STATIC EQUILIBRIUM

Objective

To show that if a body is in Static Equilibrium it must satisfy the following conditions:

(1) the vector sum of all the external forces must be zero.
(2) the vector sum of all the external torques about any point must be zero.
(3) the body must NOT have translational or rotational motion (the body must be at rest).

Equipment

1. meter stick
2. hangers(2)
3. large rod, small rod
4. small clamps(3), large clamp(1)
5. set of masses
6. triple-beam balance

Theory

The conditions for static equilibrium are the following:

1. The vector sum of all the external forces must be zero.

$$\sum \vec{F} = 0$$

In component form:

$$\sum F_x = 0, \quad \sum F_y = 0, \quad \sum F_z = 0$$

2. The vector sum of all the external torques about any point must be zero.

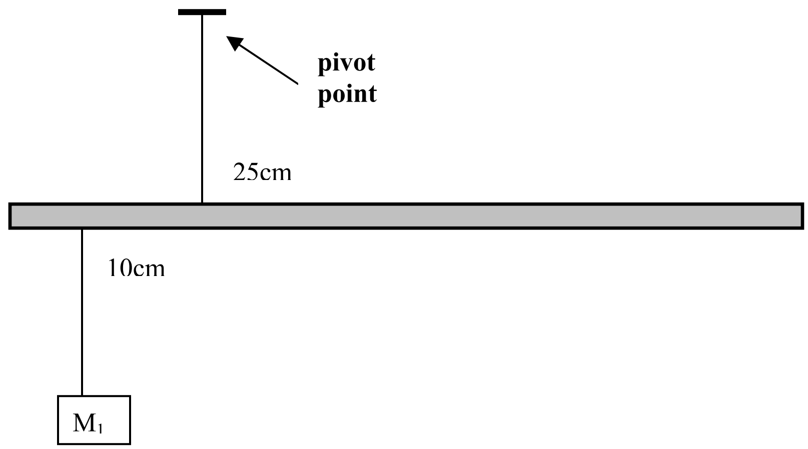
$$\sum \vec{\tau} = 0 \text{ (about any point)}$$

3. The body must NOT have translational or rotational motion. That is, the body must be at rest.

Procedure

Part 1

1. Weigh the meter stick with the triple-beam balance.
2. Locate the center of mass of the meter stick by balancing on a pivot point.
3. Pivot meter stick about the 25cm mark. Add mass to the 10cm mark until the stick is balanced horizontally (see figure below).



4. Draw a Free-Body Diagram for the meter stick.
5. Calculate the net torque (sum of the torques) about the 25 cm mark. Do not forget to include the mass of the small clamp used to attach the mass at the 10cm mark.
6. Calculate the tension in the string supporting the meter stick.

Part 2

1. Pivot meter stick about the 40cm mark. Add 200g to the 95 cm. Add mass to the 10cm mark until the stick is balanced horizontally.
2. Draw a Free-Body Diagram for the meter stick.
3. Calculate the tension in the string supporting the meter stick by first calculating the net torque (sum of the torques) about the 75 cm mark. Do not forget to include the mass of the small clamps used to attach the masses at the 95cm and 10cm marks.
4. Calculate $\sum F_y$.