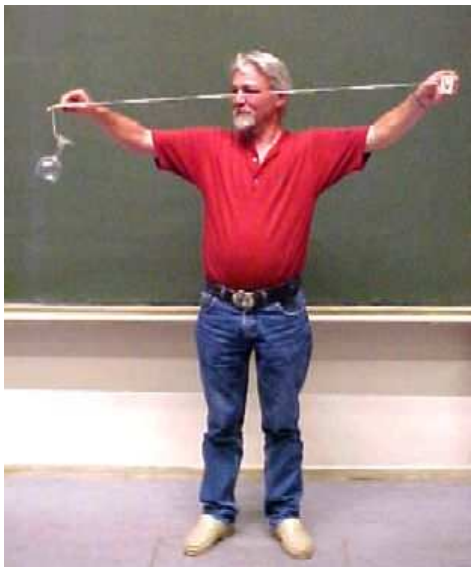
# Matchbox and wineglass

Aim: To show an example in which conservation of angular momentum explains the trick.

Subjects: 1Q10 (Momentum of Inertia)
1Q40 (Conservation of Angular Momentum)

Diagram:



Equipment:

- Light mass (empty matchbox).
- Heavy mass (wineglass).
- String, 1 meter.
- Stick ( $\approx 50cm$ long).

# Matchbox and wineglass

Presentation: See diagram. The wineglass hangs straight down a few centimetres below the pencil, the matchbox is held so that its string is nearly horizontal. Now release the matchbox and ... the wineglass will not hit the floor!

Explanation: As the heavy mass descends and pulls the light mass towards the pencil, the rotational velocity of the light mass increases rapidly, first because it is swinging like a pendulum and secondly because for a given value of angular momentum, any decrease in radial distance must result in an increase in the angular speed: $\bar{L} = I\omega = const.$. Were it only for the pendulum motion, the light mass would swing only up to its original height. But due to the second cause of increase in angular speed, the string goes over the top of the pencil and wraps itself around it a number of times (enough to create a large frictional force). When you do the demonstration once more, the speeding up of the empty matchbox is very good observable.

Remarks:

- We do this demonstration at the beginning of the lecture on 'moment of inertia', just to awaken students' interest in the subject. At the end of the lecture an explanation follows.
- Every now and then the demonstration fails because the matchbox hits the thread the wineglass is hanging to. The effect is that the wineglass hits the floor and breaks. So keep a spare wineglass at hand.
  We always hope that the demonstration happens in this way: first a broken wineglass and next a perfect demonstration, because such a failed demonstration is better remembered by the students.

Sources:


- Acheson, D.J. and Mullin, T., Nature, Vol.366, vol. 63, nr. 9, pag. 854-855, Comment on "A surprising mechanics demonstration", R.E.J. Sears
- Ehrlich, R., Why Toast Lands Jelly-Side Down: Zen and the Art of Physics Demonstrations, pag. 74