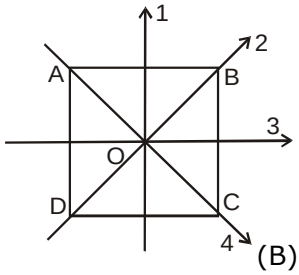
Exercise - II (Multiple Choice Problems)

(A) MOMENT OF INERTIA

1. ABCD is a square plate with centre O. The moments of inertia of the plate about the perpendicular axis through O is I and about the axes 1, 2, 3 & 4 are I_1, I_2, I_3 & I_4 respectively. It follows that :



(A) $I_2 = I_3$ (B) $I = I_1 + I_4$
(C) $I = I_2 + I_4$ (D) $I_1 = I_3$

(B) TORQUE & PURE ROTATIONAL MOTION

2. A rod of weight w is supported by two parallel knife edges A and B and is in equilibrium in a horizontal position. The knives are at a distance d from each other. The centre of mass of the rod is at a distance x from A.

(A) the normal reaction at A is $\frac{wx}{d}$

(B) the normal reaction at A is $\frac{w(d-x)}{d}$

(C) the normal reaction at B is $\frac{wx}{d}$

(D) the normal reaction at B is $\frac{w(d-x)}{d}$

3. A block with a square base measuring axa and height h, is placed on an inclined plane. The coefficient of friction is μ. The angle of inclination (θ) of the plane is gradually increased. The block will

(A) topple before sliding if $\mu > \frac{a}{h}$

(B) topple before sliding if $\mu < \frac{a}{h}$

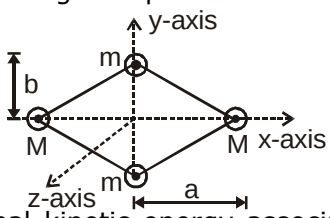
(C) slide before toppling if $\mu > \frac{a}{h}$

(D) slide before toppling if $\mu < \frac{a}{h}$

4. A body is in equilibrium under the influence of a number of forces. Each force has a different line of action. The minimum number of forces required is
(A) 2, if their lines of action pass through the centre of mass of the body
(B) 3, if their lines of action are not parallel
(C) 3, if their lines of action are parallel
(D) 4, if their lines of action are parallel and all the forces have the same magnitude

5. A block of mass m moves on a horizontal rough surface with initial velocity v. The height of the centre of mass of the block is h from the surface. Consider a point A on the surface
(A) angular momentum about A is mvh initially
(B) the velocity of the block decreases at time passes
(C) torque of the forces acting on block is zero about A
(D) angular momentum is not conserved about A

6. Four point masses are fastened to the corners of a frame of negligible mass lying in the xy plane. Let w be the angular speed of rotation. Then



(A) rotational kinetic energy associated with a given angular speed depends on the axis of rotation.
(B) rotational kinetic energy about y-axis is independent of m and its value is $Ma^2\omega^2$
(C) rotational kinetic energy about z-axis depends on m and its value is $(Ma^2 + mb^2)\omega^2$
(D) rotational kinetic energy about z-axis is independent of m and its value is $Mb^2\omega^2$

7. A particle falls freely near the surface of the earth. Consider a fixed point O (not vertically below the particle) on the ground.
(A) Angular momentum of the particle about O is increasing
(B) Torque of the gravitational force on the particle about O is decreasing
(C) The moment of inertia of the particle about O is decreasing
(D) The angular velocity of the particle about O is increasing

(C) ANGULAR MOMENTUM

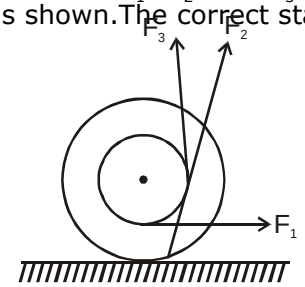
8. If a person sitting on a rotating stool with his hands outstretched, suddenly lowers his hands, then his
(A) Kinetic energy will decrease
(B) Moment of inertia will decrease
(C) Angular momentum will increase
(D) Angular velocity will remain constant

9. A man spinning in free space changes the shape of his body, eg. by spreading his arms or curling up. By doing this, he can change his
(A) moment of inertia
(B) angular momentum
(C) angular velocity
(D) rotational kinetic energy

(D) COMBINED TRANSLATIONAL + ROTATIONAL MOTION

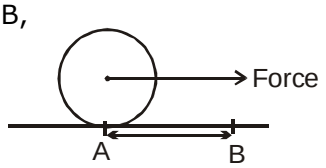
10. A ring rolls without slipping on the ground. Its centre C moves with a constant speed u. P is any point on the ring. The speed of P with respect to the ground is v.
(A) $0 \le v \le 2u$
(B) v = u, if CP is horizontal
(C) v = u, if CP makes an angle of 30º with the horizontal and P is below the horizontal level of C
(D) $v = \sqrt{2}u$, if CP is horizontal

11. A yo-yo is resting on a perfectly rough horizontal table. Forces F_1, F_2 and F_3 are applied separately as shown.The correct statement is



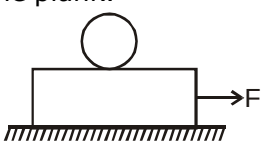
(A) when F_3 is applied the centre of mass will move to the right
(B) when F_2 is applied the centre of mass will move to the left
(C) when F_1 is applied the centre of mass will move to the right
(D) when F_2 is applied the centre of mass will move to the right

12. A disc of circumference s is at rest at a point A on a horizontal surface when a constant horizontal force begins to act on its centre. Between A and B there is sufficient friction to prevent slipping, and the surface is smooth to the right of B. AB = s. The disc moves from A to B in time T. To the right of B,



(A) the angular acceleration of the disc will disappear, linear acceleration will remain unchanged
(B) linear acceleration of the disc will increase
(C) the disc will make one rotation in time T/2
(D) the disc will cover a distance greater than s in further time T.

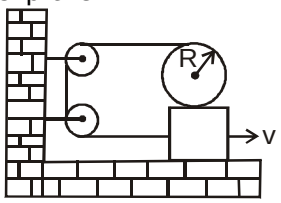
13. A plank with a uniform sphere placed on it, rests on a smooth horizontal plane. Plank is pulled to right by a constant force F. If the sphere does not slip over the plank.



(A) acceleration of centre of sphere is less than that of the plank
(B) acceleration of centre of sphere is greater than the plank because friction acts rightward on the sphere
(C) acceleration of the centre of sphere may be towards left
(D) acceleration of the centre of sphere relative to plank may be greater than that of the plank relative to floor

14. A hollow sphere of radius R and mass m is fully filled with water of mass m. It is rolled down a horizontal plane such that its centre of mass moves with a velocity v. If it purely rolls
(A) Kinetic energy of the sphere is $\frac{5}{6}mv^2$
(B) Kinetic energy of the sphere is $\frac{4}{5}mv^2$
(C) Angular momentum of the sphere about a fixed point on ground is $\frac{8}{3}mvR$
(D) Angular momentum of the sphere about a fixed point on ground is $\frac{14}{5}mvR$

15. In the figure shown, the plank is being pulled to the right with a constant speed v. If the cylinder does not slip then :



(A) the speed of the centre of mass of the cylinder is 2v
(B) the speed of the centre of mass of the cylinder is zero
(C) the angular velocity of the cylinder is v/R
(D) the angular velocity of the cylinder is zero

16. If a cylinder is rolling down the incline with sliding
(A) after some time it may start pure rolling
(B) after sometime it will start pure rolling
(C) it may be possible that it will never start pure rolling
(D) none of these

17. Which of the following statements are correct
(A) friction acting on a cylinder without sliding on an inclined surface is always upward along the incline irrespective of any external force acting on it.
(B) friction acting on a cylinder without sliding on an inclined surface is may be upward may be downwards depending on the external force acting on it.

(C) friction acting on a cylinder rolling without sliding may be zero depending on the external force acting on it.
(D) nothing can be said exactly about it as it depends on the friction coefficient on inclined plane

Question No. 18 to 20 (3 Questions)

A cylinder and a ring of same mass M and radius R are placed on the top of a rough inclined plane of inclination θ. Both are released simultaneously from the same height h.

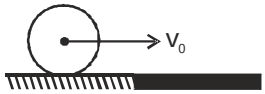
18. Choose the correct statement(s) related to the motion of each body
(A) The friction force acting on each body opposes the motion of its centre of mass
(B) The friction force provides the necessary torque to rotate the body about its centre of mass
(C) without friction none of the two bodies can roll
(D) The friction force ensures that the point of contact must remain stationary

19. Identify the correct statement(s)
(A) The friction force acting on the cylinder may be more than that acting on the ring
(B) The friction force acting on the ring may be more than that acting on the cylinder
(C) If the friction is sufficient to roll the cylinder then the ring will also roll
(D) If the friction is sufficient to roll the ring then the cylinder will also roll

20. When these bodies roll down to the foot of the inclined plane, then
(A) the mechanical energy of each body is conserved
(B) the velocity of centre of mass of the cylinder is $2\sqrt{\frac{gh}{3}}$
(C) the velocity of centre of mass of the ring is $\sqrt{gh}$
(D) the velocity of centre of mass of each body is $\sqrt{2gh}$

Question No. 21 to 24 (4 Questions)

A ring of mass M and radius R sliding with a velocity v_0 suddenly enters into rough surface where the coefficient of friction is μ, as shown in figure.



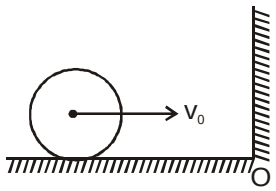
21. Choose the correct statement(s)
(A) As the ring enters on the rough surface, the limiting friction force acts on it
(B) The direction of friction is opposite to the direction of motion
(C) The friction force accelerates the ring in the clockwise sense about its centre of mass
(D) As the ring enters on the rough surface it starts rolling

22. Choose the correct statement(s)
(A) The momentum of the ring is conserved
(B) The angular momentum of the ring is conserved about its centre of mass
(C) The angular momentum of the ring conserved about any point on the horizontal surface
(D) The mechanical energy of the ring is conserved

23. Choose the correct statement(s)
(A) The ring starts its rolling motion when the centre of mass stationary
(B) The ring starts rolling motion when the point of contact becomes stationary
(C) The time after which the ring starts rolling is $\frac{v_0}{2\mu g}$
(D) The rolling velocity is $\frac{v_0}{2}$

24. Choose the correct alternative(s)
(A) The linear distance moved by the centre of mass before the ring starts rolling is $\frac{3v_0^2}{8\mu g}$
(B) The net work done by friction force is $-\frac{3}{8}mv_0^2$
(C) The loss is kinetic energy of the ring is $\frac{mv_0^2}{4}$
(D) The gain in rotational kinetic energy is $+\frac{mv_0^2}{8}$

25. Consider a sphere of mass 'm' radius 'R' doing pure rolling motion on a rough surface having velocity $\vec{v}_0$ as shown in the Figure. It makes an elastic impact with the smooth wall and moves back and starts pure rolling after some time again.



(A) Change in angular momentum about 'O' in the entire motion equals $2mv_0R$ in magnitude.
(B) Moment of impulse provided by wall during impact about O equals $2mv_0R$ in magnitude
(C) Final velocity of ball will be $\frac{3}{7}\vec{v}_0$
(D) Final velocity of ball will be $-\frac{3}{7}\vec{v}_0$