PHYSICS

BOOKS - CENGAGE PHYSICS (HINGLISH)

CIRCULAR MOTION

Question Bank

1. A table fan rotating at a speed of 2400 revolutions per minute(rpm), is switched off

and the resulting variation of the rpm with time is shown in the figure. Total number of revolutions of the fan before it comes to rest is

'(##CEN_KSR_PHY_JEE_C07_001_Q01##)'

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2. A particle is whirled in a vertical circle of radius $1.0m$ using a string with one end fixed. If the ratio of maximum to minimum tensions in the string is $\frac{5}{3}$, then the minimum velocity

(in m / s) of the particle during circular motion is

'(##CEN_KSR_PHY_JEE_C07_002_Q02##)'

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3. A rod is rotating with an angular velocity of $3\pi t^3$ rad / s. The angle rotated by the rod from $t = 0$ to the time when it has an angular velocity of 24π rad/sec is given by $\alpha\pi$ radian. Find $\frac{\alpha}{2}$.

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4. In a park there are three concentric circular running tracks. Radius of 2 nd track is double of the first and of 3rd track is triple of the first. Three runners are running on these tracks with constant speed. When the runner in the first track completes one round, the runner in $2^n d$ has completed half round and the runner in third track has completed quarter round. If the accelerations of the runners are in ratio $\alpha : \beta : \gamma$, where α, β and γ are least integers, then find the value of $\dfrac{\alpha + \beta + \gamma}{9}$.

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5. As shown in the figure, a cube of mass m starts from rest from point 1 at a height $4R$, where R is the radius of the circular track. The cube slides down the frictionless track and goes around the loop as shown. The force which the track exerts on the cube at point. 2 is βmg. Find β.

'(##CEN_KSR_PHY_JEE_C07_005_Q03##)'

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6. A particle starts from rest at time $t = 0$ and move on a circular path of radius $1m$ with tangential acceleration $\sqrt{3}\ \frac{m}{s^2}$.After 1s, its acceleration makes an angle θ, with its velocity. What is the value of $3\tan^2\theta$?

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7. A particle starts moving in a non-uniform circular motion and has angular acceleration as shown in the figure. If the angular velocity

at the end of 4 rad is given by ω rad/s, then find the value of ω.

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8. Starting from, rest, a particle rotates in a circle of radius $R = \sqrt{2}m$ with an angular acceleration $\alpha = \frac{\pi}{4} ra \frac{d}{s^2}$. Calculate the magnitude of average velocity (in $\frac{m}{s}$) of the particle.over the time it rotates quarter circle.

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9. The end B of the rod AB which makes angle θ with the floor is being pulled with a constant velocity v_0 as shown. The length of the rod is l. At the instant when $\theta = 37^\circ$, the angular velocity of the rod is $\frac{p}{q}\frac{v_0}{l}$. Find $(p+q)$.

'(##CEN_KSR_PHY_JEE_C07_009_Q05##) '

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10. A small mass m rests at the edge of a horizontal disc of radius R. The coefficient of static friction between the mass and the disc is μ. The disc is rotated about its axis at an angular velocity such that the mass slides off the disc and lands on the floor h metres below. The horizontal "distance of travel of the mass is : $\sqrt{k\mu Rh}$. Find k.

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11. Velocity of a particle moving in a curvilinear path in horizontal XY plane varies with time as $\vec{v} = \left(2t\hat{i} + t^2\vec{j}\right.$ m / s. Here, t is in second. At t =1s, the radius of curve ture of the path is $\frac{\alpha\sqrt{5}}{\beta}m$. Find $(\alpha + \beta)$.

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12. A pendulum, comprising a light string of length L and a small sphere, swings in a vertical plane. The string hits a peg located a

distance d below the point of suspension as shown in the figure. If the pendulum is released from the horizontal position $(\theta = 90^\circ)$ and is to swing in a complete circle centered on the peg, then the minimum value of d is kL. Find k :

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13. Particle A is moving in a horizontal plane. with constant velocity V as shown. Another

particle B is moving in a circle with same speed V. At the moment when A is diametrically opposite to B, the radius of curvature of B as seen by A is nR. Find n. (Radius. of circle is R)

'(##CEN_KSR_PHY_JEE_C07_013_Q07##)'

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14. Two particles start moving on circles of radii R_1 and R_2 shown with velocities $V_1 = 2\frac{m}{s}$ and $V_2 = 15\frac{m}{s}$, respectively. The

minimum time after which the particles will again be collinear with the centre is equal to $\frac{\pi}{n}$ second. Find n.

'(##CEN_KSR_PHY_JEE_C07_014_Q08##)'

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15. A single wire ACB passes through a smooth ring at C which revolves at a constant speed in the horizontal circle of radius r as shown in the figure. The speed of revolution is

$\sqrt{\frac{yrg}{6}}$. Find y.

'(##CEN_KSR_PHY_JEE_C07_015_Q09##)'

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16. A particle is moving with constant angular acceleration (α) in a circular path of radius $\sqrt{3}m$. At $t = 0$, it was at rest and at $t = 1s$, the magnitude of its acceleration becomes $\sqrt{6}\frac{m}{s^2}$, then α (in $ra\frac{d}{s^2}$) is

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17. A toy car revolves in a circular path of radius $1m$ on a horizontal rough plane. Its speed varies' with time as $V = 2t^2$. It 'starts sliding at $t = 1mathrm(\sim s)$. The value of coefficient of friction between the ground and the wheels of the car $unp\sqrt{q}\Big)$ is $P'V^2$ .Find $(p + q + r)$. $(use =$ 10 m/s^(2)`.)

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18. A particle begins to move with a tangential acceleration of constant magnitude $0.6\frac{m}{s^2}$ in

a circular path. If it slips when its total acceleration becomes $1\frac{m}{s^2}$, then the angle through which it would have turned before it stårts to slip is $\frac{a}{b}$ radian. Find (ab).

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19. A circular platform rotates around a vertical axis with angular velocity $\omega = 10ra\frac{d}{s}$. On the platform is a' ball of mass $2kg$, attached to the long axis of the platform by a thin rod of length $16cm(\alpha = 30^\circ)$. Find the

normal force (in N). exerted by the ball on the platform. Assume friction is absent.

'(##CEN_KSR_PHY_JEE_C07_019_Q10##)'

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20. A small $100g$ sleeve B can slide on a smooth, circular and rigid wire frame A of radius $5m$ placéd in vertical plane. The wire frame is rotating about its vertical diameter at $2ra\frac{d}{s}$. When the sleeve is brought at a particular angular position other than the

bottom and the top of the ring, the sleeve will not slide on the wire frame. What is force of interaction (in N) between the sleeve and the wire frame at this position?

'(##CEN_KSR_PHY_JEE_C07_020_Q11##)'

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21. You are shown a photo of a car driven on a vertical-inside wall of a huge cylinder of radius $50m$. The coefficient of static friction between the car tires and the cylinder is $\mu_s = 0.8$. The

minimum speed (in $\frac{m}{s}$) at which the car can be driven like that is $5x$. Find x.

'(##CEN_KSR_PHY_JEE_C07_021_Q12##)'

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22. A particle is moving in a circle of radius R with constant speed. The time period of particle is $T = 1s$. In a time $t = \frac{T}{6}$, the difference between the average speed and the average velocity of the particle is $2\frac{m}{s}$. Find

the radius R (in metres) of the circle. (Take $\pi = \frac{22}{7}$)

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23. A certain light truck can go around a curve having a radius of $100m$ with a maximum speed of $16\frac{m}{s}$. To have the same acceleration, at what maximum speed (in $\frac{m}{s}$) can it go around a curve having a radius of $25m$?

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24. A particle of mass m is moving with constant speed in a vertical circle in $x-z$ plane. There is a small bulb at some distance on z -axis. The maximum distance of the shadow of the particle on x -axis is found to be $\alpha\left(\frac{25}{24}\right)$. Find the value of α.

'(##CEN_KSR_PHY_JEE_C07_024_Q13##)'

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25. Two particles A and B are moving in a horizontal plane anticlockwise on two different concentric circles with different constant angular velocities 2ω and ω ,respectively. Find the relative velocity (in' $\frac{m}{s}$) of B w.r.t. A after time $t = \frac{\pi}{\omega}$. $(Takeomega=3$ rad / s, r=2`)

'(##CEN_KSR_PHY_JEE_C07_025_Q14##)'

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26. A small object is moving on a special slope consisting of a concaye and a convex circular arc, both of which have a' right angle at the centre and radius $R = 0.8m$, and they join smoothly, with horizontal common tangent, as it is shown' in the figure. The height from which the object should be released if it detaches from the slope at the altitude $\frac{3}{4}R$ is given by h metre. Find the value of $10h$.

'(##CEN_KSR_PHY_JEE_C07_026_Q15##)'

(Friction is negligibly small)

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27. A section of fixed smooth circular track of radius R in vertical plane is shown in the figure. A block is released from position A and leaves the track at B. The radius of curvature of itstrajectory when it just leaves the track at B is R. Find x.

'(##CEN_KSR_PHY_JEE_C07_027_Q16##)'

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28. The square of angular velocity ω of a certain wheel increases linearly with the angular displacement θ during 100 revolutions of the wheel's motion as shown in the figure. The time t required for given 100 revolutions is $\frac{10m\pi}{n}$. Find $(m+n)$.

'(##CEN_KSR_PHY_JEE_C07_028_Q17##)'

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29. A spotlight S rotates in a horizontal plane with a constant angular velocity of $0.1 rad\frac{d}{s}$. The spot P of light moves along the wall at a distance $3m$. The velocity of the spot P when $\theta = 45^{\circ}$ is $v\left(mathrm\frac{\sim m}{s}\right)$. Find $5v$.

'(##CEN_KSR_PHY_JEE_C07_029_Q18##)'

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30. A car is moving with constant acceleration a. There is a.conical pendulum of length l in

the car which just. touches the roof while performing circular motion (of conical pendulum). The time period of periodic motion is $\pi\sqrt{\frac{xl}{g}}$, Find x.

'(##CEN_KSR_PHY_JEE_C07_030_Q19##)'

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31. A rigid equilateral triangular plate ABC of side $2m$ is in motion in the $x-y$ plane. At the instant shown in the figure, the point B has velocity $\overrightarrow{v}_B = \left(3\hat{i}+8\hat{j}\right)\frac{m}{s}$ and the plate

has angular velocity $\overrightarrow{\omega} = 2\hat{k}ra\frac{d}{s}$. Find the speed (in $\frac{m}{s}$) of point A.

'(##CEN_KSR_PHY_JEE_C07_031_Q20##)'

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32. A small block slides with velocity $v_0 = 0.5\sqrt{gr}$ on the horizontal frictionless surface as shown in the figure. The block leaves the surface at point C. The angle θ in the figure is $\frac{\cos^{-1}(x)}{y}$. Find $(x + y)$.

'(##CEN_KSR_PHY_JEE_C07_032_Q21##)'

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33. A bob of mass m is suspended by a light inextensible string of length l from a fixed point such that it is free to rotate in a vertical plane. The bob is given' a speed of $\sqrt{4gl}$ horizontally. The, height of the bob from the lower most point where the string just becomes slacked is $\frac{nl}{3}$. Find n.

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34. Three particles are located at the corners of an equilateral triangle of side $a = \sqrt{3}m$. The particles start moving with a constant speed $v = 2\frac{m}{s}$ such that the particle initially at A always heads towards the particle initially at B. and the particle at B heads for the particle at C and the particle at C heads for the particle-at A. The magnitude of initial acceleration (in $\frac{m}{s^2}$) of the particle at $\cdot C$ is

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35. A small ball is thrown horizontally in a uniform gravita.tional field at $t = 0$ with initial velocity v_0 If the angular velocity of its velocity vector at time $t = 1s$ is $\frac{1}{n}$, then find the value of n. Take $v_0 = 10\frac{m}{s}$ and $g = 10\frac{m}{s^2}$. (Neglect the air drag)

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36. The figure shows a rod arranged at an angle of 30° from the horizontal. Two strings are fixed to rod as shown. Attached to the two

strings is the mass m as shown. The rod is rotated maintaining its direction in space, so that m travels in a circular path. The strings are of equal length and make angle of 60° with the rod as shown. Calculate the minimum value of the tangential speed $\left(\frac{m}{s}\right)$ of the mass such that the string with tension T_2 does not become slack when the mass is directly aboye the rod. Take length of string as. $l = 2.4m$

'(##CEN_KSR_PHY_JEE_C07_036_Q22##)'

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37. A block of mass $m = 20kg$ is kept at a distance $R = 1m$ from central axis of rotation of a round turn table (A table whose surface can rotate about central axis). The table starts from rest and rotates with constant angular acceleration $\alpha = 3ra\frac{d}{s^2}$. The friction coefficient between the block and the table is $\mu = 0.5$. At time $t = \frac{x}{3}$ second from starting of motion (i.e. $t = 0$), the block is just about to slip. Find the value of x.

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38. A block is.moving in horizontal circular motion with constant speed of $10\frac{m}{s}$ (with respect to lift) about a point O on the smooth surface of the lift. The lift is moving upward with constant speed of $10\frac{m}{s}$ and the length of string of the lift is $2m$, The radius of curvature (in m) of the motion of block with respect to ground is

'(##CEN_KSR_PHY_JEE_C07_038_Q23##)'

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39. An old record player of $10mathrm(\sim cm)$ radius turns at $10ra\frac{d}{s}$ while mounted on a 37° incline as shown in the figure. A particle of mass m can be placed anywhere on the rotating record. If the least possible coefficient of friction that must exist for no slipping to oceur is μ, then find 4μ.

'(##CEN_KSR_PHY_JEE_C07_039_Q24##)A block is.moving in horizontal circular motion with constant speed of $10\frac{m}{s}$ (with respect to lift) about a point O on the smooth surface of the lift. The lift is moving upward with constant speed of $10\frac{m}{s}$ and the length of string of the

lift is $2m$, The radius of curvature (in m) of the motion of block with respect to ground is '(##CEN_KSR_PHY_JEE_C07_038_Q23##)'

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40. A small cubical block of mass $1kg$ is placed inside a rough rectangular groove made in a circular rough table as shown in the figure. The coefficient of friction for afl the rough surfaces is $\mu = 0.5$. The table starts rotating clockwise with angular acceleration $1ra\frac{d}{s^2}$ in

ahorizontal plane about its axis. Find the time (in's) after which the block will start moving with respect to the table. Assume the size of block slightly smaller then the width of groove.

'(##CEN_KSR_PHY_JEE_C07_040_Q25##)'

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