# Rotational Equilibrium Activities

|  |  |
| --- | --- |
| Location | Rank |
| 10 cm |  |
| 20 cm |  |
| 30 cm |  |
| 40 cm |  |
| 50 cm |  |
| 60 cm |  |
| 70 cm |  |
| 80 cm |  |
| 90 cm |  |

##  Are Torque and Force the same?

Hold a meter stick so that your index finger is as the 5-cm mark. With the stick held horizontally, position the string at the 10-cm mark, and suspend a 1 kg mass from it. Raise and lower the free end of the stick. Rank how easy or hard that was to do using a scale from 1 to 10. (1 being very easy and 10 being very difficult)

Now, move the hanger to the 20-cm mark and repeat. Continue this process in 10-cm intervals until you get to the end of the stick. Complete the table.

**Does it get easier or harder to rotate the stick as the mass gets farther from the pivot point?**

**Does the weight (Force of gravity) of the mass increase as you move the mass away from the pivot point?**

**Based on your previous answers, are torque and force the same?**

**Torque is dependent on what 2 things?**

## Where’s Your CG?

Your Center of Gravity is the point that moves when you move. When you raise your hands above your head, your CG is a little higher than when your hands are at your sides. The board should be positioned so that the amount of force on each force plate is about equal. (Don’t move them!) The mark on the floor indicates the halfway point between the two force plates.

You will ***each*** take a turn at this. Lay down on the board. Your partner will read the force values on the LabQuests. Direct the person on the board to scoot forward or backward until the two readings are about equal. Locate where the line on the floor would be on your body – that point in YOUR center of gravity.

**Measure how far above (+) or below (-) your navel where your CG is located.**

**\_\_\_\_\_\_\_\_ cm**

**Find someone of the opposite gender and compare. Discuss the differences and why.**

**When an astronaut spins when doing acrobatics aboard an orbiting space vehicle, what point does the body spin about?**

## Do males & females have the Same CG?

Stand two foot lengths away from a wall and place a chair between yourself and the wall. Have the back of the chair against the wall. Bend over with a straight back and let your head lean against the wall. Lift the chair off the floor while your head is still leaning against the wall. Now attempt to straighten up while still holding onto the chair.

**Were you successful? Why not?**

**Why can females generally do this while males cannot?**

Now, stand with your back to the wall. Your heels should be next to the wall. Try to bend over and touch your toes without falling.

**Were you successful? Why not?**

**Is this activity gender dependent?**

**When you carry a heavy load with one arm like a pail of water, why do you tend to hold your free arm out horizontally?**

## Find the mass of an unknown object

Gravity pulls on every part of an object. The average position of these pulls (the weight) is the center of gravity (CG) of the object. The sum of all these pulls is the weight of the object. The entire weight of the object is concentrated at its CG. The CG of a uniform meter stick is at the geometric center – the 50-cm mark.

Find the mass of an unknown mass using the balanced torque equation, F1d1 = F2d2.

Balance a meter stick with nothing hanging on it. (Should be close to the 50-cm mark) position = \_\_\_\_\_\_\_ cm

Using a string, attach an unknown mass to one side of the fulcrum at the 90-cm mark. Use a known mass of your choice on the other side of the fulcrum to balance the stick.

**Known mass = \_\_\_\_\_\_\_\_\_ Position of known mass = \_\_\_\_\_\_\_\_\_ cm**

**Calculate the unknown mass – show your work.**

**Check using a balance. Unknown mass = \_\_\_\_\_\_\_\_\_\_\_**

**How does your calculated value compare to your measured value?**

**Compute percent error. (mass calculated – mass measured)/mass measured X 100% =**