Fun with Rotation!

I. Rotational Equilibrium

In this section of the lab you will examine the effect of forces that do not act at a common point and to verify the conditions necessary for a body to be in rotational equilibrium. The body will be a meter stick suspended from a lab stand. The forces will be weights hanging from the meter stick. For the meter stick to be in rotational equilibrium, the sum of the torques about the point of suspension should be zero. *Another way to look at it is: To balance the meter stick, it should be suspended from the Center of Mass of the system (meter stick and weights).*

Materials: meter stick, hanging masses, labstand, string

Procedure:

- Suspend the meter stick from its center of mass.
- For each combination below
  - calculate the unknown position,
  - determine the position experimentally, and
  - determine percent *error* between the calculated and experimental values.

1. If a 350g mass is placed at the 70cm mark, where should a 150g mass be placed to keep the meter stick in rotational equilibrium?
2. If a 100g mass is placed at the 90cm mark and a second mass is placed at the 20cm mark, what should the second mass be to keep the meter stick in rotational equilibrium?
3. In 2, above, add 50g to each mass at its current location. Determine whether the meter stick is still in rotational equilibrium.
4. If a 20g mass is placed at the 70cm mark and a 300g mass at the 90cm mark, where should a 500g mass be placed to keep the meter stick in rotational equilibrium?

Now suspend the meter stick from the 30cm mark.

5. If a 400g mass is placed at the 10cm mark, where should a 200g mass be placed to keep the meter stick in rotational equilibrium?

Questions

1) Both torque and work are products of force and distance. How are they different? Do they have the same units?
2) Why are tire irons longer than a normal wrench?

II. Conservation of Angular Momentum

In this section of the lab you get to play around with some demo equipment and experience the effects of the *conservation of angular momentum. Angular momentum* is similar to *linear momentum* (**p**) in that both the magnitude of total momentum and direction of the total momentum are conserved as long as no outside force acts.

Station 1: Distribution of Mass

Experiment with your distribution of mass and observe what happens with your speed. Describe in your write up what effect each movement had on your rotational speed. With each trial, have one of your lab partner's help you get started spinning.

1. Start with your arms out and then bring them in.
2. Now start with your arms in and then spread them out.
3. Try putting a leg straight out, and then pull it back in.
4. Try squatting down and then stand up.
5. Put the weights in each hand, start with arms straight out, then bring them in.
6. Other

Station 2: Direction of Angular Momentum

- Sit or stand on a rotating stool.
- Hold a weighted bicycle wheel with both hands.
- Have your lab partner get the bicycle wheel spinning *really* fast while you hold it.
- Now tilt the wheel to the right and then to the left.

What happens? What do you feel? Why is this?

Station 3: Direction of Angular Momentum

- Pick up the wheel that has the rope tied to one side.
- Hang the stationary wheel by the rope.

What happens?

- Now get the wheel spinning *really* fast and carefully suspend it by the rope while it spins.

What happens this time? Why is it different?

Why do you think the demo bicycle wheels are so heavy? What does this accomplish?