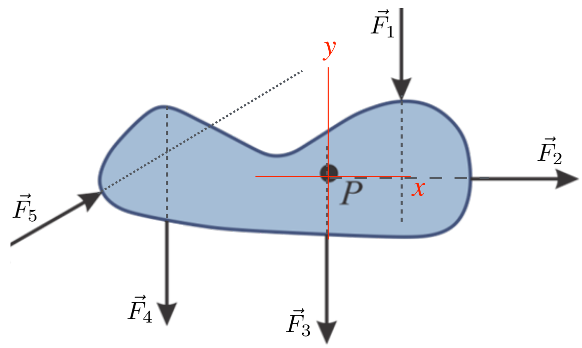
Solving Rotational Equilibrium Problems:

Setup Stage: Sketch a Free-Body Diagram.
Because distances, either r (from pivot to force) or $r_\perp$ ($\perp$ from pivot to line of action), are essential for calculating torques, you should provide some idea of the geometry of the object of interest.

Do <u>not</u> simply represent the object as a dot at the origin of a coordinate system for torque problems.



Analysis Stage: Apply Newton's Laws for Rotations (i.e. "Read" the free-body diagrams).
▶ Similar to translational motion problems, <u>**EACH STEP IS GRADED**</u>.

• **Physics Principle:** write Newton's First Law for Rotational Motion (corollary of Newton's 1st Law). i.e. $\Sigma\tau = 0$ and indicate the point used as pivot.	example: $\sum \vec{\tau} = 0$ (about point P)
• **Application:** Write the explicit sum of torque vectors; include a torque term for every force in the FBD. Recall: If the line of action of a force crosses the pivot, it exerts no torque.	$\vec{\tau}_1 + \cancel{\vec{\tau}_2} + \cancel{\vec{\tau}_3} + \vec{\tau}_4 + \vec{\tau}_5 = 0$
• **Sign Convention:** Separate magnitude and direction. Use the right-hand rule to determine direction of torque terms about pivot; represent it with +/– signs. Note: the τ terms are now magnitudes, so no arrow caps; the direction is described by the +/– signs.	$-\tau_1 + \tau_4 - \tau_5 = 0$
• Using the torque definition and either method of visualizing it, express <u>each</u> torque term as a function of r or $r_\perp$, and *F*.	$\tau_1 = r_1 F_1 \sin\phi_1$ or $\tau_1 = r_{\perp 1} F_1$ $\tau_4 = r_4 F_4 \sin\phi_4$ or $\tau_4 = r_{\perp 4} F_4$
• Identify and solve for the desired quantity.	