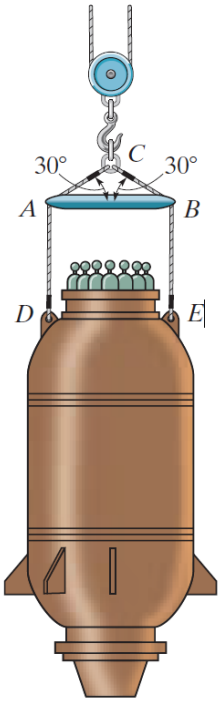
Problem 3-13

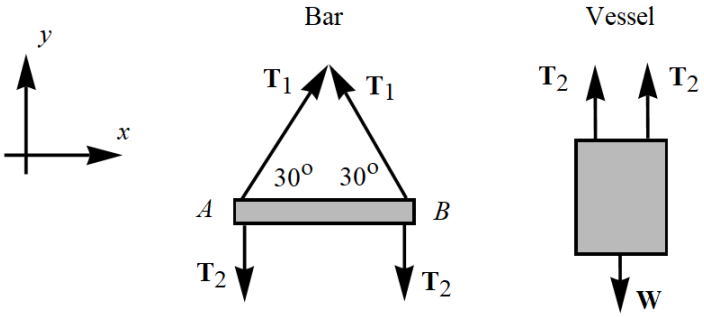
A nuclear-reactor vessel has a weight of $500(10^3)$ lb. Determine the horizontal compressive force that the spreader bar AB exerts on point A and the force that each cable segment CA and AD exert on this point while the vessel is hoisted upward at constant velocity.



Prob. 3–13

Solution

Because of the symmetry about the vertical axis, the tension will be the same in both pairs of cables. Draw one free-body diagram for the spreader bar and one free-body diagram for the vessel.



In order for the vessel to move at constant velocity, the sum of the forces in each direction must be zero.

$$\sum F_x = 0: \qquad T_1 \cos 30° - T_1 \cos 30° = 0 \qquad 0 = 0$$

$$\sum F_y = 0: \qquad 2T_1 \sin 30° - 2T_2 = 0 \qquad 2T_2 - W = 0$$

Only the equations in the y-direction are relevant here. Solve for T_1, the tension in cable CA, and T_2, the tension in cable AD.

$$T_2 = \frac{W}{2} = \frac{500(10^3)\text{ lb}}{2} = 250(10^3)\text{ lb}$$

$$T_1 = \frac{T_2}{\sin 30^\circ} = 500(10^3)\text{ lb}$$

By Newton's third law, the force that the horizontal bar exerts on A is equal to the horizontal force of cable CA.

$$F_A = T_1 \cos 30^\circ \approx 433(10^3)\text{ lb}$$