Circular Motion

Question1

A wire of length 2.5 m is fixed at one end and a box of mass 4 kg is tied at the other end. If the wire rotates in a horizontal circle about the fixed end with $\frac{2}{\pi}$ rotations per second, then the tension in the wire is

AP EAPCET 2025 - 23rd May Morning Shift

Options:

A.

16 N

B.

32 N

C.

64 N

D.

160 N

Answer: D

Solution:

Tension in the wire

$= \text{ centripetal force } = mr\omega^2$

$= 4 \times 2.5 \times (2\pi f)^2 = 10 \times 4\pi^2 f^2$

$= 10 \times 4\pi^2 \times \left(\frac{2}{\pi}\right)^2 = 160 \text{ N}$

Question2

If a particle of mass ' m ' covers half of the horizontal circle with constant speed ' v ', then the change in its kinetic energy is

AP EAPCET 2025 - 21st May Evening Shift

Options:

A.

mv^2

B.

zero

C.

$2mv^2$

D.

$\frac{1}{2}mv^2$

Answer: B

Solution:

Since speed is constant throughout its entire motion on semicircular path, thus its speed is constant. Thus, change in kinetic energy is zero.

Question3

Ratio of angular velocity of hour hand of a watch and the angular velocity of rotation of Earth is

Options:

A.

1 : 1

B.

2 : 1

C.

4 : 1

D.

1 : 2

Answer: B

Solution:

Step 1: Angular velocity of the hour hand

The **hour hand** of a clock completes **one full revolution (360° or 2π radians)** in **12 hours**.

$$\omega_{\text{hour hand}} = \frac{2\pi}{12 \text{ hours}} = \frac{\pi}{6 \text{ hours}}$$

Step 2: Angular velocity of Earth's rotation

The **Earth** completes **one full rotation (360° or 2π radians)** in **24 hours**.

$$\omega_{\text{Earth}} = \frac{2\pi}{24 \text{ hours}} = \frac{\pi}{12 \text{ hours}}$$

Step 3: Ratio of angular velocities

$$\frac{\omega_{\text{hour hand}}}{\omega_{\text{Earth}}} = \frac{\frac{\pi}{6}}{\frac{\pi}{12}} = \frac{12}{6} = 2$$

$$\boxed{\text{Ratio } = 2 : 1}$$

✅ **Correct Option: B)** 2 : 1

Question4

The centripetal acceleration of a particle in uniform circular motion is 18 ms^{-2}. If the radius of the circular path is 50 cm , the change in

velocity of the particle in a time of $\frac{\pi}{18}$ s is

AP EAPCET 2024 - 21th May Morning Shift

Options:

A. $9 \mathrm{~ms}^{-1}$

B. $2 \mathrm{~ms}^{-1}$

C. $3 \mathrm{~ms}^{-1}$

D. $6 \mathrm{~ms}^{-1}$

Answer: C

Solution:

Given:

Centripetal acceleration, $a_c = 18\,\mathrm{m/s^2}$

Radius of the circular path, $r = 50\,\mathrm{cm} = 50 \times 10^{-2}\,\mathrm{m}$

We know the formula for centripetal acceleration:

$a_c = \frac{v^2}{r}$

To find the velocity v, rearrange the formula:

$v = \sqrt{a_c \cdot r}$

Substituting the given values:

$v = \sqrt{18 \times 50 \times 10^{-2}}$

$v = \sqrt{900 \times 10^{-2}}$

$v = 3\,\mathrm{m/s}$

The angular velocity ω is:

$\omega = \frac{v}{r} = \frac{3}{50 \times 10^{-2}}$

$\omega = 6\,\mathrm{rad/s}$

To find the angular displacement θ over the time interval $\frac{\pi}{18}$ s:

$\theta = \omega t$

$\theta = 6 \times \frac{\pi}{18} = \frac{\pi}{3}\,\mathrm{rad}$

The change in velocity due to a change in angle θ is given by:

$|\Delta v| = 2v \sin\left(\frac{\theta}{2}\right)$

Substituting the known values:

$|\Delta v| = 2 \times 3 \times \sin\left(\frac{\pi}{6}\right)$

$|\Delta v| = 2 \times 3 \times \frac{1}{2}$

$|\Delta v| = 3\,\mathrm{m/s}$

Question5

A particle revolving in a circular path travels the first half of the circumference in 4 s and the next half in 2 s . What is its average angular velocity?

AP EAPCET 2024 - 20th May Evening Shift

Options:

A. $\frac{4\pi}{9}\,\mathrm{rad/s}$

B. $\frac{\pi}{6}\,\mathrm{rad/s}$

C. $\frac{2\pi}{3}\,\mathrm{rad/s}$

D. $\frac{\pi}{3}\,\mathrm{rad/s}$

Answer: D

Solution:

To find the average angular velocity of a particle moving around a circular path, we use the formula:

$\text{Average angular velocity} = \frac{\text{Total angular displacement}}{\text{Total time}}$

For the first half of the path, which is half the circumference, the angular displacement is calculated as follows:

$\theta_1 = \frac{\pi r}{r} = \pi \text{ rad}$

Similarly, for the second half of the path, the angular displacement is:

$\theta_2 = \frac{\pi r}{r} = \pi \text{ rad}$

Thus, the total angular displacement for the entire circular path is:

$\text{Total angular displacement} = \theta_1 + \theta_2 = 2\pi \text{ rad}$

Given that it takes 4 seconds to travel the first half and 2 seconds for the second half, the total time is:

Total time $= 4 + 2 = 6$ s

Therefore, the average angular velocity is:

Angular velocity $= \frac{2\pi}{6}$ rad/s $= \frac{\pi}{3}$ rad/s

----

Question6

A small disc is on the top of a smooth hemisphere of radius R. The smallest horizontal velocity v that should be imparted to the disc, so that disc leaves the hemisphere surface without sliding down is (there is no friction)

AP EAPCET 2024 - 20th May Evening Shift

Options:

A. $v = \sqrt{g^2 R}$

B. $v = \sqrt{2gR}4$

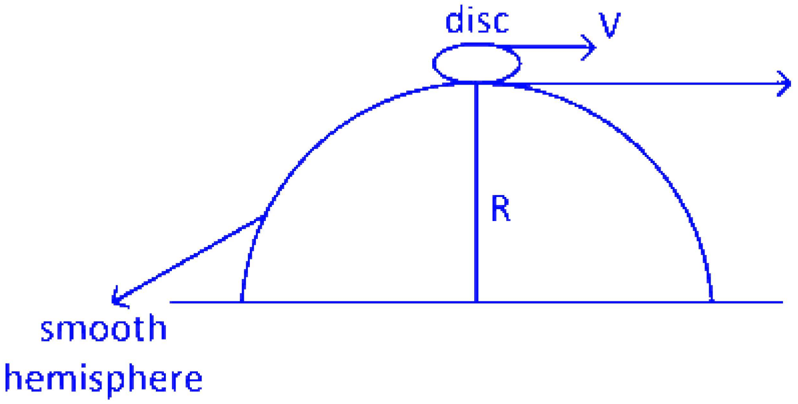
C. $v = \sqrt{gR}$

D. $v = \sqrt{\frac{g}{R}}$

Answer: C

Solution:

Drawing the diagram of the condition that is mentioned in question.



The condition is that disc is moving not sliding on hemisphere.

Here centripetal force by moving disc is balancing the weight of disc.

$$\frac{mv^2}{R} = mg$$
$$v = \sqrt{gR}$$

Question7

A wheel of angular speed $600 \mathrm{rev/min}$ in is made to slow down at a rate of $2 \mathrm{rad s}^{-2}$. The number of revolutions made by the wheel before coming to rest is

AP EAPCET 2024 - 18th May Morning Shift

Options:

A. 157

B. 314

C. 177

D. 117

Answer: A

Solution:

Explanation

We need to determine the number of revolutions a wheel makes before coming to a stop. Here's the breakdown of the solution:

Given Values:

Initial angular velocity, $\omega_0 = 600 \text{ rev/min}$

To convert to radians per second:

$\omega_0 = 600 \times \frac{2\pi}{60} = 20\pi \text{ rad/s}$

Angular deceleration, $\alpha = -2 \text{ rad/s}^2$

Final angular velocity, $\omega = 0 \text{ rad/s}$

Find:

Number of revolutions, N

Solution:

Using the angular kinematic equation:

$\omega^2 = \omega_0^2 + 2\alpha\theta$

Plugging in the given values:

$0 = (20\pi)^2 + 2(-2)\theta$

Simplify:

$0 = 400\pi^2 - 4\theta$

Rearrange to solve for θ:

$4\theta = 400\pi^2\theta = 100\pi^2$

Relate θ to revolutions:

Since $\theta = 2\pi N$,

$2\pi N = 100\pi^2$

Solve for N:

$N = \frac{100\pi^2}{2\pi} N = 50\pi$

Assuming $\pi \approx 3.14$,

$N = 50 \times 3.14 = 157$

So, the number of revolutions the wheel makes before coming to rest is **157**.

Question8

A body of mass 10 kg is attached to a wire of 0.3 m length. The breaking stress is 4.8×10^7 Nm^{-2}. The area of cross-section from the wire is 10^{-6} m^2. The maximum angular velocity with which it can be rotated in a horizontal circle is

AP EAPCET 2021 - 20th August Morning Shift

Options:

A. 4 rad s^{-1}

B. 8 rad s^{-1}

C. 16 rad s^{-1}

D. 32 rad s^{-1}

Answer: A

Solution:

Given,

Mass of body, $m = 10$ kg

Length of wire, $l = 0.3$ m

Breaking stress, $\sigma = 4.8 \times 10^7 \text{ N/m}^2$

Area of cross-section, $A = 10^{-6} \text{ m}^2$

Let angular velocity be ω

$$\because \text{ Stress, } \sigma = \frac{\text{Force }(F)}{A}$$

$$\Rightarrow \quad F = \sigma A = m\omega^2 l \Rightarrow \omega = \sqrt{\frac{\sigma A}{ml}}$$

$$\Rightarrow \quad \omega = \sqrt{\frac{4.8 \times 10^7 \times 10^{-6}}{10 \times 0.3}} = \sqrt{16} = 4 \text{ rad s}^{-1}$$

Question9

A 500 kg car takes a round turn of radius50 m with a velocity of 36 km/h. Thecentripetal force acting on the car is

AP EAPCET 2021 - 19th August Evening Shift

Options:

A. 250 N

B. 750 N

C. 1000 N

D. 1200 N

Answer: C

Solution:

Given, mass of car, $m = 500$ kg

Radius of track, $r = 50$ m

Velocity of car, $v = 36\ \text{km/h} = \frac{36 \times 10^3}{60 \times 60} = 10\ \text{ms}^{-1}$

Let centripetal force be F.

As we know that,

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

$$\therefore \quad F = \frac{500 \times 10^2}{50} = 10 \times 10^2 = 1000\ \text{N}$$

Question10

A motor cyclist wants to drive in horizontal circles on the vertical inner surface of a large cylindrical wooden well of radius 8.0 m, with minimum speed of $5\sqrt{5}\ \text{ms}^{-1}$. The minimum value of coefficient of friction between the tyres and the wall of the well must be

$\left(g = 10\ \text{ms}^{-2}\right)$

AP EAPCET 2021 - 19th August Evening Shift

Options:

A. 0.10

B. 0.64

C. 0.30

D. 0.40

Answer: B

Solution:

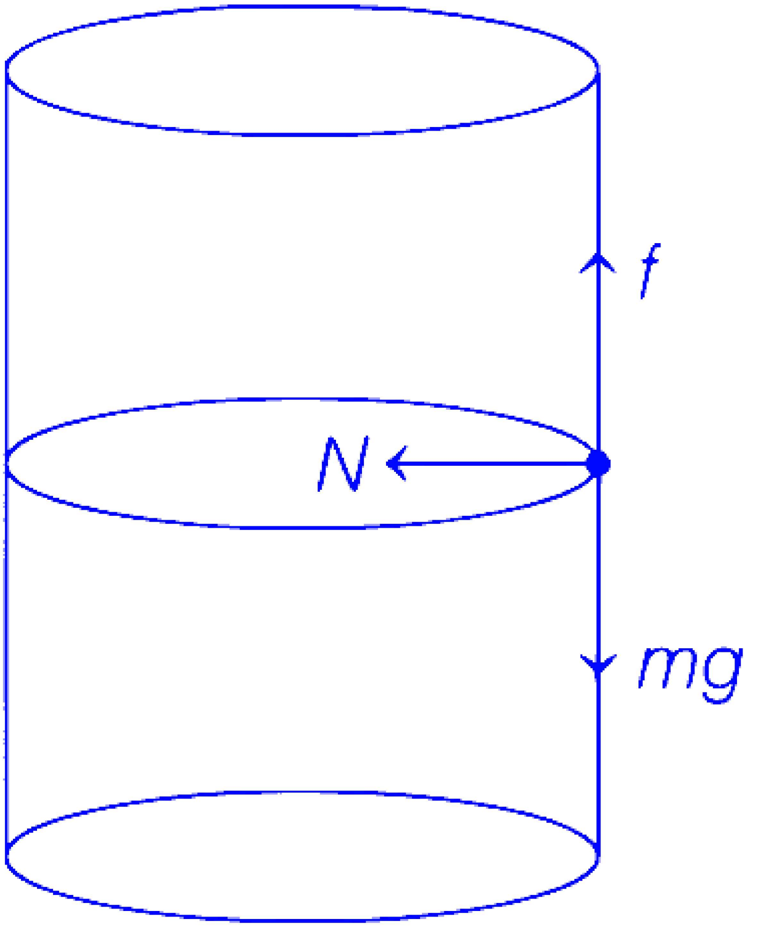
Given, radius of wall, R = 8 m

Minimum speed, $v = 5\sqrt{5}\ \mathrm{ms}^{-1}$

Acceleration due to gravity, g = 10 ms^{-1}

Let coefficient of friction be μ.

According to diagram,



$f = mg$ ..... (i)

$\therefore \quad f = \mu N$ ..... (ii)

where, f is friction force and N is normal reaction = centripetal force

$\Rightarrow N = \frac{mv^2}{R}$

Substituting in Eq. (ii), we get

$f = \mu \frac{mv^2}{R}$ .... (iii)

Now, on equating Eqs. (i) and (iii), we get

$$f = mg = \mu \frac{mv^2}{R}$$

$$\Rightarrow \quad \mu = \frac{Rg}{v^2} = \frac{8 \times 10}{(5\sqrt{5})^2} = \frac{80}{125} = 0.64$$

Question11

Assertion (A) Two identical trains move inopposite senses in equatorial plane withsame speeds relative to the Earth's surface.They have equal magnitude of normalreaction.

Reason (R) The trains have differentcentripetal accelerations due to differentspeeds.

AP EAPCET 2021 - 19th August Morning Shift

Options:

A. Both A and R are true and R is a correct explanation for A.

B. Both A and R are true but R is not a correct explanation for A.

C. A is true, R is false.

D. A is false, R is true.

Answer: D

Solution:

As we know that,

Earth rotates from West to East and, in assertiontwo trains are moving in opposite direction.

$\therefore$ The train going towards East will have high speed with respect to earth from the train goingtowards West.

$\because$ Normal reaction is proportional to $(\text{speed})^2$ and speeds of different trains are different.

Hence, magnitude of normal reaction is different.

$\therefore$ Assertions will be false and reason will be true because their relative speeds are different. But actual speeds of both the trains are same.
