Shiksha Classes Bhandara
CHAPTER TEST

Subject : Physics **Topic : Circular Motion** **M.M. : 100**

Marking Scheme:

(i) Each question is allotted 4 (four) marks for each correct response.

(ii) ¼ (one fourth) marks will be deducted for indicating incorrect response of each question. No deduction from the total score will be made if no response is indicated for an item in the answer sheet.

Q.1 A 1 kg stone at the end of 1m long string is whirled in a vertical circle at constant speed of 4 m/sec. The tension in the string is 6N, when the stone is at
($g = 10$ m\sec^2)
(A) Top of the circle
(B) Bottom of the circle
(C) Half way down
(D) None of the above

Q.2 A ring of mass 2π kg and of radius 0.25m is making 300rpm about an axis through its centre perpendicular to its plane. The tension (in newtons) developed in the ring is:
(A) 50 (B)100
(C) 175 (D) 250

Q.3 A car is travelling with linear velocity v on a circular road of radius r. If it is increasing its speed at the rate of 'g' meter/sec^2, then the resultant acceleration will be

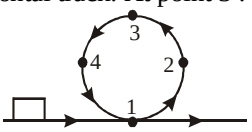
(A) $\sqrt{\left\{\frac{v^2}{r^2}-g^2\right\}}$ (B) $\sqrt{\left\{\frac{v^4}{r^2}+g^2\right\}}$

(C) $\sqrt{\left\{\frac{v^4}{r^2}-g^2\right\}}$ (D) $\sqrt{\left\{\frac{v^2}{r^2}+g^2\right\}}$

Q.4 You may have seen in a circus a motorcyclist driving in vertical loops inside a 'death well' (a hollow spherical chamber with holes, so the spectators can watch from outside).What is the minimum speed required at the uppermost position to perform a vertical loop if the radius of the chamber is 25 m ?
(A) 18.65 ms^{-1}. (B) 25.65 ms^{-1}.
(C) 5.65 ms^{-1}. (D) 15.65 ms^{-1}.

Q.5 What is the linear velocity of a body on the surface of the earth at the equator ? Given radius of the earth is 6400 km. Period of rotation of the earth = 24 hours.
(A) 465 m/s (B) 165 m/s
(C) 665 m/s (D) 410 m/s

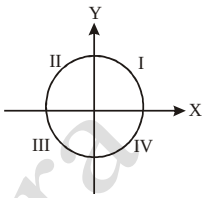
Q.6 A rectangular block is moving along a frictionless path when it encounters the circular loop as shown. The block passes points 1, 2, 3, 4, 1 before returning to the horizontal track. At point 3 :



(A) its mechanical energy is a minimum
(B) it is not accelerating
(C) its speed is a minimum
(D) it experiences a net upward force

Q.7 An aircraft executes a horizontal loop of radius 1 km with a steady speed of 900 km/hr. Find ratio of its centripetal acceleration with the acceleration due to gravity ?
(A) 3.2 (B) 6.4
(C) 1.8 (D) 7.9

Q.8 A particle is moving along a circular path as shown in the figure. The instantaneous velocity of the particle is $\vec{v} = (4m/s)\,\hat{i} - (3m/s)\,\hat{j}$. The particle is moving through ..... quadrant if it is travelling clockwise and through ..... quadrant if it is travelling anticlockwise, respectively around the circle –



(A) First, first (B) First, second
(C) First, third (D) Third, first

Q. 9 A particle of mass m moves along the internal smooth surface of a vertical cylinder of radius R. Find the force with which the particle acts on the cylinder wall if at the initial moment of time its velocity equals V_0. and forms an angle α with the horizontal.

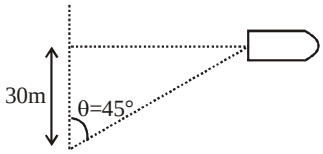
(A) $\left(\frac{mV_0^2}{R}\right)\sin^2\alpha$ (B) $\left(\frac{mV_0^2}{2R}\right)\cos^2\alpha$

(C) $\left(\frac{2mV_0^2}{R}\right)\cos^2\alpha$ (D) $\left(\frac{mV_0^2}{R}\right)\cos^2\alpha$

Q.10 A particle is moving in a circular path. The acceleration and momentum vectors at an instant of time are $\vec{a} = 2\hat{i} + 3\hat{j}$ m/s^2 and $\vec{P} = 6\hat{i} - 4\hat{j}$ kgm/s. Then the motion of the particle is
(A) uniform circular motion
(B) circular motion with tangential acceleration
(C) circular motion with tangential retardation
(D) we cannot say anything from a and P only.

Q.11 A long playing record revolves with a speed of $33\frac{1}{4}$ rev/min. and has a radius of 15cm. Two coins are placed at 4cm and 14cm away from the centre of the record. If the coefficients of friction between the coin and the record is 0.15, then choose the correct option –
(A) the coin placed at 4cm will revolve with the record.
(B) the coin placed at 14cm will revolve with the record.
(C) both the coins will revolve with the record.
(D) None of these

Q.12 A boat is travelling with a speed of 27 kmph due east. An observer is situated at 30m south of the line of travel. The angular velocity of boat relative to the observer in the position shown will be –



(A) 0.125 rad/sec (B) zero
(C) 0.250 rad/sec (D) 0.67 rad/sec

Q.13 For a particle moving along circular path, the radial acceleration a_r is proportional to time t. If a_t is the tangential acceleration, then which of the following will be independent of time t ?

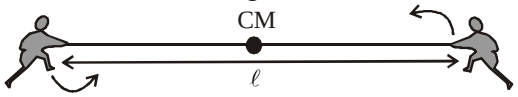
(A) a_t (B) $a_r.a_t$

(C) $\frac{a_r}{a_t}$ (D) $a_r (a_t)^2$

Q.14 A cyclist goes around a circular track of circumference 410m, in 20s. Find the angle that this cycle makes with the vertical.

(A) $\tan^{-1}(0.65)$ (B) $\tan^{-1}(0.45)$
(C) $\tan^{-1}(0.15)$ (D) $\tan^{-1}(0.95)$

Q.15 Two astronauts each have a mass of 75.0 kg are connected by a 10.0m long rope of negligible mass. They are isolated in space and orbit around common centre of mass with a speed of 10.0 m/s relative to each other, as shown in figure.



(A) Tension in the string will be 375 N
(B) Tension in the string will be 1500 N
(C) Acceleration of astronaut will be 15 m/s^2
(D) Acceleration of astronaut will be 20 m/s^2

Q.16 A particle of mass m is attached to one end of string of length ℓ while the other end is fixed to a point height h ($h < \ell$) above the smooth horizontal table. The particle is made to revolve in a circle on the table so as to make n revolutions per second. The value of n if the particle is in contact with the table will be –

(A) $\frac{1}{2\pi}\sqrt{\frac{g}{h}}$ (B) $\frac{1}{2\pi}\sqrt{\frac{g}{\ell}}$

(C) $\frac{1}{2\pi}\sqrt{\frac{g}{2h}}$ (D) None of these

Q.17 A cyclist wants to loop a loop inside a death globe of radius 5m. Calculate the least velocity the cyclist should have at the lowest point.

(A) 12.65 m/s (B) 25.65 m/s
(C) 18.65 m/s (D) 15.65 m/s

Q.18 An unbanked circular highway curve on level ground makes a turn of 90°. The highway carries traffic at 108 km/hr, and the centripetal force on a vehicle is not to exceed $\frac{1}{10}$ of its weight. What is the approximate minimum length of the curve, in km ?

(A) 1.4 km. (B) 1 km.
(C) 0.6 km (D) None of these

Q.19 In a circular motion of a particle, the tangential acceleration of the particle is given by a_t = 9 m/s^2. The radius of the circle is 4m. The particle was initially at rest. Time after which total acceleration of the particle makes an angle of 45° with the radial acceleration is –

(A) 1/3 sec. (B) 2/3 sec.
(C) 1 sec. (D) 4/3 sec.

Q.20 A point mass m is suspended by means of a light metallic wire. The mass is given enough horizontal velocity so that it moves in a vertical circle. Now temperature is increased but the wire continues to move in a vertical circle of increased radius. If T_H and T_L are the value of tension in the wire at its highest and lowest point respectively, then due to increase in temperature the value of $(T_L - T_H)$ will –

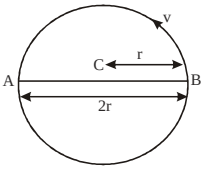
(A) decrease
(B) increase
(C) remain same
(D) cannot be determined

For Q.21-Q.25 :

The answer to each question is a NUMERICAL VALUE.

Q.21 The velocity and acceleration vectors of a particle undergoing circular motion are $\vec{v} = 2\hat{i}\ m/s$ and $\vec{a} = 2\hat{i} + 4\hat{j}\ m/s^2$ respectively at an instant of time. The radius (in m) of the circle is –

Q.22 A particle P is moving in a circle of radius 'a' with a uniform speed v. C is the centre of the circle and AB is a diameter. When passing through B the angular velocity of P about and A and C are in the ratio is 1 : X. Find the value of X.



Q.23 Suppose the coefficient of static friction between the road and the tires on a formula one car is 0.6 during a Grand Prix auto race. What speed (in m/s) will put the car on the verge of sliding as it rounds a level curve of 30.5 m radius ?

Q.24 The wheels on the old time bicycle shown in figure have radii of 60.0 cm. and 10.0cm. If the larger wheel is rotating at 12.0 rad/s, then the angular speed (in rad/s) of the smaller wheel is –

Q.25 A small ball of mass m is attached to the end of the string of length ℓ = 1m whose other end is fixed. From its lowest position, the ball is given a kinetic energy $mg\ell/5$. The net acceleration (in m/s^2) of the ball at the instant when the string makes an angle θ of 37° with the vertical is –