

JEE MAIN SYSTEM OF PARTICLES AND ROTATIONAL MOTION — PYQS

Max. Marks: 348

Questions: 87

Section A (MCQ) — 50 questions

- Q.1** A solid cylinder having radius R and length L is slipping on a rough horizontal plane. At time $t = 0$ the cylinder has a translational velocity $v_0 = 49$ m/s, perpendicular to its axis and a rotational velocity $v_0/4R$ about the centre. The time taken by the cylinder to start rolling is _____ seconds. (coefficient of kinetic friction $\mu_K = 0.25$ and $g = 9.8$ m/s²) [JEE Main 2026 (Online) 8th April Evening Shift]
- (1) 15 (2) 5 (3) 10 (4) 7.5

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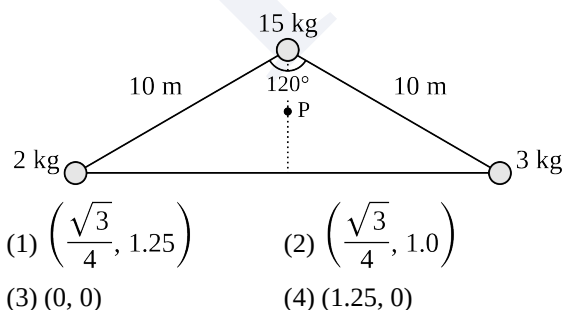


- Q.2** A solid sphere of radius 4 cm and mass 5 kg is rotating (rotation axis is passing through the centre of the sphere) with an angular velocity of 1200 rpm. It is brought to rest in 10 s by applying a constant torque. The torque applied and the number of rotations it made before it comes to rest are _____ and _____ respectively. [JEE Main 2026 (Online) 6th April Morning Shift]
- (1) 0.128π Nm, 100 (2) 0.0128π Nm, 50
(3) 0.128π Nm, 50 (4) 0.0128π Nm, 100

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- Q.3** The position of center of mass of three masses 2 kg, 3 kg and 15 kg placed with respect to mid point (P) of normal bisector, as shown in the figure is _____. [JEE Main 2026 (Online) 6th April Morning Shift]



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- Q.4** A solid sphere (A) of mass $5m$ and a spherical shell (B) of mass m , both having same radius, are placed on a rough surface. When a force of same magnitude is applied tangentially at the highest points of A and B, they start rolling without slipping with an acceleration of a_A and a_B , respectively. The ratio of a_A and a_B is _____. [JEE Main 2026 (Online) 6th April Evening Shift]
- (1) 5 : 21 (2) 6 : 10 (3) 21 : 25 (4) 1 : 5

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- Q.5** Two identical bodies A and B of equal masses have initial velocities $\vec{v}_1 = 4\hat{i}$ m/s and $\vec{v}_2 = 4\hat{j}$ m/s respectively. The body A has acceleration $\vec{a}_1 = 6\hat{i} + 6\hat{j}$ m/s² while the acceleration of the other body B is zero. The centre of mass of the two bodies moves in _____ path. [JEE Main 2026 (Online) 6th April Evening Shift]
- (1) circular (2) parabolic
(3) straight line (4) elliptical

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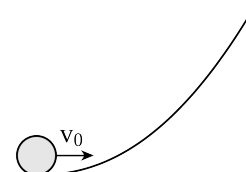


- Q.6** A wheel initially at rest is subjected to a uniform angular acceleration about its axis. In the first 2 s it rotates through an angle θ_1 and in the next 2 s it rotates through an angle θ_2 . The ratio $\frac{\theta_2}{\theta_1}$ is _____. [JEE Main 2026 (Online) 5th April Evening Shift]
- (1) 6 (2) 3 (3) 4 (4) $\frac{1}{3}$

Scan or tap for the full solution



- Q.7** An object of uniform density rolls up the curved path with the initial velocity v_0 as shown in the figure. If the maximum height attained by an object is $\frac{7v_0^2}{10g}$ (g = acceleration due to gravity), the object is a _____. [JEE Main 2026 (Online) 5th April Evening Shift]



- (1) solid cylinder (2) ring
(3) disc (4) solid sphere

Scan or tap for the full solution



Q.8 A solid sphere of mass M and radius R is divided into two unequal parts. The smaller part having mass $M/8$ is converted into a sphere of radius r and the larger part is converted into a circular disc of thickness t and radius $2R$. If I_1 is moment of inertia of a sphere having radius r about an axis through its centre and I_2 is the moment of inertia of a disc about its diameter, the ratio of their moment of inertia $I_2/I_1 =$ _____.

[JEE Main 2026 (Online) 4th April Morning Shift]

- (1) 35 (2) 70 (3) 140 (4) 210

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Q.9 The position of an object having mass 0.1 kg as a function of time t is given as $\vec{r} = (10t^2\hat{i} + 5t^3\hat{j})$ m. At $t = 1$ s, which of the following statements are **correct**?

- A. The linear momentum $\vec{p} = (2\hat{i} + 1.5\hat{j})$ kg·m/s.
B. The force acting on the object $\vec{F} = (2\hat{i} + 3\hat{j})$ N.
C. The angular momentum of the object about its origin $\vec{L} = 15\hat{k}$ J·s.
D. The torque acting on the object about its origin $\vec{\tau} = 20\hat{k}$ N·m.

Choose the **correct** answer from the options given below: [JEE Main 2026 (Online) 2nd April Morning Shift]

- (1) A, B and C only (2) B, C and D only
(3) A, C and D only (4) A, B and D only

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Q.10 A particle is rotating in a circular path and at any instant its motion can be described as $\theta = \frac{5t^4}{40} - \frac{t^3}{3}$. The angular acceleration of the particle after 10 seconds is _____ rad/s².

[JEE Main 2026 (Online) 2nd April Morning Shift]

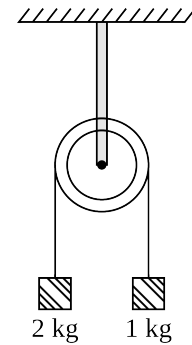
- (1) 150 (2) 120 (3) 130 (4) 170

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Q.11 Two blocks of masses 2 kg and 1 kg respectively, are tied to the ends of a string which passes over a light frictionless pulley as shown in the figure below. The masses are held at rest at the same horizontal level and then released. The distance traversed by the centre of mass in 2 s is _____ m. (Take $g = 10$ m/s²)

[JEE Main 2026 (Online) 2nd April Evening Shift]



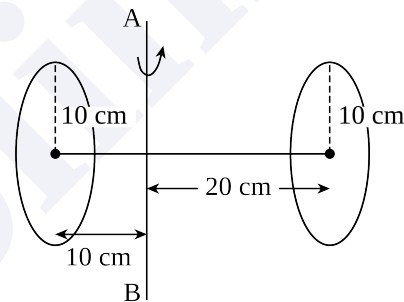
- (1) 3.33 (2) 3.12 (3) 2.22 (4) 1.42

Scan or tap for the full solution



Q.12 Two circular discs of radius each 10 cm are joined at their centres by a rod of length 30 cm and mass 600 gm as shown in figure. If the mass of each disc is 600 gm and applied torque between two discs is 43×10^5 dyne·cm, the angular acceleration of the discs about the given axis AB is _____ rad/s².

[JEE Main 2026 (Online) 28th January Morning Shift]



- (1) 100 (2) 22 (3) 27 (4) 11

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Q.13 When the position vector $\vec{r} = x\hat{i} + y\hat{j} + z\hat{k}$ changes sign as $-\vec{r}$, which one of the following vector will not flip under sign change?

[JEE Main 2026 (Online) 28th January Evening Shift]

- (1) Velocity (2) Linear momentum
(3) Acceleration (4) Angular momentum

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Q.14 Two masses 400 g and 350 g are suspended from the ends of a light string passing over a heavy pulley of radius 2 cm. When released from rest the heavier mass is observed to fall 81 cm in 9 s. The rotational inertia of the pulley is _____ kg·m². ($g = 9.8$ m/s²)

[JEE Main 2026 (Online) 24th January Morning Shift]

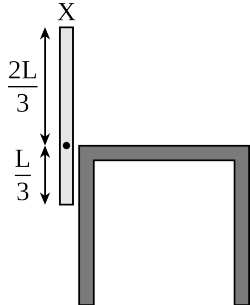
- (1) 8.3×10^{-3} (2) 4.75×10^{-3}
(3) 1.86×10^{-2} (4) 9.5×10^{-3}

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- Q.15** A thin uniform rod (X) of mass M and length L is pivoted at a height $\left(\frac{L}{3}\right)$ as shown in the figure. The rod is allowed to fall from a vertical position and lie horizontally on the table. The angular velocity of this rod when it hits the table top, is _____.
(g = gravitational acceleration)

[JEE Main 2026 (Online) 24th January Evening Shift]



- (1) $\sqrt{\frac{3g}{2L}}$ (2) $\sqrt{\frac{3g}{L}}$
(3) $\frac{3}{\sqrt{2}}\sqrt{\frac{g}{L}}$ (4) $\frac{1}{\sqrt{2}}\sqrt{\frac{g}{L}}$

Scan or tap for the full solution



- Q.16** Two small balls with masses m and $2m$ are attached to both ends of a rigid rod of length d and negligible mass. If angular momentum of this system is L about an axis (A) passing through its centre of mass and perpendicular to the rod then angular velocity of the system about A is :

[JEE Main 2026 (Online) 23rd January Morning Shift]

- (1) $\frac{4}{3}\frac{L}{md^2}$ (2) $\frac{3}{2}\frac{L}{md^2}$ (3) $\frac{2L}{5md^2}$ (4) $\frac{2L}{md^2}$

Scan or tap for the full solution



- Q.17** The moment of inertia of a square loop made of four uniform solid cylinders, each having radius R and length L ($R < L$) about an axis passing through the mid points of opposite sides, is (Take the mass of the entire loop as M):

[JEE Main 2026 (Online) 23rd January Morning Shift]

- (1) $\frac{3}{4}MR^2 + \frac{1}{6}ML^2$ (2) $\frac{3}{8}MR^2 + \frac{7}{12}ML^2$
(3) $\frac{3}{4}MR^2 + \frac{7}{12}ML^2$ (4) $\frac{3}{8}MR^2 + \frac{1}{6}ML^2$

Scan or tap for the full solution



- Q.18** A solid sphere of mass 5 kg and radius 10 cm is kept in contact with another solid sphere of mass 10 kg and radius 20 cm . The moment of inertia of this pair of spheres about the tangent passing through the point of contact is _____ $\text{kg}\cdot\text{m}^2$.

[JEE Main 2026 (Online) 22nd January Morning Shift]

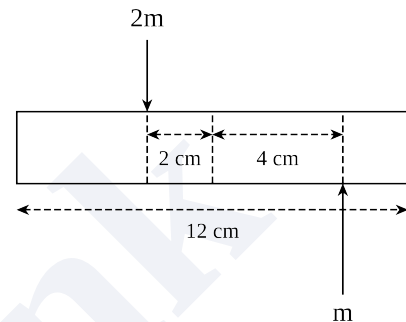
- (1) 0.18 (2) 0.72 (3) 0.36 (4) 0.63

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- Q.19** A uniform bar of length 12 cm and mass 20 m lies on a smooth horizontal table. Two point masses m and $2m$ are moving in opposite directions with same speed of v and in the same plane as the bar, as shown in figure. These masses strike the bar simultaneously and get stuck to it. After collision the entire system is rotating with angular frequency ω . The ratio of v and ω is :

[JEE Main 2026 (Online) 22nd January Evening Shift]



- (1) 33 (2) $2\sqrt{88}$
(3) 32 (4) 66

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- Q.20** Given below are two statements :

Statement-I: For a mechanical system of many particles total kinetic energy is the sum of kinetic energies of all the particles.

Statement-II: The total kinetic energy can be the sum of kinetic energy of the center of mass w.r.t. the origin and the kinetic energy of all the particles w.r.t. the center of mass as the reference.

In the light of the above statements, choose the correct answer from the options given below :

[JEE Main 2026 (Online) 22nd January Evening Shift]

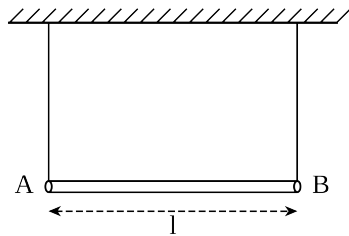
- (1) Both Statement-I and Statement-II are false
(2) Statement-I is false but Statement-II is true
(3) Statement-I is true but Statement-II is false
(4) Both Statement-I and Statement-II are true

Scan or tap for the full solution



- Q.21** A uniform rod of mass m and length l is suspended by means of two identical inextensible light strings as shown in figure. Tension in one string immediately after the other string is cut, is _____.
(g acceleration due to gravity)

[JEE Main 2026 (Online) 21st January Morning Shift]



- (1) $mg/3$ (2) $mg/4$ (3) mg (4) $mg/2$

Scan or tap for the full solution



- Q.22** Two cars A and B each of mass 10^3 kg are moving on parallel tracks separated by a distance of 10 m, in same direction with speeds 72 km/h and 36 km/h. The magnitude of angular momentum of car A with respect to car B is _____ J·s.

[JEE Main 2026 (Online) 21st January Evening Shift]

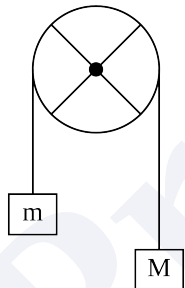
- (1) 3.6×10^5 (2) 10^5
(3) 3×10^5 (4) 2×10^5

Solution



- Q.23** The pulley shown in figure is made using a thin rim and two rods of length equal to diameter of the rim. The rim and each rod have a mass of M . Two blocks of mass of M and m are attached to two ends of a light string passing over the pulley, which is hinged to rotate freely in vertical plane about its center. The magnitude of the acceleration experienced by the blocks is _____ (assume no slipping of string on pulley).

[JEE Main 2026 (Online) 21st January Evening Shift]



- (1) $\frac{(M-m)g}{\left[\left(\frac{8}{3}\right)M+m\right]}$ (2) $\frac{(M-m)g}{2M+m}$
(3) $\frac{(M-m)g}{M+m}$ (4) $\frac{(M-m)g}{\left[\left(\frac{13}{6}\right)M+m\right]}$

Scan or tap for the full solution



- Q.24** A rod of linear mass density ' λ ' and length ' L ' is bent to form a ring of radius ' R '. Moment of inertia of ring about any of its diameters is:

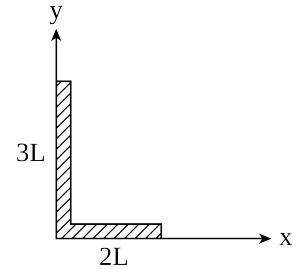
[JEE Main 2025 (Online) 8th April Evening Shift]

- (1) $\frac{\lambda L^3}{8\pi^2}$ (2) $\frac{\lambda L^3}{16\pi^2}$ (3) $\frac{\lambda L^3}{4\pi^2}$ (4) $\frac{\lambda L^3}{12}$

Scan or tap for the full solution



- Q.25** A rod of length $5L$ is bent at right angle keeping one side length as $2L$.



The position of the centre of mass of the system :
(Consider $L = 10$ cm)

[JEE Main 2025 (Online) 7th April Morning Shift]

- (1) $4\hat{i} + 9\hat{j}$ (2) $2\hat{i} + 3\hat{j}$ (3) $5\hat{i} + 8\hat{j}$ (4) $3\hat{i} + 7\hat{j}$

Scan or tap for the full solution



- Q.26** Which of the following are correct expressions for torque acting on a body?

($\vec{r}$ = position vector; $\vec{p}$ = linear momentum; $\vec{L}$ = angular momentum; $\vec{\alpha}$ = angular acceleration; I = moment of inertia; $\vec{F}$ = force; t = time)

A. $\vec{\tau} = \vec{r} \times \vec{L}$ B. $\vec{\tau} = \frac{d}{dt}(\vec{r} \times \vec{p})$

C. $\vec{\tau} = \vec{r} \times \frac{d\vec{p}}{dt}$ D. $\vec{\tau} = I\vec{\alpha}$

E. $\vec{\tau} = \vec{r} \times \vec{F}$

Choose the correct answer from the options given below: [JEE Main 2025 (Online) 4th April Morning Shift]

- (1) A, B, D and E Only (2) C and D Only
(3) B, C, D and E Only (4) B, D and E Only

Scan or tap for the full solution



- Q.27** A wheel is rolling on a plane surface. The speed of a particle on the highest point of the rim is 8 m/s. The speed of the particle on the rim of the wheel at the same level as the centre of the wheel, will be :

[JEE Main 2025 (Online) 4th April Evening Shift]

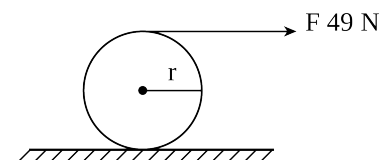
- (1) $4\sqrt{2}$ m/s (2) 8 m/s
(3) 4 m/s (4) $8\sqrt{2}$ m/s

Scan or tap for the full solution



- Q.28** A force of 49 N acts tangentially at the highest point of a sphere (solid) of mass 20 kg, kept on a rough horizontal plane. If the sphere rolls without slipping, then the acceleration of the center of the sphere is

[JEE Main 2025 (Online) 3rd April Morning Shift]



- (1) 2.5 m/s^2 (2) 3.5 m/s^2
 (3) 0.25 m/s^2 (4) 0.35 m/s^2

Scan or tap for the full solution



Q.29 Moment of inertia of a rod of mass 'M' and length 'L' about an axis passing through its center and normal to its length is ' α '. Now the rod is cut into two equal parts and these parts are joined symmetrically to form a cross shape. Moment of inertia of cross about an axis passing through its center and normal to plane containing cross is :

[JEE Main 2025 (Online) 2nd April Morning Shift]

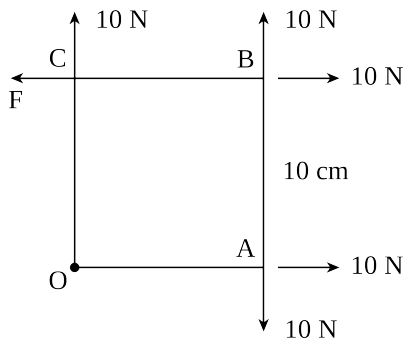
- (1) $\alpha/4$ (2) $\alpha/8$ (3) α (4) $\alpha/2$

Scan or tap for the full solution



Q.30 A square lamina OABC of length 10 cm is pivoted at 'O'. Forces act at lamina as shown in figure. If lamina remains stationary, then the magnitude of F is :

[JEE Main 2025 (Online) 2nd April Morning Shift]



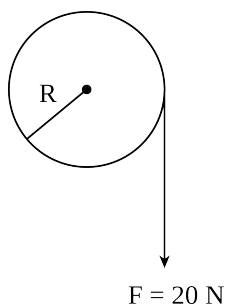
- (1) 10 N (2) 0 (zero)
 (3) $10\sqrt{2}$ N (4) 20 N

Scan or tap for the full solution



Q.31 A cord of negligible mass is wound around the rim of a wheel supported by spokes with negligible mass. The mass of wheel is 10 kg and radius is 10 cm and it can freely rotate without any friction. Initially the wheel is at rest. If a steady pull of 20 N is applied on the cord, the angular velocity of the wheel, after the cord is unwound by 1 m, would be:

[JEE Main 2025 (Online) 2nd April Morning Shift]



- (1) 20 rad/s (2) 30 rad/s
 (3) 10 rad/s (4) 0 rad/s

Scan or tap for the full solution



Q.32 The moment of inertia of a circular ring of mass M and diameter r about a tangential axis lying in the plane of the ring is :

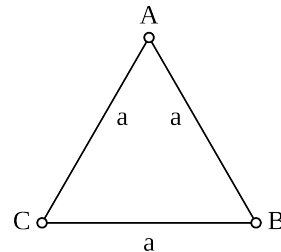
[JEE Main 2025 (Online) 2nd April Evening Shift]

- (1) $\frac{3}{8}Mr^2$ (2) $2Mr^2$ (3) $\frac{1}{2}Mr^2$ (4) $\frac{3}{2}Mr^2$

Scan or tap for the full solution



Q.33



Three equal masses m are kept at vertices (A, B, C) of an equilateral triangle of side a in free space. At $t = 0$, they are given an initial velocity $\vec{V}_A = V_0 \vec{AC}$, $\vec{V}_B = V_0 \vec{BA}$ and $\vec{V}_C = V_0 \vec{CB}$. Here, $\vec{AC}$, $\vec{CB}$ and $\vec{BA}$ are unit vectors along the edges of the triangle. If the three masses interact gravitationally, then the magnitude of the net angular momentum of the system at the point of collision is :

[JEE Main 2025 (Online) 29th January Evening Shift]

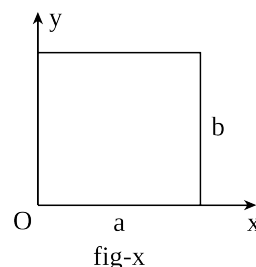
- (1) $\frac{1}{2} a m V_0$ (2) $3 a m V_0$
 (3) $\frac{3}{2} a m V_0$ (4) $\frac{\sqrt{3}}{2} a m V_0$

Scan or tap for the full solution



Q.34 The center of mass of a thin rectangular plate (fig - x) with sides of length a and b, whose mass per unit area (σ) varies as $\sigma = \frac{\sigma_0 x}{ab}$ (where σ_0 is a constant), would be _____.

[JEE Main 2025 (Online) 28th January Morning Shift]



- (1) $\left(\frac{2}{3}a, \frac{2}{3}b\right)$ (2) $\left(\frac{2}{3}a, \frac{b}{2}\right)$
 (3) $\left(\frac{1}{3}a, \frac{b}{2}\right)$ (4) $\left(\frac{a}{2}, \frac{b}{2}\right)$

Scan or tap for the full solution



- Q.35** A uniform rod of mass 250 g having length 100 cm is balanced on a sharp edge at 40 cm mark. A mass of 400 g is suspended at 10 cm mark. To maintain the balance of the rod, the mass to be suspended at 90 cm mark, is

[JEE Main 2025 (Online) 28th January Evening Shift]

- (1) 290 g (2) 200 g (3) 190 g (4) 300 g

Scan or tap for the full solution



- Q.36** An object of mass 'm' is projected from origin in a vertical xy plane at an angle 45° with the x-axis with an initial velocity v_0 . The magnitude and direction of the angular momentum of the object with respect to origin, when it reaches at the maximum height, will be [g is acceleration due to gravity]

[JEE Main 2025 (Online) 24th January Morning Shift]

- (1) $\frac{mv_0^3}{2\sqrt{2}g}$ along negative z-axis
 (2) $\frac{mv_0^3}{2\sqrt{2}g}$ along positive z-axis
 (3) $\frac{mv_0^3}{4\sqrt{2}g}$ along positive z-axis
 (4) $\frac{mv_0^3}{4\sqrt{2}g}$ along negative z-axis

Scan or tap for the full solution



- Q.37** A uniform solid cylinder of mass 'm' and radius 'r' rolls along an inclined rough plane of inclination 45° . If it starts to roll from rest from the top of the plane then the linear acceleration of the cylinder's axis will be

[JEE Main 2025 (Online) 24th January Morning Shift]

- (1) $\sqrt{2}g$ (2) $\frac{1}{\sqrt{2}}g$
 (3) $\frac{1}{3\sqrt{2}}g$ (4) $\frac{\sqrt{2}}{3}g$

Scan or tap for the full solution



- Q.38** A solid sphere and a hollow sphere of the same mass and of same radius are rolled on an inclined plane. Let the time taken to reach the bottom by the solid sphere and the hollow sphere be t_1 and t_2 , respectively, then

[JEE Main 2025 (Online) 24th January Evening Shift]

- (1) $t_1 < t_2$ (2) $t_1 = 2t_2$ (3) $t_1 > t_2$ (4) $t_1 = t_2$

Scan or tap for the full solution



- Q.39** A solid sphere is rolling without slipping on a horizontal plane. The ratio of the linear kinetic energy of the centre of mass of the sphere and rotational kinetic energy is :

[JEE Main 2025 (Online) 24th January Evening Shift]

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

Scan or tap for the full solution



- Q.40** A solid sphere of mass 'm' and radius 'r' is allowed to roll without slipping from the highest point of an inclined plane of length 'L' and makes an angle 30° with the horizontal. The speed of the particle at the bottom of the plane is v_1 . If the angle of inclination is increased to 45° while keeping L constant. Then the new speed of the sphere at the bottom of the plane is v_2 . The ratio $v_1^2 : v_2^2$ is

[JEE Main 2025 (Online) 23rd January Morning Shift]

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

Scan or tap for the full solution



- Q.41** Consider a circular disc of radius 20 cm with centre located at the origin. A circular hole of radius 5 cm is cut from this disc in such a way that the edge of the hole touches the edge of the disc. The distance of centre of mass of residual or remaining disc from the origin will be

[JEE Main 2025 (Online) 23rd January Morning Shift]

- (1) 1.5 cm (2) 2.0 cm (3) 0.5 cm (4) 1.0 cm

Scan or tap for the full solution



- Q.42** A circular disk of radius R meter and mass M kg is rotating around the axis perpendicular to the disk. An external torque is applied to the disk such that $\theta(t) = 5t^2 - 8t$, where $\theta(t)$ is the angular position of the rotating disc as a function of time t. How much power is delivered by the applied torque, when $t = 2$ s ?

[JEE Main 2025 (Online) 23rd January Evening Shift]

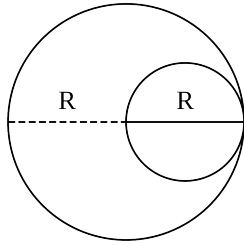
- (1) $60 MR^2$ (2) $72 MR^2$
 (3) $8 MR^2$ (4) $108 MR^2$

Scan or tap for the full solution



- Q.43** A uniform circular disc of radius 'R' and mass 'M' is rotating about an axis perpendicular to its plane and passing through its centre. A small circular part of radius $R/2$ is removed from the original disc as shown in the figure. Find the moment of inertia of the remaining part of the original disc about the axis as given above.

[JEE Main 2025 (Online) 22nd January Morning Shift]



- (1) $\frac{17}{32}MR^2$ (2) $\frac{13}{32}MR^2$
 (3) $\frac{9}{32}MR^2$ (4) $\frac{7}{32}MR^2$

Scan or tap for the full solution



Q.44 The torque due to the force $(2\hat{i} + \hat{j} + 2\hat{k})$ about the origin, acting on a particle whose position vector is $(\hat{i} + \hat{j} + \hat{k})$, would be

[JEE Main 2025 (Online) 22nd January Evening Shift]

- (1) $\hat{j} + \hat{k}$ (2) $\hat{i} - \hat{k}$
 (3) $\hat{i} - \hat{j} + \hat{k}$ (4) $\hat{i} + \hat{k}$

Scan or tap for the full solution



Q.45 A heavy iron bar, of weight W is having its one end on the ground and the other on the shoulder of a person. The bar makes an angle θ with the horizontal. The weight experienced by the person is :

[JEE Main 2024 (Online) 9th April Morning Shift]

- (1) $W \sin \theta$ (2) W
 (3) $\frac{W}{2}$ (4) $W \cos \theta$

Scan or tap for the full solution



Q.46 A thin circular disc of mass M and radius R is rotating in a horizontal plane about an axis passing through its centre and perpendicular to its plane with angular velocity ω . If another disc of same dimensions but of mass $M/2$ is placed gently on the first disc co-axially, then the new angular velocity of the system is :

[JEE Main 2024 (Online) 8th April Evening Shift]

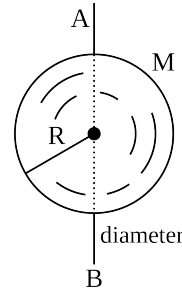
- (1) $\frac{4}{5}\omega$ (2) $\frac{5}{4}\omega$ (3) $\frac{3}{2}\omega$ (4) $\frac{2}{3}\omega$

Scan or tap for the full solution



Q.47 Ratio of radius of gyration of a hollow sphere to that of a solid cylinder of equal mass, for moment of Inertia about their diameter axis AB as shown in figure is $\sqrt{8/x}$. The value of x is :

[JEE Main 2024 (Online) 5th April Morning Shift]



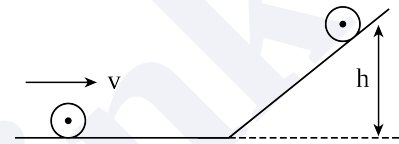
- (1) 34 (2) 51 (3) 67 (4) 17

Scan or tap for the full solution



Q.48 A disc of radius R and mass M is rolling horizontally without slipping with speed v . It then moves up an inclined smooth surface as shown in figure. The maximum height that the disc can go up the incline is :

[JEE Main 2024 (Online) 1st February Evening Shift]



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

Scan or tap for the full solution



Q.49 A particle of mass m is projected with a velocity ' u ' making an angle of 30° with the horizontal. The magnitude of angular momentum of the projectile about the point of projection when the particle is at its maximum height h is :

[JEE Main 2024 (Online) 30th January Morning Shift]

- (1) $\frac{mu^3}{\sqrt{2}g}$ (2) zero
 (3) $\frac{\sqrt{3}}{2} \frac{mu^2}{g}$ (4) $\frac{\sqrt{3}}{16} \frac{mu^3}{g}$

Scan or tap for the full solution



Q.50 A heavy iron bar of weight 12 kg is having its one end on the ground and the other on the shoulder of a man. The rod makes an angle 60° with the horizontal, the weight experienced by the man is :

[JEE Main 2024 (Online) 27th January Evening Shift]

- (1) 3 kg (2) 6 kg
 (3) $6\sqrt{3}$ kg (4) 12 kg

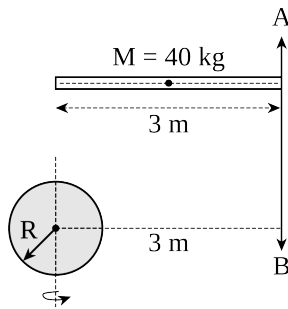


Solution

Section B (Numerical) — 37 questions

- Q.51** Moment of inertia about an axis AB for a rod of mass 40 kg and length 3 m is same as that of a solid sphere of mass 10 kg and radius R about an axis parallel to AB axis with separation of 3 m as shown in figure below. The value of R is given as $\sqrt{\frac{\alpha}{2}}$. The value of α is _____.

[JEE Main 2026 (Online) 2nd April Evening Shift]



Scan or tap for the full solution



- Q.52** A solid sphere of radius 10 cm is rotating about an axis which is at a distance 15 cm from its centre. The radius of gyration about this axis is $\sqrt{n}$ cm. The value of n is _____.

[JEE Main 2026 (Online) 28th January Morning Shift]

Scan or tap for the full solution



- Q.53** A flywheel having mass 3 kg and radius 5 m is free to rotate about a horizontal axis. A string having negligible mass is wound around the wheel and the loose end of the string is connected to 3 kg mass. The mass is kept at rest initially and released. Kinetic energy of the wheel when the mass descends by 3 m is _____ J. ($g = 10 \text{ m/s}^2$)

[JEE Main 2026 (Online) 28th January Evening Shift]

Scan or tap for the full solution



- Q.54** A uniform solid cylinder of length L and radius R has moment of inertia about its axis equal to I_1 . A small concentric cylinder of length $L/2$ and radius $R/3$ carved from this cylinder has moment of inertia about its axis equal to I_2 . The ratio I_1/I_2 is _____.

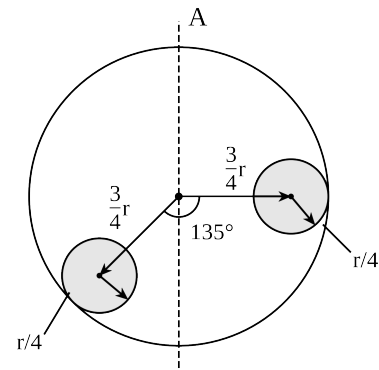
[JEE Main 2026 (Online) 24th January Evening Shift]

Scan or tap for the full solution



- Q.55** Suppose there is a uniform circular disc of mass M kg and radius r m shown in figure. The shaded regions are cut out from the disc. The moment of inertia of the remainder about the axis A of the disc is given by $\frac{x}{256}Mr^2$. The value of x is _____.

[JEE Main 2026 (Online) 23rd January Evening Shift]



Scan or tap for the full solution



- Q.56** A circular disc has radius R_1 and thickness T_1 . Another circular disc made of the same material has radius R_2 and thickness T_2 . If the moments of inertia of both discs are the same and $\frac{R_1}{R_2} = 2$ then $\frac{T_1}{T_2} = \frac{1}{\alpha}$. The value of α is _____.

[JEE Main 2026 (Online) 22nd January Morning Shift]

Scan or tap for the full solution



- Q.57** Two masses m and 2m are connected by a light string going over a pulley (disc) of mass 30m with radius $r = 0.1$ m. The pulley is mounted in a vertical plane and it is free to rotate about its axis. The 2m mass is released from rest and its speed when it has descended through a height of 3.6 m is _____ m/s. (Assume string does not slip and $g = 10 \text{ m/s}^2$)

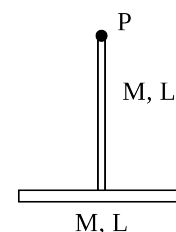
[JEE Main 2026 (Online) 22nd January Evening Shift]

Scan or tap for the full solution



- Q.58** Two identical thin rods of mass M kg and length L m are connected as shown in figure. Moment of inertia of the combined rod system about an axis passing through point P and perpendicular to the plane of the rods is $\frac{x}{12}ML^2 \text{ kg m}^2$. The value of x is _____.

[JEE Main 2026 (Online) 21st January Morning Shift]



Scan or tap for the full solution



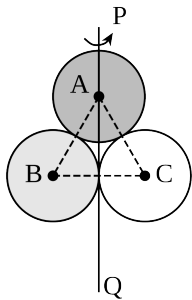
- Q.59** A thin solid disk of 1 kg is rotating along its diameter axis at the speed of 1800 rpm. By applying an external torque of 25π N m for 40 s, the speed increases to 2100 rpm. The diameter of the disk is _____ m.

[JEE Main 2025 (Online) 8th April Evening Shift]

Scan or tap for the full solution



- Q.60** A, B and C are disc, solid sphere and spherical shell respectively with same radii and masses. These masses are placed as shown in figure.



The moment of inertia of the given system about PQ axis is $\frac{x}{15}I$, where I is the moment of inertia of the disc about its diameter. The value of x is _____.

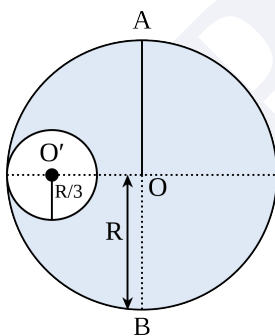
[JEE Main 2025 (Online) 7th April Morning Shift]

Scan or tap for the full solution



- Q.61** Let M and R be the mass and radius of a disc. A small disc of radius $R/3$ is removed from the bigger disc as shown in figure. The moment of inertia of remaining part of bigger disc about an axis passing through the centre O and perpendicular to the plane of disc is $\frac{4}{x}MR^2$. The value of x is _____.

[JEE Main 2025 (Online) 7th April Evening Shift]



Scan or tap for the full solution



- Q.62** A circular ring and a solid sphere having same radius roll down on an inclined plane from rest without slipping. The ratio of their velocities when reached at the bottom of the plane is $\sqrt{\frac{x}{5}}$ where $x =$ _____.

[JEE Main 2025 (Online) 4th April Morning Shift]

Scan or tap for the full solution



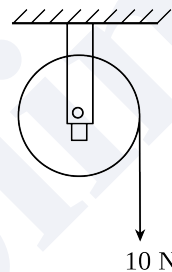
- Q.63** A solid sphere with uniform density and radius R is rotating initially with constant angular velocity (ω_1) about its diameter. After some time during the rotation it starts losing mass at a uniform rate, with no change in its shape. The angular velocity of the sphere when its radius becomes $R/2$ is $x\omega_1$. The value of x is _____.

[JEE Main 2025 (Online) 4th April Evening Shift]

Scan or tap for the full solution



Q.64



A wheel of radius 0.2 m rotates freely about its center when a string that is wrapped over its rim is pulled by a force of 10 N as shown in figure. The established torque produces an angular acceleration of 2 rad/s^2 . Moment of inertia of the wheel is _____ kg m^2 . (Acceleration due to gravity = 10 m/s^2)

[JEE Main 2025 (Online) 2nd April Evening Shift]

Scan or tap for the full solution



- Q.65** The coordinates of a particle with respect to origin in a given reference frame is (1, 1, 1) meters. If a force of $\vec{F} = \hat{i} - \hat{j} + \hat{k}$ acts on the particle, then the magnitude of torque (with respect to origin) in z -direction is _____.

[JEE Main 2025 (Online) 29th January Morning Shift]

Scan or tap for the full solution



- Q.66** Two iron solid discs of negligible thickness have radii R_1 and R_2 and moment of inertia I_1 and I_2 , respectively. For $R_2 = 2R_1$, the ratio of I_1 and I_2 would be $1/x$, where $x =$ _____.

[JEE Main 2025 (Online) 28th January Morning Shift]

Scan or tap for the full solution



- Q.67** The moment of inertia of a solid disc rotating along its diameter is 2.5 times higher than the moment of inertia of a ring rotating in similar way. The moment of inertia of a solid sphere which has same radius as the disc and rotating in similar way, is n times higher than the moment of inertia of the given ring. Here, $n = \underline{\hspace{2cm}}$. Consider all the bodies have equal masses.

[JEE Main 2025 (Online) 28th January Morning Shift]

Scan or tap for the full solution



- Q.68** The position vectors of two 1 kg particles, (A) and (B), are given by $\vec{r}_A = (\alpha_1 t^2 \hat{i} + \alpha_2 t \hat{j} + \alpha_3 t \hat{k})\text{m}$ and $\vec{r}_B = (\beta_1 t \hat{i} + \beta_2 t^2 \hat{j} + \beta_3 t \hat{k})\text{m}$, respectively; ($\alpha_1 = 1 \text{ m/s}^2$, $\alpha_2 = 3 \text{ n m/s}$, $\alpha_3 = 2 \text{ m/s}$, $\beta_1 = 2 \text{ m/s}$, $\beta_2 = -1 \text{ m/s}^2$, $\beta_3 = 4 \text{ p m/s}$), where t is time, n and p are constants. At $t = 1 \text{ s}$, $|\vec{v}_A| = |\vec{v}_B|$ and velocities $\vec{v}_A$ and $\vec{v}_B$ of the particles are orthogonal to each other. At $t = 1 \text{ s}$, the magnitude of angular momentum of particle (A) with respect to the position of particle (B) is $\sqrt{L} \text{ kg m}^2 \text{ s}^{-1}$. The value of L is $\underline{\hspace{2cm}}$.

[JEE Main 2025 (Online) 22nd January Morning Shift]

Scan or tap for the full solution



- Q.69** A string is wrapped around the rim of a wheel of moment of inertia 0.40 kg m^2 and radius 10 cm . The wheel is free to rotate about its axis. Initially the wheel is at rest. The string is now pulled by a force of 40 N . The angular velocity of the wheel after 10 s is $x \text{ rad/s}$, where x is $\underline{\hspace{2cm}}$.

[JEE Main 2024 (Online) 9th April Morning Shift]

Scan or tap for the full solution



- Q.70** A circular disc reaches from top to bottom of an inclined plane of length l . When it slips down the plane, it takes $t \text{ s}$. When it rolls down the plane then it takes $\left(\frac{\alpha}{2}\right)^{1/2} t \text{ s}$, where α is $\underline{\hspace{2cm}}$.

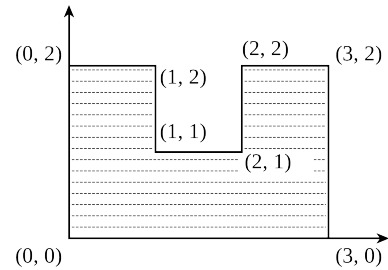
[JEE Main 2024 (Online) 9th April Evening Shift]

Scan or tap for the full solution



- Q.71** A uniform thin metal plate of mass 10 kg with dimensions is shown. The ratio of x and y coordinates of center of mass of plate is $\frac{n}{9}$. The value of n is $\underline{\hspace{2cm}}$.

[JEE Main 2024 (Online) 8th April Morning Shift]



Scan or tap for the full solution



- Q.72** If the radius of earth is reduced to three-fourth of its present value without change in its mass then value of duration of the day of earth will be $\underline{\hspace{2cm}}$ hours 30 minutes.

[JEE Main 2024 (Online) 6th April Morning Shift]

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- Q.73** Three balls of masses 2 kg , 4 kg and 6 kg respectively are arranged at centre of the edges of an equilateral triangle of side 2 m . The moment of inertia of the system about an axis through the centroid and perpendicular to the plane of triangle, will be $\underline{\hspace{2cm}} \text{ kg m}^2$.

[JEE Main 2024 (Online) 6th April Evening Shift]

Scan or tap for the full solution



- Q.74** A hollow sphere is rolling on a plane surface about its axis of symmetry. The ratio of rotational kinetic energy to its total kinetic energy is $\frac{x}{5}$. The value of x is $\underline{\hspace{2cm}}$.

[JEE Main 2024 (Online) 5th April Evening Shift]

Scan or tap for the full solution



- Q.75** A solid sphere and a hollow cylinder roll up without slipping on same inclined plane with same initial speed v . The sphere and the cylinder reach upto maximum heights h_1 and h_2 respectively, above the initial level. The ratio $h_1:h_2$ is $\frac{n}{10}$. The value of n is $\underline{\hspace{2cm}}$. [JEE Main 2024 (Online) 4th April Morning Shift]

Scan or tap for the full solution



- Q.76** In a system two particles of masses $m_1 = 3 \text{ kg}$ and $m_2 = 2 \text{ kg}$ are placed at certain distance from each other. The particle of mass m_1 is moved towards the center of mass of the system through a distance 2 cm . In order to keep the center of mass of the system at the original position, the particle of mass m_2 should move towards the center of mass by the distance $\underline{\hspace{2cm}} \text{ cm}$.

[JEE Main 2024 (Online) 4th April Evening Shift]

Scan or tap for the full solution



- Q.77** Three identical spheres each of mass $2M$ are placed at the corners of a right angled triangle with mutually perpendicular sides equal to 4 m each. Taking point of intersection of these two sides as origin, the magnitude of position vector of the centre of mass of the system is $\frac{4\sqrt{2}}{x}$, where the value of x is _____.

[JEE Main 2024 (Online) 1st February Morning Shift]

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- Q.78** A uniform rod AB of mass 2 kg and length 30 cm is at rest on a smooth horizontal surface. An impulse of force 0.2 N s is applied to end B. The time taken by the rod to turn through at right angles will be $\frac{\pi}{x}\text{ s}$, where $x =$ _____.

[JEE Main 2024 (Online) 1st February Evening Shift]

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- Q.79** A solid circular disc of mass 50 kg rolls along a horizontal floor so that its center of mass has a speed of 0.4 m/s . The absolute value of work done on the disc to stop it is _____ J.

[JEE Main 2024 (Online) 31st January Morning Shift]

Scan or tap for the full solution



- Q.80** A body of mass ' m ' is projected with a speed ' u ' making an angle of 45° with the ground. The angular momentum of the body about the point of projection, at the highest point is expressed as $\frac{\sqrt{2}mu^3}{Xg}$. The value of ' X ' is _____.

[JEE Main 2024 (Online) 31st January Evening Shift]

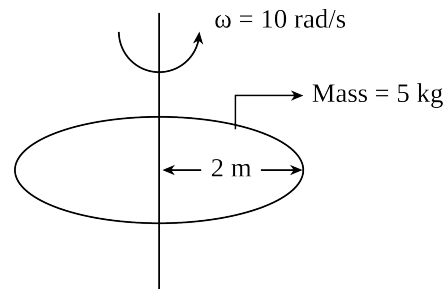
Scan or tap for the full solution



- Q.81** Two identical spheres each of mass 2 kg and radius 50 cm are fixed at the ends of a light rod so that the separation between the centers is 150 cm . Then, moment of inertia of the system about an axis perpendicular to the rod and passing through its middle point is $\frac{x}{20}\text{ kg m}^2$, where the value of x is _____.

[JEE Main 2024 (Online) 31st January Evening Shift]

Scan or tap for the full solution

**Q.82**

Consider a Disc of mass 5 kg , radius 2 m , rotating with angular velocity of 10 rad/s about an axis perpendicular to the plane of rotation. An identical disc is kept gently over the rotating disc along the same axis. The energy dissipated so that both the discs continue to rotate together without slipping is _____ J.

[JEE Main 2024 (Online) 30th January Morning Shift]

Scan or tap for the full solution



- Q.83** Two discs of moment of inertia $I_1 = 4\text{ kg m}^2$ and $I_2 = 2\text{ kg m}^2$, about their central axes & normal to their planes, rotating with angular speeds 10 rad/s & 4 rad/s respectively are brought into contact face to face with their axes of rotation coincident. The loss in kinetic energy of the system in the process is _____ J.

[JEE Main 2024 (Online) 30th January Evening Shift]

Scan or tap for the full solution



- Q.84** A cylinder is rolling down on an inclined plane of inclination 60° . Its acceleration during rolling down will be $\frac{x}{\sqrt{3}}\text{ m/s}^2$, where $x =$ _____ (use $g = 10\text{ m/s}^2$).

[JEE Main 2024 (Online) 29th January Morning Shift]

Scan or tap for the full solution



- Q.85** A body of mass 5 kg moving with a uniform speed $3\sqrt{2}\text{ ms}^{-1}$ in $X - Y$ plane along the line $y = x + 4$. The angular momentum of the particle about the origin will be _____ $\text{kg m}^2\text{ s}^{-1}$.

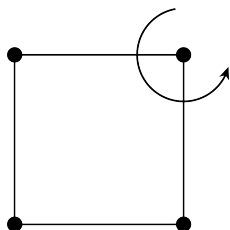
[JEE Main 2024 (Online) 29th January Evening Shift]

Scan or tap for the full solution



- Q.86** Four particles each of mass 1 kg are placed at four corners of a square of side 2 m . Moment of inertia of system about an axis perpendicular to its plane and passing through one of its vertex is _____ kg m^2 .

[JEE Main 2024 (Online) 27th January Morning Shift]



Scan or tap for the full solution



Q.87 A ring and a solid sphere roll down the same inclined plane without slipping. They start from rest. The radii of both bodies are identical and the ratio of their kinetic energies is $\frac{7}{x}$, where x is _____.

[JEE Main 2024 (Online) 27th January Evening Shift]

Scan or tap for the full solution



ANSWER KEY

Section A (MCQ) — 50 questions

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

Section B (Numerical) — 37 questions

Ques.	51	52	53	54	55
Ans.	15	265	30	162	109
Ques.	56	57	58	59	60
Ans.	16	2	17	40	199
Ques.	61	62	63	64	65
Ans.	9	4 or 3.5	32	1	2
Ques.	66	67	68	69	70
Ans.	16	4	90	100	3
Ques.	71	72	73	74	75
Ans.	15	13	4	2	7
Ques.	76	77	78	79	80
Ans.	3	3	4	6	8
Ques.	81	82	83	84	85
Ans.	53	250	24	10	60
Ques.	86	87			
Ans.	16	7			