Circular Motion

Disclaimer: Physics

Date: 23/09/2022

Subject: Physics

Topic : Centripetal and Centrifugal Force

Class: Standard XI

Time: 00:20 hrs

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1. The force required to keep a body in uniform circular motion is

   ✔ **A.** centripetal force.

   ✘ **B.** centrifugal force.

   ✘ **C.** resistance.

   ✘ **D.** None of the above

   As we know that there exists only centripetal acceleration in uniform circular motion as because of constant speed, tangetial acceleration ceases to zero. Hence, the force required to keep a body in uniform circular motion is centripetal force.

2. A particle moves in a circle of radius $10\ cm$ with a constant speed and time period of $0.2\pi\ s$. The acceleration of the particle is

   ✘ **A.** $5\ m/s^2$

   ✘ **B.** $40\ m/s^2$

   ✘ **C.** $10\ cm/s^2$

   ✔ **D.** $10\ m/s^2$

   For uniform circular motion,
   the acceleration of the particle $(a_C) = rw^2$
   $w = \frac{2\pi}{T} = \frac{2\pi}{0.2\pi} = 10\ rad/s$
   $\therefore a_C = 10 \times 10^{-2} \times (10)^2 = 10\ m/s^2$

3. A body of mass $500\ \text{g}$ is moving in a circular path of radius $\frac{10}{\pi^2}\text{cm}$ with an angular speed of $2\pi\ \text{rad/s}$. The centripetal force is

A. $0.1\ \text{N}$

B. $0.2\ \text{N}$

C. $0.3\ \text{N}$

D. $40\ \text{N}$

Given, mass of a body $(m) = 500\ \text{g} = 0.5\ \text{kg}$

Radius of circular path $(r) = \frac{10}{\pi^2}\text{cm} = \frac{10}{\pi^2} \times 10^{-2}\ \text{m}$

Angular speed $= 2\pi\ \text{rad/s}$

To find centripetal force:

$F_c = mr\omega^2$

$F_c = 0.5 \times \frac{10}{\pi^2} \times (2\pi)^2 \times 10^{-2}$

$F_c = \frac{10}{2\pi^2} \times 4\pi^2 \times 10^{-2}$

$F_c = 20 \times 10^{-2}\ \text{N}$

$F_c = 0.2\ \text{N}$

Hence option B is the correct answer.

4. A $30\ \mathrm{kg}$ boy is riding a merry-go-round. If the linear speed and angular speed of the boy are $6\ \mathrm{m/s}$ and $2\ \mathrm{rad/s}$ respectively. The magnitude of centripetal force on the boy is

   A. $60\ \mathrm{N}$

   B. $40\ \mathrm{N}$

   C. $360\ \mathrm{N}$

   D. $1080\ \mathrm{N}$

   Given, mass of boy $(m) = 30\ \mathrm{kg}$
   linear speed $(v) = 6\ \mathrm{m/s}$
   Angular speed $(\omega) = 2\ \mathrm{rad/s}$

   Radius of curvature $(r) = \dfrac{v}{\omega} = 3\ \mathrm{m}$
   To find centripetal force: we know that,

   $$F_c = \frac{mv^2}{r} = \frac{30 \times (6)^2}{3} = \frac{30 \times 36}{3} = 360\ \mathrm{N}$$

   Hence option C is the correct answer

5. A particle is moving in a circular path of radius r with an angular speed $'\omega'$. Suddenly, the radius is quadrupled and angular speed is halved. Then which of the following statements is correct?

✗ **A.** Centripetal force is doubled

✗ **B.** Centripetal force is halved

✓ **C.** Centripetal force remains same

✗ **D.** None of the above

For a particle moving in a circular path of radius 'r' with an angular speed $'\omega'$, centripetal force is given by

$F = mr\omega^2$

Initially, $r_1 = r, \omega_1 = \omega$

$\Rightarrow F_1 = mr_1\omega_1^2 = mr\omega^2$

Finally, $r_2 = 4r, \omega_2 = \dfrac{\omega}{2}$

$\Rightarrow F_2 = mr_2\omega_2^2 = m(4r)\left(\dfrac{\omega}{2}\right)^2$

$= mr\omega^2 = F_1$

$\therefore$ centripetal force remains the same.