

NCERT Analog Assignment

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Question 11.14.17: A simple pendulum of length l and having a bob of mass M is suspended in a car. The car is moving on a circular track of radius R with a uniform speed v . If the pendulum makes small oscillations in a radial direction about its equilibrium position, what will be its time period?

Solution:

The car experiences a centripetal acceleration $a_{centripetal}$ towards the center of the circular track such that

$$a_{centripetal} = \frac{v^2}{R}$$

Inside the car, the bob experiences a pseudo-force called centrifugal force $F_{centrifugal}$ such that

$$F_{centrifugal} = Ma_{centripetal}$$

$$F_{centrifugal} = \frac{Mv^2}{R}$$

$$\Rightarrow a_{centrifugal} = \frac{v^2}{R}$$

Time period of a simple pendulum T is given by:

$$T = 2\pi \sqrt{\frac{l}{g_{effective}}}$$

$$T = 2\pi \sqrt{\frac{l}{\sqrt{g^2 + a_{centrifugal}^2}}}$$

$$T = 2\pi \sqrt{\frac{lR}{\sqrt{g^2 R^2 + v^4}}}$$

Therefore, the time period of the pendulum is

$$2\pi \sqrt{\frac{lR}{\sqrt{g^2 R^2 + v^4}}} \text{ seconds.}$$