IITIAN'S SPECTRUM

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IITIAN'S SPECTRUM

Prudent Minds, Promising Path

Founder-Director

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B.Tech (IIT)

PHYSICS

Class XI

DPS-5

DAILY PRACTICE SHEET

Motion of System of Particles and Rigid Body

INSTRUCTIONS

- DPS contains 45 topicwise questions and 5 exam section questions.
- Each question has four options out of which only one option is correct.
- Mark the correct answer in the OMR Sheet given at the end of the DPS.
- Each question carries 4 marks.
- For every incorrect answer deduct 1 mark.

Time : 50 minutes

Marks : 200

Date: ....

Centre of Mass

1. The centre of mass of a system of three particles of masses 1 g, 2 g and 3 g is taken as the origin of a coordinate system. The position vector of a fourth particle of mass 4 g such that the centre of mass of the four particle system lies at the point (1, 2, 3) is $\alpha(\hat{i}+2\hat{j}+3\hat{k})$, where α is a constant. The value of α is

(a) $\frac{10}{3}$ (b) $\frac{5}{2}$ (c) $\frac{1}{2}$ (d) $\frac{2}{5}$

2. A uniform rod of length 1.0 metre is bent at its midpoint to make 90° angle. The distance of the centre of mass from the centre of the rod is

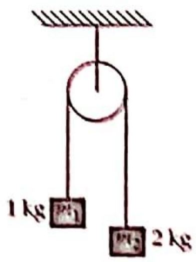
(a) 36.1 cm (b) 25.2 cm
(c) 17.7 cm (d) Zero

3. A body of mass 2.0 kg makes an elastic collision with another body at rest and continues to move in the original direction but with one-fourth of its original speed v. What is the mass of other body and the speed of the centre of mass of two bodies?

(a) 1.0 kg and $\frac{2}{3}v$ (b) 1.2 kg and $\frac{5}{8}v$

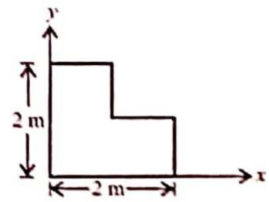
(c) 1.4 kg and $\frac{10}{17}v$ (d) 1.5 kg and $\frac{4}{7}v$

4. Two masses $m_1 = 1$ kg and $m_2 = 2$ kg are connected by a light inextensible string and suspended by means of a weightless pulley as shown in the figure. Assuming that both the masses start from rest, the distance travelled by the centre of mass in two seconds is (Take $g = 10\text{ m s}^{-2}$)



(a) $\frac{20}{9}$ m (b) $\frac{40}{9}$ m (c) $\frac{2}{3}$ m (d) $\frac{1}{3}$ m

5. The (x, y) coordinates of the centre of mass of a uniform L-shaped lamina of mass 3 kg is



(a) $\left(\frac{5}{6}\text{ m}, \frac{5}{6}\text{ m}\right)$

(b) (1 m, 1m)

(c) $\left(\frac{6}{5}\text{ m}, \frac{6}{5}\text{ m}\right)$

(d) (2 m, 2 m)

6. Two particles of equal mass have velocities $\vec{v}_1 = 2\hat{i}\text{ m s}^{-1}$ and $\vec{v}_2 = 2\hat{j}\text{ m s}^{-1}$. First particle has an acceleration $\vec{a}_1 = (3\hat{i}+3\hat{j})\text{ m s}^{-2}$ while the acceleration of the other particle is zero. The centre of mass of the two particles moves in a path of

(a) straight line (b) parabola
(c) circle (d) ellipse

Relation between Linear Velocity and Angular Velocity

7. Given $\vec{C} = \vec{A}\times\vec{B}$ and $\vec{D} = \vec{B}\times\vec{A}$. What is the angle between $\vec{C}$ and $\vec{D}$?

(a) 30° (b) 60° (c) 90° (d) 180°

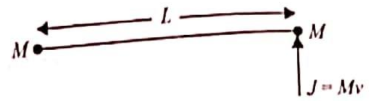
8. $\vec{A}$ and $\vec{B}$ are two vectors and θ is the angle between them, if $|\vec{A}\times\vec{B}| = \sqrt{3}(\vec{A}\cdot\vec{B})$, the value of θ is

(a) 45° (b) 30° (c) 90° (d) 60°

9. A body is rotating with angular velocity $\vec{\omega} = (3\hat{i}-4\hat{j}+\hat{k})$. The linear velocity of a point having position vector $\vec{r} = (5\hat{i}-6\hat{j}+6\hat{k})$ is

(a) $6\hat{i}+2\hat{j}-3\hat{k}$ (b) $18\hat{i}+3\hat{j}-2\hat{k}$

(c) $-18\hat{i}-13\hat{j}+2\hat{k}$ (d) $6\hat{i}-2\hat{j}+8\hat{k}$



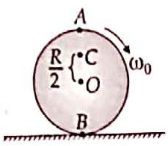
10. If $\vec{A}+\vec{B}+\vec{C}=0$, then $\vec{A}\times\vec{B}$ is
(a) $\vec{B}\times\vec{C}$ (b) $\vec{C}\times\vec{B}$
(c) $\vec{A}\times C$ (d) None of these

11. What is the value of linear velocity, if $\vec{r}=3\hat{i}+4\hat{j}+6\hat{k}$ and $\vec{\omega}=-5\hat{i}+3\hat{j}+5\hat{k}$?
(a) $-2\hat{i}+45\hat{j}-29\hat{k}$ (b) $2\hat{i}-45\hat{j}+29\hat{k}$
(c) $3\hat{i}-29\hat{j}+45\hat{k}$ (d) $5\hat{i}-6\hat{j}+4\hat{k}$

12. Two cars A and B move along a concentric circular path of radius r_A and r_B with velocity v_A and v_B maintaining constant distance, then v_A/v_B =
(a) r_B/r_A (b) r_A/r_B (c) $r_B\times r_A$ (d) $2(r_A/r_B)$

13. The direction of the angular velocity vector is along the
(a) tangent to the circular path
(b) inward radius
(c) outward radius
(d) axis of rotation

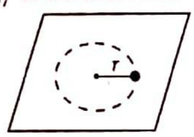
14. A disc rotating about its axis with angular speed ω_0 is placed lightly (without any translational push) on a perfectly frictionless table. The radius of the disc is R. Let v_A, v_B and v_C be the magnitudes of linear velocities of the points A, B and C on the disc as shown. Then
(a) $v_A > v_B > v_C$
(b) $v_A < v_B < v_C$
(c) $v_A = v_B < v_C$
(d) $v_A = v_B > v_C$



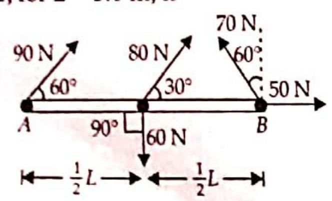
Torque and Angular Momentum

15. Which of the following statements is correct?
(a) For a general translation motion, momentum $\vec{p}$ and velocity $\vec{v}$ need not parallel.
(b) For a general rotational motion, angular momentum $\vec{L}$ and angular velocity $\vec{\omega}$ always be parallel.
(c) For a general translation motion, acceleration $\vec{a}$ and velocity $\vec{v}$ are always parallel.
(d) For a general rotational motion, angular momentum $\vec{L}$ and angular velocity $\vec{\omega}$ need not be parallel.

16. A small mass attached to a string rotates on a frictionless table top as shown. If the tension in the string is increased by pulling the string causing the radius of the circular motion to decrease by a factor of 2, the kinetic energy of the mass will
(a) decrease by a factor of 2
(b) remain constant
(c) increase by a factor of 2
(d) increase by a factor of 4



17. The total torque about pivot A provided by the forces shown in the figure, for L = 3.0 m, is

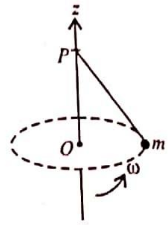


(a) 210 N m (b) 140 N m
(c) 95 N m (d) 75 N m

18. Consider a body shown in figure consisting two identical balls, each of mass M connected by a light rigid rod. If an impulse $J = Mv$ is imparted to the body at one of its ends, what would be its angular velocity ?
(a) $\frac{v}{L}$ (b) $\frac{2v}{L}$ (c) $\frac{v}{3L}$ (d) $\frac{v}{4L}$

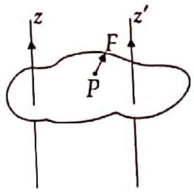
19. The angular speed of a motor wheel is increased from 1200 rpm to 3120 rpm in 16 seconds. The angular acceleration of the motor wheel is
(a) 2π rad s^{-2} (b) 4π rad s^{-2}
(c) 6π rad s^{-2} (d) 8π rad s^{-2}

20. A small mass m is attached to a massless string whose other end is fixed at P as shown in figure. The mass is undergoing circular motion in x-y plane with centre O and constant angular speed ω. If the angular momentum of the system, calculated about O and P and denoted by $\vec{L}_O$ and $\vec{L}_P$ respectively, then



(a) $\vec{L}_O$ and $\vec{L}_P$ do not vary with time.
(b) $\vec{L}_O$ varies with time while $\vec{L}_P$ remains constant.
(c) $\vec{L}_O$ remains constant while $\vec{L}_P$ varies with time.
(d) $\vec{L}_O$ and $\vec{L}_P$ both vary with time.

21. Figure shows a lamina in x-y plane. Two axes z and z' pass perpendicular to its plane. A force F acts in the plane of lamina at point P as shown. Which of the following statements is incorrect? (The point P is closer to z'-axis than the z-axis).



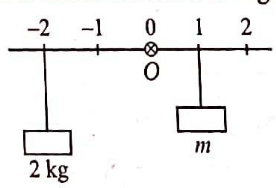
(a) Torque $\vec{\tau}$ caused by F about z axis is along $\hat{k}$.
(b) Torque $\vec{\tau}'$ caused by F about z' axis is along $-\hat{k}$.
(c) Torque caused by F about z axis is greater in magnitude than that about z' axis.
(d) Total torque is given by $\vec{\tau}_t = \vec{\tau}+\vec{\tau}'$.

22. The position of a particle is given by $\vec{r}=\hat{i}+2\hat{j}-\hat{k}$ and its linear momentum is given by $\vec{p}=3\hat{i}+4\hat{j}-2\hat{k}$. Then its angular momentum about the origin is perpendicular to
(a) x-axis (b) y-axis (c) z-axis (d) yz-plane

23. When a ceiling fan is switched off, its angular velocity reduces to half its initial value after it completes 36 rotations. The number of rotations it will make further before coming to rest is (assume angular retardation to be uniform)
(a) 10 (b) 20 (c) 18 (d) 12

Equilibrium of a Rigid Body

24. A horizontal beam is pivoted at O as shown in the figure. Find the mass m to make the scale straight.



(a) 2 kg (b) 1 kg (c) 4 kg (d) 2.5 kg

25. Two point objects of masses 1.5 g and 2.5 g respectively are at a distance of 16 cm apart, the centre of gravity is at a distance x from the object of mass 1.5 where x is
(a) 10 cm (b) 6 cm (c) 13 cm (d) 3 cm

40. A ring starts to roll down the inclined plane of height h without slipping. The velocity with which it reaches the ground is

(a) $\sqrt{\frac{10gh}{7}}$ (b) $\sqrt{\frac{4gh}{7}}$ (c) $\sqrt{\frac{4gh}{3}}$ (d) $\sqrt{gh}$

41. A solid sphere of mass m rolls down an inclined plane without slipping, starting from rest at the top of an inclined plane. The linear speed of the sphere at the bottom of the inclined plane is v. The kinetic energy of the sphere at the bottom is

(a) $\frac{1}{2}mv^2$ (b) $\frac{5}{3}mv^2$ (c) $\frac{2}{5}mv^2$ (d) $\frac{7}{10}mv^2$

42. If a sphere is rolling, the ratio of its rotational energy to the total kinetic energy is given by

(a) 7 : 10 (b) 2 : 5 (c) 10 : 7 (d) 2 : 7

43. A solid sphere rolls down two different inclined planes of the same heights but different angles of inclination. In both cases

(a) the speed and time of descend will be same.
(b) the speed will be same but time of descend will be different.
(c) the speed will be different but time of descend will be same.
(d) speed and time of descend both are different.

44. When a solid sphere rolls without slipping down an inclined plane making an angle θ with the horizontal, the acceleration of its centre of mass is a. If the same sphere slides without friction, its acceleration a' will be

(a) $\frac{7}{2}a$ (b) $\frac{5}{7}a$ (c) $\frac{7}{5}a$ (d) $\frac{5}{2}a$

45. A body is rolling down an inclined plane. If kinetic energy of rotation is 40% of kinetic energy in translatory state, then the body is a

(a) ring (b) cylinder
(c) hollow ball (d) solid ball

EXAM SECTION

46. Two rotating bodies A and B of masses m and $2m$ with moments of inertia I_A and I_B ($I_B > I_A$) have equal kinetic energy of rotation. If L_A and L_B be their angular momenta respectively, then

(a) $L_A = \frac{L_B}{2}$ (b) $L_A = 2L_B$
(c) $L_B > L_A$ (d) $L_A > L_B$

(NEET Phase II 2016)

47. A light rod of length l has two masses m_1 and m_2 attached to its two ends. The moment of inertia of the system about an axis perpendicular to the rod and passing through the centre of mass is

(a) $\frac{m_1m_2}{m_1+m_2}l^2$ (b) $\frac{m_1+m_2}{m_1m_2}l^2$
(c) $(m_1+m_2)l^2$ (d) $\sqrt{m_1m_2}\,l^2$

(NEET Phase II 2016)

48. A solid sphere of mass m and radius R is rotating about its diameter. A solid cylinder of the same mass and same radius is also rotating about its geometrical axis with an angular speed twice that of the sphere. The ratio of their kinetic energies of rotation ($E_{sphere} / E_{cylinder}$) will be

(a) 2 : 3 (b) 1 : 5 (c) 1 : 4 (d) 3 : 1

(NEET Phase II 2016)

49. From a disc of radius R and mass M, a circular hole of diameter R, whose rim passes through the centre is cut. What is the moment of inertia of the remaining part of the disc about a perpendicular axis, passing through the centre?

(a) $11\ MR^2/32$ (b) $9\ MR^2/32$
(c) $15\ MR^2/32$ (d) $13\ MR^2/32$

(NEET Phase I 2016)

50. A disc and a sphere of same radius but different masses roll off on two inclined planes of the same altitude and length. Which one of the two objects gets to the bottom of the plane first?

(a) Both reach at the same time
(b) Depends on their masses
(c) Disc
(d) Sphere

(NEET Phase I 2016)

OMR SHEET

Use HB pencil only and darken each circle completely.
Mark only one choice for each question as indicated.

Correct marking ● ⓑ ⓒ ⓓ
Wrong marking

1. ⓐⓑⓒⓓ	7. ⓐⓑⓒⓓ	13. ⓐⓑⓒⓓ	19. ⓐⓑⓒⓓ	25. ⓐⓑⓒⓓ	31. ⓐⓑⓒⓓ	37. ⓐⓑⓒⓓ	43. ⓐⓑⓒⓓ	49. ⓐⓑⓒⓓ
2. ⓐⓑⓒⓓ	8. ⓐⓑⓒⓓ	14. ⓐⓑⓒⓓ	20. ⓐⓑⓒⓓ	26. ⓐⓑⓒⓓ	32. ⓐⓑⓒⓓ	38. ⓐⓑⓒⓓ	44. ⓐⓑⓒⓓ	50. ⓐⓑⓒⓓ
3. ⓐⓑⓒⓓ	9. ⓐⓑⓒⓓ	15. ⓐⓑⓒⓓ	21. ⓐⓑⓒⓓ	27. ⓐⓑⓒⓓ	33. ⓐⓑⓒⓓ	39. ⓐⓑⓒⓓ	45. ⓐⓑⓒⓓ	
4. ⓐⓑⓒⓓ	10. ⓐⓑⓒⓓ	16. ⓐⓑⓒⓓ	22. ⓐⓑⓒⓓ	28. ⓐⓑⓒⓓ	34. ⓐⓑⓒⓓ	40. ⓐⓑⓒⓓ	46. ⓐⓑⓒⓓ	
5. ⓐⓑⓒⓓ	11. ⓐⓑⓒⓓ	17. ⓐⓑⓒⓓ	23. ⓐⓑⓒⓓ	29. ⓐⓑⓒⓓ	35. ⓐⓑⓒⓓ	41. ⓐⓑⓒⓓ	47. ⓐⓑⓒⓓ	
6. ⓐⓑⓒⓓ	12. ⓐⓑⓒⓓ	18. ⓐⓑⓒⓓ	24. ⓐⓑⓒⓓ	30. ⓐⓑⓒⓓ	36. ⓐⓑⓒⓓ	42. ⓐⓑⓒⓓ	48. ⓐⓑⓒⓓ	

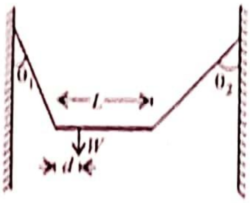
SELF CHECK

No. of questions attempted ......
No. of questions correct ......
Marks scored in percentage ......

Check your score! If your score is

> 90%	EXCELLENT WORK !	You are well prepared to take the challenge of final exam.
90-75%	GOOD WORK !	You can score good in the final exam.
74-60%	SATISFACTORY !	You need to score more next time.
< 60%	NOT SATISFACTORY!	Revise thoroughly and strengthen your concepts.

26. A non-uniform bar of weight W and length L is suspended by two strings of negligible weight as shown in figure. The angles made by the strings with the vertical are θ_1 and θ_2 respectively. The distance d of the centre of gravity of the bar from its left end is



(a) $L\left(\frac{\tan\theta_1 + \tan\theta_2}{\tan\theta_1}\right)$ (b) $L\left(\frac{\tan\theta_1}{\tan\theta_1 + \tan\theta_2}\right)$

(c) $L\left(\frac{\tan\theta_2}{\tan\theta_1 + \tan\theta_2}\right)$ (d) $L\left(\frac{\tan\theta_1 + \tan\theta_2}{\tan\theta_2}\right)$

27. A car weighs 1800 kg. The distance between its front and back axles is 1.8 m. Its centre of gravity is 1 m behind the front axle. The force exerted by the level ground on each front wheel and each back wheel respectively is (Take $g = 10\ \text{m s}^{-2}$)

(a) 4000 N and 5000 N (b) 5000 N and 4000 N
(c) 4500 N and 4500 N (d) 3000 N and 6000 N

Moment of Inertia

28. The ratio of radii of gyration of a circular ring and a circular disc, of the same mass and radius, about an axis passing through their centres and perpendicular to their planes are

(a) $1 : \sqrt{2}$ (b) $3 : 2$ (c) $2 : 1$ (d) $\sqrt{2} : 1$

29. If I_1 is the moment of inertia of a thin rod about an axis perpendicular to its length and passing through its centre of mass, and I_2 is the moment of inertia of the ring about an axis perpendicular to plane of ring and passing through its centre formed by bending the rod, then I_1/I_2 is

(a) $\frac{\pi^2}{3}$ (b) $\frac{3}{\pi^2}$ (c) $\frac{2}{\pi^2}$ (d) $\frac{\pi^2}{2}$

30. The moment of inertia of a circular disc of mass M and radius R about an axis passing through the centre of mass is I_0. The moment of inertia of another circular disc of same mass and thickness but half the density about the same axis is

(a) $\frac{I_0}{8}$ (b) $\frac{I_0}{4}$ (c) $8I_0$ (d) $2I_0$

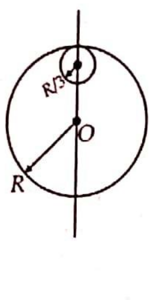
31. From a circular disc of radius R and mass $9M$, a small disc of radius $\frac{R}{3}$ is removed as shown in figure. The moment of inertia of the remaining disc about an axis perpendicular to the plane of the disc and passing through O is

(a) $4\ MR^2$

(b) $\frac{40}{9} MR^2$

(c) $40\ MR^2$

(d) $\frac{37}{9} MR^2$



32. Which of the following has the largest moment of inertia when each of them has the same mass and the same radius?

(a) A ring about any of its diameter.
(b) A disc about any of its diameter.
(c) A hollow sphere about any of its diameter.
(d) A solid sphere about any of its diameter.

33. A child is standing with his two arms outstretched at the centre of a turn table that is rotating about its central axis with an angular speed ω_0. Now, the child folds his hands back so that moment of inertia becomes 3 times the initial value. The new angular speed is

(a) $3\omega_0$ (b) $\frac{\omega_0}{3}$ (c) $6\omega_0$ (d) $\frac{\omega_0}{6}$

34. A circular disc of moment of inertia I_t is rotating in a horizontal plane, about its symmetry axis, with a constant angular speed ω_i. Another disc of moment of inertia I_b is dropped coaxially onto the rotating disc. Initially the second disk has zero angular speed. Eventually both the discs rotate with a constant angular speed ω_f. The energy lost by the initially rotating disc to friction is

(a) $\frac{1}{2}\frac{I_b^2}{(I_t + I_b)}\omega_i^2$ (b) $\frac{1}{2}\frac{I_t^2}{(I_t + I_b)}\omega_i^2$

(c) $\frac{I_b - I_t}{(I_t + I_b)}\omega_i^2$ (d) $\frac{1}{2}\frac{I_b I_t}{(I_t + I_b)}\omega_i^2$

35. A string is wound round the rim of a mounted flywheel of mass 20 kg and radius 20 cm. A steady pull of 25 N is applied on the cord. Neglecting friction and mass of the string, the angular acceleration (in rad s^{-2}) of the wheel is

(a) 50 (b) 25 (c) 12.5 (d) 6.25

36. The moment of inertia of a circular disc of radius 2 m and mass 1 kg about an axis perpendicular to the disc and passing through its centre of mass is 2 kg m^2. Its moment of inertia about an axis parallel to this axis and passing through its edge in kg m^2 is

(a) 10 (b) 8 (c) 6 (d) 4

37. A hollow cylinder of mass M and radius R is rotating about its axis of symmetry and a solid sphere of same mass and radius is rotating about an axis passing through its centre. If torques of equal magnitude are applied to them, then the ratio of angular accelerations produced is

(a) $\frac{2}{5}$ (b) $\frac{5}{2}$ (c) $\frac{5}{4}$ (d) $\frac{4}{5}$

38. The instantaneous angular position of a point on a rotating wheel is given by the equation $\theta(t) = 2t^3 - 6t^2$. The torque on the wheel becomes zero at

(a) $t = 1$ s (b) $t = 0.5$ s
(c) $t = 0.25$ s (d) $t = 2$ s

Rolling Motion

39. A uniform disc of mass M and radius R, is resting on a table on its rim. The coefficient of friction between disc and table is μ. Now the disc is pulled with a force F as shown in the figure. What is the maximum value of F for which the disc rolls without slipping?

(a) μMg
(b) $2\mu Mg$
(c) $3\mu Mg$
(d) $4\mu Mg$