Mobile Mechanics Calculations

Where an object is in equilibrium, there can be no unbalanced force NOR torque acting on the object. That is:

$\Sigma F = 0$ and $\Sigma \tau = 0$

Project Calculations: You must complete similar calculations for EACH beam (each group should have at least three beams). If you have more than three beams, complete the calculations for the lowest three beams.

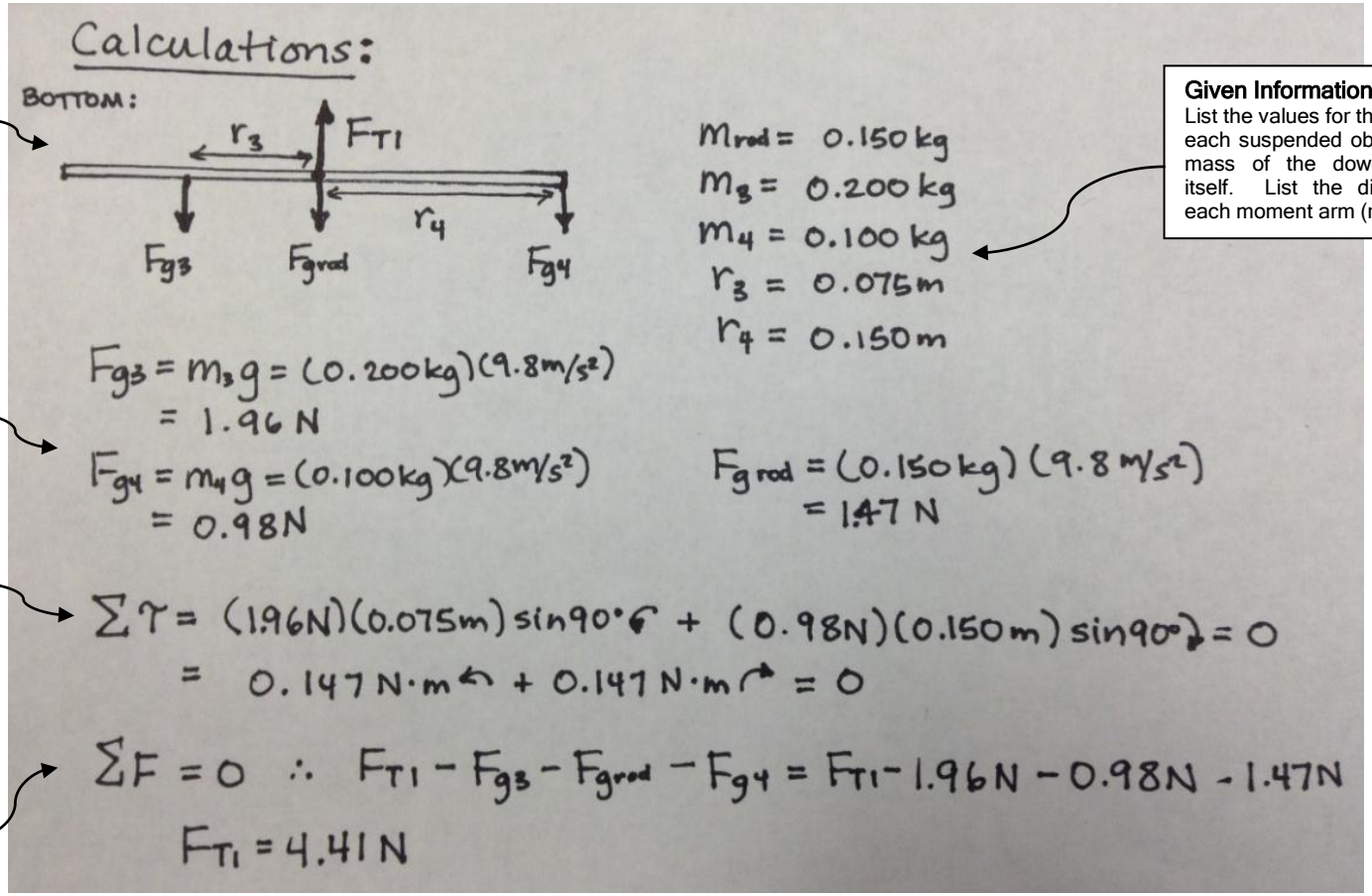
☆☆☆Calculations will be easier if you begin with the lowest beam, and work your way up. ☆☆☆

Free-Body Diagrams:
- Draw the FBD for each beam
- Make sure to draw
  - Weights suspended
  - Weight of beam
  - Supporting tension force
  - Labels for moment arms (r_1, r_2, etc.)

Weight Calculations:
Calculate the weights of each suspended mass AND the dowel rod/beam.

Net Torque Calculations:
Sum the torques about the axis of rotation. Note, the supporting thread doesn't contribute to the net torque IF the beam is (a) uniform in size and density, and (b) suspended from the center. Your net torque should be VERY nearly zero.

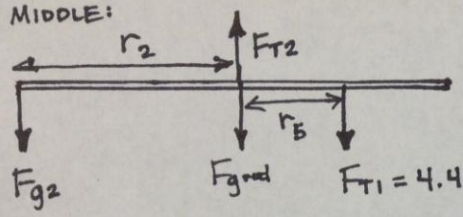
Net Force Calculations:
Sum the forces acting on the beam. The sum of the forces acting down should be equal to the tension force supporting the beam.



Given Information:
List the values for the masses for each suspended object, and the mass of the dowel rod/beam itself. List the dimension for each moment arm ($r_1 = 0.12$ m).

In addition, your calculations must be clear and neat, as demonstrated in these samples.

MIDDLE:



$m_2 = 0.225\ kg$
$m_{rod} = 0.150\ kg$
$r_2 = 0.150\ m$
$r_5 = 0.075m$
$F_{T1} = 4.41N$

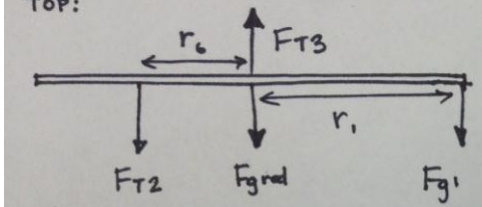
$F_{g2} = m_2 g = (0.225kg)(9.8m/s^2)$
$= 2.205N$

$F_{grod} = m_{rod} g = (0.150kg)(9.8m/s^2) = 1.47N$

$\Sigma\tau = (2.205N)(0.150m)\sin 90°\ \curvearrowleft + (4.41N)(0.075m)\sin 90°\ \curvearrowright$
$= 0.3308\ N\cdot m\ \curvearrowleft + 0.3308N\cdot m\ \curvearrowright = 0$

$\Sigma F = 0 \therefore F_{T2} - F_{g2} - F_{grod} - F_{T1} = 0$
$F_{T2} = 4.41N + 2.205N + 1.47N = 8.085\ N$
$F_{T2} = 8.085\ N$

TOP:



$m_1 = 0.4125\ kg$
$F_{T2} = 8.085N$
$m_{rod} = 0.150\ kg$
$r_1 = 0.150\ m$
$r_6 = 0.075m$

$F_{g1} = m_1 g = (0.4125\ kg)(9.8m/s^2)$
$= 4.0425\ N$

$F_{grod} = m_{rod} g = (0.150kg)(9.8m/s^2)$
$= 1.47N$

$\Sigma\tau = (4.0425N)(0.150m)\sin 90°\ \curvearrowleft + (8.085N)(0.075m)\sin 90°\ \curvearrowright$
$= 0.606\ N\cdot m\ \curvearrowleft + 0.606\ N\cdot m\ \curvearrowright = 0$

$\Sigma F = 0 \therefore F_{T3} - F_{T2} - F_{g1} - F_{grod}$
$F_{T3} = 8.085N + 4.0425N + 1.47N = 13.6N$