CBSE

SYSTEM OF PARTICLES AND ROTATIONAL MOTION WS 5

Class 11 - Physics

Section A

1. 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 **[1]**

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

2. The angular velocity of a wheel increases from 100 rps to 300 rps in 10 s. The number of revolutions made during that time is **[1]**

   a) 1000
   b) 600
   c) 2000
   d) 1500

3. The angular velocity of a body changes from 1 rev/sec to 25 rev/sec. without applying any external torque. The ratio of the radii of gyration in the two cases is: **[1]**

   a) 1: 25
   b) 25:1
   c) 5:1
   d) 1: 5

4. The direction of angular velocity vector is along **[1]**

   a) the outward radius
   b) the axis of rotation
   c) the tangent to the circular path
   d) the inward radius

5. A horizontal platform is rotating with a uniform angular velocity ω around the vertical axis passing through its centre. At some instant of time, a viscous liquid of mass m is dropped at the centre and is allowed to spread out and finally fall. The angular velocity during this period **[1]**

   a) remains unaltered
   b) decreases initially and increases again
   c) increases continuously
   d) decreases continuously

6. Two bodies have their moments of inertia I and 2 I respectively about their axis of rotation. If their kinetic energies of rotation are equal, their angular velocity will be in the ratio **[1]**

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

7. The angular acceleration vector is defined as: **[1]**

   a) $\alpha = \frac{d^2w}{dt^2}$
   b) $\alpha = \frac{d\omega}{dt}$
   c) $\alpha = 2\frac{d\omega}{dt}$
   d) $\alpha = \frac{d^3\omega}{dt^3}$

8. If a body is rotating about z-axis with a speed ω and a point is at a distance of r in the x-y plane then the velocity of the point is: **[1]**

a) $3r\omega$ b) $r\omega$

c) $2r\omega$ d) $r\omega/2$

9. A mass is revolving in a circle, which is in the plane of the paper. The direction of angular acceleration if any, is: **[1]**

a) Upward from the plane of the paper b) Tangential

c) At right angles to the plane of the paper d) Towards the radius

10. The angular velocity of a body changes forms 1 rev/sec to 16 rev/sec. Without applying any external torque. The ratio of its radius of gyration in the two cases is: **[1]**

a) 1:16 b) 4: 1

c) 16:1 d) 1:4

11. A disc having mass M and radius R is rotating with angular velocity ω, another disc of mass 2M and radius $\frac{R}{2}$ is placed coaxially on the first disc gently. The angular velocity of the system will now be **[1]**

a) $\frac{3\omega}{2}$ b) $\frac{4\omega}{5}$

c) $\frac{2\omega}{3}$ d) $\frac{2\omega}{5}$

12. **Assertion (A):** Angular velocity of second's hand of a watch is $\frac{\pi}{30}$ rad/sec. **[1]**
Reason (R): Angular velocity is inversely proportional to the total time.

a) Both A and R are true and R is the correct explanation of A. b) Both A and R are true but R is not the correct explanation of A.

c) A is true but R is false. d) A is false but R is true.

13. **Assertion:** All particles of a rigid body, which do not lie on an axis of rotation move on circular paths with centres at an axis of rotation. **[1]**
Reason: In a rigid body, no two particles in the same plane perpendicular to an axis of rotation have the same velocity and acceleration vectors.

a) Assertion and reason both are correct statements and reason is correct explanation for assertion. b) Assertion and reason both are correct statements but reason is not correct explanation for assertion.

c) Assertion is correct statement but reason is wrong statement. d) Assertion is wrong statement but reason is correct statement.

14. **Assertion:** The relative angular velocity between any two points of a rigid body is zero at any instant. **[1]**
Reason: There is no relative velocity between the points of a rigid body.

a) Assertion and reason both are correct statements and reason is correct explanation for assertion. b) Assertion and reason both are correct statements but reason is not correct explanation for assertion.

c) Assertion is correct statement but reason is wrong statement. d) Assertion is wrong statement but reason is correct statement.

15. **Assertion:** Average angular velocity is a scalar quantity. **[1]**
Reason: Large angular displacement $(\Delta\theta)$ is a scalar.

a) Assertion and reason both are correct statements and reason is correct explanation b) Assertion and reason both are correct statements but reason is not correct

for assertion.

explanation for assertion.

c) Assertion is correct statement but reason is wrong statement.

d) Assertion is wrong statement but reason is correct statement.

16. **Assertion:** When a rigid body is rotating about a fixed axis, every particle of the rigid body have same angular velocity and angular acceleration. **[1]**

Reason: For every pair of particles in a rigid body, there is no velocity of separation or approach between the particles.

a) Assertion and reason both are correct statements and reason is correct explanation for assertion.

b) Assertion and reason both are correct statements but reason is not correct explanation for assertion.

c) Assertion is correct statement but reason is wrong statement.

d) Assertion is wrong statement but reason is correct statement.

17. **Assertion:** Instantaneous angular velocity is a vector quantity. **[1]**

Reason: Infinitesimal angular displacement ($d\theta$) is a vector.

a) Assertion and reason both are correct statements and reason is correct explanation for assertion.

b) Assertion and reason both are correct statements but reason is not correct explanation for assertion.

c) Assertion is correct statement but reason is wrong statement.

d) Assertion is wrong statement but reason is correct statement.

18. **Fill in the blanks:** **[1]**

(a) In _____, one end axis of rotation is fixed and other end rotates about a circular path. **[1]**

19. If point P is the point of contact of a wheel on ground which rolls on ground without slipping, then value of displacement of point P when wheel completes half of rotation (if radius of wheel is 1 m) is **[1]**

a) π m

b) $\sqrt{\pi^2 + 2}m$

c) $\sqrt{\pi^2 + 4}m$

d) 2 m

Section B

20. **State True or False:** **[2]**

(a) Angular displacement is a vector quantity. **[1]**

(b) If no external torque acts on a body, its angular velocity remains conserved. **[1]**

21. What is the angular velocity of a second hand and minute hand of a clock? **[2]**

22. Show that for an isolated system the centre of mass moves with uniform velocity along a straight line path. **[2]**

23. A particle performing uniform circular motion has angular momentum L. What will be the new angular momentum if its angular frequency is doubled and its kinetic energy halved? **[2]**

Section C

24. A car is moving at a speed of 72kmh^{-1}. The diameter of its wheels is 0.50 m. If the wheels are stopped in 20 rotations by applying brakes, calculate the angular retardation produced by the brakes. **[3]**

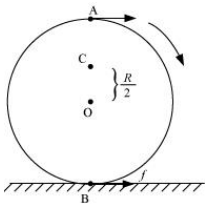
25. A star of mass twice the solar mass and radius 10^6 km rotates about its axis with an angular speed of 10^{-6} rad s^{-1}. What is the angular speed of the star when it collapses (due to inward gravitational force) to a radius of 10^4 km? Solar mass 1.99×10^{30} kg. **[3]**

26. A cylinder of mass 5 kg and radius 30 cm, and free to rotate about its axis, receives an angular impulse of 3 kg $m^2 s^{-1}$ initially followed by a similar impulse after every 4s. What is the angular speed of the cylinder 30s after the initial impulse? The cylinder is at rest initially. **[3]**

27. How is angular velocity related to linear velocity of a particle of the body in rotational motion ? Does pure rotation take place at uniform angular velocity or at uniform linear velocity? **[3]**

28. The motor of an engine is rotating about it's axis with an angular velocity of 100 rpm. It comes to rest in 15s after being switched off. Assuming constant angular deceleration, calculate the number of revolutions made by it before coming to rest. **[3]**

29. A disc rotating about its axis with angular speed ω_o is placed lightly (without any translational push) on a perfectly frictionless table. The radius of the disc is R. What are the linear velocities of the points A, B and C on the disc? Will the disc roll in the direction indicated? **[3]**



Section D

Question No. 30 to 34 are based on the given text. Read the text carefully and answer the questions: **[5]**

Relation between externally applied torque and the angular momentum is

$\tau = \frac{dL}{dt}$

Since L = Iω

$\therefore t = \frac{d}{dt}(I\omega)$

If no torque acts on a rotating body,

$\frac{d}{dt}(l\omega) = 0$, i.e., I$\omega$ = constant

This is known as law of conservation of angular momentum.

This law has several applications in sports and dance.

When a man with outstretched hands, holding weights in each hand, stands on a revolving turntable, he attains certain angular velocity. If he pulls the weights towards his body there is an increase in angular velocity.

When a diver jumps from a spring board and performs somersaults, he/she folds his legs and arms to decrease his moment of inertia. Consequently his/her angular velocity increases and the diver instead of turning 180^o now can tum 360^o.

30. Why the diver stretches her arm and leg while touching the water?

a) to increase her moment of inertia
b) to relax her body
c) to decrease her moment of inertia
d) to increase her velocity

31. If torque is applied on a rotating body

a) Its angular velocity changes
b) Its moment of inertia changes
c) Its angular velocity remains unchanged
d) both its moment of inertia changes and its angular velocity changes

32. When a man with outstretched hands, holding weights in each hand, standing on a revolving turntable, pulls the weights towards his body

a) there will be a decrease in angular velocity
b) there will be an increase in angular velocity

due to decreases in moment of inertia

due to decreases in moment of inertia

c) there will a decrease in angular velocity due to increases in moment of inertia

d) there will be an increase in angular velocity due to increases in moment of inertia

33. In which of the following positions, the moment of inertia of the ballet dancer will be minimum?

a)

b)

c)

d)

34. In which positions of the diver the angular velocities are maximum and minimum?

a)

b)

c)

d)

35. A bucket of mass 8 kg is supported by a light rope wound around a solid wooden cylinder of mass 12 kg and radius 20 cm free to rotate about its axis. A man holding the free end of the rope, with the bucket and the cylinder at rest initially, lets go the bucket freely downwards in a well 50 m deep. Neglecting friction, obtain the speed of the bucket and the angular speed of the cylinder just before the bucket enters water. Take g = 10 ms^{-2} **[5]**