Physics Multiple Choice Questions (MCQs) On Circular Motion

Class 11 Physics - Important Question answer for students preparing for XI Board ... Physics Multiple Choice Questions (MCQs) on the topic of Circular Motion.

**MULTIPLE CHOICE QUESTIONS (MCQs)**

1. A body is moving along a circular path with variable speed, it has

   a) A radical acceleration

   b) A tangential acceleration

   c) Zero acceleration

   d) Both radical and tangential acceleration

2. A body is traveling in a circle at a constant speed.

   It

   a) has a constant velocity

   b) has no acceleration
c) has an inward acceleration  
d) has an outward radial acceleration

3. A car sometimes overturns while taking a turn. When it overturns, it is  
a) The inner wheel which leaves the ground first  
b) The outer wheel which leaves the ground first  
c) both the wheel leave the ground simultaneously  
d) Either inner wheel or the outer wheel leaves the ground

4. A particle is performing a U.C.M. Which is the wrong statement regarding its motion?  
a) The velocity vector is tangential to the circle  
b) The acceleration vector is tangential to the circle  
c) The acceleration vector is directed towards the center of the circle  
d) The velocity and acceleration vectors are perpendicular to each other

5. A particle is acted upon by a force of constant magnitude which is always perpendicular to the velocity of the particle? The motion takes place in a plane. It follows that  
a) its velocity is constant  
b) its acceleration is constant  
c) its motion is linear  
d) its motion is circular

6. A stone is tied to one end of a string. Holding the other end, the string is whirled in a horizontal plane with progressively increasing speed. It breaks at some speed because  
a) Gravitational forces of the earth are greater than the tension in the string.  
b) The required centripetal force is greater than the tension sustained by the string.  
c) The required centripetal force is less than the tension in the string.  
d) The centripetal force is greater than the weight of the stone.
7. In a vertical circle of radius $r$ at what point in its path, a particle has a tension equal to zero?

a) Highest point  
b) Lowest point  
c) Any point  
d) A horizontal point

8. For a particle performing a U.C.M. the acceleration is

a) constant in direction  
b) constant in magnitude but not in the direction  
c) constant in magnitude and direction  
d) constant in neither magnitude nor in direction

9. An airplane is taking a turn in a horizontal plane

a) its remains horizontal  
b) it inclines inward  
c) it inclines outward  
d) its wings become vertical

10. When particle revolves with uniform speed on a circular path

a) no force acts on it  
b) no acceleration acts on it  
c) no work is done by it  
d) its velocity is constant

Answers
Ans1. (d) Both radical and tangential acceleration

Ans2. (c) Has an inward acceleration

Ans3. (a) The inner wheel which leaves the ground

First Circle

Ans4. (b) The acceleration vector is tangential to the

Ans5. (d) Its motion is circular

Ans6. (b) The required centripetal force is greater than
The tension sustained by the string.

Ans7. (a) Highest point

Ans8. (b) constant in magnitude but not in the direction

Ans9. (b) it inclines inward

Ans10. (c) no work is done by it

SHORT ANSWER QUESTIONS

Q1. Define circular motion.

**Ans1.** It is a movement of an object or body, along a circular path.

Q2. i) Which of the following remains constant in a uniform circular motion, speed or velocity or both?
   
   ii) Name the force required for uniform circular motion. State its direction.

**Ans2.**

i) Speed remains constant in a uniform circular motion.

ii) Centripetal force is required for uniform circular motion.

Centripetal force is directed towards the center.
Q3. An airplane tilts when it makes a curved flight, why? Explain.

Ans3. An airplane tilts when it makes a curved flight because the weight of the airplane gets used in providing it the necessary centripetal force.

Q4. Why a force is necessary to keep a body moving with uniform speed in a circular path?

Ans4. A force (centripetal force) is required to keep a body moving with uniform speed in a circular motion because if no centripetal force will act on the moving body it will strike the sides of the roads.

Q5. What is the centripetal force?

Ans5. The centripetal force on a body is defined as the external force which causes the body to move in a circular path with a constant speed and acts along the radius and towards the center of the circular path.

\[ \alpha = r \omega^2 \]

\[ \therefore F_c = mr \omega^2 \]

Q6. What is centrifugal force?

Ans6. The outward forces acting on bodies when they move in circular paths are called centrifugal forces.

[centrifugal force] = mv2r

It is not a real force but a fictitious force and is due to the inertial property of the body.

Q7. In a circus why does not a motorcyclist fall down when he moves on the vertical walls of the “wall of death”?

Ans7. In a circus, a motorcyclist does not fall down when he moves on the vertical walls of the wall of death because of the centripetal force that keeps the motorcyclist in a circular path.

Q8. Explain why the earth is flattened at the poles.

Ans8. The earth is flattened at the poles because of the gravitational pull of the moon and the sun.
Q9. Why does a cyclist lean inwards while rounding a curve?

**Ans9.** When cyclist tends to move in a curved path, sidewise frictional forces come into play between the tires and the road. The forces of friction act towards the center of the curved path and hence provide necessary centripetal force and cyclists lean inwards while rounding a curve.

Q10. Why are curved railway tracks banked?

**Ans10.** When a fast-moving train takes a curved path, it tends to move away tangentially off the track. In order to prevent this, the curved tracks are banked on the outside to produce the necessary centripetal force required to keep the train moving in a curved path.

### LONG ANSWER QUESTIONS

Q1. Distinguish between centripetal and centrifugal force. A body of mass $m$ is moving with uniform velocity $v$ on a circular path of radius $r$. Find the magnitudes and direction of force acting on it.

**Centripetal force:**

It is defined as the inward force acting on a body when it moves in a circular path. This force is directed towards the center of the circular path.

It is given by,

$$F = \frac{mv^2}{r}$$

**Centrifugal force:**

It is defined as the outward force experienced by a body moving in a circular path.

It is directed away from the center. Its magnitude is equal to that of centripetal force.

$$\therefore \text{Centripetal force } (F) = \frac{mv^2}{r} = mr\omega^2$$
Let us consider a body of mass ‘m’ is moving in a circular path of radius ‘r’ with uniform speed ‘v’. The velocity of the body is changing due to direction. At any instant, the body is at point A.

Let $\vec{V_A}$ be the velocity of the body at A

After time $\Delta T$, the body reaches point B

Let $\vec{V_B}$ be the velocity of the body at B.

Change in velocity is, $\vec{V_A} - \vec{V_B}$

Let us draw a vector triangle PQR. So, that the triangles AOB and PQR are similar triangles because both are an isosceles triangle with the same vertex angle.

$\frac{OA}{OB} = \frac{PQ}{PR}$

or, $\frac{r}{AB} = \frac{V}{\Delta V}$

In a similar triangle, the ratio of the corresponding side is equal.
We know,

Distance = speed x time

\[ AB = V \Delta t \]

Putting the value of \( AB \) in equation ii)

\[ \frac{r}{V \Delta t} = \frac{V}{\Delta V} \]

\[ \frac{V}{\Delta V} = \frac{v^2}{r} \]

\[ a = \frac{v^2}{r} \quad \text{---------} \Rightarrow (iv) \]

It gives the centripetal acceleration.

\[ F = ma \]

\[ F = \frac{mv^2}{r} \]

By Newton’s 2\textsuperscript{nd} law of motion,

It gives centripetal force

As we have,

\[ V = \omega r \]

Then,

\[ F = m\omega^2 r \]

\[ F = m\omega^2 r \]

It gives centripetal force in terms of angular velocity.

Q2. Explain:

A) The force of gravity acts on all bodies in proportion to their masses, why does not a heavy body fall faster than a light body?

B) In what factor does the orbital velocity of an earth satellite depends?

C) Why is the orbital speed of an earth satellite in circular orbit constant?

D) What is meant by geostationary satellite?

\textbf{Ans2.}
(A) The force of gravity acts on all bodies in proportion to their masses, but a heavy body fall faster than a light body due to presence of air.

(B) \[ V_{\text{orbit}} = \sqrt{\frac{GM}{R}} \]

Orbital velocity on an earth satellite depends upon the
- Gravitational constant \( G \)
- Mass of the body at center \( M \)
- The radius of the orbit \( R \)

(C) A satellite orbiting about the earth in a circular motion is moving at a constant speed and remains at the same height above the surface of the earth. It accomplishes this feat by moving with a tangential velocity that allows it to fall at the same rate at which the earth curves. At all instance during its trajectory, the force of gravity acts in a direction perpendicular to the direction that the satellite is moving. Since perpendicular components of motion are independent of each other, the inward force cannot affect the magnitude of the tangential velocity. For this reason, there is no acceleration in the tangential direction and the satellite remains in a circular motion at a constant speed.

(D) The geostationary satellite is the one whose orbital motion is synchronized with the rotation of the earth. In this way, the synchronous satellite remains always over the same point on the equator as the earth spins on its axis.

Q3. What is the Uniform Circular Motion?

Ans3. Uniform Circular Motion can be described as the motion of an object in a circular path at a constant speed.

It is possible for a body to move in a circular path with uniform speed as long as it is traveling equal distances in equal intervals of time.

The velocity of the body moving in a circle with uniform speed is not uniform because the direction of motion is constantly changing.

Examples of Uniform Circular Motion:

Artificial satellites move in uniform motion around the earth. Therefore, the motion of a satellite around the earth is accelerated. The moon moves in a uniform circular motion around the earth. We know that the moon is a natural satellite of the earth. Similarly, we can say that the movement of the earth around the sun is also a uniform circular motion. So, the motion of the earth around the sun is accelerated.
Q4. What is Non-uniform Circular Motion?

Non-uniform circular motion denotes a change in the speed of the particle moving along the circular path. In non-uniform circular motion, the size of the velocity vector (speed) changes, denoting the change in the magnitude of velocity.

The change in speed has implications for radial (centripetal) acceleration. There are two possibilities:

- The radius of the circle is constant
- The radial (centripetal) force is constant

In either case, the angular velocity in a non-uniform circular motion is not constant, as \( \omega = vr \), and \( v \) varies.
Q5. (a) A constant torque of 1.56 N·m is applied to a rotating solid disk of radius 15 cm and mass 5.71 kg. What is the angular velocity of the disk after 10 seconds?
(b) A string 1 meter long is used to whirl a 50 kg stone in a vertical circle. What is the tension in the string when the stone is at the top of the circle moving at 5.0 m/s.

**Ans5. (a)**

Torque \( T = 1.56 \text{ Nm} \)

Radius \( r = 15 \text{ cm} = 0.15 \text{ m} \)

Mass \( m = 5.71 \text{ kg} \)

Time \( t = 10 \text{ s} \)

Initial angular velocity \( w_0 \) of the disc is not given. We assume it to be zero.

Final angular velocity of the disc \( w = w_0 + at \)

Where \( a \) is the angular acceleration

And torque \( T = Ia \)

Where \( I \) is the moment of inertia, which for a solid disc, about an axis passing through its center and perpendicular to it is \( \frac{1}{2} mr^2 \)

\[
I = \frac{1}{2} \times 0.15 \times 0.15 \times 5.71 = 0.064
\]

\[
hence \ a = \frac{1.56}{0.064} = 24.28
\]

and \( w = 24.28 \times 10 = 242.8 \text{ rad/s} \)

(b) \( R = 1 \text{ m}, \ m=0.50 \text{ kg}, \ VH = 5 \text{ m/s} \)

Tension at the highest point:

\[
T_H = \frac{mvH^2}{r} - mg
\]

\[
= \left( \frac{(0.50 \times 5^2)}{1} \right) - 0.50 \times 9.8
\]

\[
= 12.5 - 4.9
\]

\[
= 7.6 \text{ N.}
\]
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