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Loop-the-Loop Apparatus #ACCLOP

Warning:

- **Not a toy; use only in a laboratory or educational setting.**

- **Choking Hazard: Contains small parts.**

- **California Proposition**

65 Warning: This product can expose you to chemicals including nickel and lead, which are known to the State of California to cause cancer, birth defects, or other reproductive harm. For more information go to www.P65Warnings.ca.gov.



Introduction

Loop the loop is an inclined track with a single loop to demonstrate the transformation of potential energy to kinetic energy and vice versa and to explore the condition necessary for the metal sphere to stick to the track at its highest point in the loop. It comprises a looped aluminum track about 125cm long, having 'V' shaped cross-section with a stopper at the end to prevent the metal sphere from falling.

The capacity of doing work is known as energy. The kinetic energy is the mechanical energy of an object due to its motion and the potential energy is the energy due to its position of an object. The object has this energy inside a force field. In Loop the Loop Apparatus, the potential energy comes from its height because the gravitational force of the earth is acting on it.

If an object is to continue through a vertical loop, it is not sufficient for it to merely reach the highest point of the loop. It must actually have a minimum non-zero velocity along the track at the top point in order to stay in contact with the track. This is due to the effect of gravitational acceleration that pulls the object vertically downward and off the circular shape of the loop. The minimum velocity is determined by the following force balance:

Centripetal force is the total force acting on an object as it moves in a circle, with acceleration directed toward the center of the circle. If the object has velocity, 'V', around a circle of radius, 'R', mass 'M', the corresponding centripetal force is given by:

$$F = mv^2/r$$

This force must equal to the sum of external forces acting on the object, which in our case is the gravitational force, plus the force that the wall of the slide exerts on the ball, known as the normal force, 'F_N'. The formula for normal force varies depending on the slope of the surface.

For flat surfaces: $F_N = mg$

For inclined surfaces: $F_N = mg \times \cos(a)$

$$F = G \times m_1 m_2 / r^2 + F_N$$



The normal force must be greater than zero (directed downward with gravity), at the top of the loop, if the ball is to stay on the track at that point. This means that the minimum velocity at the top of a loop is that of an object in a circle with a normal force equal to zero. The minimum velocity in a loop is given by the relation:

$$V = \sqrt{rg}$$

The kinetic energy of a rolling steel ball is related to its velocity by the relation:

$$KE = 1/2mv^2$$

At the top of the loop, the potential energy is given by the relation:

$$PE = mgh$$

Procedure:

1. In the beginning, fix the track of the apparatus at 125 cm above the floor.
2. Now slide the steel ball down 50 cm away from the edge of the track using a photogate.
3. If the ball makes it over the hill then raise the height to 60 cm and repeat step 2 and repeat this process until the maximum hill height is determined.
4. Drop the ball from maximum 125cm and determine the maximum height of the hill.

Note: The potential energy of the steel ball with mass, 'M', that starts at height, 'H', is equal to mgh. There is no kinetic energy initially if it starts at rest.

What's Included:

- 1 Loop the Loop track
- 1 Solenoid, 5V
- 1 Photogate
- 1 Solid steel physics ball, 1/2"
- 1 Catch basket