Gravitational Torque Experiments

A short aluminum rod is included as part of the Magnetic Torque accessories. This rod is designed to be used with the plastic slider mass to provide a gravitational torque to the magnetized sphere. The length of the rod assures that it will not make contact with either the magnetic coils or the brass support rods of the magnet assembly when the ball is precessing or oscillating.

With this new rod, it is now possible for the experimenter to observe the dynamic behavior of the magnetized sphere with both a gravitational and a magnetic torque present. A student can begin by observing the precessional motion of the sphere with a gravitational and no magnetic torque. Then, by continuously adjusting the magnetic field, the student can observe the effect of introducing a magnetic torque which can either add to or subtract from that gravitational torque.

There was one problem with the new short rod. It was not easy to spin the sphere with the short rod in place. After many a false start, we think we have come up with an effective way to get the ball spinning. Hold the tip of the rod at your desired angle with one hand. Try not to exert any radial pressure on the rod. Use a few fingers of your other hand along the ball's equator to bet the ball in motion. You almost slap the "edge" of the ball, very much the way you slap the outer edge when you spin a tire. A pictorial explanation of this technique will be included in the new instruction manual.

Initially, we made the short rod just to show how the magnetic and gravitational torques combines to create precession. We now think other interesting experiments are possible with this accessory.

Students can balance the static torques and show that the torques are still balanced no matter how fast the ball is spun. More advanced students can look for the small effects introduced when a mass on the short rod is used while doing harmonic motion and precession experiments. We think the mass of the slider may be large enough that it be included in the moment of inertia when doing physical pendulum experiments. Likewise, we suspect that the moment of inertia of the rod-slider system will affect the precessional motion of the ball. There may even be an observable angular dependence for the period of precession since the perpendicular distance of the slider from the vertical axis, and thus its contribution to the moment of inertia, does vary with angle.

The short rod even makes it possible to use Magnetic Torque during a mechanics course to demonstrate the dependence of precession on both angular momentum and torque. Keeping the location of the slider fixed the student can spin up the ball to a variety of frequencies and observe the effect of spin frequency on precession. A qualitative pattern will easily be observed even if the exact frequency and period are not determined. A nice extension might be to determine the ball's frequency using the strobe and measuring the time for a single precession. Once an experimenter becomes facile at spinning the ball, the effect of torque on precession frequency can easily be shown. The location of the slider can be changed and the ball spun up to the same frequency each time. The larger torques will give a dramatically faster precession. Again, quantitative measurements could be a nice extension for a particularly good student.

These quantitative experiments that the new short rod makes possible should provide a significant challenge for your advanced students.