Mathematics of Circular Motion

Lesson Notes

Learning Outcomes

- What are the main formulas used in circular motion problems?
- How can the formulas be used to solve problems?

Formulas for v, a, and F_{net}

The three quantities of primary interest are speed (**v**), acceleration (**a**), and net force (F_{net}).

Speed (v): $v = d / t \rightarrow v = 2 \cdot \pi \cdot R/T$ or $v = f \cdot 2 \cdot \pi \cdot R$

R = radius
T = period
f = revolution/s

Acceleration (a): $a = v^2/R$ $\quad a = 4 \cdot \pi^2 \cdot R/T^2$

Net Force (F_{net}): $F_{net} = m \cdot v^2/R$ $\quad F_{net} = m \cdot 4 \cdot \pi^2 \cdot R/T^2$

Using Circular Motion Equations

Physics equations have two primary uses in a Physics course:

1. **Equations as a Guide to Thinking** ...

   … about how a change in one quantity would affect a second quantity.

   For instance, if the speed is doubled or halved, what effect would this have on other quantities such as the acceleration or the net force.

2. **Equations as Algebraic Recipes for Problem Solving**

   For instance, if values of m, R, and T are known, calculate the values of the speed, acceleration and net force.

Use the video to work through the solutions to the five examples that are given.

Example 1 - Equations as a Guide to Thinking

A car rounding a corner has an acceleration of 4.2 m/s/s. If it rounds the same corner at twice the speed, what would be its new acceleration?

Example 2 - Equations as a Guide to Thinking

A car rounding a corner has an acceleration of 4.2 m/s/s. If it rounds a corner with twice the radius at the same speed, what would be its new acceleration?

Example 3 - Equations as a Guide to Thinking

A roller coaster car rounding a corner has a net force of 4500 N. If the car had three times the mass and rounded a different corner with two times the radius and at twice the speed, then what would be the new net force?

Example 4 - Equations as an Algebraic Recipe

A 920-kg car moving at 16 m/s takes a turn around a circle with a radius of 32 m. Determine the acceleration and the net force acting upon the car.

Example 5 - Equations as an Algebraic Recipe

A 95-kg halfback makes a turn on the football field. The halfback sweeps out a path that is a portion of a circle with a radius of 12-meters. The halfback makes a quarter of a turn around the circle in 2.1 seconds. Determine the speed, acceleration and net force acting upon the halfback.