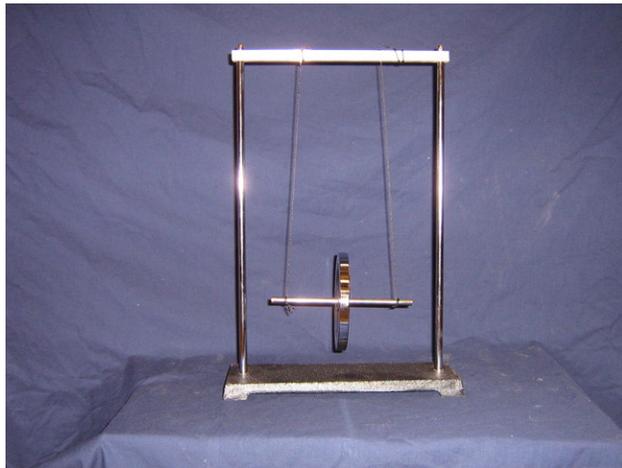


1M40.50 Maxwells Yo-yo

Abstract

Maxwell's pendulum demonstrates conservation of energy how it relates to conservation of angular momentum. The device features a wheel fixed to an axel suspended by a string on either side. When the string is wrapped around the axle, the wheel rises increasing its gravitational potential energy. After releasing the yo-yo the potential energy is translated into both translational and rotational kinetic energy. After completely uncoiling the string the wheel will still retain its angular moment and begin wrapping the string around the axle the other way round, rising back up and converting the rotational kinetic energy back into translational and potential energy. After slowing down the yo-yo stops and begins to fall reinitiating the process.

Picture



Equipment

- Maxwell's Yo-yo

Procedure

Take both ends of the axle and begin twisting towards your self to raise the yo-yo. Once its reaches the top of the apparatus release the axle and watch the motion of the yo-yo.

Theory

The potential energy of the yo-yo can be defined as,

$$U = mgh$$

where m is the mass, g is the acceleration due to gravity and h is the height of the yo-yo. The translational kinetic energy is defined as,

$$K_{trans} = \frac{1}{2}mv^2,$$

and the rotational kinetic energy is,

$$K_{rot} = \frac{1}{2}I\omega^2,$$

where v is the velocity of the falling axle, I is the moment of Inertia of the yo-yo and ω is the angular velocity.

In a system where no energy would be lost to the surrounding environment the yo-yo would return to its original drop height every time. In reality however the system loses energy to air resistance, friction and heat.

Therefore when the yo-yo is falling, conservation of energy gives the following equation,

$$U = K_{trans} + K_{rot} + W_{external}.$$

In order to find the energy lost from the system this equation can be manipulated to show that,

$$mgh = \frac{1}{2}mv^2 + \frac{1}{2}I\omega^2 + W_{external}$$

$$W_{external} = 2mgh - mv^2 - I\omega^2$$