Rotational Energy and Moment of Inertia

Equipment

- Rotary Motion Sensor
- Rotation stage with ring and disk
- Assorted masses
- Pendulum apparatus

Objective

Data collection

- Quantitative analysis of rotational motion

Data analysis

- Determine angular position, velocity and rotational energy
- Fit appropriate functions to data

Physics Concepts

- Rotational Energy, Moment of Inertia

Conceptual (C-Level)

Draw a schematic for a cart being pulled down a horizontal track by a mass hung over a pulley.

- Draw a graph for the (kinetic) energy of the cart as a function of displacement.
- What happens to the energy vs displacement graph for the cart if mass is added to the cart?
- Does it matter where the mass is added to the cart? (i.e. in the back or in the front)
- Draw a graph for the (kinetic) energy of the cart as a function of time.

Draw a schematic for an object that is free to spin by means of a string wrapped around its rotation axis and pulled by a mass hung over a pulley.

- Is the instantaneous velocity constant for every point on the spinning object?
- Find an expression for the length of string pulled as function of angle rotated.

Basic Lab (B-level)

You are investigating whether mass distribution is important for spinning objects. Setup a rotation stage to be spun by a string connected to a mass hung over the pulley of a rotary motion sensor.

- Compare the angular velocity for a disk and for a ring.
  - Plot angular velocity of the object as a function of time.
  - Plot angular velocity of the object as a function of string pulled (proportional to angle).
  - Experimentally determine the moment of inertia of each object.

Investigate the swinging rod (with movable mass) attached to a rotary motion sensor.

- Determine the oscillation frequency.
- Qualitatively determine how the oscillation frequency changes as the mass attached to the rod is moved.

Advanced/Extended Lab Ideas (A-level)

- Compare an oscillating pendulum and an oscillating rod.
- Determine how the oscillation frequency varies with mass distribution for a rod.
- Compare theoretical and experimental moment of inertia of a swinging object.
- Investigate a question of your own construction.