Circular Motion Questions:

MCQs:

1. In a uniform circular motion, the direction of linear velocity is along the
   a. **Tangent to the curve path** b. Radius vector towards the centre
   c. Perpendicular to the plane of the circular motion d. Radius vector
2. The angular speed of the wheels of a bicycle is 8π rad/s. Their period of rotation is
   a. 0.25 s b. 0.4 s c. $\frac{\pi}{4}s$ d. 4s
3. A particle describes a circular path of diameter 20 m every 2s. The average angular speed of the particle during 4s is
   a. 20 / π rad/s b. 10 / π rad/s c. 5 / π rad/s **d. π rad/s**
4. The speed of revolution of a particle around a circle is halved and its angular speed is doubled what happens to the radial acceleration?
   a. Remains unchanged b. Halved c. Doubled d. Quadrupled
5. A body is describing circular motion with constant speed v along a circular path of radius r. Then its tangential acceleration will be, $[MOE]$
   a. $\frac{v^2}{2\pi r}$ b. $\frac{v^2}{\pi r}$ c. $\frac{v^2}{r}$ **d. 0**
6. Two particles of equal masses are revolving in a circular path of radii r_1 and r_2 respectively with the same speed. What will be the ratio of their forces?
   a. $\frac{r_1}{r_2}$ b. $\sqrt{\frac{r_2}{r_1}}$ c. $\left(\frac{r_1}{r_2}\right)^2$ d. $\left(\frac{r_2}{r_1}\right)^2$
7. A $600gm$ object is tied to a string $1m$ long and it is rotated in a horizontal circle of radius $0.8m$. Then the tension produced in the string is,
   a. $\boldsymbol{g}$ b. $\frac{g}{2}$ c. $\frac{5g}{2}$ d. $\frac{3g}{2}$
8. A bucket filled with water is revolved in a vertical circle of radius 4m. The time period of revolution will nearly be if water just does not fall,
   a. $3s$ **b. $4s$** c. $8s$ d. $10s$
9. A body moves in a circle with radius of $25cm$ at $2rev/sec$. The acceleration of body in m/s^2 is,
   a. π^2 b. $2\pi^2$ **c. $4\pi^2$** d. $8\pi^2$
10. Two vehicles are describing uniform circular motion along two circular tracks of radii R_1 and R_2 such that these vehicles complete one revolution in equal time. Then the ratio of their acceleration is:
    a. $1:1$ b. $R_1:R_2$ c. $R_2:R_1$ d. $R_1^2:R_2^2$
11. A body of mass $0.1\ kg$ tied by a string is rotating around a vertical circle of radius $1m$ with a speed of $10m/s$. What is the tension experienced by the string at the highest point?
    a. $8N$ b. $11N$ c. $10N$ **d. $9N$**

SQs:

1. Why are roads banked on the curved path?
2. Explain why a cyclist inclines himself to the vertical while moving around the circular path?
3. A uniform circular motion is an accelerated motion. Justify the statement.
4. In a circus why does not a motorcyclist fall when he moves on the vertical walls of the 'well of death'?
5. A solid tied at a string's end is revolved vertically. At what point the tension in the string will be the greatest?
6. Why a force is necessary to keep a body moving with uniform speed in a circular path?
7. What is the source of centripetal force to a satellite revolving round the earth?
8. Why it is more difficult to revolve a stone by tying it to a longer string than by tying it to a shorter string?
9. Define angular velocity. Derive the relation between linear velocity and angular velocity.

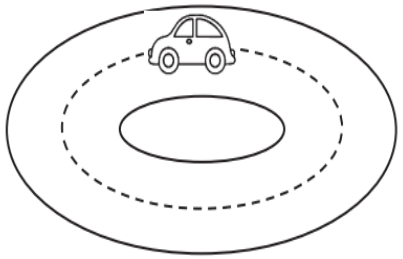
Numerical:

1. A particle of mass $0.3kg$ vibrates with a period of $2s$ if the radius is $0.5m$. What is its maximum kinetic energy? $[Ans: 0.37J]$
2. A coin placed on a disc rotates with a speed of $33\frac{1}{3}rev/min$ provided that the coin is not more than $10cm$ from the axis. Calculate the coefficient of static friction between the coin and the disc. $[Ans: 0.122]$
3. A stone of mass $2kg$ tied with string is whirled in a vertical circle of radius $1m$ with a constant speed of $10m/s$. Find the maximum and minimum tensions of the string. (Use $g = 9.8m/s^2$) $[Ans: 219.6N, 180.4N]$4.
4. An object of mass $4kg$ moves around a circle of radius $6m$ with a constant speed of $12m/s$. Calculate the angular velocity and the force towards the centre. $[Ans: 2\ rad/s, 96N]$

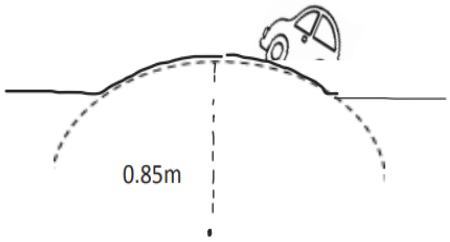
5. A body of mass $0.2kg$ is whirled in a horizontal circle of radius $0.5m$ by a string inclined at 30^0 to the vertical. Calculate the tension in the string and the speed of the mass in the horizontal circle. [$\boldsymbol{Ans: 22.3N, 1.7m/s}$]
6. An object of mass $0.5kg$ is rotated in a horizontal circle by a string in $1m$ long. The maximum tension in the string before it breaks is $50N$. What is the greatest number of revolutions per second of the object? [$\boldsymbol{Ans: 1.6\frac{rev}{s}}$]
7. A stone with mass $0.8kg$ is attached to one end of a string $0.9m$ long. The string will break if its tension exceeds $600N$. The stone is whirled in a horizontal circle, and the other end of the string remains fixed. Find the maximum speed, the stone can attain without breaking string.[$\boldsymbol{Ans: 0.75\frac{rev}{s}}$]
8. A mass of $0.2kg$ is rotated by a string at a constant speed in a vertical circle of radius $1m$. If the minimum tension in the string is $3N$, calculate the magnitude of the speed and the maximum tension in the string. [$\boldsymbol{5m/s, 7N}$]
9. At what angle should a circular road be banked so that a car running at $50km/hr$ be safe to go round the circular turn of $200m$ radius? [$\boldsymbol{Ans: 5.5^0}$]

Exam Style Questions:

1. A boy is operating a remote-controlled toy car on a horizontal circular track, as shown in The track has a radius of 1·8 m and the car travels around the track with a constant speed.

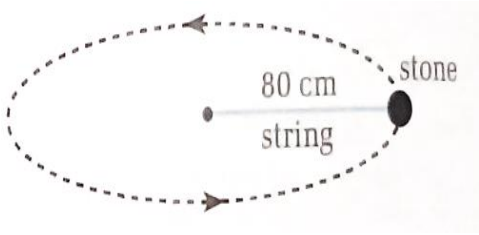


   a. Explain why the car is accelerating, even though it is travelling at a constant speed.
   b. The car has a mass of $0 \cdot 50\ kg$. The boy now increases the speed of the car to $6 \cdot 0\ m/s$. The total radial friction between the car and the track has a maximum value of $7.0\ N$. Show by calculation that the car cannot continue to travel in a circular path.

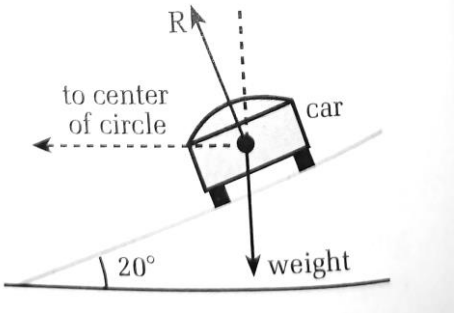


   c. The car is now placed on a track, which includes a raised section. This is shown in The raised section of the track can be considered as the arc of a circle, which has radius r of 0·85 m. The car will lose contact with the raised section of track if its speed is greater than v_{max}. Show that v_{max} is given by the relationship $v_{max} = \sqrt{rg}$

2. The diagram shows a stone tied to the end of the length of the string. It is whirled round in a horizontal circle of radius 80 cm. The stone has a mass of 90 g and it completes 10 revolutions in a time of 8.2 s.



   a. Calculate,
      i. The time taken for one revolution. [$\boldsymbol{0.82sec}$]
      ii. The distance travelled by the stone during one revolution (this distance is equal to the circumference of the circle). [$\boldsymbol{5.03m}$]
      iii. The speed of the stone as it travels in the circle. [$\boldsymbol{6.13ms^{-1}}$]
      iv. The centripetal acceleration of the stone. [$\boldsymbol{47ms^{-2}}$]
      v. The centripetal force on the stone. [$\boldsymbol{4.2N}$]
   b. What provides the centripetal force on the stone?
   c. What is the angle between the acceleration of the stone and its velocity?
3. A car mass $820kg$ travels at a constant speed of $32ms^{-1}$ along a banked track. The track is banked at an angle of 20^0 to the horizontal.



   a. The net vertical force on the car is zero. Use this to show that the contact force R on the car is $8.56kN$.
   b. Use the answer from (a) to calculate the radius of the circle described by the car. [$\boldsymbol{Ans: 287m}$]
   c. Write the one application of the banking of road and write its significance.