CENTRAL SCIENTIFIC COMPANY

# OPERATING INSTRUCTIONS

**Motor-Driven Rotator**
**No. 74350-01**

## 1. Introduction

The Motor-Driven Rotator (74350-01) is designed to be used in all laboratory and classroom experiments requiring a mechanical source of rotary motion at constant or variable speed. Used in conjunction with the equipment listed in Section 5, “Replacements and Accessories,” the rotator will enable the student to perform a variety of experiments. This rotator operates on 115 VAC, 60 Hz.

## 2. Description

### 2.1 General

The Motor-Driven Rotator has a motor-driven shaft that, through a variable-speed friction drive, connects a spindle to which accessories can be attached for direct rotation. The rotator is mounted on top of a 14 x 38cm base. The overall height of the unit (from the table to the top of the spindle is 25cm. The unit weighs 8.9kg (19.5 lbs.)

### 2.2 Components and Their Functions

The drive shaft is belt-driven by an electric motor. The shaft turns a driving plate, a metal disk faced with rubber, which drives a friction rubber ring mounted near the lower end of the spindle. The upper end of the spindle is equipped with a collet in which accessories such as Centrifugal Hoops, the Centrifugal Force Apparatus, etc., can be attached and secured in place by a set screw.

A 2-inch spindle extension is normally positioned in the collet and secured in place by a locking nut and set screw. Accessories such as color disks can be mounted on this spindle extension.

By loosening the large plastic knob on top of the drive shaft housing, the spindle mounting can be rotated through 360°; it can be secured in place by tightening the knob. Notice the wording on top of this plastic knob: “Lock driving disk away from rubber disk when not in use.” If this instruction is not followed, the friction rubber ring can become flattened at the spot where it presses against the driving plate and cause slippage when the rotator is operated next. Look at the pin on the shaft of the driving plate. Turn and push the plate until it catches in the notch in the housing to lock the driving plate in place. Starting the rotator releases the driving plate automatically.

By turning the knurled knob at the bottom of the long screw running parallel to the spindle, the spindle speed can be precisely adjusted from about 0-1200 rpm. This knob controls the position of the friction rubber ring on the drive plate. When the friction ring is positioned toward the edge of the drive plate, the spindle goes faster, and when the ring is positioned near the center of the plate, the spindle goes slower. A set screw located near the knurled knob provides the means for locking the friction ring in any position on the plate.

The drive plate can be completely disengaged by locking it away from the friction ring, and the spindle can then be turned by hand if desired. Both the friction ring and the facing on the drive plate are made of material specially fabricated to give maximum power transmission consistent with satisfactory operating life.

A variety of accessories can be easily attached to the rotator.

To mount disks with center holes of 8mm (5/16-inch) OD, unscrew the knurled nut on the spindle extension, position the disk on the spindle extension, replace the knurled nut, and tighten it.

To mount accessories such as Watt's Governor (32456) with a shaft of 8mm (5/16 inch) OD or less, remove the spindle extension, insert the shaft of the accessory into the rotator collet, and secure it in place by tightening the set screw.

## 3. Experiments

### 3.1 Verification of the Centripetal Force

The relationship expressed by the formula

$$F = mv^2 / r$$

is determined with the aid of the Precision Centripetal Force Apparatus (74470). Complete operating instructions are supplied with the apparatus.

### 3.2 Effect of Centripetal Force on Two Balls of Unequal Mass Associated in a Common System

Clamp the 74430 Centrifugal Force Apparatus in the collet of the rotator, positioning the two balls on the rod so one is on each side of the axial center. Start with a low speed of rotation, then slowly increase the speed. Note the equilibrium position assumed by the balls at different speeds.

This experiment demonstrates in a simple yet striking way the effect of centripetal force on celestial bodies, such as the earth and the moon, rotating about a common center of mass.

### 3.3 Shape Assumed by Plastic or Non-Rigid Rotating Body

Clamp the 74435 Centrifugal Hoops in the collet of the rotator and, beginning at a low rate of speed, gradually increase the speed and observe the shapes assumed by the hoops. This demonstration supports the theory of the oblate shape of the earth and other planets. While the original theory stated that the earth had cooled from a molten condition and had assumed the oblate shape while it was still in a plastic condition, the new theory claims that it is not necessary to assume that the molten condition affected the current shape. Any non-rigid rotating body must assume such a shape, the exact amount of flattening at the poles being determined by the mass, speed of rotation, density, and other factors.

### 3.4 Separation of Liquids or Solids of Unequal Density

Clamp the Rotator Globe in the collet of the rotator. Pour into the globe about 2 ounces of mercury (*if preferred, the experiment can be carried out without the mercury; then there are only two bands*), 2 ounces of water to which a coloring agent has been added, and 2 ounces of a clear oil, such as kerosene or gasoline. The oil can be dyed a color different from the water. Start the rotator and speed it up until the three liquids are visible as three bands on the globe at the position of maximum diameter. Note that the mercury constitutes the narrow center band with the water extending beyond it on each side and the oil extending beyond the water.

This demonstration illustrates the manner in which liquids of different density can be separated in a centrifugal separator — which is the commercial means for separating milk from cream.

If a ball of cork and one of rubber are placed gently in the bottom of the globe and the rotator is started up *very* slowly and gradually speeded up, the balls will arrange themselves at different

positions on the side of the globe. The ball with the greater density will be located where the diameter, and the centrifugal force, is maximum.

**3.5 Steam Engine Governor**

Clamp a 32456 Watt's Governor in the collet of the rotator and notice the effect on the balls when the speed of rotation is increased. As the balls fly apart, the spring is compressed, and a lever is moved. The corresponding lever of a governor installed in a real steam engine operates a valve in the pipe through which steam is admitted to the steam engine, controlling the speed of the engine. As the steam supply is cut off, the balls are no longer driven out with the same force and the spring pressure forces the lever down to open the valve and admit more steam through the pipe to the engine, thus tending again to speed up the engine. The force of the spring and the inertia of the two balls work against each other effectively controlling the speed of the engine.

**3.6 Doppler's Principle**

Clamp the stem of the 74595 Doppler's Principle Apparatus in the rotator collet. Beginning with a low rate of rotation, increase the speed of the rotator until the reed of the apparatus emits an easily recognizable musical tone. Listen carefully and note that the pitch seems to rise as the reed comes toward the ear of the listener and to fall as it goes away from the listener. This experiment illustrates Doppler's principle. According to this principle, as the source of sound approaches the ear, the time interval between successive impulses is decreased, giving the effect of increased frequency or higher pitch. As the source goes away, the interval is increased, giving the effect of lower frequency and pitch.

**3.7 Newton's Color Disk**

Clamp onto the spindle of the rotator a 74600 Newton Color Disk. The spindle of the rotator should be clamped in such a position that the plane of the disk is vertical. As the speed of the rotator is increased, notice that the colors blend together to give the impression that the disk is gray. If the proper colors are used in the correct proportions, the color of the disk appears to be white.

## 4. Maintenance

When the rotator is not being used, the driving plate should be pushed back out of contact with the friction ring and locked with the pin in the shaft. This prevents flattening of the friction ring which can cause slippage, irregular speed, and noise when the rotator is operated.

All bearings of the rotator are wool-packed to ensure proper lubrication. One oiling should last for several months. At the time these bearings are lubricated, oil the motor bearings.

The friction ring is easily removed and replaced when worn. With an Allen wrench, loosen the set screw in the collar above the friction ring on the shaft. Then carefully lift up the spindle and lay it on the table. The assembly retaining the friction ring drops onto the table. Pull off the worn friction ring and fit the new ring in place, then reverse the disassembly procedure.

If you should experience any difficulty with the apparatus, please contact Central Scientific Company, giving details of the problem. To ensure better service, please do not return any item to Central Scientific Company until we have sent you authorization.

## 5. Replacement Parts and Accessories

| Description | Cat. No. |
|---|---|
| Friction Ring | 00270-71 |
| Rotator Spindle | 74425 |
| Centrifugal Force Apparatus | 74430 |
| Centrifugal Hoops | 74435 |
| Glass Rotator Globe | 74445?? |
| Precision Centripetal Force Apparatus | 74470 |
| Watt's Governor | 32456?? |
| Newton Color Disk | 74600 |
| Centripetal Force Apparatus | 31378?? |

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