Static Equilibrium of a Rigid Body

For a rigid body in static equilibrium there must be both translational and rotational equilibrium. Therefore, the net force acting on the body must be zero ($\sum \vec{F} = 0$) and the net torque acting on the body must be zero ($\sum \tau = 0$).

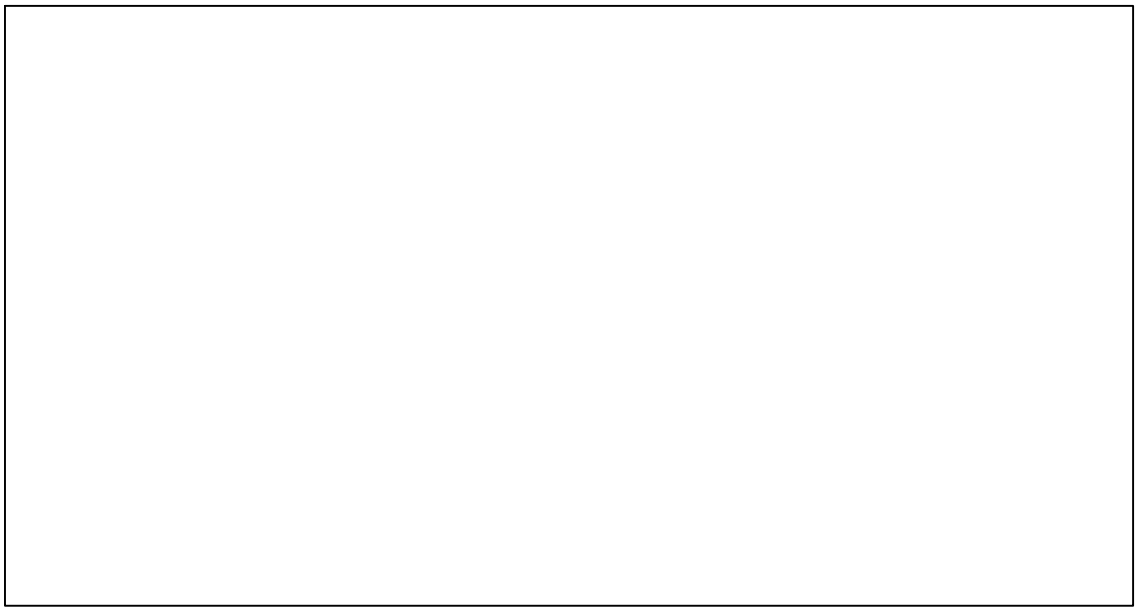
1. Place 4 weight hangers on your meter stick: Two near the ends (for example at 10 cm and at 90 cm) with the hooks up, one off center (for example at 60 cm) with the hook down, and the fourth (with no hook) to the other side of the center. Clamp all but the last one into position. No uncertainties needed for the positions.

2. Move the hookless weight hanger around until you are able to balance the meter stick in your hand from its position. Clamp it in that location. This is the location of the center of gravity of this system (meter stick plus the 4 weight hangers). The force of gravity on the system pulls down at the center of gravity. Again, no uncertainty necessary here.

3. Measure the mass of the meter stick + weight hangers system. No uncertainty for the mass.

4. Now, using the weight hangers near the ends of the meter stick, suspend the meter stick from the spring balances attached to the supports. Hang a mass from the off-center hanger. Use as large a mass as you can without exceeding the range of the scales (maybe 400-500g). Adjust the supports until the meter stick is approximately horizontal.

5. Record the positions of the scales, hanging mass, and center of gravity; the readings of the scales; and the angles of the forces with respect to the meter stick. Draw a diagram of the meter stick illustrating all this.



6. The big uncertainties in this lab are in the angles of the scale forces and the magnitudes of the scale forces. You will need to determine an uncertainty in the magnitude of the scale forces. Make your best judgement.

For the angles, you will use an absolute uncertainty of 0.025 for $\sin(\theta)$ or $\cos(\theta)$ whenever they are used in your calculations.

e.g. If you have a force acting at an angle of 40°, the sine of that angle with uncertainty would be $\sin(40°) = 0.643 \pm 0.025 = 0.643 \pm 3.9\%$.

7. Compute the net force in the x direction.

Is the condition for static equilibrium satisfied within uncertainties?

8. Compute the net force in the y direction.

Is the condition for static equilibrium satisfied within uncertainties?

9. Compute the net torque about a point of your choice.

Is the condition for static equilibrium satisfied within uncertainties?