# Horizontal Circular Motion

1. **A particle of mass m is tied to a light string and rotated with a speed v along a circular path of radius r. If T is tension in the string and mg is gravitational force on the particle then, the actual forces acting on the particle are**

   1) mg, and T only

   2) mg, T and an additional force of $\frac{mv^2}{r}$ directed inwards

   3) mg, T and an additional force of $\frac{mv^2}{r}$ directed outwards

   4) Only a force $\frac{mv^2}{r}$ directed outwards

2. **Many great rivers flow towards the equator, what effect does the sediment they carry to sea have on the rotation of the earth?**

   1) The rotation of the earth slows down 2) The rotation of the earth speeds up

   3) No effect on the rotation of the earth 4) None

3. **Identify the increasing order of angular velocities of following**

   **a) Earth rotating about its own axis**

   **b) Hour's hand of clock**

   **c) Seconds hand of clock**

   **d) Fly wheel of radius 2m making 300 r.p.m.**

   1) a, b, c, d 2) b, c, d, a 3) c, d, a, b 4) d, a, b, c

4. **A): Centripetal force does not work in circular motion.**

   **R): Force and displacements are perpendicular to each other in circular motion.**

   1) Both (A) and (R) are true and (R) is the correct explanation of (A).

   2) Both (A) & (R) are true but (R) is not correct explanation of (A).

   3) (A) is true and (R) is false.

   4) (A) is false but (R) is true.

5. **A): A coin placed on a rotating disc flies away if the angular velocity is gradually increased.**

   **R): Friction cannot provide the sufficient centripetal force.**

   1) Both (A) and (R) are true and (R) is the correct explanation of (A).

   2) Both (A) & (R) are true but (R) is not correct explanation of (A).

   3) (A) is true and (R) is false.

   4) (A) is false but (R) is true.

6. **A): A ball connected to a string is in circular motion on a frictionless horizontal table and is in equilibrium.**

   **R): 'Magnitude of the centripetal force is equal to the magnitude of the tension in the string.**

   1) Both (A) and (R) are true and (R) is the correct explanation of (A).

   2) Both (A) & (R) are true but (R) is not correct explanation of (A).

   3) (A) is true and (R) is false.

   4) (A) is false but (R) is true.

7. **A particle moves around a circular path in the xy-plane with angular velocity $\vec{\omega}$ and angular acceleration $\vec{\alpha}$.**

   **(A): $\vec{\alpha}$ lies along the z-axis.**

   **(R): The direction of $\vec{\alpha}$ must be the same as the direction of $d\vec{\omega}$ .**

   (1) Both A and R are true and R is the correct explanation of A.

   (2) Both A and R are true but R is not the correct explanation of A.

   (3) A is true, R is false.

   (4) A is false but R is true.

**8. In a conical pendulum, the bob moves on a horizontal circular path, with constant speed and the string makes a fixed angle with vertical.**

**(A): The net force due to tension of the string and weight of the bob is non-zero**

**(R): This must be so because a force is required to keep the bob moving in a circle with constant speed.**

(1) Both A and R are true and R is the correct explanation of A.

(2) A is false and R is the true explanation of A.

(3) A is true but R is false.

(4) Both A and R are true, but R is not the correct explanation of A.

**9. Match list-I with List-II.**

| List - I | List -II |
|---|---|
| **(a) Centripetal force** | **(e) Earth's rotation** |
| **(b) Centrifugal force** | **(f) Steam governors** |
| **(c) Conical Pendulum** | **(g) Tides** |
| **(d) Foucault's Pendulum** | **(h) Tension in the string of a simple pendulum** |

(1) a-e, b-h, c-f, d-g (2) a-e, b-g, c-f, d-e

(3) a-f, b-h, c-e, d-g (4) a-g, b-f, c-e, d-g

**10. Match list I with list – II.**

| List - I | List - II |
|---|---|
| **a) Conservation of** | **e) Kinetic energy is same angular momentum** |
| **b) Uniform circular** | **f) No dimensions** |
| **c) Angular displacement** | **g) Torque is zero motion** |
| | **h) Force** |

(1) a-g, b-e, c-f, d-h (2) a-g, b-h, c-f, d-f

(3) a-e, b-h, c-f, d-g (4) a-e, b-f, c-h, d-g

**11. A particle of mass m is moving in a horizontal circle of radius r under a centripetal force equal to $k/r^2$, where k is a constant. Match List-I with List-II.**

| List - I | List - II |
|---|---|
| **(a) Kinetic energy** | **(e)** $\sqrt{kmr}$ |
| **(b) Total energy** | **(f)** $\sqrt{\frac{km}{r}}$ |
| **(c) Linear momentum** | **(g)** $-\frac{k}{r}$ |
| **(d) Angular momentum** | **(h)** $\frac{k}{2r}$ |

(1) a-g, b-h, c-e, d-f
(2) a-h, b-e, c-g, d-f
(3) a-g, b-h, c-f, d-e
(4) a-h, b-g, c-f, d-e

**12. Match list-I with list – II.**

| List - I | List - II |
|---|---|
| **a) Centrifugal force** | **e) Along the axis of rotation** |
| **b) Centripetal force** | **f) Towards the centre of rotations** |
| **c) Tangential force** | **g) Away from the centre of rotation** |
| **d) Angular velocity** | **h) Changes the angular velocity** |

(1) a-h, b-g, c-f, d-e
(2) a-g, b-f, c-h, d-e
(3) a-f, b-g, c-h, d-e
(4) a-e, b-h, c-e, d-f

**13. The angular velocity of second's hand in a watch clock is: (in $rads^{-1}$)**

1) $\frac{\pi}{30}$ 2) $\frac{\pi}{60}$ 3) $\frac{\pi}{1800}$ 4) $\frac{\pi}{3600}$

**14. A car is moving with a speed of 30 $ms^{-1}$ on a circular path of radius 500 m. If its speed is increasing at the rate of 2 $ms^{-2}$, the net acceleration of the car is**

1) 3.6 $ms^{-2}$ 2) 2.7 $ms^{-2}$ 3) 1.8 $ms^{-2}$ 4) 2 $ms^{-2}$

**15. The speed of a motor increases from 1200 rpm to 1800 rpm in 20S.Number of revolutions made in this period of time**

1) 400 2) 200 3) 500 4) 800

**16. A particle of mass 'm' is moving in a horizontal circle of radius 'r' under a centripetal force – $k/r^2$ where 'K' is a constant. The total energy of the particle is**

1) – K/r 2) – K/2r 3) K/2r 4) –2K/r

**17. A particle describes a horizontal circle on the smooth surface of an inverted cone. The plane of that circle is at a height of 9.8cm above the vertex. Then the speed of the particle is**

1) 0.49 $ms^{-1}$ 2) 0.98 $ms^{-1}$ 3) 1.96 $ms^{-1}$ 4) 3.92 $ms^{-1}$

**18. A chain of 100 links is 1m long and has a mass of 2kg. With the ends fastened together it is set rotating at 3000 rpm, in a horizontal plane. The centripetal force on each link is**

1) 3.14 N 2) 31.4N 3) 314 N 4) 3140 N

**19. A boy is sitting on a horizontal platform in the shape of a disc at a distance of 5m from its centre. The boy begins to slip when the speed of wheel exceeds 10 rpm. The coefficient of friction between the boy and platform is. ($g = 10\ ms^{-2}$)**

1) $\pi^2/6$ 2) $\pi^2/18$ 3) $\pi/6$ 4) $\pi/2$

**20. Length of seconds hand in a clock, is 15 cm. Change in the linear velocity of the tip of the hand after 15 sec. is**

1) $\frac{\pi}{\sqrt{2}} cm/\sec$ 2) $\sqrt{2}\pi\, cm/\sec$ 3) $\frac{\pi}{2\sqrt{2}} cm/\sec$ 4) $\pi/2$ cm/sec

## Key

1) 1 2) 1 3) 1 4) 1 5) 1 6) 4 7) 1 8) 1 9)2
10) 1 11) 4 12) 2 13) 1 14) 2 15) 3 16) 2 17) 2 18)3
19) 2 20) 1

## Hints

13. $\omega = \frac{2\pi}{T} = \frac{2\pi}{60} = \frac{\pi}{30} rad/s$

14. $a = \sqrt{a_r^2 + a_t^2}$

$a_t = 2ms^{-2}$

$a_r = \frac{v^2}{r} = \frac{900}{500} = 1.8 m/s^2$

$a_r = \sqrt{3.26+4} = \sqrt{7.26} = 2.7 m/s^2$

15. $\theta = 2\pi N = \left(\frac{60\pi + 40\pi}{2}\right).20$

$N = 500$

16. $\frac{mv^2}{r} = \frac{k}{r^2} \Rightarrow mv^2 = \frac{k}{r}$

KE = K/2r

TE = -KE = $-K/2r$

17. $N\cos\theta = mrw^2 \qquad NSin\theta = mg$

$Tan\theta = \frac{g}{rw^2} = \frac{gr}{v^2} \qquad \frac{r}{h} = \frac{gr}{v^2}$

$v = \sqrt{gh} = 0.98 ms^{-1}$

18. $F = mrw^2$

$$= \frac{2}{100} \text{x} \frac{1}{2\pi} \text{x} \left( 3000 \text{x} \frac{2\pi}{60} \right)^2 = 314N$$

19. $\mu mg = mrw^2$ $\qquad \mu = \dfrac{5\text{x}\left(10\text{x}\dfrac{2\pi}{60}\right)^2}{10} = \dfrac{\pi^2}{18}$

20. $\omega_S = \dfrac{\pi}{30}$

$$\Delta V = 2V \ Sin\frac{\theta}{2} = 2r\omega_S Sin\frac{90}{2} = 2\times 15\times\frac{\pi}{30}\times\frac{1}{\sqrt{2}}$$

$$\Delta V = \frac{\pi}{\sqrt{2}} cm/\sec$$