Shiksha Classes Bhandara
CHAPTER TEST

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

Marking Scheme:

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

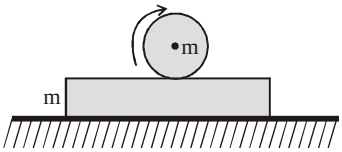
(ii) ¼ (one fourth) marks will be deducted for indicating incorrect response of each question. No deduction from the total score will be made if no response is indicated for an item in the answer sheet.

Q.1 A string is wrapped around a cylinder of mass m and radius R. The string is pulled vertically upward to prevent the centre of mass from falling as the cylinder unwinds the string. The length of the string unwound when the cylinder has reached a speed ω will be :

(A) $\frac{R\omega}{4g}$ (B) $\frac{R^2\omega^2}{4g}$

(C) $\frac{R\omega}{8g}$ (D) $\frac{R^2\omega^2}{8g}$

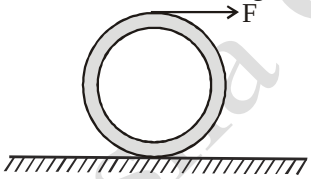
Q.2 A sphere of mass 'm' is given some angular velocity about a horizontal axis through its centre and gently placed on a plank of mass 'm'. The coefficient of friction between the two is μ. The plank rests on a smooth horizontal surface. The initial acceleration of the plank is –



(A) zero (B) (7/5) μg

(C) μg (D) 2 μg

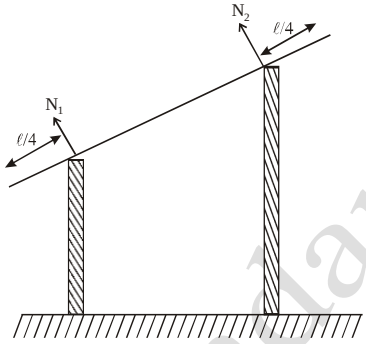
Q.3 A ring of mass m and radius R rolls on a horizontal rough surface without slipping due to an applied force 'F'. The friction force acting on ring is :



(A) F/3 (B) 2F/3

(C) F/4 (D) zero

Q.4 A uniform rod of length ℓ is placed symmetrically on two walls as shown in figure. The rod is equilibrium. If N_1 and N_2 are the normal forces exerted by the walls on the rod then –



(A) $N_1 > N_2$

(B) $N_1 = N_2$

(C) $N_1 < N_2$

(D) N_1 and N_2 would be in the vertical directions

Q.5 Choose incorrect one. If no external force acts on a system:

(A) Velocity of centre of mass remains constant

(B) Velocity of centre of mass is not constant

(C) Velocity of centre of mass may be zero

(D) Acceleration of centre of mass is zero.

Q.6 A system consists of mass M and m(<M). The centre of mass of the system is ;

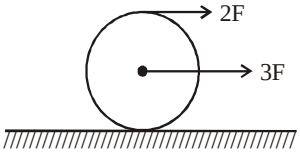
(A) At the middle

(B) Nearer to M

(C) Nearer to m

(D) At the position of large mass

Q.7 Two forces of magnitude 2F and 3F are acting on a uniform solid sphere initially kept at rest on a horizontal surface as shown in the figure. Friction force by the horizontal surface on the sphere will be



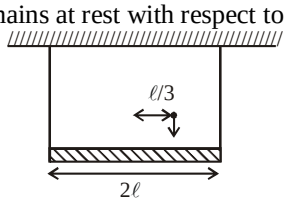
(A) in forward direction

(B) in backward direction

(C) zero

(D) depend on the value of F

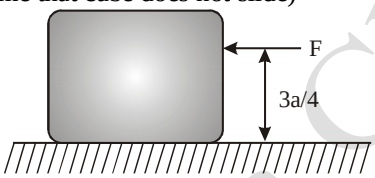
Q.8 A rod of mass m and length 2ℓ hangs by two identical light threads tied to its ends. An insects of mass $\frac{3}{8}$m hits the rod with a speed v at a distance $\ell/3$ from the centre of the rod as shown and sticks to it. As a result one of the thread breaks. The acceleration of the insect just after the thread breaks given that the insect remains at rest with respect to the rod –



(A) g/4 (B) 3g/4
(C) 2g/3 (D) g

Q.9 A body is in pure rotation. The linear speed v of a particle, the distance r of the particle from the axis and the angular velocity ω of the body are related as ω = v/r. Thus :
(A) $\omega \propto 1/r$
(B) $\omega \propto r$
(C) $\omega = 0$
(D) ω is independent of r.

Q.10 A uniform cube of side a and mass m rests on a rough horizontal table. A horizontal force F is applied normal to one of the faces at a point that is directly above the centre of the face, at a height 3a/4 above the base. The minimum value of F for which the cube begins to topple an edge is
(Assume that cube does not slide)



(A) $\frac{mg}{3}$ (B) $\frac{mg}{2}$
(C) $\frac{2mg}{3}$ (D) $\frac{3mg}{4}$

Q.11 The angular momentum of a moving body remains constant if :
(A) net external force is applied
(B) net pressure is applied
(C) net external torque is applied
(D) net external torque is not applied

Q.12 Two particles of mass 1 kg and 0.5 kg are moving in the same direction with speed of 2m/sec, 6 m/sec respectively on a smooth horizontal surface. Find the speed of centre of mass of the system.
(A) 3.33 m/sec (B) 5.13 m/sec
(C) 0.33 m/sec (D) 8.13 m/sec

Q.13 A train of mass M is moving on a circular track of radius R with constant speed V. The length of the train is half of the perimeter of the track. The linear momentum of the train will be –
(A) 0 (B) 2MV/π
(C) MVR (D) MV

Q.14 A sphere of mass m is rolling without sliding along positive x-axis on a rough horizontal surface of coefficient of friction μ. It elastically collides with a wall and then returns back. The correct statement of friction force (f) acting on the sphere is –
(A) $f = \mu mg\hat{i}$ before collision and $f = -\mu mg\hat{i}$ after collision
(B) f = 0 before collision and $f = +\mu mg\hat{i}$ after collision
(C) $f < \mu mg$ before collision and $f = \mu mg\hat{i}$ just after collision
(D) $f=\mu mg\hat{i}$ before collision and just after collision

Q.15 A billiard ball of at rest is struck horizontally one tenth of the diameter below the top. If P be the impulse of the blow find the initial kinetic energy of the ball, the mass of the ball is being m.
(A) $\frac{13P^2}{10m}$ (B) $\frac{11P^2}{10m}$
(C) $\frac{13P^2}{9m}$ (D) $\frac{9P^2}{10m}$

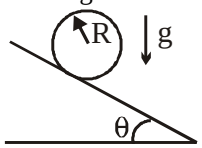
Q.16 Two points of a rod move with velocities 3v and v perpendicular to the rod and in the same direction, separated by a distance 'r'. Then the angular velocity of the rod is –
(A) $\frac{2v}{r}$ (B) $\frac{3v}{r}$
(C) $\frac{4v}{r}$ (D) $\frac{5v}{r}$

Q.17 In a free space, a rifle of mass ' M' shoots a bullet of mass 'm' at a stationary block of mass M distance 'D' away from it. When the bullet has moved through a distance 'd' towards the block, the centre of mass of the bullet block system is at a distance of
(a) $\frac{(D-d)m}{M+m}$ from the block
(b) $\frac{md+MD}{M+m}$ from the rifle
(c) $\frac{2dm+DM}{M+m}$ from the rifle
(d) $(D-d)\frac{M}{M+m}$ from the bullet
(A) b, c (B) a, d
(C) a, b, c (D) a, b

Q.18 Consider a system of two identical particles. One of the particles is at rest and the other has an acceleration $\vec{a}$. The centre of mass has an acceleration
(A) zero (B) $\vec{a}/2$
(C) $\vec{a}$ (D) $2\vec{a}$

Q.19 The rotational analogue of force in linear motion is :
(A) torque (B) weight
(C) moment of inertia (D) angular momentum

Q.20 The ball rolls without slipping down an inclined plane inclined at an angle θ to the horizontal, as shown. The coefficient of static friction between the ball and the surface is μ_s, and the coefficient of kinetic friction is μ_k. What is the magnitude of the force of friction acting on the ball ?

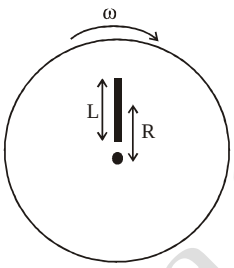


(A) zero (B) μ_s mg cos θ
(C) $\mu_s \frac{7}{5}$ mg sin θ (D) $\frac{2}{7}$ mg sin θ

For Q.21-Q.25 :

The answer to each question is a NUMERICAL VALUE.

Q.21 A uniform rod of mass M and length L lies radially on a disc rotating with angular speed ω in a horizontal plane about its axis. The rod does not slip on the disc and the centre of the rod is at a distance R from the centre of the disc. Then the kinetic energy of the rod is $\frac{1}{2}m\omega^2\left(R^2+\frac{L^2}{X}\right)$. Find the value of X.



Q.22 The moment of inertia of a door of mass m, length 2ℓ and width ℓ about its longer side is $\frac{m\ell^2}{X}$. Find the value of X.

Q.23 A rotating star has a period of 30 days about an axis passing through its centre. The star undergoes an internal explosion and converts to a neutron star. Initial radius of the core was 1.0×10^4 km, whereas final radius is 3.0km. The period of rotation of the neutron star is 2.7×10^{-X} days. Find the value of X.

Q.24 The angular velocity of a body is $\vec{\omega} = 2\hat{i}+3\hat{j}+4\hat{k}$ and a torque $\vec{\tau} = \hat{i}+2\hat{j}+3\hat{k}$ acts on it. The rotational power (in watt) will be :

Q.25 A man is trying to roll a barrel along a level street by pushing forward along its top rim. At the same time another man is pushing backward at the middle, with a force of equal magnitude 4N (see figure), the barrel rolls without slipping. Find the magnitude (in N) of the friction force at the point of contact with the street. The barrel is a uniform cylinder of mass 1kg.