Balancing a broom on your palm with the heavier, straw end upward isn't very hard. In contrast, trying to balance a broom with the straw end downward against your palm is very difficult (and this has nothing to do with the stiffness of the straw!). Discuss why this is so. (You are encouraged to try it out before answering.)

Good discussion of the broom's geometry and how torque enters

The broom has a non-uniform mass distribution where most of its mass is at the straw end. The center of the mass of the broom is closer to the straw end, therefore when the broom is balanced from the straw end, the center of the mass is closer to the palm. The torque due to gravitational force would be less, but when the broom is balanced from the other end, the torque due to the gravitational force is larger leading the broom the falling over.

Key physical influence is the magnitude of the moment of inertia

It is easier to balance a broom with the weighted end (straws) far from the point of support (your palm). The pole has a tendency to rotate much slower, because the rotational inertia of the pole is greater when balanced with the straw end upwards. The mass has not changed but what has changed is where the mass is. So, the further the mass is distributed from the axis of rotation, the greater the rotational inertia that is contains; thus the greater the resistance to a change in a state off rotational motion.

Good identification of why moment of inertia is important

In a broom, most of its mass is at the end of the straw, so when the straw end is upward that mass or heavier weight of the broom is farther away from the palm of your hand; this means that it would prevent the broom from rotating off because it has a higher momentum of inertia and will be more resistant to having its angular motion change. If it is balanced with the straw end downward against the palm of the hand then it will have the tendency to fall down due to their being an unbalanced torque where there are changes in rotational motion and the gravitational force being larger.

Estimate your own moment of inertia. Explain your logic and don't forget the units!

Excellent example with proper spirit of estimation:

Lets do a simple clumsy example I fall forward onto my face, therefore my head will fall towards the ground in a circular motion if my feet are a fixed point.

I am almost 6ft so height is about 2m

I weigh about 150 lbs so 75 kg

My body can be thought of as a thin rod falling so I= 1/3(ML^2)

I predict I will fall pretty hard since there is alot more mass in my head(I hope) then my calves

I = (1/3)*75kg*2m

150kg*m(1/3)

I= 50kg*m

A response that could be much simpler

Considering the the human body can be most closely described as a solid cylinder, and based on the notes, I = (mr^2)/2.

my mass = 60 kg (for easy calculations),

The circumference of a circle (C)= 2(pi)(r), therefore r = C/2(pi)

Let's assume my circumference is 90 cm. Therefore my r = 90cm/2(pi) ≈ 90cm/2(3) ≈ 90cm/6 = 15cm.

Therefore my moment of inertia would be as follows:

I = (mr^2)/2

I = (60kg)[(15cm)^2]/2 ≈ 60kg[(225cm)^2]/2 ≈ 60kg(200cm^2)/2 ≈ 60kg(100cm^2) = 6000 kg*cm^2 = 60 kg*m^2

Without looking back at the formulas (really!), which of the following would you expect to have the highest moment of inertia?

a. A solid, uniform ball of mass 1 kg and radius 10 cm
b. A hollow spherical shell of mass 1 kg and radius 10 cm
c. A circular hoop or ring of mass 1 kg and radius 10 cm
d. A uniform disk of mass 1 kg and radius 10 cm
e. They should all be the same