Maximum rotational inertia

Aim: To show that an object prefers to rotate around an axis with largest moment of inertia.

Subjects: 1Q10 (Momentum of Inertia)
1Q60 (Rotational Stability)

Diagram:

Equipment:

- Electric hand drill (or other electric motor).
- Aluminium bar ϕ 12mm, l=180mm with string l=200mm.
- A rope, l=500mm.
- A chain, l=500mm.
- Transparent screen

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Presentation: The bar hung from a string is fixed to the drill and set spinning. The bar starts to rotate and will not remain vertical, but rises. Finally, the bar spins in a horizontal plane (see Diagram).
A rope suspended in the drills head will climb very fast to a rotation in a horizontal plane (passing through an interesting sequence of movement).
When a chain is used, this chain will also finally rotate in a horizontal plane, but it takes much more time to go from the vertical suspension to the horizontal rotation. (Now a study of the sequence in between is possible.)
Figure1 shows several objects that can be used in this demonstration.

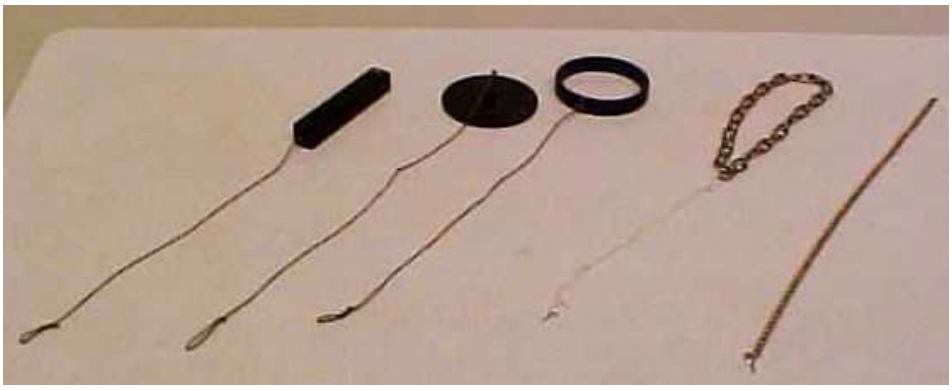

Figure 1

Explanation:

- When the vertical bar is just a little out of its equilibrium, then due to opposing centripetal forces on the upper and lower part of the bar, the bar will eventually align itself horizontally.
- The angular velocity vector ω points vertically downward. The angular vector momentum does not, because the rotational inertia of the bar is greater about an axis perpendicular to the bar. The downward impulse $\bar{L}\Delta t$ attempts to align the angular momentum with ω.

Remarks:

- While rotating the bar, rope or chain, take care that these objects, while rotating horizontally, leave enough free space. A transparent screen between the rotating objects and the observers is advised.

Sources:

- Meiners, Harry F., Physics demonstration experiments, part I, pag. 275
- Roest, R., Inleiding Mechanica, pag. 216-222