

Self -Assessment

Module 1 System of Particles

Q.7.1.1 Given below are three statements (p), (q) and (r) in respect of the reduced mass (μ) of the two body electron- proton system, having individual masses m_e , m_p respectively.

(p) $m_e < \mu < m_p$

(q) $m_e < m_p < \mu$

(r) $\mu < m_e < m_p$

Identify the correct statement among the following.

(A) only (p)

(B) only (q)

(C) only (r)

(D) It may vary between (p) and (q)

Q.7.1.2 Given below are four statements (p), (q), (r), and (s) about the reduced mass μ of the sun-earth system –

(p) μ is less than each of the masses of the sun and the earth

(q) μ is greater than each of the masses of the sun and the earth

(r) μ is equal to the arithmetic mean of the masses of the sun and the earth

(s) μ is equal to the harmonic mean of the masses of the sun and the earth

Which among the following statements is/are correct?

(A) only (p)

(B) only (q)

(C) (q) and (r)

(D) (p) and (s)

Q.7.1.3 Which one among the following statements is/are correct in respect of the two-body system under the influence of their mutual action and reaction forces?

(p) The centre of mass of the system drifts in space with a uniform velocity.

(q) A frame of reference can exist with respect to which the centre of mass remains at rest.

(r) The two equations representing the motion of two bodies can be reduced to a single equation in terms of the relative coordinates of the two bodies.

(A) only (p)

(B) only (q)

(C) All three, (p), (q) and (r)

(D) (p) and (q), but not (r)

Q.7.1.4 A square hole is cut out from a uniform circular lamina of radius a as shown in the Fig.Q.7.1.1

. The distance of the centre of gravity of the remaining lamina from the centre of the circle is

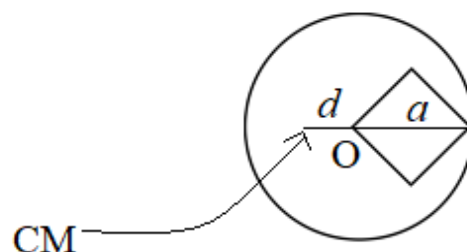


Fig.Q.7.1.1

(A) $\frac{a}{2\pi}$

(B) $\frac{a}{2\pi-1}$

(C) $\frac{a}{4\pi}$

(D) $\frac{a}{4\pi-2}$

Q.7.1.5 The centre of mass of a triangular lamina is located at its

(A) circumcentre

(B) in centre

(C) centroid

(D) ortho centre

Q.7.1.6 Find the coordinates of the centre of mass of the portion of the first quadrant of the circle

$$x^2 + y^2 = a^2$$

(A) $\left(\frac{4a}{3\pi}, \frac{4a}{3\pi} \right)$

(B) $\left(\frac{4a}{3\pi}, \frac{8a}{3\pi} \right)$

(C) $\left(\frac{8a}{3\pi}, \frac{4a}{3\pi} \right)$

(D) $\left(\frac{8a}{3\pi}, \frac{8a}{3\pi} \right)$

Q.7.1.7 For a two-particle system with masses 1 kg and 2 kg, the velocity of the first particle about to the center of mass is 2 ms^{-1} along a straight line AB. The velocity of the second particle about the centre of mass will be

- (A) 1 ms^{-1} along AB
- (B) 1 ms^{-1} along BA
- (C) 2 ms^{-1} along AB
- (D) 2 ms^{-1} along BA

Q.7.1.8 For a two-particle having masses 1 kg and 2 kg, the kinetic energy about its centre of mass is 15 J and the velocity of the centre of mass is 2 ms^{-1} . The total kinetic energy of the system is

- (A) 9 J
- (B) 10 J
- (C) 15 J
- (D) 21 J

Q.7.1.9 A bomb is thrown and it explodes while moving in its trajectory. The centre of mass of the fragments after explosion will follow a/an

- (A) parabolic path
- (B) elliptical path
- (C) linear path
- (D) hyperbolic path

Q.7.1.10 Given below are four statements, pertaining to the centre of mass coordinates and the reduced mass of a two-body system. In which case the mass of one body is much larger than that of the other?

- (A) The centre of mass coordinates are very nearly the same as that of the heavier mass and the reduced mass is approximately equal to the heavier mass.
- (B) The centre of mass coordinates are almost the same as that of the lighter mass and the reduced mass is approximately equal to the heavier mass.
- (C) The centre of mass coordinates are almost the same as that of the heavier mass and the reduced mass is nearly equal to the lighter mass.
- (D) The centre of mass coordinates are almost the same as that of the lighter mass and the reduced mass is nearly equal to the lighter mass.

Module 2 : Kinematics of Rotational Motion

Q.7.2.1 If ω_1 , ω_2 and ω_3 are the angular speeds of the seconds hand, minute hand and hour hand respectively of a watch then $\omega_1:\omega_2:\omega_3$ is equal to

- (A) 360 : 6 : 1
- (B) 360 : 12 : 1
- (C) 720 : 10 : 1
- (D) 720 : 12 : 1

Q.7.2.2 The radius of the dial of a wrist watch is 2 cm. The angular velocity of the midpoint of the minute hand in radians per second is

- (A) $\frac{\pi}{900}$

(B) $\frac{\pi}{1200}$

(C) $\frac{\pi}{1800}$

(D) $\frac{\pi}{3600}$

Q.7.2.3 Statements (p), (q), (r), and (s) pertain to the rotation of a rigid body about a fixed axis —

- (p) The magnitude of the angular velocity vector does not change with time.
- (q) The magnitude of the angular velocity vector may change with time.
- (r) The direction of the angular velocity vector does not change with time.
- (s) The direction of the angular velocity vector may change with time.

Which among the above statements are correct?

(A) (p) and (q)

(B) (p) and (r)

(C) (q) and (r)

(D) (q) and (s)

Q.7.2.4 When observed at time $t_0 = 0$, a ceiling fan has angular velocity ω_o . After a time t it describes an angle θ and attains angular velocity ω . If the angular velocity of fan is assumed constant and its angular acceleration is α , then ω can be expressed by which of the following expression or expressions?

(p) $\frac{2\theta}{t} - \omega_o$,

(q) $\omega_o + \alpha t$

(r) $\omega_o^2 + 2\alpha\theta$

$$(s) \left(\omega_o^2 + \frac{1}{2} \alpha \theta \right)^{\frac{1}{2}}$$

Options

- (A) Only (p)
- (B) (p) and (q)
- (C) Only (r)
- (D) Only (s)

Q.7.2.5 For a particle executing uniform circular motion, the angular speed is 10 rad s^{-1} . The angular speed of the particle about a point on the circumference of the circle is

- (A) 5 rad s^{-1}
- (B) 10 rad s^{-1}
- (C) 20 rad s^{-1}
- (D) dependent on the location on the circumference of the point concerned

Q.7.2.6 A body rotating about an axis has an initial angular velocity, ω_o and angular acceleration α . The angle described by it during the tenth second is -

- (A) $\omega_o + (9.5)\alpha$
- (B) $\omega_o + 4\alpha$
- (C) $5(\omega_o + \alpha)$
- (D) $5\omega_o + 4\alpha$

Stem for Question Q.7.2.7 and Q.7.2.9

A body executing uniformly accelerated circular motion describes 8π rad during the first 2 seconds and 30π rad in the first 6 seconds.

Q.7.2.7 What is the value of its angular acceleration?

(A) $\frac{\pi}{6} \text{ rad/s}^2$

(B) $\frac{\pi}{4} \text{ rad/s}^2$

(C) $\frac{\pi}{3} \text{ rad/s}^2$

(D) $\frac{\pi}{2} \text{ rad/s}^2$

Q.7.2.8 What is the number of revolutions undergone by the body in 10 seconds?

(A) 10

(B) 20

(C) 30

(D) 40

Q.7.2.9 What is the value of angular velocity of the body attained after 10 seconds? Options

(A) 7π

(B) 8.5π

(C) 9.5π

(D) 12π

Q.7.2.10 A body is moving with a uniform velocity u along the straight line $x = a$. What is the value of its angular velocity about the origin when its end makes an angle 45° with the x-axis?

- (A) $\frac{u}{a}$
 - (B) $\frac{u}{2a}$
 - (C) $\frac{2u}{a}$
 - (D) $\frac{\sqrt{2}u}{a}$
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Module 3 : Dynamics of Rotational Motion

Q.7.3.1 Given below are three statements about the moment of a couple

- (p) Its value does not depend on the location of the fulcrum
- (q) Its value depends on the location of the fulcrum
- (r) Its value becomes zero if the fulcrum point lies on the line of action of any of the forces constituting the couple

Which among the following is/are true?

- (A) Only (p)
- (B) Only (q)
- (C) Only (r)
- (D) (q) and (r)

Q.7.3.2 P and Q are two points on the lines of action of two equal and opposite parallel forces that make an angle θ with PQ. At this stage the moment of the couple is A (Fig. A.7.3.1). The lines of action of the forces are now turned through 90° . The moment of the couple now is B. The moment of the couple when the lines of action of the forces are perpendicular to PQ is

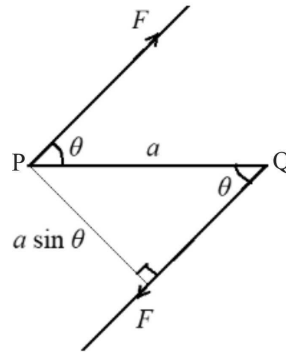


Fig. A.7.3.1

- (A) $A + B$
- (B) $A - B$
- (C) $\sqrt{A^2 + B^2}$
- (D) $\sqrt{A^2 - B^2}$

Q.7.3.3 A circular plate of radius R has a mass, M . Its moment of inertia about one of its diameter is

- (A) MR^2
- (B) $\frac{1}{4}MR^2$
- (C) $\frac{1}{3}MR^2$
- (D) $\frac{1}{2}MR^2$

Stem for Question Q.7.3.4 and Q.7.3.5

A merry-go-round in the form of a heavy wooden disc of mass M and radius R is being pushed at its edge continuously by a person by a force of magnitude F . Friction at the mechanism used for turning is negligible.

Q 7.3.4 What is the angular acceleration acquired by the merry-go-round ?

(A) $\frac{F}{MR}$

(B) $\frac{F}{2MR}$

(C) $\frac{2F}{MR}$

(D) $\frac{4F}{MR}$

Q.7.3.5 A child of mass m_1 is now made to sit near the edge on a seat of mass m_2 . What will be the angular acceleration if the child and the seat can be considered as point masses at the edges.

(A) $\frac{2F}{(M+m_1+m_2)R}$

(B) $\frac{2F}{(M+2m_1+2m_2)R}$

(C) $\frac{F}{(2M+m_1+m_2)R}$

(D) $\frac{2F}{(2M+m_1+m_2)R}$

Q.7.3.6 A body of radius R rolls without slipping down an inclined plane of inclination θ with the horizon with an acceleration $\frac{3}{5}g\sin\theta$. The body is a

- (A) hollow cylinder
- (B) solid cylinder
- (C) hollow sphere
- (D) solid sphere

Q.7.3.7 Four bodies (a hollow cylinder, a solid cylinder, a hollow sphere, a solid sphere), each of the same radius, are made to roll without slipping down an inclined plane. If the velocities of the bodies on reaching the base are v_1, v_2, v_3 and v_4 respectively, then

- (A) $v_3 > v_2 > v_4 > v_1$
- (B) $v_3 > v_4 > v_2 > v_1$
- (C) $v_4 > v_3 > v_2 > v_1$
- (D) $v_4 > v_2 > v_3 > v_1$

Q.7.3.8 Match the terms in the two columns of the given Table from the point of view of rotational analogues of the linear motion.

Displacement (A)	Torque (P)
Mass (B)	Angular displacement (Q)
Force (C)	Angular momentum (R)

Linear momentum (D)	Moment of inertia (S)
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- (A) A-Q, B-P, C-S, D-R
- (B) A-R, B-S, C-P, D-Q
- (C) A-R, B-Q, C-S, D-P
- (D) A-Q, B-S, C-P, D-R

Q.7.3.9 A simple pendulum having a bob of mass m and effective length l is released from a position where its angular displacement from the mean position is 60° . The work done by the restoring torque in reducing the angular displacement to 30° is

- (A) $-\sqrt{3-1} mgl$
- (B) $\sqrt{3-1} mgl$
- (C) $-\frac{1}{2} mgl$
- (D) $\frac{1}{2} mgl$

Q.7.3.10 A young girl stands at the centre of a turntable with her two arms outstretched. The turn-table is set into rotation with an angular speed of 60 rev/min. How much is the angular speed of the girl if she folds her hands back and thereby reduces her moment of inertia to 60% of its initial value? Assume that the turn-table rotates without friction.

- (A) $\frac{2\pi}{5} \text{ rad s}^{-1}$
- (B) $\frac{5\pi}{4} \text{ rad s}^{-1}$
- (C) $\frac{10\pi}{3} \text{ rad s}^{-1}$

(D) $\frac{12\pi}{5} \text{ rad s}^{-1}$



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