8.4: Solving Statics Problems

learning objectives

- Formulate and apply six steps to solve static problems

Statics is the study of forces in equilibrium. Recall that Newton's second law states:

$$\sum \mathrm{F} = \mathrm{ma} \tag{8.4.1}$$

Therefore, for all objects moving at constant velocity (including a velocity of 0 — stationary objects), the net external force is zero. There are forces acting, but they are balanced — that is to say, they are "in equilibrium. "

When solving equilibrium problems, it might help to use the following steps:

1. First, ensure that the problem you're solving is in fact a static problem—i.e., that no acceleration (including angular acceleration) is involved Remember:$\sum \mathrm{F} = \mathrm{ma} = 0$ for these situations. If rotational motion is involved, the condition $\sum \tau = \mathrm{I}\alpha = 0$ must also be satisfied, where is torque, is the moment of inertia, and is the angular acceleration.
2. Choose a pivot point. Often this is obvious because the problem involves a hinge or a fixed point. If the choice is not obvious, pick the pivot point as the location at which you have the most unknowns. This simplifies things because forces at the pivot point create no torque because of the cross product:$\tau = \mathrm{rF}$
3. Write an equation for the sum of torques, and then write equations for the sums of forces in the *x* and *y* directions. Set these sums equal to 0. Be careful with your signs.
4. Solve for your unknowns.
5. Insert numbers to find the final answer.
6. Check if the solution is reasonable by examining the magnitude, direction, and units of the answer. The importance of this last step cannot be overstated, although in unfamiliar applications, it can be more difficult to judge reasonableness. However, these judgments become progressively easier with experience.

Key Points

- First, ensure that the problem you're solving is in fact a static problem—i.e., that no acceleration (including angular acceleration) is involved.
- Choose a pivot point — use the location at which you have the most unknowns.
- Write equations for the sums of torques and forces in the *x* and *y* directions.
- Solve the equations for your unknowns algebraically, and insert numbers to find final answers.

Key Terms

- **torque**: A rotational or twisting effect of a force; (SI unit newton-meter or Nm; imperial unit foot-pound or ft-lb)
- **moment of inertia**: A measure of a body's resistance to a change in its angular rotation velocity

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