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APPS ON PHYSICS
Model of a Looping Coaster (Centripetal Force)

Abstract:

This simulation demonstrates the motion of a rolling ball on a looping coaster. It focuses on centripetal force. A looping coaster is a type of roller coaster that features a vertical loop, where the riding vehicle completes a full 360-degree inversion. The model assumes a circular loop with straight inlet and outlet paths while neglecting factors such as friction and self-rotation.

You can access the simulation at:
Apps on physics >> Mechanics >> Model of a Looping Coaster (Centripetal Force).

The simulation explores three key scenarios based on the ball's initial height relative to the loop's radius:

1. If the initial height is less than or equal to the loop's radius, the ball oscillates like a pendulum.
2. If the height is between the radius and 2.5 times the radius, the ball rolls up the loop partially before falling back.
3. If the height exceeds 2.5 times the radius, the ball successfully completes the loop.

Using the control panel, you can adjust parameters such as the loop radius, initial height, and mass. The simulation also visualizes key forces, including centripetal, gravitational, and contact forces. It highlights the fundamental conditions for completing circular motion, such as maintaining sufficient speed at the loop's highest point, the relationship between initial height and velocity, and how the loop's radius affects the ball's success in completing the loop.

Formulae used:

TITLE	FORMULA	DESCRIPTION
Centripetal Force (Fc)	$F_c = \frac{mv^2}{r}$	m = Mass, v = Velocity, r = Radius
Gravitational Force (Fg)	$F_g = mg$	m = Mass, g = Acceleration due to gravity
Minimum Speed to Complete the Loop (at top to avoid falling off)	$v_{\min} = \sqrt{gr}$	g = Acceleration due to gravity, r = Radius
Velocity at the Top of the Loop	$v_{\text{top}} = \sqrt{2g(h-2r)}$	g = Acceleration due to gravity, h = Initial height, r = Radius

- The centripetal force formula helps you understand the force required to keep the ball on the track.
- The minimum speed at the top of the loop ensures the ball won't fall off.

Keywords: centripetal force, gravitational force, normal force,radius of loop, height of ball.