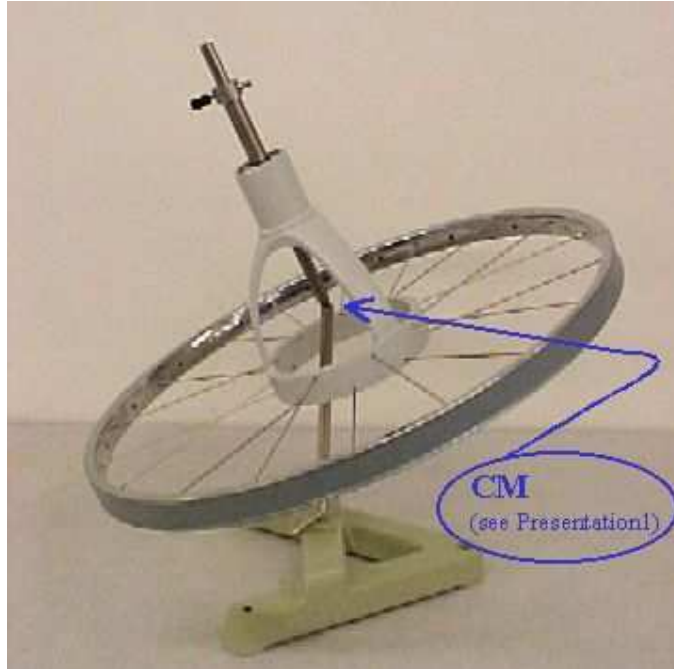


Precession (1)

Aim: To show the relationship between gravitational torque and precession.
Subjects: 1Q50 (Gyros)
Diagram:



Equipment:

- Large gyroscope (Laybold 34818)
- Pointed rod
- Rod with cup

Precession (1)

- Presentation:
1. The pointed support-rod is shifted so that the gyroscope is supported at its centre of mass (CM). Show this to the students by placing this axis in different orientations and observe that any orientation is in neutral equilibrium. Now the gyroscope is made spinning and given an angle of about 20° with the vertical. The spinning gyroscope will remain stationary in space.
 2. The ball-bearing of the gyroscope is gripped (while the gyroscope is spinning) and the gyroscope is lifted somewhat so now its centre of mass is above its point of support. The gyroscope performs its rotary motion on a cone-shaped shell. This motion along the cone-surface is called precession.
 3. The ball bearing of the still rotating gyroscope is gripped again and the gyroscope is lowered somewhat such that now its centre of mass is below its point of support. The spinning gyroscope shows again precession, but now in the other direction.

While the gyroscope slows down, it can be observed that the angular velocity of precession increases.

Also can be shown that the angular velocity of precession is proportional to the moment of the applied force by repeatedly varying the position of the point of support of the gyroscope.

Explanation: Since angular momentum is a vector quantity that may be represented by a vector parallel to the axis of spin, the combination of two angular moments may be treated by the parallelogram law.

The spinning gyroscope has an angular momentum of $I\omega_0$. This is represented by a vector parallel to the axis of spin (see Figure 1).

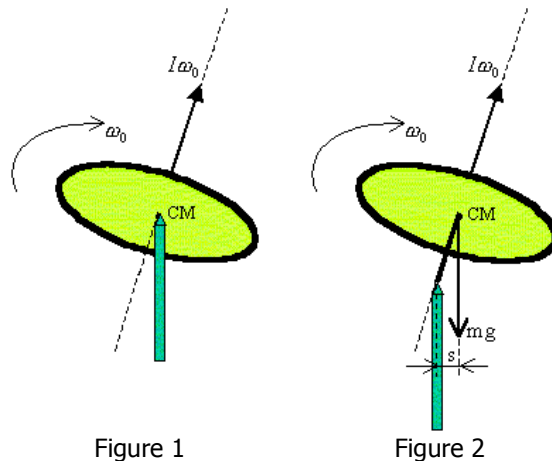


Figure 1

Figure 2

When the centre of mass (CM) is above the point of support, then there is a gravitational torque $mg s$ (see Figure 2), pointing away from you.

Precession (1)

This torque tends to change $I\omega_0$, so $I\omega_0$ moves into the direction of $mg s$ (see Figure 3),

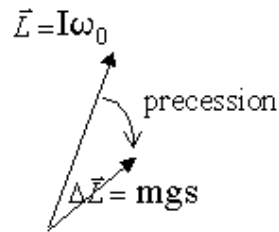


Figure3

and in that way changes the axis of rotation of the wheel (precession).

The speed of precession (ω_p) equals $\omega_p = \frac{mg s}{I\omega_0}$, so:

- increasing s , increases ω_p ;
- positioning s above the CM changes direction of ω_p ;
- slowing down of ω_0 , as will inevitably happen during the demonstration, increases ω_p as the formula shows.

- Sources:
- [Sutton, Richard Manliffe, Demonstration experiments in Physics](#), pag. 79
 - [Leybold Didactic GmbH, Gerätekarte](#), pag. 34818
 - [Roest, R., Inleiding Mechanica](#), pag. 226-228