	INDIAN SCHOOL AL WADI AL KABIR	
Class: XI	Department: Science 2025-26 Subject: Physics	Date: 19/10/2025
Worksheet No:06	Topic: SYSTEM OF PARTICLES AND ROTATIONAL MOTION	Note: A4 FILE FORMAT
CLASS/SEC.:	NAME OF THE STUDENT:	ROLL NO.:

SECTION A [1 MARKS QUESTIONS]
OBJECTIVE TYPE QUESTIONS

1) If the resultant of all external forces is zero, then velocity of centre of mass will be
    a) Zero
    b) Constant
    c) Either (a) or (b)
    d) Neither (a) or (b)

2) During summersault, a swimmer bends his body to
    a) Increase moment of inertia
    b) Decrease moment of inertia
    c) Decrease the angular momentum
    d) Reduce the angular velocity

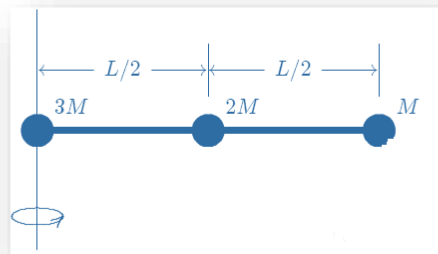
3) A boy comes and sits suddenly on a circular rotating table. What will remain conserved for the table – boy system?
    a) Angular velocity
    b) Angular momentum
    c) Linear momentum
    d) Angular acceleration

4) Three masses are placed on the axis: 300 g at origin, 500 g at x = 40 cm and 400 g at x = 70 cm. The distance of the centre of mass from the origin is
    a) 40 cm
    b) 45 cm
    c) 50 cm
    d) 30 cm

5) 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

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) 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) $3ML^2/4$



8) The sum of moments of all the particles in a system about the centre of mass is always
   a) maximum
   b) minimum
   c) infinite
   d) zero

9) Which of the following statements are incorrect about centre of mass?
I. Centre of mass can coincide with geometrical centre of a body
II. Centre of mass of a system of two particles does not always lie on the line joining the particles
III. Centre of mass should always lie on the body.
   a) II and III
   b) I and II
   c) I and III
   d) I, II and III

10) 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

11) Three particles of the same mass lie in the x-y plane. The (x, y) coordinates of their positions are (1, 1), (2, 2) and (3, 3) respectively. The (x, y) co-ordinates of the centre of mass are :

a) (1, 2)
b) (2, 2)
c) (4, 2)
d) (6, 6)

12) A mass m is moving with a constant velocity along a line parallel to the X-axis away from the origin, its angular momentum w.r.t. origin :

a) is zero
b) is constant
c) goes on decreasing
d) goes on increasing

13) A child is standing with folded hands at the center of a platform rotating about its central axis. The kinetic energy of the system is K. The child now stretches his arms so that the moment of inertia of the system doubles. The kinetic energy of the system now is :

a) 2K
b) K/ 2
c) K/ 4
d) 4K.

14) Which of the following statements is FALSE for a particle moving in a circle with a constant angular speed ?

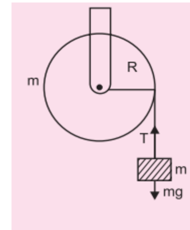
a) The velocity vector is tangent to the circle
b) The acceleration vector is tangent to the circle
c) The acceleration vector points to the centre of the circle
d) The velocity and acceleration vectors are perpendicular to each other.

15) Angular momentum of the particle rotating with a central force is constant due to :

a) Constant linear momentum

b) Zero Torque
c) Constant Torque
d) Constant Force.

16) A mass 'm' is supported by a massless string wound around a uniform hollow cylinder of mass m and radius R. If the string does not slip on the cylinder, with what acceleration will the mass fall on release?



(a) g
(b) 2/ 3 g
(c) g/2
(d) 5 /6 g

17) A bob of mass m attached to an inextensible string of length l is suspended from a vertical support. The bob rotates in a horizontal circle with an angular speed ω rad/s about the vertical. About the point of suspension:
(a) angular momentum changes in direction but not in magnitude.
(b) angular momentum changes both in direction and magnitude.
(c) angular momentum is conserved.
(d) angular momentum changes in magnitude but not in direction.

18) A thin horizontal circular disc is rotating about a vertical axis passing through its centre. An insect is at rest at a point near the rim of the disc. The insect now moves along a diameter of the disc to reach its other end. During the journey of the insect, the angular speed of the disc :

a) continuously decreases
b) continuously increases
c) first increases and then decreases
d) remains unchanged

19) Two uniform rods of the same diameter, having lengths of 2 m and 3 m, and having linear densities of 4 kg m^{-1} and 6 kg m^{-1} respectively are joined end to end. The distance of the centre of mass of the combined rod from the centre of mass of the first rod is :
(a) 4/3 m
(b) 6/9 m
(c) 45/26 m
(d) 26/45 m

20) Four particles of masses 1 kg, 2 kg, 3 kg and 4 kg are at the vertices of a rectangle of sides a and b with a > b. If a = 1 m, b = 2 m, what is the

location of their centre of mass ? (a) 0.5 m, 1.4 m
(b) 1.4 m, 0.5 m
(c) 0.14 m, 0.05 m
(d) 0.05 m, 0.14 m.

21] If a wheel turns with constant angular speed then:

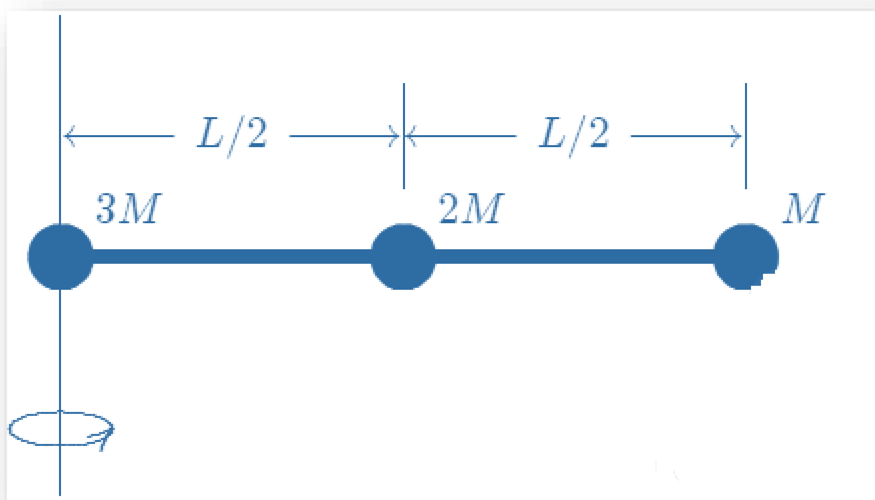
A. each point on its rim moves with constant velocity
B. each point on its rim moves with constant acceleration
C. the wheel turns through equal angles in equal times
D. the angle through which the wheel turns in each second increases as time goes on

22]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

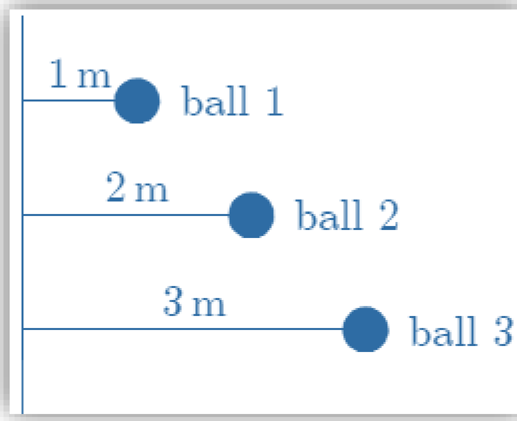
23]Three identical balls, with masses of M, 2M, and 3M, are fastened to a massless rod of length L as shown. The rotational inertia about the left end of the rod is:

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



24] Three identical balls are tied by light strings to the same rod and rotate around it, as shown below. 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



25] 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. $4\pi^2$ B. 2π
C. 1/30 D. $\pi/15$

Assertion and Reason:

26]Statement–I: The centre of mass of a body may lie at a point where there is no mass. Statement–II: Centre of mass of a body is a point where whole mass of the body is supposed to be concentrated.

(a) Statement–I is true, Statement–II is false.

(b) Statement–I is false, Statement–II is true.

(c) Statement–I is true, Statement–II is true and statement–II is correct explanation of Statement–I

(d) Statement–I is true, Statement–II is true and Statement –II is not correct explanation of Statement–I.

27]Statement–I: The M.I. of a solid sphere about the axis passing through its centre is $I = 2/5\ mR^2$, where m is its mass and R is the radius.

Statement–II: M.I. does not depend upon the distribution of mass of the body about axis.

(a) Statement –I is true, Statement–II is false.

(b) Statement– I is false, Statement–II is true.

(c) Statement–I is true, Statement–II is true and Statement – II is correct explanation for Statement–I.

(d) Statement–I is true, Statement–II is true and Statement–II is not correct explanation of Statement–I.

SECTION B [2 MARKS QUESTIONS]

Descriptive type of questions:

28] 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

29]The angular speed of the minute hand of a watch is:

A. ($60/\pi$) rad/s B. ($1800/\pi$) rad/s
C. (π) rad/s D. ($\pi/1800$) rad/s

30] 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

31] 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

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

[33]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?

[34] How will you distinguish between a hard-boiled egg and a raw egg by spinning each on a table top?

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[35] If earth were to shrink suddenly, what would happen to the length of the day?

[36] If the ice on the polar caps of the earth melts, how will it affect the duration of the day? Explain.

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SECTION C [3 MARKS QUESTIONS]

Descriptive type of questions:

[37] Derive an expression for the rotational kinetic energy of a rigid body .
[38]Derive the equation to show that , torque is equal to rate of change of angular momentum
[39]Show that angular momentum , L = I ω, where 'i' is moment of inertia and 'w' the angular velocity
[40] A wheel starting from rest is rotating with the constant angular acceleration of 3 rad/s^2. An observer notes that it traces an angle of 120 radians in four second interval. For how long the wheel had been rotated when the observer started hits observation?
[41] A 2 kg body and a 3 kg body are moving along the X axis. At a particular instant, the 2 kg body is 1 meter from the origin and has a velocity of 3 m/s and the 3 kg body is 2 meter from the origin, and has the velocity of 1 m/s. Find the position and velocity of center of mass. Also find the total momentum.

SECTION D [4 MARKS QUESTIONS]

CASE STUDY

[42]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

SECTION E [5 MARKS QUESTIONS]

[43]Show that torque $\tau = r \times f$ and angular momentum $L = r \times p$
[44] S how that $\tau = I\alpha$
[45] Expression for the position of centre of mass of 2 particle system, velocity and acceleration of 2 particle system.

ANSWERS:

1	Either (a) or (b)
2	Decrease moment of inertia
3	Angular momentum
4	40 cm
5	0.105 rad/s
6	6.7 rad/s
7	$3ML^2/2$
8	zero
9	II and III
10	3.14 rad/s^2
11	(2, 2)
12	is constant
13	K/ 2
14	The acceleration vector is tangent to the circle
15	Zero Torque
16	g/2
17	angular momentum is conserved
18	first increases and then decreases
19	45/26 m
20	0.5 m, 1.4 m

21	C. the wheel turns through equal angles in equal times
22	D. speed of rotation
23	$I = I_1 + I_2 + I_3 = 3M(0)^2 + 2M(\frac{L}{2})^2 + M(L)^2$ C. $3ML^2/2$
24	A. 1, 2, 3
25	D. $\pi/15$
26	Statement–I is true, Statement–II is true and statement–II is correct explanation of Statement–I
27	Statement –I is true, Statement–II is false.
28	D. 63 rad/s
29	D. $(\pi/1800)$ rad/s
30	D. 6.7 rad/s
31	A. 3.14 rad/s^2
32	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
33	Moments of inertia of the two satellites will be different. This is because, I = mass × $(\text{distance})^2$. For the satellite revolving at a greater height, distance from the axis of rotation is larger. Therefore, its moment of inertia is larger.

34	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.
35	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
36	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, $\therefore L=I\omega=I(2\pi/T)$ = constant With increases of I, T will increase i.e. length of the day will increase.
37	REFER NOTES
38	REFER NOTES
39	REFER NOTES
40	$\theta = \omega t + \frac{1}{2}\alpha t^2$ $120 = \omega \times 4 + \frac{1}{2} \times 3 \times (4)^2 \quad \therefore \quad \omega = 24$ rad/s $\omega = \omega_0 + \alpha t \quad$ or $\quad t = \frac{\omega - \omega_0}{\alpha} = \frac{24-0}{3} = 8$ s

41	**Hint.** The x-coordinate of centre of mass is $$x = \frac{m_1 x_1 + m_2 x_2}{m_1 + m_2} = \frac{2\times 1 + 3\times 2}{2+3} = \frac{8}{5} = 1.6 \text{ m}$$ The velocity of the centre of mass is $$V = \frac{m_1 v_1 + m_2 v_2}{m_1 + m_2} = \frac{2\times 3 + 3\times(-1)}{2+3} = \frac{3}{5} = 0.6 \text{ ms}^{-1}$$ Total momentum $= (m_1 + m_2)\, V = (2 + 3) \times 0.6 = 3 \text{ kg ms}^{-1}$
42	[1[c [2] d [3] a [4] b
43	REFER NOTES
44	REFER NOTES
45	REFER NOTES

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