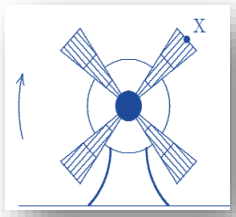
INDIAN SCHOOL AL WADI AL KABIR

CLASS: XI	**DEPARTMENT: SCIENCE (2024-2025)** **SUBJECT: PHYSICS**	**DATE: 28/10/2024**
WORKSHEET NO: 6 WITH ANSWERS	**TOPIC: SYSTEM OF PARTICLES AND ROTATIONAL MOTION**	**NOTE: A4 FILE FORMAT**
CLASS & SEC:	**NAME OF THE STUDENT:**	**ROLL NO.**

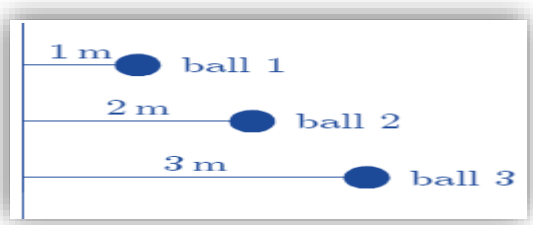
MULTIPLE CHOICE QUESTIONS

1. A radian is about:
   A. 25◦ B. 37◦
   C. 45◦ D. 57◦
2. One revolution per minute is about:
   A. 0.0524 rad/s B. 0.105 rad/s
   C. 0.95 rad/s D. 1.57 rad/s
3. If a wheel turns with constant angular speed then:
   A. each point on its rim moves with constant velocity
   B. each point on its rim moves with constant acceleration
   C. the wheel turns through equal angles in equal times
   D. the angle through which the wheel turns in each second increases as time goes on
4. If wheel turning at a constant rate completes 100 revolutions in 10 s its angular speed is:
   A. 0.31 rad/s B. 0.63 rad/s
   C. 31 rad/s D. 63 rad/s
5. The angular speed of the minute hand of a watch is:
   A. (60/π) rad/s B. (1800/π) rad/s
   C. (π) rad/s D. (π/1800) rad/s
6. A flywheel is initially rotating at 20 rad/s and has a constant angular acceleration. After 9.0 s it has rotated through 450 rad. Its angular acceleration is:
   A. 3.3 rad/s B. 4.4 rad/s
   C. 5.6 rad/s D. 6.7 rad/s
7. Ten seconds after an electric fan is turned on, the fan rotates at 300 rev/min. Its average angular acceleration is:
   A. 3.14 rad/s^2 B. 30 rad/s^2
   C. 30 rev/s^2 D. 50 rev/min^2
8. The angular velocity of a rotating wheel increases by 2 rev/s every minute. The angular acceleration in rad/s^2 of this wheel is:
   A. 4π^2 B. 2π
   C. 1/30 D. π/15
9. A child, riding on a large merry-go-round, travels a distance of 3000m in a circle of diameter 40 m. The total angle through which she revolves is:
   A. 50 rad B. 75 rad
   C. 150 rad D. 314 rad
10. The fan shown has been turned on and is now slowing as it rotates clockwise. The direction of the acceleration of the point X on the fan tip could be:

A.↗
B.↖
C. ↓
D. ←

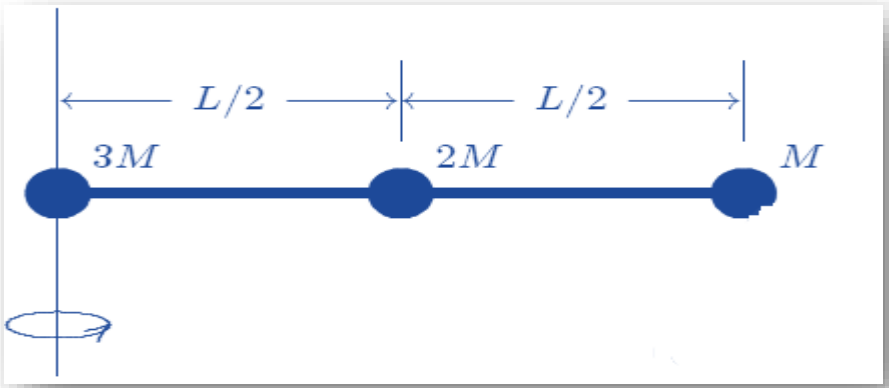


11. Three identical balls are tied by light strings to the same rod and rotate around it, as shown. Rank the balls according to their rotational inertia, least to greatest.



A. 1, 2, 3
B. 3, 2, 1
C. 3, then 1 and 2 tie
D. 1, 3, 2

12. Three identical balls, with masses of M, 2M, and 3M, are fastened to a massless rod of length L as shown. The rotational inertia about the left end of the rod is:



A. $ML^2/2$
B. ML^2
C. $3ML^2/2$
D. $3ML^2/4$

13. The rotational inertia of a wheel about its axle does not depend upon its:
A. diameter
B. mass
C. distribution of mass
D. speed of rotation

14. A uniform solid cylinder made of lead has the same mass and the same length as a uniform solid cylinder made of wood. The rotational inertia of the lead cylinder compared to the wooden one is:
A. greater
B. less
C. same
D. unknown unless the radii are given

15. The rotational inertia of a disk about its axis is 0.70 kgm^2. When a 2.0-kg weight is added to its rim, 0.40m from the axis, the rotational inertia becomes:
A. 0.38 kgm^2
B. 0.54 kgm^2
C. 0.70 kgm^2
D. 1.0kgm^2

16. When a thin uniform stick of mass M and length L is pivoted about its midpoint, its rotational inertia is $ML^2/12$. When pivoted about a parallel axis through one end, its rotational inertia is:
A. $ML^2/12$
B. $ML^2/6$
C. $ML^2/3$
D. $7ML^2/12$

17. The rotational inertia of a solid uniform sphere about a diameter is (2/5) MR^2, where M is its mass and R is its radius. If the sphere is pivoted about an axis that is tangent to its surface, its rotational inertia is:
    A. MR^2 B. (2/5) MR^2
    C. (3/5) MR^2 D. (7/5) MR^2
18. When the speed of a rear-drive car is increasing on a horizontal road the direction of the frictional force on the tires is:
    A. forward for all tires
    B. backward for all tires
    C. forward for the front tires and backward for the rear tires
    D. backward for the front tires and forward for the rear tires
19. The angular momentum vector of Earth about its rotation axis, due to its daily rotation, is directed:
    A. tangent to the equator toward the east
    B. tangent to the equator toward the west
    C. north
    D. south
20. A 2.0 kg block travels around a 0.50 m radius circle with an angular velocity of 12 rad/s. The magnitude of its angular momentum about the center of the circle is:
    A. 6.0kgm^2/s B. 12 kgm^2/s
    C. 48 kg/m^2s D. 72 kgm^2/s^2

ANSWERS OF MCQs; -1. (D),2. (B), 3. (C), 4. (D), 5. (D), 6. (D), 7. (A), 8. (D), 9. (C), 10. (C), 11. (A), 12. (D), 13. (D), 14. (B), 15. (D),16. (C),17. (D), 18. (D), 19. (C), 20. (D)

SHORT ANSWER TYPE (2 MARKS)

1. **Can centre of mass of a body coincide with the geometrical centre of the body?**

Yes, when a body has a uniform mass density, its centre of mass shall coincide with its geometrical centre.

2. **A person is sitting in the compartment of a train moving with uniform velocity on a smooth track. How will the velocity of centre of mass of compartment change if the person begins to run in the compartment?**

We know that velocity of centre of mass of a system changes only when an external force acts on it. The person and the compartment form one system on which no external force is applied when the person begins to run. Therefore, there will be no change in velocity of centre of mass of the compartment.

3. **If a body is rotating, is it necessarily being acted upon by an external torque?**

No, torque is required only for producing angular acceleration. For uniform rotation, no torque is needed.

4. **Why is the handle of a screw made wide?**

Turning moment of a force = force x distance (r) from the axis of rotation. To produce a given turning moment, force required is smaller, when r is large. This is what happens when handle of the screw is made wide.

5. **For a given mass and size, moment of inertia of a solid disc is smaller than that of a ring. Why?**

This is because entire mass of ring is at its periphery i.e. at maximum distance from the centre. The mass of disc is distributed from the centre to the rim

6. **Two satellites of equal masses, which can be considered as particles are orbiting the earth at different heights. Will their moments of inertia be same or different?**

Moments of inertia of the two satellites will be different. This is because, I = mass × (distance)^2. For the satellite revolving at a greater height, distance from the axis of rotation is larger. Therefore, its moment of inertia is larger.

7. **How will you distinguish between a hard-boiled egg and a raw egg by spinning each on a table top?**

To distinguish between a hard-boiled egg and a raw egg, we spin each on a table top. The egg which spins at a slower rate shall be a raw egg. This is because in a raw egg, liquid matter inside tries to get away from the axis of rotation. Therefore, its moment of inertia I increases. As $\tau = I\alpha$ = constant, therefore, α decreases i.e. raw egg will spin with smaller angular acceleration.

8. **If earth were to shrink suddenly, what would happen to the length of the day?**

If earth were to shrink suddenly, its radius R would decrease. The moment of inertia of earth = $2/5MR^2$ would decrease. As no external torque is acting on earth, its angular momentum $L = I\omega = I2\pi/t$ remains constant. As I decreases, T must decrease. Hence the length of the day will decrease.

SHORT ANSWER TYPE (3 MARKS)

1. Calculate the angular momentum of Earth rotating about an axis, if the Mass of the Earth is 5.98 x 10^{24} kg and the radius of the Earth is 6.3 x 10^6 m
   Ans. [7.08 x 10^{33} Si unit]
2. The spin driver of a washing machine revolving at 15rps slows down to 5rps, while making 50 revolutions. Find angular acc. and time taken ?
   Ans. 4∏ rad/s^2 and t =5s

CASE STUDY TYPE(4 MARKS)

The time rate of the total angular momentum of a system of particles about a point (taken as the origin of our frame of reference) is equal to the sum of the external torques (i.e. the torques due to external forces) acting on the system taken about the same point. $\tau ext = dL\ dt$ If τext =0 $dL\ dt$ =0 or L = constant. Or $I\omega = constant$

With the help of above comprehension, choose the most appropriate alternative for each of the following questions:

1. Which of the following can be explained with the help of conservation of angular momentum?
   A. Driving
   B. Ice- skating
   C. Diving
   D. running

2. For angular momentum to be conserved what must be true about the net torque of the system?
   A. Net torque is constant.
   B. Net torque increases.
   C. Net torque decreases.
   D. Net torque is zero.

3. A person sits on a freely spinning lab stool that has no friction in its axle. When this person extends her arms,
   A. her moment of inertia increases and her angular speed decreases.
   B. her moment of inertia decreases and her angular speed increases.
   C. her moment of inertia increases and her angular speed increases.
   D. her moment of inertia increases and her angular speed remains the same.

4. Two children, Ahmed and Saleh, ride on a merry-go-round. Ahmed is at a greater distance from the axis of rotation than Saleh. Which of the following are true statements?
   A. Saleh and Ahmed have the same tangential speed.
   B. Ahmed has a greater tangential speed than Saleh.
   C. Saleh has a greater angular speed than Ahmed.
   D. Saleh has a smaller angular speed than Ahmed

ANSWER

1.C 2. D 3. A 4. B

LONG ANSWER TYPE (5 MARKS)

1. a. If the ice on the polar caps of the earth melts, how will it affect the duration of the day? Explain.

Earth rotates about its polar axis. When ice of polar caps of earth melts, mass concentrated near the axis of rotation spreads out. Therefore, moment of inertia I increases. As no external torque acts,

$$\therefore L=I\omega=I(2\pi/T) = \text{constant}$$

With increases of I, T will increase i.e. length of the day will increase.

1. b. An isolated particle of mass m is moving in a horizontal plane (X-Y) along the x-axis at a certain height above the ground. It explodes suddenly into two fragments of masses m/4 and 3 m/4. An instant later, the smaller fragment is at y = + 15 cm. What is the position of larger fragment at this instant?

As isolated particle is moving along x-axis at a certain height above the ground, there is no motion along Y-axis. Further, the explosion is under internal forces only. Therefore, centre of mass remains stationary along Y-axis after collision. Let the co-ordinates of centre of mass be $(x_{cm}, 0)$. Now, $y_{cm} = \frac{m_1 y_1 + m_2 y_2}{m_1 + m_2} = 0$ $\therefore m_1 y_1 + m_2 y_2 = 0$ or $m_2 = \frac{-m_1 y_1}{y_2}$ $y_2 = \frac{-m_1 y_1}{m_2} = \frac{-m/4}{3m/4} \times 15 = -5cm$ $\therefore$ Larger fragment will be at y = -5 cm; along x-axis.

ASSERTION REASON TYPE

1. **Assertion**: For a system of particles under central force field, the total angular momentum is conserved.
   Reason: The torque acting on such a system is zero.
   Ans. b. Both Assertion and Reason are true but Reason is not the correct explanation of Assertion
2. **Assertion**: A satellite is orbiting about a planet then its angular momentum is conserved.
   Reason: Linear momentum conservation leads to angular momentum conservation.
   Ans. c. Assertion is true but Reason is false
3. **Assertion**: In rolling, all points of a rigid body have same linear velocity.
   Reason: The rotational motion does not affect the linear velocity.
   Ans. d. Assertion is false and Reason is also false

Additional questions based on previous papers

1. The Moment of inertia of 2 rotating bodies A and B are 5 and 10 units respectively and their angular momentum are equal. Which one has less K. Energy?
   Ans. Body [B]
2. A disc of metal is melted and recast in the form of a solid sphere. What will happen to the moment of inertia about a vertical axis passing through the centre?
   Ans. decreases
3. A planet moves around the sun under the effect of gravitational force exerted by the sun. Why is the torque on the planet due to gravitational force is zero?
   Ans. Perpendicular distance is zero
4. Two satellites of equal masses which can be considered as particles are orbiting the Earth at different heights. Will the moment of inertia be the same or different?
   Ans. different
5. How does an ice skater take the advantage of the conservation of momentum?
   Ans. L = Iω
   As I increases, ω decreases if torque = 0

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