

# NCERT Discrete Assignment

EE23BTECH11007 - Aneesh Kadiyala\*

**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

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