Additional Problems For Self Practice (APSP)

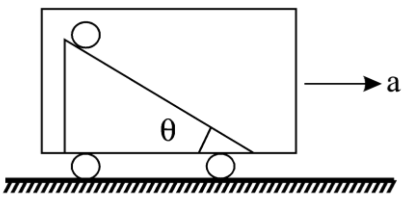
PART-I : PRACTICE TEST PAPER

Max. Marks : 120 **Max. Time : 1 Hr.**

Important Instructions :

1. The test is of **1 hour** duration and max. marks 120.
2. The test consists **30** questions, **4 marks** each.
3. Only one choice is correct **1 mark** will be deducted for incorrect response. No deduction from the total score will be made if no response is indicated for an item in the answer sheet.
4. There is only one correct response for each question. Filling up more than one response in any question will be treated as wrong response and marks for wrong response will be deducted accordingly as per instructions 3 above.

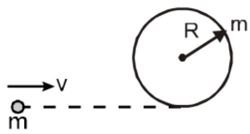
1. A smooth inclined plane fixed in a car accelerating on a horizontal road is shown in figure. The angle of incline θ is related to the acceleration a of the car as $a = g \tan\theta$. If the sphere is set in pure rolling on the incline



(1) it will continue pure rolling
(2) it will slip up the plane
(3) its angular velocity will increase
(4) its angular velocity will decrease.

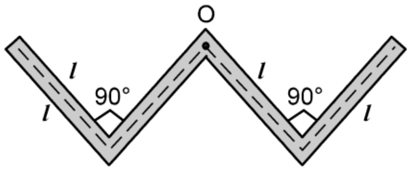
2. A sphere is released on a smooth inclined plane from the top. When it moves down its angular momentum is:
(1) conserved about every point
(2) conserved about the point of contact only
(3) conserved about the centre of the sphere only
(4) conserved about any point on a fixed line parallel to the inclined plane and passing through the centre of the ball.

3. A circular wooden loop of mass m and radius R rests flat on a horizontal frictionless surface. A bullet, also of mass m, and moving with a velocity V, strikes the loop and gets embedded in it. The thickness of the loop is much smaller than R. The angular velocity with which the system rotates just after the bullet strikes the loop is



(1) $\frac{V}{4R}$
(2) $\frac{V}{3R}$
(3) $\frac{2V}{3R}$
(4) $\frac{3V}{4R}$

4. A thin uniform rod of length $4\,l$, mass 4m is bent at the points as shown in the fig. What is the moment of inertia of the rod about the axis passing point O & perpendicular to the plane of the paper.

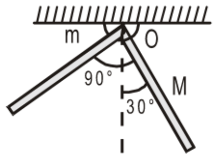


(1) $\frac{m\ell^2}{3}$ (2) $\frac{10\,m\ell^2}{3}$ (3) $\frac{m\ell^2}{12}$ (4) $\frac{m\ell^2}{24}$

5. The moment of inertia of a hollow cubical box of mass M and side a about an axis passing through the centres of two opposite faces is equal to

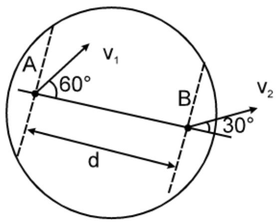
(1) $\frac{5Ma^2}{3}$ (2) $\frac{5Ma^2}{6}$ (3) $\frac{5Ma^2}{12}$ (4) $\frac{5Ma^2}{18}$

6. Two uniform rods of equal length but different masses are rigidly joined to form an L-shaped body, which is then pivoted about O as shown in the figure. If in equilibrium the body is in the shown configuration, ratio M/m will be:



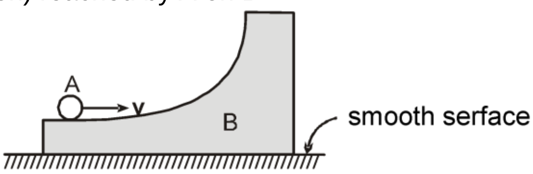
(1) 2
(2) 3
(3) $\sqrt{2}$
(4) $\sqrt{3}$

7. Two points A & B on a disc have velocities v_1 & v_2 at some moment. Their directions make angles 60° and 30° respectively with the line of separation as shown in figure. The angular velocity of disc is :



(1) $\frac{\sqrt{3}v_1}{d}$
(2) $\frac{v_2}{\sqrt{3}d}$
(3) $\frac{v_2 - v_1}{d}$
(4) $\frac{v_2}{d}$

8. In the figure shown a ring A is rolling without sliding with a velocity v on the horizontal surface of the body B (of same mass as A). All surfaces are smooth. B has no initial velocity. What will be the maximum height (from initial position) reached by A on B.



(1) $\frac{3v^2}{4g}$ (2) $\frac{v^2}{4g}$ (3) $\frac{v^2}{2g}$ (4) $\frac{v^2}{3g}$

9. The angular momentum of a particle about origin is varying as L = 4t + 8 (SI units) when it moves along a straight line y = x – 4 (x,y in meters). The magnitude of force acting on the particle would be :

(1) 1 N (2) 2 N (3) $\sqrt{2}$ N (4) $\sqrt{3}$ N

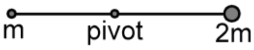
10. A particle is attached to the lower end of a uniform rod which is hinged at its other end as shown in the figure. The minimum speed given to the particle so that the rod performs circular motion in a vertical plane will be :
[length of the rod is ℓ, consider masses of both rod and particle to be same]

(1) $\sqrt{5g\ell}$
(2) $\sqrt{4g\ell}$
(3) $\sqrt{4.5g\ell}$
(4) none of these

11. When a person throws a meter stick it is found that the centre of the stick is moving with a speed of 10 m/s vertically upwards & left end of stick with a speed of 20 m/s vertically upwards. Then the angular speed of the stick is:

(1) 20 rad/ sec (2) 10 rad/sec (3) 30 rad/sec (4) none of these

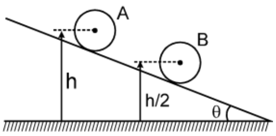
12. A rod of negligible mass and length ℓ is pivoted at its centre. A particle of mass m is fixed to its left end & another particle of mass 2 m is fixed to the right end. If the system is released from rest and after sometime becomes vertical, the speed v of the two masses and angular velocity at that instant.



(1) $\sqrt{g\ell/3}$, $\sqrt{4g/3\ell}$ (2) $\sqrt{4g\ell/3}$, $\sqrt{4g/3\ell}$

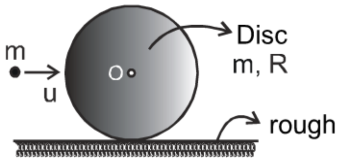
(3) $\sqrt{4g/3\ell}$, $\sqrt{4g\ell/3}$ (4) $\sqrt{g\ell/3}$, $\sqrt{g\ell/3}$

13. Two identical solid balls A & B of mass m each are placed on a fixed wedge as shown in figure. Ball B is kept at rest and it is released just before two balls collide. Ball A rolls down without slipping on inclined plane & collide elastically with ball B. The kinetic energy of ball A just after the collision with ball B is (Neglect friction between A and B) :



(1) $\frac{mgh}{7}$ (2) $\frac{mgh}{2}$ (3) $\frac{2mgh}{5}$ (4) $\frac{7mgh}{5}$

14. A point mass m collides with a disc of mass m and radius R resting on a rough horizontal surface as shown in figure. Its collision is perfectly inelastic and immediately system starts pure rolling. Find angular velocity of the system after pure rolling starts :



(1) $\left(\frac{2u}{7R}\right)$ (2) $\left(\frac{7u}{2R}\right)$ (3) $\left(\frac{5u}{2R}\right)$ (4) $\left(\frac{2u}{5R}\right)$

15. If the positions of two like parallel forces on a light rod are interchanged, their resultant shifts by one-fourth of the distance between them then the ratio of their magnitude is:

(1) 1: 2 (2) 2: 3 (3) 3: 4 (4) 3: 5

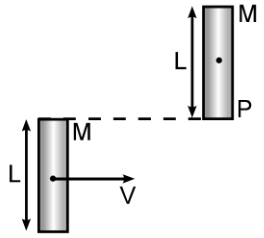
16. A bit of mud stuck to a bicycle's front wheel of radius R detaches and is flung horizontally forward when it is at the top of the wheel. The bicycle is moving forward at a speed v and it is rolling without slipping. The horizontal distance travelled by the mud after detaching from the wheel is:

(1) $\sqrt{2rv^2/g}$ (2) $\sqrt{8rv^2/g}$ (3) $\sqrt{4rv^2/g}$ (4) $\sqrt{16Rv^2/g}$

17. A uniform disk of mass 300kg is rotating freely about a vertical axis through its centre with constant angular velocity ω. A boy of mass 30kg starts from the centre and moves along a radius to the edge of the disk. The angular velocity of the disk now is

(1) $\frac{\omega_0}{6}$ (2) $\frac{\omega_0}{5}$ (3) $\frac{4\omega_0}{5}$ (4) $\frac{5\omega_0}{6}$

18. A bar of mass M & length L is in pure translatory motion with its centre of mass velocity V. It collides with and sticks to a second identical bar which is initially at rest. (Assume that it becomes one composite bar of length 2 L). The angular velocity of the composite bar will be:



(1) 3V/4L clockwise (2) 4V/3L clockwise
(3) 3V/4L counter clockwise (4) V/L counter clockwise

19. A body rolls down without slipping on an inclined plane. The fractional of its total energy associated with rotation will be (radius of gyration is k & radius of body is R)

(1) $\frac{R^2}{R^2+k^2}$ (2) $\frac{k^2}{R^2+k^2}$ (3) $k^2 + R^2$ (4) $\frac{1}{k^2+R^2}$

20. A body starts form rest, on applying a constant torque on a body
(1) linear velocity increases (2) angular velocity increases
(3) it will rotate with constant angular velocity (4) it will move with constant velocity

21. Three rods each of length L and mass M are placed along X. Yand Z axes in such a way that one end of each of the rod is at the origin. The moment of inertia of this system about Z axis is

(1) $\frac{2ML^2}{3}$ (2) $\frac{4ML^2}{3}$ (3) $\frac{5ML^2}{3}$ (4) $\frac{ML^2}{3}$

22. Of two eggs which have identical sizes, shapes and weights, one is raw and the other is halfboiled. The ratio between the moment of interia of the raw egg and that of the half-boiled egg about a central axis is
(1) One (2) Greater than one (3) Less than one (4) Incomparable

23. Let ℓ be the moment of inertia of a uniform square plate about an axis AB that passes through its centre and is parallel to two of its sides. CD is a line in the plane of the plate that passes through the centre of the plate and makes an angle θ with AB. The moment of inertia of the plate about the axis CD is then equal to
(1) ℓ (2) $\ell \sin^2 \theta$ (3) $\ell \cos^2 \theta$ (4) $\ell \cos^2 \theta/2$

24. If the moment of inertia of a disc about an axis tangential and parallel to its surface be I, then what will be the moment of inertia about the axis tangential but perpendicular to the surface

(1) $\frac{6}{5}I$ (2) $\frac{3}{4}I$ (3) $\frac{3}{2}I$ (4) $\frac{5}{4}I$

25. The moment of inertia of a sphere of mass M and radius R about an axis passing through its centre is $\frac{2}{5}MR^2$. The radius of gyration of the sphere about a parallel axis to the above and tangent to the sphere is

(1) $\frac{7}{5}R$ (2) $\frac{3}{5}R$ (3) $\left(\sqrt{\frac{7}{5}}\right)R$ (4) $\left(\sqrt{\frac{3}{5}}\right)R$

26. One circular ring and one circular disc, both are having the same mass and radius. The ratio of their moments of inertia about the axes passing through their centres and perpendicular to their planes. will be
(1) 1 : 1 (2) 2 : 1 (3) 1: 2 (4) 4 : 1

27. A uniform rod of length 2L is placed with one end in contact with the horizontal and is then inclined at an angle α to the horizontal and allowed to fall without slipping at contact point. When it becomes horizontal. its angular velocity Will be

(1) $\omega = \sqrt{\frac{3g\sin\alpha}{L}}$ (2) $\omega = \sqrt{\frac{2L}{3g\sin\alpha}}$ (3) $\omega = \sqrt{\frac{6g\sin\alpha}{L}}$ (4) $\omega = \sqrt{\frac{L}{g\sin\alpha}}$

28. A uniform heavy disc is rotating at constant angular velocity ω about a vertical axis through its eentre and perpendicular to the plane of the disc. Let L be its angular momentum. A lump of plasticine is dropped vertically on the disc and sticks to it. Which will be constant

(1) ω (2) ω and L both (3) L only (4) Neither ω nor L

29. Two rigid bodies A and B rotate with rotational kinetic energies E_A and E_B respectively. The moments of inertial of A and B about the axis of rotation are I_A and I_B respectively. If $I_A = I_B/4$ and $E_A = 100\ E_B$ the ratio of angular momentum (L_A) of A to the angular momentum (L_B) of B is

(1) 25 (2) 5/4 (3) 5 (4) 1/4

30. A disc is rotating with an angular speed of ω. If a child sits on it at edge, which of the following is conserved

(1) Kinetic energy (2) Potential energy (3) Linear momentum (4) Angular momentum

Practice Test (JEE-Main Pattern)

OBJECTIVE RESPONSE SHEET (ORS)

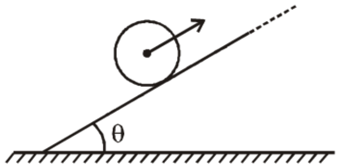
Que.	1	2	3	4	5	6	7	8	9	10
Ans.										
Que.	11	12	13	14	15	16	17	18	19	20
Ans.										
Que.	21	22	23	24	25	26	27	28	29	30
Ans.										

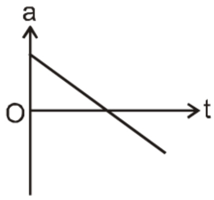
PART - II : PRACTICE QUESTIONS

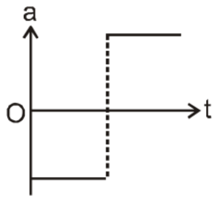
1. Two men of equal masses stand at opposite ends of the diameter of a turntable disc of a certain mass, moving with constant angular velocity. The two men make their way to the middle of the turntable at equal rates. In doing so

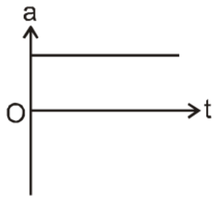
(1) kinetic energy of rotation has increased while angular momentum remains same.
(2) kinetic energy of rotation has decreased while angular momentum remains same.
(3) kinetic energy of rotation has decreased but angular momentum has increased.
(4) both, kinetic energy of rotation and angular momentum have decreased.

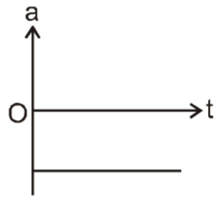
2. A uniform solid sphere rolls up (without slipping) the rough fixed inclined plane, and then back down. Which is the correct graph of acceleration 'a' of centre of mass of solid sphere as function of time t (for the duration sphere is on the incline) ? Assume that the sphere rolling up has a positive velocity.



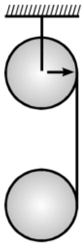
(1) 

(2) 

(3) 

(4) 

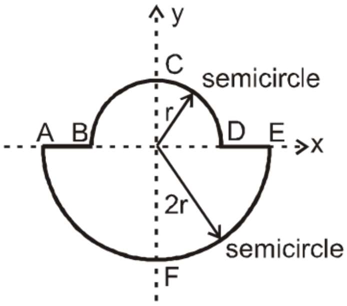
3. Two identical discs of mass m and radius r are arranged as shown in the figure. If α is the angular acceleration of the lower disc and a_{cm} is acceleration of centre of mass of the lower disc, then relation between a_{cm}, α & r is :



(1) $a_{cm} = \frac{\alpha}{r}$ (2) $a_{cm} = 2\alpha r$

(3) $a_{cm} = \alpha r$ (4) none of these

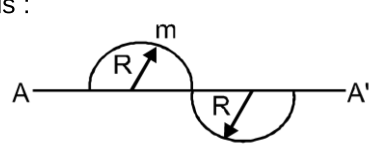
4. A uniform thin rod is bent in the form of closed loop ABCDEFA as shown in the figure.



The ratio of moment of inertia of the loop about x-axis to that about y-axis is.

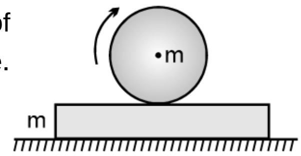
(1) > 1 (2) < 1 (3) = 1 (4) = 1/2

5. A wire of uniform mass density and total mass m is bent to form two semi–circles as shown in the figure Its moment of inertia about AA' is :



(1) $2\ mR^2$ (2) mR^2 (3) $\frac{mR^2}{2}$ (4) $\frac{mR^2}{4}$

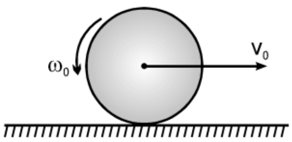
6. A sphere of mass ' m ' is given some angular velocity about a horizontal axis through its centre and gently placed on a plank of mass ' m '. The co-efficient of friction between the two is μ. The plank rests on a smooth horizontal surface. The initial acceleration of the centre of sphere relative to the plank will be:



(1) zero (2) μg

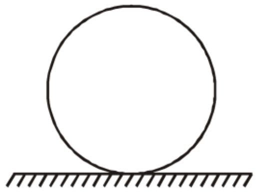
(3) (7/5) μg (4) 2 μg

7. A uniform circular disc placed on a horizontal rough surface has initially a velocity v_0 and an angular velocity ω_0 as shown in the figure. The disc comes to rest after moving some distance in the direction of motion. Then v_0/ω_0 is:



(1) r/2 (2) r (3) 3 r/2 (4)2

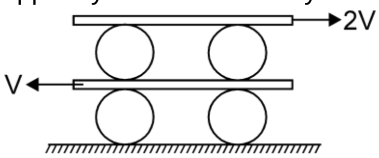
8. A ring of radius R rolls without slipping on a rough horizontal surface with a constant velocity. The radius of curvature of the path followed by any particle of the ring at the highest point of its path will be :



(1) 1 R
(2) 2 R
(3) 4 R
(4) none of these

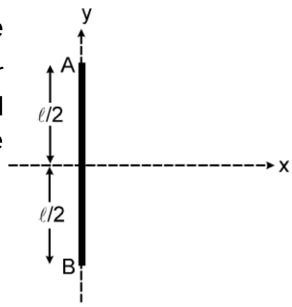
9. A solid cylinder and a solid sphere, both having the same mass and radius, are released from an incline of angle θ one by one. They roll on the incline without slipping. The statement that holds good in this motion is that
(1) the force of friction that acts on the two is the same
(2) the force of friction is greater in case of a sphere than for a cylinder.
(3) the force of friction is greater in case of cylinder than for sphere.
(4) the force of friction will depend on the nature of the surface of the body that is moving and that of the inclined surface, and is independent of the shape and size of the moving body.

10. A system of uniform cylinders and plates is shown in figure. All the cylinders are identical and there is no slipping at any contact. Velocity of lower & upper plate is V and 2V respectively as shown in figure. Then the ratio of angular speed of the upper cylinders to lower cylinders is



(1) 3 (2) 1/3 (3) 1 (4) none of these

11. A uniform rod of mass m, length ℓ is placed over a smooth horizontal surface along y-axis and is at rest as shown in figure. An impulsive force F is applied for a small time Δt along x-direction at point A. The x–coordinate of end A of the rod when the rod becomes parallel to x–axis for the first time is (initially the coordinate of centre of mass of the rod is (0, 0)) :



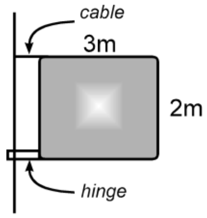
(1) $\frac{\pi\ell}{12}$
(2) $\frac{\ell}{2}\left(1+\frac{\pi}{12}\right)$
(3) $\frac{\ell}{2}\left(1-\frac{\pi}{6}\right)$
(4) $\frac{\ell}{2}\left(1+\frac{\pi}{6}\right)$

12. A particle is attached to the lower end of a uniform rod which is hinged at its other end as shown in the figure. The minimum speed given to the particle so that the rod performs circular motion in a vertical plane will be :
[length of the rod is ℓ, consider masses of both rod and particle to be same]

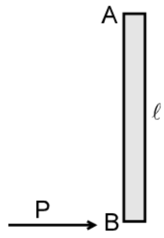
(1) $\sqrt{5g\ell}$
(2) $\sqrt{4g\ell}$
(3) $\sqrt{4.5g\ell}$
(4) none of these

13. In figure the uniform gate weighs 300 N and is 3 m wide & 2 m high. It is supported by a hinge at the bottom left corner and a horizontal cable at the top left corner, as shown , the tension in the cable and the force that the hinge exerts on the gate (magnitude & direction :
(1) T = 225 N , F_X = 225N, F_Y = 300 N
(2) T = 300 N , F_X = 225 N, F_Y = 300 N
(3) T = 225 N , F_X = 300N, F_Y = 250 N

(4) T = 300 N , F_X = 300 N, F_Y = 250 N



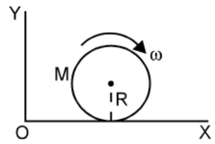
14. A uniform rod AB of mass m and length ℓ at rest on a smooth horizontal surface. An impulse P is applied to the end B. The time taken by the rod to turn through a right angle is :



(1) $\frac{2\pi m\ell}{P}$ (2) $\frac{\pi m\ell}{3P}$

(3) $\frac{\pi m\ell}{12P}$ (4) $\frac{2\pi m\ell}{3P}$

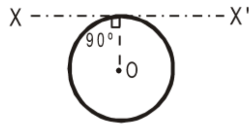
15. A disc of mass M and radius R is rolling with angular speed ω on a horizontal plane as shown. The magnitude of angular momentum of the disc about the origin O is



(1) $(1/2)MR^2\omega$ (2) $MR^2\omega$

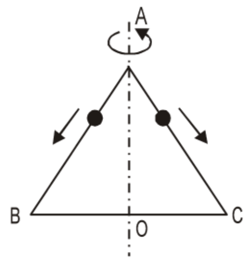
(3) $(3/2)MR^2\omega$ (4) $2MR^2\omega$

16. A thin wire of length L and uniform linear density ρ is bent into a circular loop with centre at O as shown. The moment of inertia of the loop about the axis XX' is



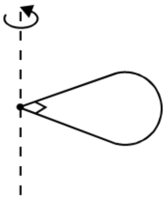
(1) $\frac{\rho L^3}{8\pi^2}$ (2) $\frac{\rho L^3}{16\pi^2}$ (3) $\frac{5\rho L^3}{16\pi^2}$ (4) $\frac{3\rho L^3}{8\pi^2}$

17. An equilateral triangle ABC formed from a uniform wire has two small identical beads initially located at A. The triangle is set rotating about the vertical axis AO. Then the beads are released from rest simultaneously and allowed to slide down, one along AB and the other along AC as shown. Neglecting frictional effects, the quantities that are conserved as the beads slide down, are



(1) Angular velocity and total energy (kinetic energy and potential energy)
(2) Total angular momentum and total energy
(3) Angular velocity and moment of inertia about the axis of rotation
(4) Total angular momentum and moment of inertia about axis AO

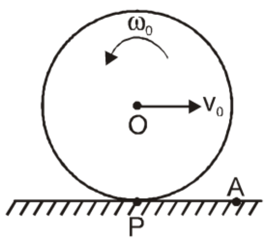
18. One quarter sector is cut from a uniform circular disc of radius R. This sector has mass M . It is made to rotate about a line perpendicular to its plane and passing through the centre of the original disc. Its moment of inertial about the axis of rotation is :



(1) $\frac{1}{2}MR^2$ (2) $\frac{1}{4}MR^2$ (3) $\frac{1}{8}MR^2$ (4) $\sqrt{2}MR^2$

Comprehension # 1

A uniform wheel is released on a rough horizontal floor after imparting it an initial horizontal velocity v_0 and angular velocity ω_0 as shown in the figure below. Point O is the centre of mass of the wheel and point P is its instantaneous point of contact with the ground. The radius of wheel is r and its radius of gyration about O is k. Coefficient of friction between wheel and ground is μ. A is a fixed point on the ground.



19. Which of the following is conserved ?

(1) linear momentum of wheel (2) Angular momentum of wheel about O

(3) Angular momentum of wheel about A (4) none of these

20. If the wheel comes to permanent rest after sometime, then :

(1) $v_0 = \omega_0 r$ (2) $v_0 = \frac{\omega_0 k^2}{r}$ (3) $v_0 = \frac{\omega_0 r^2}{R}$ (4) $V_0 = \omega_0\left(r + \frac{k^2}{r}\right)$

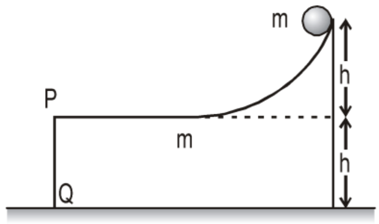
21. In above question, distance travelled by centre of mass of the wheel before it stops is -

(1) $\frac{v_0^2}{2\mu g}\left(1+\frac{r^2}{k^2}\right)$ (2) $\frac{v_0^2}{2\mu g}$ (3) $\frac{v_0^2}{2\mu g}\left(1+\frac{k^2}{r^2}\right)$ (4) None of these

Comprehension # 2

A small ball (uniform solid sphere) of mass m is released from the top of a wedge of the same mass m. The wedge is free to move on a smooth horizontal surface. The ball rolls without sliding on the wedge. The required height of the wedge are mentioned in the figure.

22. The speed of the wedge when the ball is just going to leave the wedge at point 'P' of the wedge is



(1) $\sqrt{\frac{5gh}{9}}$ (2) $\sqrt{gh}$

(3) $\sqrt{\frac{5gh}{6}}$ (4) None of these

23. The total kinetic energy of the ball just before it falls on the ground

(1) 2 mgh (2) mgh (3) $\frac{13}{18}$ mgh (4) None of these

24. The horizontal separation between the ball and the edge 'PQ' of wedge just before the ball falls on the ground is

(1) $\frac{3\sqrt{10}}{2}h$ (2) $\frac{2\sqrt{10}}{3}h$ (3) 2 h (4) None of these

APSP Answers

PART - I

1.	(1)	**2.**	(4)	**3.**	(2)	**4.**	(2)	**5.**	(4)	**6.**	(4)	**7.**	(4)
8.	(2)	**9.**	(3)	**10.**	(3)	**11.**	(1)	**12.**	(1)	**13.**	(1)	**14.**	(1)
15.	(4)	**16.**	(4)	**17.**	(4)	**18.**	(3)	**19.**	(2)	**20.**	(2)	**21.**	(1)
22.	(2)	**23.**	(1)	**24.**	(1)	**25.**	(3)	**26.**	(2)	**27.**	(1)	**28.**	(3)
29.	(3)	**30.**	(4)										

PART - II

1.	(1)	**2.**	(4)	**3.**	(2)	**4.**	(2)	**5.**	(3)	**6.**	(4)	**7.**	(1)
8.	(3)	**9.**	(3)	**10.**	(1)	**11.**	(4)	**12.**	(3)	**13.**	(1)	**14.**	(3)
15.	(3)	**16.**	(4)	**17.**	(2)	**18.**	(1)	**19.**	(3)	**20.**	(2)	**21.**	(2)
22.	(1)	**23.**	(4)	**24.**	(2)								