# QB365 <br> Important Questions - System of Particles and Roational Motion 

11th Standard CBSE
Physics

Reg.No. : |  |  |  |  |  |  |
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Time : 01:00:00 Hrs

Total Marks : 50

## Section-A

1) A ballet dancer stretches her hand out for slowing down. Name the conservation obeyed.
2) A wheel of moment of inertia $50 \mathrm{~kg}-\mathrm{m}^{2}$ about its own axis is revolving at a rate of 5 revolutions per second. What is its angular momentum?
3) Should there necessarily be any mass at centre of mass of system?
4) Is centre of mass a reality?
5) A faulty balance with unequal arms has its beam horizontal. Area the weights of the two pans equal?
6) Why in hand driven grinding machine, a handle is put near the circumference of the stone or wheel?
7) Find centre of mass of a triangular lamina.
8) Two boys of the same weight it at the opposite ends of a diameter of a rotating circular table. What happens to the speed of rotation if they move nearer to the axis of rotation?
9) If ice on poles melts, then what is the change in duration of day?
10) The speed of the whirl wind in a tornado is alarmingly high. Why?

## Section-B

11) A solid cylinder of mass 20 kg rotates about its axis with angular speed of $100 \mathrm{rad} / \mathrm{s}$. The radius of cylinder is 0.25 m . What is KE of rotation of cylinder?
12) If earth contract to half its radius. What would be the length of the day?
13) Explain how a cat is able to land on its feet after a fall taking the advantage of principle of conservation of angular momentum?
14) What is the moment of inertia of a solid cylinder of mass $M$ and radius $R$ about axis tangential to cylinder surface and parallel to the axis of cylinder?
15) If two point masses are placed at (+2 m), and (-2 m), is it necessary that the centre of mass of system must lie at origin?
16) A fan of moment of inertia is $0.6 \mathrm{~kg}-\mathrm{m}^{2}$ is to be run upto a working speed of 0.5 rps . What is the angular momentum of the fan?
17) Does angular momentum of a body in translatory motion is zero?
18) Three identical spheres each of radius $r$ and mass $m$ are placed touching each other on a horizontal floor.

Locate the position of centre of mass of the system.
19) A rope of negligible mass is wound round a hollow cylinder of mass 3 kg and radius 40 cm . What is angular
20) A solid cylinder of mass 20 kg rotates about its axis with angular speed of ( $100 \mathrm{rad} / \mathrm{s}$ ). The radius of cylinder is 0.25 m . What is the kinetic energy of rotation of cylinder? What is the magnitude of angular momentum of the cylinder about its axis?

## Section-C

21) A wheel has a constant angular acceleration of $4.2 \mathrm{rad} / \mathrm{s}^{2}$. During a certain 8.05 s interval, it turns through angle of 140 rad. Assuming that wheel started from rest, how it had been in motion before the start of the 8.0 s ?
22) To maintain a rotor at a uniform angular speed of $200 \mathrm{rads}^{-1}$, an engine needs to transmit a torque of 180 N m . What is the power required by engine? Assume 100\% efficiency of engine.
23) A man stands on a rotating platform with his arms stretched horizontally holding a 5 kg weight in each hand.

The angular speed of the platform in 30 rpm . The man then brings his arms close to his body with the distance of each weight from the axis changing from 90 cm to 20 cm . The moment of inertia of the man together with the platform may be taken to be constant and equal to $7.6 \mathrm{~kg}-\mathrm{m}^{2}$.
Is kinetic energy conserved in the process? If not, from where does the change come about?
24) A disc of radius $R$ is rotating with an angular speed $\omega$, about a horizontal axis. It is placed on a horizontal table. The coefficient of kinetic friction is $\mu_{k}$. What happens to the linear speed of the centre of mass when disc is placed in contact with the table?

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## Section-A

1) This is based on the conservation of angular momentum.
2) Here, $\mathrm{I}=50 \mathrm{~kg}-\mathrm{m}^{2}, \omega=5 \mathrm{rps}=5 \times 2 \pi \mathrm{rad} / \mathrm{s}$ Angular momentum, $L=I \omega=50 \times 10 \pi=500 \pi J-s$.
3) No, the centre of mass of a ring lies at its centre.
4) 

No, the centre of mass of a system is a hypothetical point which acts as a single mass particle of the system for an external force.
5) They are of unequal mass. Their masses are in the inverse ratio of the arms of the balance.
6)

For a given force, torque can be increased if the perpendicular distance of the point of application of the force from the axis of rotation is increased. Hence, the handle put near the circumference produces maximum torque.
7)

For any planar solid, centre of mass always lies at its geometrical centre. Geometrical centre of a triangle is intersection point of its media. So, for any given triangular lamina
 Centre of mass is at its centroid, point of intersection is media.
8)

The moment of inertia of the system (circular table + two boys) decreases. To conserve angular momentum ( $L=I \omega=$ constant $)$, the speed of rotation of the circular table increases.

Molten ice from poles into ocean and so mass is going away from axis of rotation. So, moment of inertia of earth increases and to conserve angular momentum, angular velocity ( $\omega$ ) decreases. So, time period of rotation increases $(T=2 \pi / \omega)$. So, net effect of global warming is increasing in the duration of day.
10)

In a whirl wind, the air from nearby region gets concentrated in a small space thereby decreasing the value moment of inertia considerably. Since $I \omega=$ constant, due to decrease in moment of inertia, the angular speed becomes quite high.

## Section-B

11) $\mathrm{M}=20 \mathrm{Kg}, \omega=100 \mathrm{rad} / \mathrm{s}, R=0.25 \mathrm{~m}$.

Moment of inertia of cylinder about its own axis

$$
=\frac{1}{2} M R^{2}=\frac{1}{2} \times 20 \times(0.25)^{2}
$$

Rotational KE $=\frac{1}{2} I \omega^{2}$

$$
=\frac{1}{2} I \omega^{2}=\frac{1}{2} \times 0.625 \times(100)^{2}=3125 J .
$$

12) 

The moment of inertia $\left(I=\frac{1}{2} M R^{2}\right)$ of the earth about its own axis will become one-fourth and so its
angular velocity will become four $\operatorname{times}(L=I \omega=$ constant $)$. Hence, the time period will reduce to onefourth $(T=2 \pi / \omega)$, i.e. 6 hours.
13)

When a cat falls to ground from a height, it stretches its body alongwith the tail so that its moment of inertia become high. Since, $I \omega$ is to remain constant, the value of angular speed $\omega$ decreases and therefore the cat is able to land on the ground gently.
14) $2 M R^{2}$.
15) No
16) $1.9 \mathrm{~km}-\mathrm{m} / \mathrm{s}$
17) Angular momentum of a body is measured with respect to certain origin.


So, a body in translatory motion can have angular momentum.
It will be zero, if origin lies on the line of motion of particle.
18) $\left(r, \frac{r}{3}\right)$
19) Torque on cylinder, $\tau=$ force $\times$ radius

$$
=30 \times 40=12 N-m
$$

Moment of inertia of hollow cylinder about its axis

$$
I=M R^{2}=3 \times(0.4)^{2}=0.48 \mathrm{~kg}-\mathrm{m}^{2}
$$

Also, $\quad \tau=I \alpha \Rightarrow \alpha_{I}^{\frac{\tau}{I}}$

$$
\therefore \quad \alpha=\frac{12}{0.48}=25 s^{-2}
$$

Linear acceleration of rope

$$
\alpha=\frac{F}{m}=\frac{30}{3}=10 \mathrm{~m} / \mathrm{s}^{2} .
$$

20) Moment of inertia of cylinder about its own axis $==\frac{1}{2} M R^{2}$

$$
\begin{aligned}
& =\frac{1}{2} \times 20 \times(0.25)^{2} \mathrm{~kg}-\mathrm{m}^{2} \\
& =0.625 \mathrm{~kg}-\mathrm{m}^{2}
\end{aligned}
$$

Kinetic energy of rotating cylinder

$$
=\frac{1}{2} I \omega^{2}=\frac{1}{2}(0.625)(100)^{2} J=3125 J .
$$

Angular momentum of cylinder about its own axis

$$
=I \omega=0.625 \times 100=62.5 \quad \mathrm{~kg}-\mathrm{m}^{2} / \mathrm{s}
$$

## Section-C

21) Let $=$ initial angular speed at $t=0$

Then, angle turned at end of 8.0 s is $140^{\circ}$.
Using $\quad \theta=\omega_{0} t+\frac{1}{2} \alpha t^{2}$
We have $\omega_{0}=\frac{\theta-\frac{1}{2} \alpha t^{2}}{t}$

$$
\omega_{0}=\frac{140-\frac{1}{2}(4.2)(8.0)^{2}}{8.0} \omega_{0}=0.7 \mathrm{ras} / \mathrm{s}
$$

Now using $\omega=\omega_{0}+\alpha t$ and taking $\omega=0$
We have, $\mathrm{t}=\frac{\omega-\omega_{0}}{\alpha}=\frac{0-\omega_{0}}{4.2}$

$$
=-\frac{0.7}{4.2}=-0.16 s
$$

So, wheel starts from rest 0.16 s before.
22) Work done by torque in turing rotor by angle $\mathrm{d} \theta$ is

$$
=\tau \mathrm{d} \theta
$$

So, power delivered by engine

$$
\begin{aligned}
\mathrm{P}=\frac{\text { Work } \text { done }}{\text { Time taken }} & =\tau \frac{d \theta}{d t} \\
& {[d t=\text { time for turing by angle } d \theta] }
\end{aligned}
$$

or $\mathrm{P}=\tau \omega$
So, power required $=180 \times 200=36000 \mathrm{~W}$

$$
=36 \mathrm{~kW} \quad[1 \mathrm{~kW}=1000 \mathrm{~W}]
$$

23) $K E$ is not conserved in process.

Muscular work done by the man in folding his arms is converted into KE.

If rotating disc is placed in contact with the table, its centre of mass acquires some velocity (which was zero before contact) due to kinetic friction. So, linear velocity of CM will increase.

