Precession (3b)

Aim: To show how a rotating wheel reacts to an applied torque.

Subjects: 1Q50 (Gyros)

Diagram:

Equipment:

- bicyclewheel with handles
- rotating platform
- support rods and clamps
- rotatable (hinged) clamp

Precession (3b)

Presentation: The bicyclewheel with handles is vertically mounted on a rotating platform in such a way that one handle is fixed in a hinged clamp and the other handle rests on a support (see diagram). The bicycle wheel is made fast spinning.
Now the rotating platform is slowly turned round by hand, trying both directions of rotation. In one direction of rotation, the spinning bicyclewheel will lift its free handle upwards from the support.
As soon as you stop speeding up the rotating platform, the lifting of the spinning bicyclewheel will stop also.
Leaving the spinning bicyclewheel to itself now, it slowly comes down, and the rotating platform speeds up.

Explanation: The spinning bicyclewheel has an angular momentum of $I_1\omega_0$. Rotating the platform, introduces a torque T. This torque tends to change $I_1\omega_0$, so $I_1\omega_0$ moves into the direction of T. So, when T is pointing upward, $I_1\omega_0$ moves upward: the bicyclewheel-handle lifts itself from the support. (See Figure 1.)

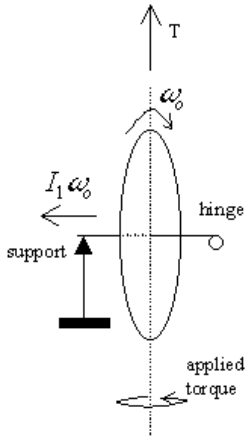

Figure 1

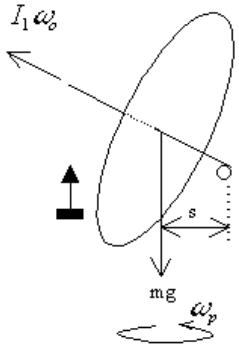

Figure 2

While the platform is freely rotating, gravitational torque mgs is acting (see Figure 2). In Figure 2 this torque is pointing out to the reader. $I_1\omega_0$ moves into the direction of mgs, keeping the platform rotating (precession). In this process, increases because the bicyclewheel is coming down. Since $\omega_p = \frac{mgs}{I_0\omega_0}$, ω_p increases due to s becoming larger (and also a little due to ω_0 becoming smaller).

Remarks:
- Our setup is in such a way that s changes substantially when the wheel comes down. When our wheel is at about 45°, s=0.
- Take care that the bicyclewheel is not lifted more than 45°, because then it surpasses the hinge and falls down to the other side, slamming the support-rods and clamps!

Sources:
- Sutton, Richard Manliffe, Demonstration experiments in Physics, pag. 79