1. (a) What do you mean by angular instantaneous angular velocity and instantaneous angular acceleration? (b) What do you mean by tangential acceleration ? Prove that tangential acceleration $a_T = r\alpha$.

2. (i) What is centripetal acceleration? Why is it often called radial acceleration. (ii) Show that the acceleration of body moving in a circular path of radius r with uniform speed v is $a_c = \frac{v^2}{r}$ and is directed towards the centre of circle. (iii) Derive an expression for the force required to make a particle of mass m moves in a circle of radius r with uniform velocity v.

3. (i) A particle moves in a circle of radius 10 cm. Its linear speed is given by v = 3 t, where t is in second and v in metre t second. Find the radial and tangential acceleration at t = 3 s. (ii) A particle describes angular motion such that angle covered by it θ at any point of time t is given by $\theta = 4t^3 + 5t + 3$. Find out the total acceleration at t = 0.8 s. (The radius of the path is 1 m) (iii) The angular position of a point on the rim of a rotating wheel is described by $\phi = 4t - 3t^2 + t^3$ where ϕ is in radians and time in seconds. (a) What is average angular velocity for t= 2 s to 4 s? (b) What is instantaneous angular acceleration at t = 2s? (iv) A car is moving in a circular path of a radius 500 m with a speed of 30 m/s. If the speed is increasing at the rate of 2 m/s^2 , find the resultant acceleration. (ans : 2.7 m/s^2) (v) A rotating fan completes 1200 revolutions every minute. Consider the tip of a blade at a radius of 0.15 m. (i) Through what distance does the tip move in one revolution? (ii) What is the tip's speed? (iii)The magnitude of its acceleration? (iv)What is the period of the motion? [Ans: 0.94 m, 19 m/s, 2.4 × $10^3 m/s^2$, 0.050 s] (vi) A disc revolves with a speed of $33\frac{1}{3}$rev/min and has a radius of 15 cm. Two coins are placed at 4 cm and 14 cm away from the centre of the record. If the coefficient of friction between the coins and the record is 0.15, which of the coin will revolve with the record?

4. (a) A 500 g particle tied to one end of a string is whirled in a vertical circle of circumference 14 m.If the tension at the highest point of its path is 2 N, what is its speed? (ANS: 5.546 m/s) (b) A stone of mass 0.2 kg is tied to one end of a thread of length 0.1m whirled in a vertical circle. When the stone is at the lowest point of circle, tension in thread is 52 N, then calculate the velocity of the stone. (ANS: 5m/s) (c) A stone of mass 1 kg is tied of the end of a string 1 m long. It is whirled in a vertical circle. If the velocity of stone at the top is 4 m/s. What is the tension in the string at the lowest point? (ANS: 66 N) (d) A particle of mass m is tied to one end of a string of length l. The particle is held horizontal with the string taut. It is then projected upward with a velocity u. The tension in the string is $\frac{mg}{2}$ when it is inclined at an angle 30 ° to the horizontal. Find the value of u. (ANS: $\sqrt{\frac{3rg}{2}}$) (e) The velocity of a body moving in a vertical circle of radius r is $\sqrt{7rg}$ at the lowest point of the circle. What is the ratio of maximum and minimum tension? (ANS: 4:1) (f) A body of mass 0.1 kg attached at the end of a string 6 m long, is whirled in a vertical circle. The tension in the string is 6.4 N at the lowest point. What is the maximum angular velocity of the body? (ANS: 3 rad/s) (g) A body of mass 0.4 kg is whirled in a vertical circle making 3 rev/s. If the radius of the circle is 2 m, then calculate tension in the string when the body is at top of the circle? (h) A body of mass 1 kg is moving in a vertical circular path of radius 1 m. Find the difference between the kinetic energies at its highest and lowest positions and difference in total energies at its highest and lowest point. (i) A bucket filled with water is revolved in a vertical circle of radius 1 m and the water just does not fall down. Find the time period of revolution. [Ans:2 s]. (j) A stone with a mass 0.8 kg is attached to one end of a string 0.9 m long. The string will break if its tension exceeds 600 N. 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 the string.

5. (i) A cyclist is riding with a speed of 27 km/h. As he approaches a circular turn on the road of radius 80 m, he applies brakes and reduces his speed at the constant rate of 0.50 m/s every second. What is the magnitude and direction of the net acceleration of the cyclist on the circular turn? (ii) Calculate the centripetal force exerted on a 900.0-kg car that negotiates a 500.0-m radius curve at 25.00 m/s. (b) Assuming an unbanked curve, find the minimum static coefficient of friction between the tires and the road, static friction being the reason that keeps the car from slipping

6. (i) What do you mean by the banking of a curved path? Derive an expression for the banking angle. (ii) At what angle should a circular road be banked so that a car running at 50 km/hr be safe to go round the circular turn of 200 m radius? (iii) What is conical pendulum? Show that the period of oscillation of conical pendulum is given by $T = 2\pi\sqrt{\frac{l\cos\theta}{g}}$, where symbols have their usual meanings. (iv) A mass of 1 kg is attached to the lower end of a string 1 m long whose upper end is fixed. The mass is made to rotate in a horizontal circle of radius 60 cm. If the circular speed is constant, find the tension produced in the string and the period of the motion. (Ans: 12.5 N and 1.78 s)

7. (i)A stone is tied at one end of the string is revolved in vertical. At what point the tension in the string will be maximum and minimum? (ii) In a washing machine, there is a spin dryer, which removes the water from cloth easily. What could be its working principle? (iii) The positively charged nucleus of an atom attracts the electrons in the orbit. Why do electrons not collapse into the nucleus? (iv) In rain a scooter may slip on the turning of a road, why?