How to solve an Equilibrium Problem

0. **Read and understand the problem**. Carefully read the problem statement and study the drawing. What do you know? What are you looking for? What kinds of supports exist? What distances and angles can you easily determine? Spend some time thinking about the situation before you begin to solve.

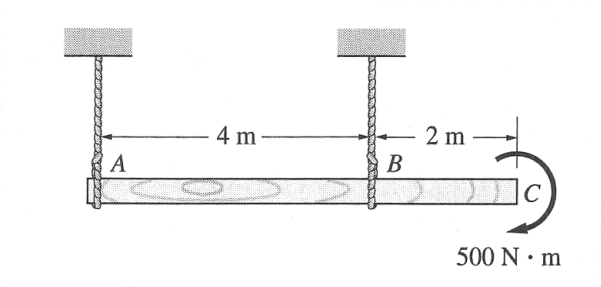
1. **Draw a Free Body Diagram.**
   a) Select appropriate object, isolate it from all supports, and sketch its outline.
   b) Traverse the perimeter of the object, and wherever it contacts the external world, show the appropriate reaction forces. Be sure that the reaction forces are consistent with the support that are providing them. (See page 90 in the book, if you are unsure.)
   c) Add force vectors representing any loads or body forces (weights). Use a ruler, sharp pencil for straight lines, and an eraser to make corrections. Show moments as circular arrows.
   d) Make sure every force and moment has a clear arrowhead indicating its assumed direction and a symbolic label.
   e) Indicate and label any other angles or distances that you will need on the FBD, but try to avoid cluttering it up with unnecessary information.

2. **Apply the equations of equilibrium.** In a planar (two-dimensional) problem, there are three available equilibrium equations. It is possible to solve for a maximum of three unknowns. Study your FBD and make sure you know what your three unknowns are!
   a) Choose and write down the three *Fundamental Equations* that you intend to use. It is often a good idea to choose as one of your equations the *sum of the moments about a point where the lines of action of two unknown forces intersect*.
   b) Refer to your FBD and *express the equations symbolically* in terms of the forces, distances, angles, and moments shown on your FBD.
   c) Continue working symbolically to *express each equation in terms of the unknowns* you are interested in.

3. **Solve for the unknowns.**
   a) Carefully use algebra to get the unknowns by themselves on the left side of the equations.
   b) Use geometry to determine any distances or angles that you will need.
   c) Substitute known values and solve for the values of the unknowns. Negative results will indicate that the actual result is opposite the assumption on your FBD.
   d) Clearly indicate your answers with an underline or box.
   e) Make sure that your answer includes correct units, and indicate the directions of all forces and moments.

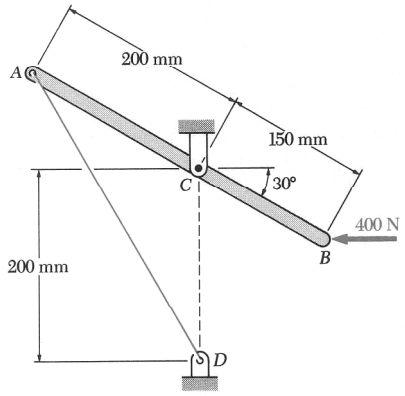
Example 1

A homogeneous 120 kg wooden beam is suspended from ropes at *A* and *B*. A power wrench applies a 500 N-m clockwise couple to tighten a bolt at *C*. Determine the tensions in the ropes.



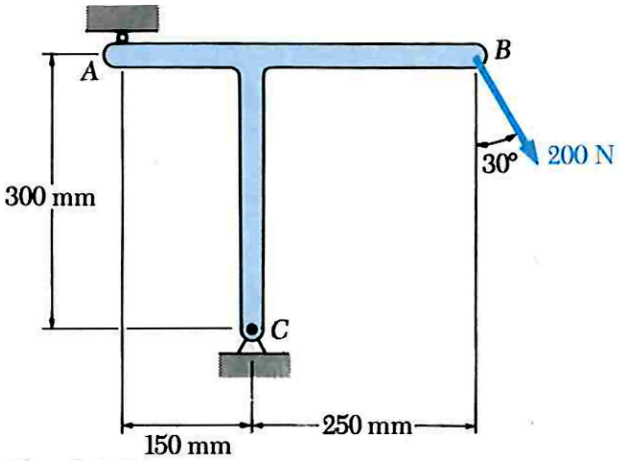
Example 2

The lever *AB* is hinged at *C* and attached to a control cable at *A*. If the lever is subjected at *B* to a 400 N horizontal force, determine (a) the tension in the cable, and (b) the reaction at *C*.



Example 3

A T-shaped bracket supports a 200-N load as shown. Determine the reactions at *A* and *C*.



Example 4

The control arm is subjected to the loading shown. Determine the magnitude of the forces acting on pins *A* and *C*.