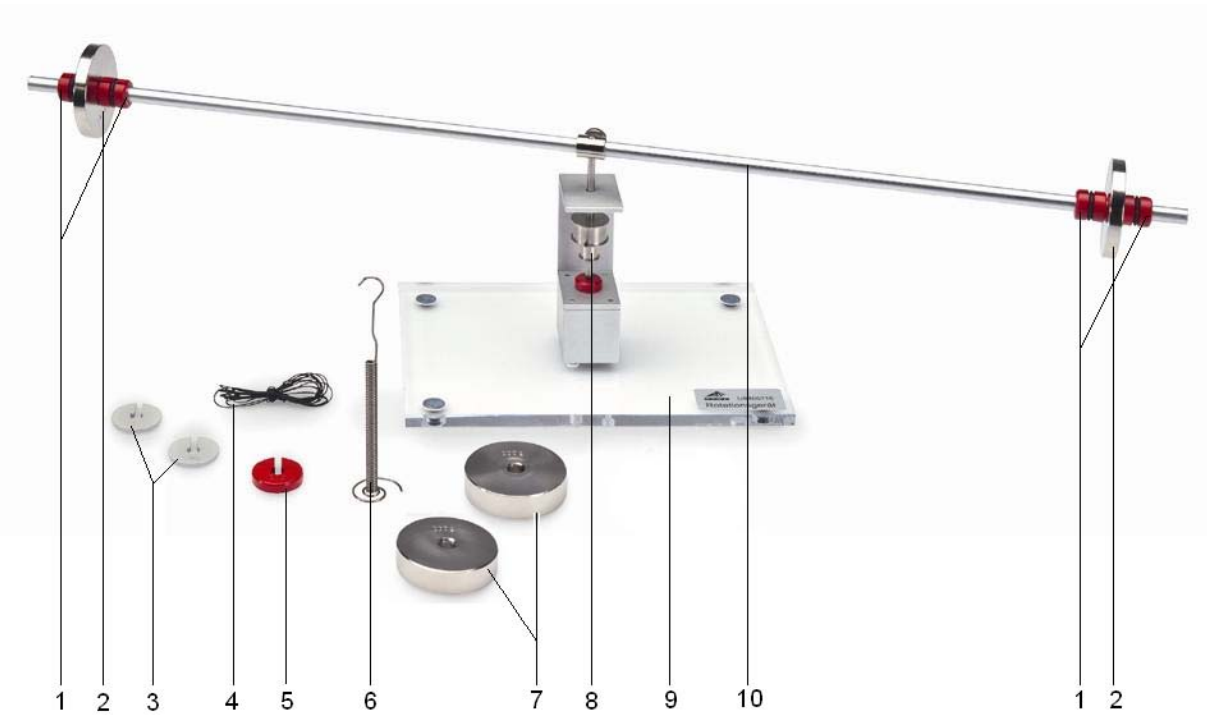
3B SCIENTIFIC® PHYSICS

...going one step further

Rotational Motion Apparatus 1006785

Instruction sheet

01/13 ADP/BJK/ALF



1 Plastic weight fasteners
2 Weight discs, 100 g, 8 mm boring
3 Slotted weights, gray, 10 g
4 Thread, 3 m
5 Slotted weight, red, 20 g
6 Hanger for slotted weights, 10 g
7 Weight discs, 200 g, 8 mm boring
8 Spindle
9 Base and mount
10 Hollow aluminium rod
Deflection pulley (not illustrated)

1. Safety instructions

To avoid injuries:

- Maintain a safe distance from the device while it is in operation. Be especially careful to keep your eyes and face away from moving parts.
- Do not use your hand to spin the apparatus to a high angular velocity! The plastic fasteners are not designed to stay in position at high velocities and the weights will fly off.

2. Description

The rotational motion apparatus is used for determining the angular acceleration as a function of torque and for determining the moment of inertia as a function of the distance of the body from the axis and its mass.

A vertical, rotating axle with agate bearing supports a crossbar for holding the weights. The force of the driving weight is transferred via a pulley and a cord wrapped around a spindle on the axis.

3. Technical data

Base plate:	200 mm x 140 mm
Crossbar:	600 mm
Spindle:	9/18 mm diam.
Weight:	approx. 1.3 kg

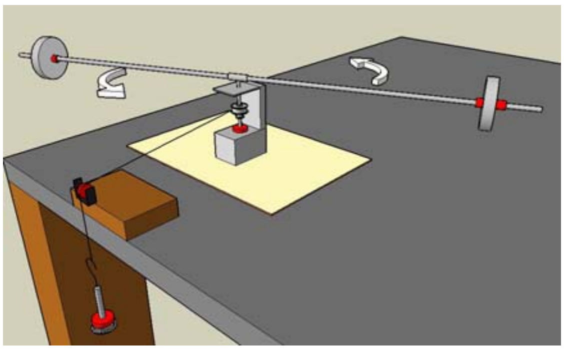
4. Additionally required

Meter Stick	1000742
Digital Stopwatch	1002811

5. Sample experiments

5.1 Calculating angular acceleration

- Place masses on crossbar and secure with weight fasteners, insert thread and wind around spindle, run thread over pulley and wind up, connect to mass hanger keep threat perpendicular to spindle. Hold mass hanger.



- Have two students standing ready with stopwatches.
- Release the mass hanger.
- One student will record the time between the release of the mass hanger and when it touches the ground.
- As soon as the mass touches the ground, the second student will record the time it takes the crossbar to rotate twice. Be sure to take this measurement before the apparatus has slowed due to friction.
- Calculate angular velocity ω of the crossbar in radians/second, remembering that one rotation is 2π radians.
- Angular acceleration is given by the equation

  $$\bar{\alpha} = \frac{\Delta\omega}{\Delta t}$$

  Δω is the value calculated for final angular velocity (initial was zero) and Δ*t* is the time it took the mass to fall to the ground.
- Repeat your measurement a few times and average the results.
- Repeat experiments by changing hanger mass, mass on the rod and position of the mass on rod and compare effects on angular velocity.

5.2 Calculating torque

The torque can be calculated theoretically and experimentally and these two values can be compared. Use the same experimental setup as in 5.1.

The theoretical torque is given by the equation:

$$\tau = r \ x F = rF \sin\theta$$

$\theta = 90$ because the thread is perpendicular to the radius of the apparatus. *r* is the radius of the spindle. *F* = *mg* where *m* is the sum of the slotted masses and hanger. Thus, the theoretical torque is given by:

$$\tau = r \cdot m \cdot g$$

- To find experimental torque, first calculate the angular acceleration using the methods outlined in section 5.1.
- Calculate the moment of inertia by measuring the distances to the masses on the crossbar and using the following equation

  $$I = \frac{1}{12} \cdot M_{\text{rod}} \cdot L^2 + M_{\text{weights}} \cdot R^2$$

- Multiply angular acceleration by the moment of inertia to find torque

  $$\tau = I \cdot \alpha$$

- Measure the change in torque from changing spindle radius and from varying the amount of mass on the hangers.

5.3 Calculating moment of inertia

- Measure the distance from the mass to the pivot axle.

- Calculate the angular acceleration as in 5.1
- Calculate the theoretical torque as in 5.2
- The moment of inertia is given by the equation:

  $$I = \frac{\tau}{\alpha}$$

- Repeat the experiment, keeping the mass on the crossbar fixed and varying the distance.
- Plot inertia versus distance.
- Repeat the experiment, but this time keep the distance fixed and vary the mass on the rod and plot inertia versus mass.

You should find that the moment of inertia varies accoring to the equation

$$I = MR^2$$