2 l_0}{m\omega^2}$ (B) $\frac{m\omega^2 l_0}{k + m\omega^2}$
(C) $\frac{m\omega^2 l_0}{k - m\omega^2}$ (D) $\frac{k + m\omega^2 l_0}{m\omega^2}$
-
29. A stone tied to a spring of length L is whirled in a vertical circle with the other end of the spring at the centre. At a certain instant of time, the stone is at its lowest position and has a speed u . The magnitude of change in its velocity, as it reaches a position where the string is horizontal, is $\sqrt{x(u^2 - gL)}$. The value of x is - (27 Jun 2022 | Shift 2)
- (A) 3 (B) 2
(C) 1 (D) 5
-
30. A boy ties a stone of mass 100 g to the end of a 2 m long string and whirls it around in a horizontal plane. The string can withstand the maximum tension of 80 N. If the maximum speed with which the stone can revolve is $\frac{K}{\pi}$ rev./min. The value of K is : (Assume the string is massless and unstretchable) (24 Jun 2022 | Shift 1)
- (A) 400 (B) 300
(C) 600 (D) 800

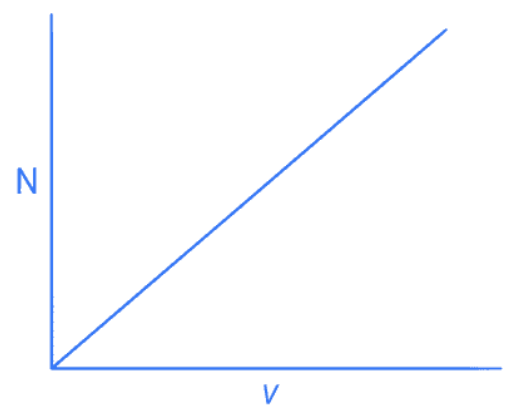
31. A smooth circular groove has a smooth vertical wall as shown in figure. A block of mass m moves against the wall with a speed v . Which of the following curve represents the correct relation between the normal reaction on the block by the wall (N) and speed of the block (v) ?



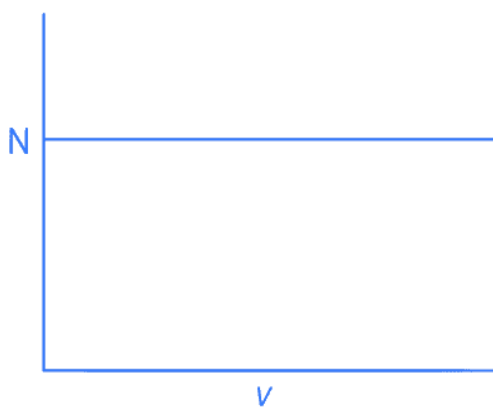
(29 Jul 2022 | Shift 1)



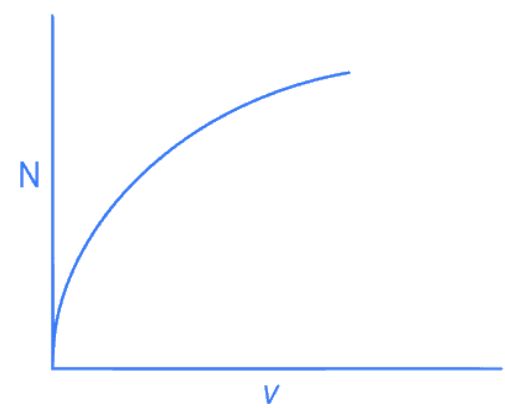
(A)



(B)

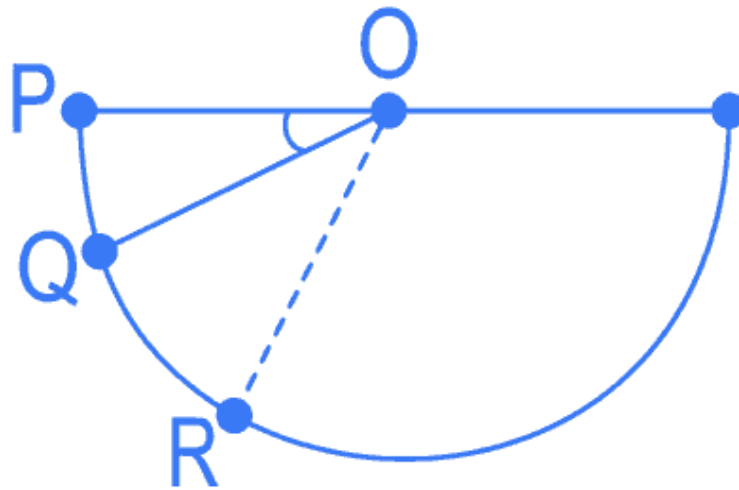


(C)

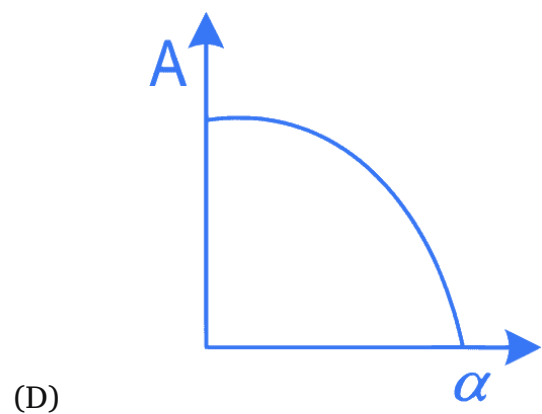
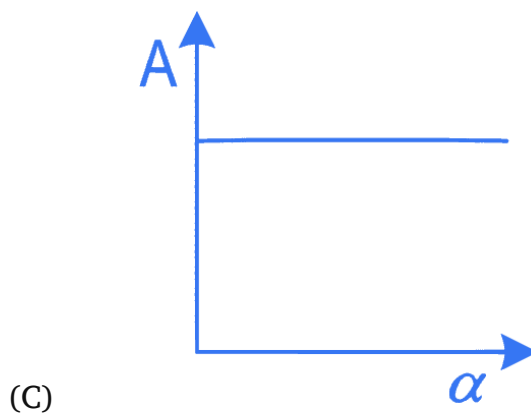
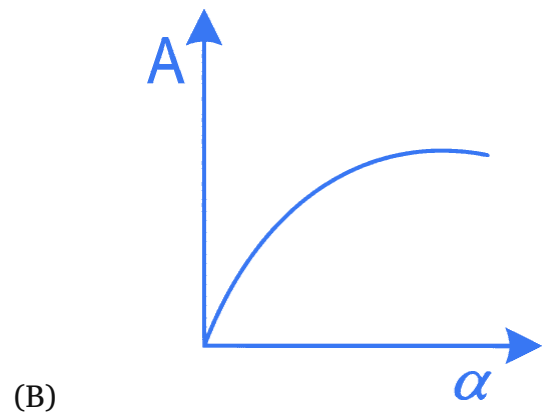
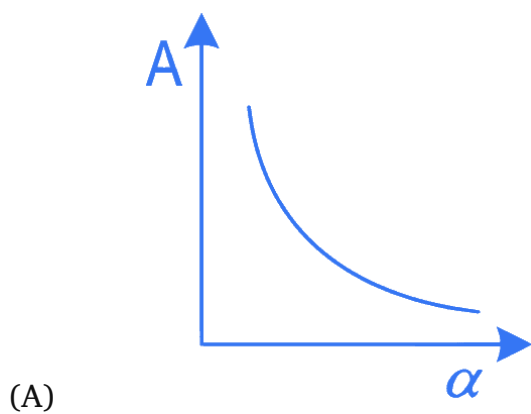


(D)

32. A ball is released from rest from point P of a smooth semi-spherical vessel as shown in figure. The ratio of the centripetal force and normal reaction on the ball at point Q is A while angular position of point Q is α with respect to point P. Which of the following graphs represent the correct relation between A and α when ball goes from Q to R?



(26 Jun 2022 | Shift 1)



33. A disc with a flat small bottom beaker placed on it at a distance R from its center is revolving about an axis passing through the center and perpendicular to its plane with an angular velocity ω . The coefficient of static friction between the bottom of the beaker and the surface of the disc is μ . The beaker will revolve with the disc if :

(25 Jun 2022 | Shift 2)

- (A) $R \leq \frac{\mu g}{2\omega^2}$ (B) $R \leq \frac{\mu g}{\omega^2}$
(C) $R \geq \frac{\mu g}{2\omega^2}$ (D) $R \geq \frac{\mu g}{\omega^2}$
-

34. A stone of mass m , tied to a string is being whirled in a vertical circle with a uniform speed. The tension in the string is

(24 Jun 2022 | Shift 2)

- (A) the same throughout the motion. (B) minimum at the highest position of the circular path.
(C) minimum at the lowest position of the circular path. (D) minimum when the rope is in the horizontal position.
-

35. 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 :

(26 Aug 2021 | Shift 2)

- (A) $\sqrt{rg}$ (B) $\sqrt{2rg}$
(C) $2\sqrt{rg}$ (D) $\sqrt{\frac{rg}{2}}$
-

36. 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/s².
[Given $\cos 30^\circ = 0.87$, $\mu_s = 0.2$]

(20 Jul 2021 | Shift 1)

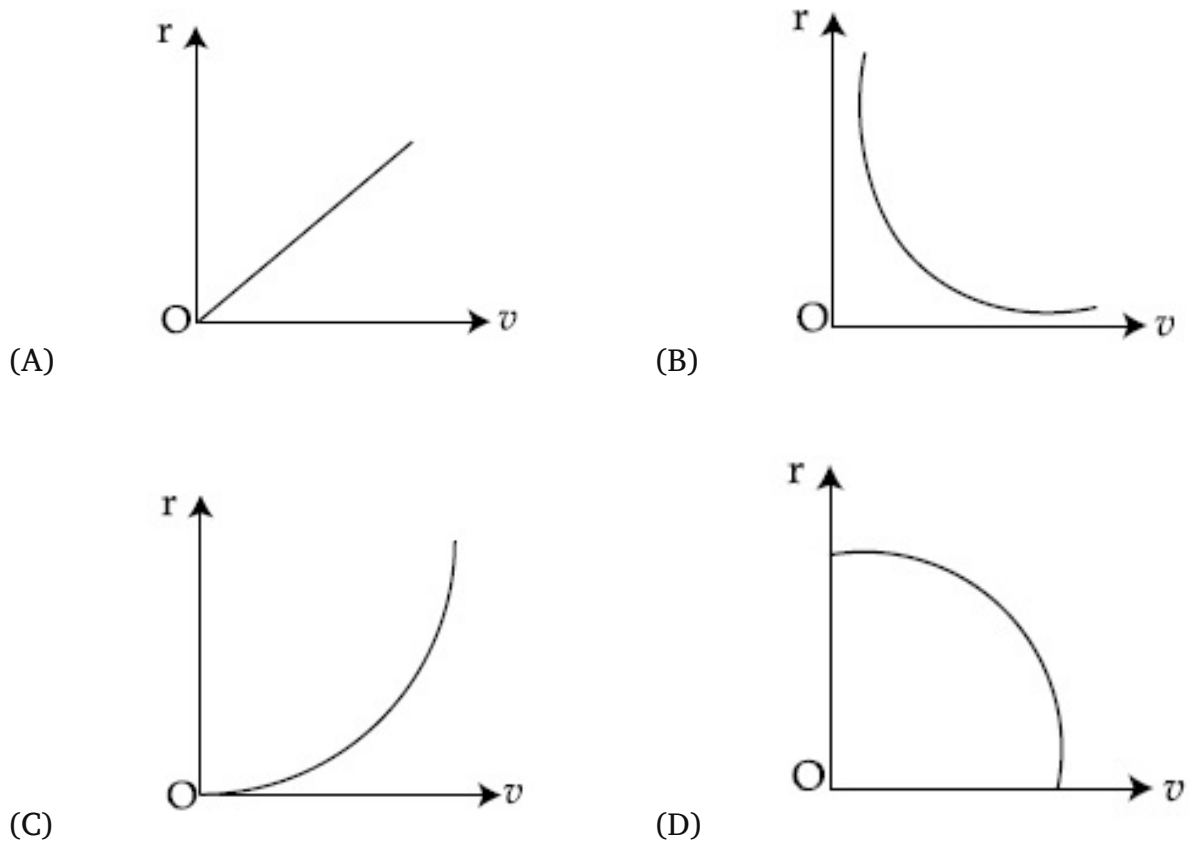
- (A) 12.4 (B) 7.2
(C) 6.96 (D) 10.2
-

37. 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 :

(16 Mar 2021 | Shift 1)

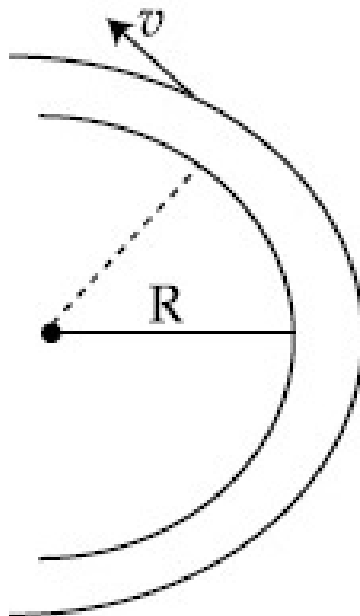
- (A) 9.859×10^{-2} N (B) 0.0314 N
(C) 9.859×10^{-4} N (D) 6.28×10^{-3} N
-

38. A particle of mass m moves in a circular orbit under the central potential field, $U(r) = -\frac{C}{r}$, where C is a positive constant. The correct radius – velocity graph of the particle's motion is : (18 Mar 2021 | Shift 2)



39. 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 2m without reducing the speed. The static friction coefficient is 0.2 . The cyclist will not slip and pass the curve. ($g = 9.8 \text{ m/s}^2$)
- Statement II : If the road is banked at an angle of 45° , cyclist can cross the curve of 2m 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. (16 Mar 2021 | Shift 2)
- | | |
|--|---|
| (A) Statement I is incorrect and statement II is correct | (B) Both statement I and statement II are true |
| (C) Statement I is correct and statement II is incorrect | (D) Both statement I and statement II are false |

40. A modern grand - prix racing car of mass m is travelling on a flat track in a circular arc of 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)



(17 Mar 2021 | Shift 1)

- (A) $m \left(g - \frac{v^2}{\mu_s R} \right)$ (B) $-m \left(g + \frac{v^2}{\mu_s R} \right)$
(C) $m \left(\frac{v^2}{\mu_s R} - g \right)$ (D) $m \left(\frac{v^2}{\mu_s R} + g \right)$

41. 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 :

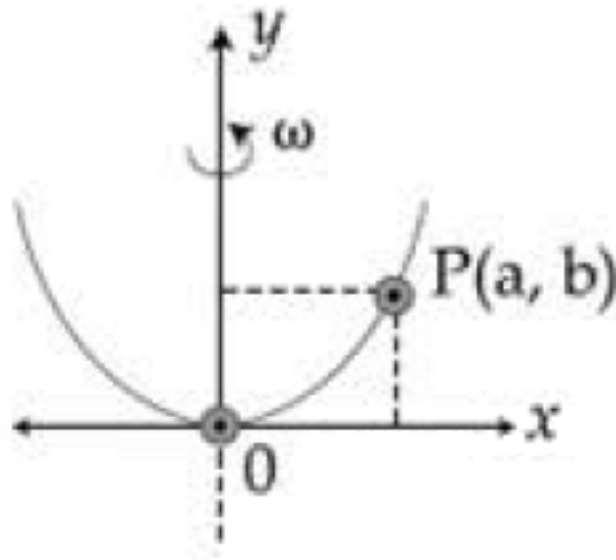
(26 Feb 2021 | Shift 1)

- (A) $T \propto R^{\frac{4}{3}}$ (B) $T \propto R^{\frac{5}{2}}$
(C) $T \propto R^{\frac{3}{2}}$ (D) $T \propto R^2$

42. A small bob tied at one end of a thin string of length 1 m is describing a vertical circle so that the maximum and minimum tension in the string are in the ratio 5 : 1. The velocity of the bob at the highest position is _____ m/s. (Take $g = 10 \text{ m/s}^2$)

(25 Feb 2021 | Shift 1)

43. 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) :



(2 Sept 2020 | Shift 1)

- (A) $2\sqrt{2gC}$ (B) $2\sqrt{gC}$
 (C) $\sqrt{\frac{2gC}{ab}}$ (D) $\sqrt{\frac{2g}{C}}$

44. A spring mass system (mass m , spring constant k and natural length l) rest in equilibrium on a horizontal disc. The free end of the spring is fixed at the centre of the disc. If the disc together with spring mass system, rotates about its axis with an angular velocity ω , ($k \gg m\omega^2$) the relative change in the length of the spring is best given by the option :

(9 Jan 2020 | Shift 2)

- (A) $\frac{m\omega^2}{3k}$ (B) $\frac{m\omega^2}{k}$
 (C) $\frac{2m\omega^2}{k}$ (D) $\sqrt{\frac{2}{3}} \left(\frac{m\omega^2}{k} \right)$

45. A disc rotates about its axis of symmetry in a horizontal plane at a steady rate of 3.5 revolutions per second. A coin placed at a distance of 1.25 cm from the axis of rotation remains at rest on the disc. The coefficient of friction between the coin and the disc is :

($g = 10 \text{ m/s}^2$)

(15 Apr 2018 | Shift 2)

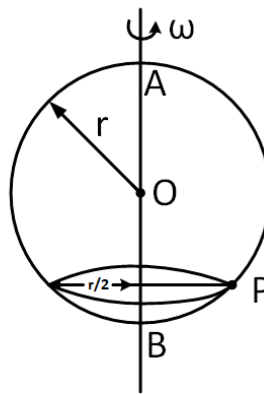
- (A) 0.5 (B) 0.3
 (C) 0.7 (D) 0.6

46. 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 :

(8 Jan 2020 | Shift 1)

- (A) $\frac{m\ell\omega^2}{k - m\omega^2}$ (B) $\frac{m\ell\omega^2}{k - m\omega}$
 (C) $\frac{m\ell\omega^2}{k + m\omega^2}$ (D) $\frac{m\ell\omega^2}{k + m\omega}$

47. A smooth wire of length $2\pi r$ is bent into a circle and kept in a vertical plane. A bead can slide smoothly on the wire. When the circle is rotating with angular speed ω about the vertical diameter AB, as shown in figure, the bead is at rest with respect to the circular ring at position P as shown. Then the value of ω^2 is equal to -



(12 Apr 2019 | Shift 2)

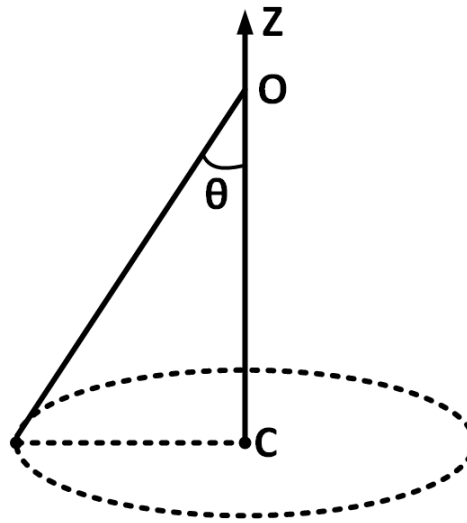
- (A) $\frac{\sqrt{3}g}{2r}$ (B) $\frac{2g}{(r\sqrt{3})}$
 (C) $\frac{(g\sqrt{3})}{r}$ (D) $\frac{2g}{r}$

48. Concrete mixture is made by mixing cement, stone and sand in a rotating cylindrical drum. If the drum rotates too fast, the ingredients remain stuck to the wall of the drum and proper mixing of ingredients does not take place. The maximum rotational speed of the drum in revolutions per minute(rpm) to ensure proper mixing is close to :
 (Take the radius of the drum to be 1.25 m and its axle to be horizontal) :

(10 Apr 2016 | Shift 1)

- (A) 0.4 (B) 1.3
 (C) 8.0 (D) 27.0

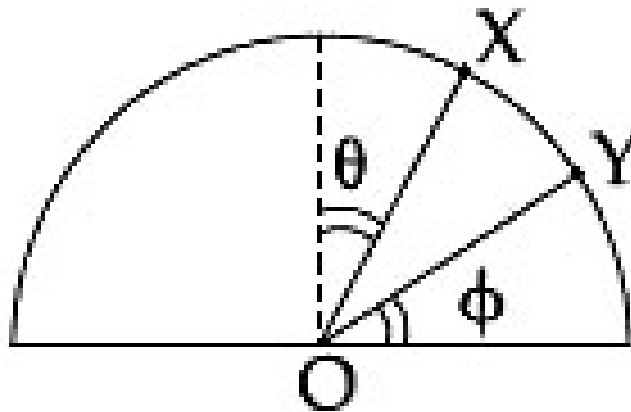
49. A conical pendulum of length 1 m makes an angle $\theta = 45^\circ$ w.r.t. Z-axis and moves in a circle in the XY plane. The radius of the circle is 0.4 m and its center is vertically below O. The speed of the pendulum, in its circular path, will be: (Take $g = 10 \text{ ms}^{-2}$)



(9 Apr 2017 | Shift 1)

- (A) 0.4 m/s (B) 4 m/s
(C) 0.2 m/s (D) 2 m/s

50.



A particle is released on a vertical smooth semicircular track from point X so that, OX makes angle θ from the vertical (see figure). The normal reaction of the track on the particle vanishes at the point where YOY makes an angle with the horizontal. Then ϕ

(19 Apr 2014 | Single slot)

- (A) $\sin \phi = \frac{2}{3} \cos \theta$ (B) $\sin \phi = \frac{3}{4} \cos \theta$
(C) $\sin \phi = \frac{1}{2} \cos \theta$ (D) $\sin \phi = \frac{1}{4} \cos \theta$

51. A body of mass ' m ' is tied to one end of a spring and whirled round in a horizontal plane with a constant angular velocity. The elongation in the spring is 1 cm. If the angular velocity is doubled, the elongation in the spring is 5 cm. The original length of the spring is (23 Apr 2013 | Single slot)
- (A) 15 cm (B) 12 cm
(C) 16 cm (D) 10 cm
-
52. A stone of mass m , tied to the end of a string, is whirled around in a circle on a horizontal frictionless table. The length of the string is reduced gradually keeping the angular momentum of the stone about the centre of the circle constant. Then, the tension in the string is given by $T = \frac{A}{r^n}$, where A is a constant, r is the instantaneous radius of the circle. The value of n is equal to (26 May 2012 | Single slot)
- (A) -1 (B) -2
(C) -4 (D) -3
-
53. The minimum velocity (in ms^{-1}) with which a car driver must traverse a flat curve of radius 150 m and coefficient of friction 0.6 to avoid skidding is (19 May 2002 | Single sitting)
- (A) 60 (B) 30
(C) 15 (D) 25