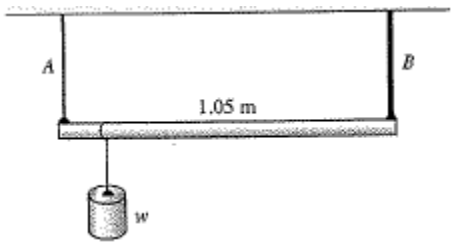
Answer on Question #49488-Physics-Mechanics-Kinematics-Dynamics

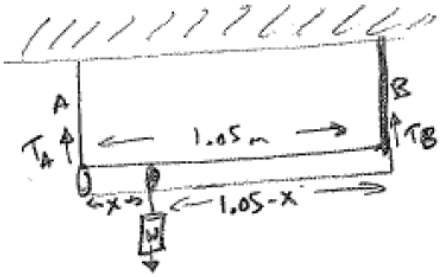
1.05-m long rod of negligible weight is supported at its ends by wires A and B of equal length. The cross-sectional area of A is $1\ mm^2$ and that of B is $4\ mm^2$. Young's Modulus for wire A is $2.4 \cdot 10^{11} Pa$; that for B is $1.6 \cdot 10^{11} Pa$. At what point along the rod should weight w be suspended to produce

a) equal stresses in A and B?

b) equal strains in A and B?

Solution





First find tensions in each wire:

$$\sum f = 0: T_A + T_B - w = 0 \to T_A = w - T_B.$$

$$\sum \tau = 0: (use\ position\ of\ w\ as\ pivot)$$

$$-T_A x + T_B(l - x) = 0$$

$$T_B(l - x) = (w - T_B)x$$

$$lT_B = wx \to T_B = \frac{wx}{l}; T_A = w - \frac{wx}{l}.$$

a) equal stresses in A and B:

$$\left(\frac{F}{A}\right)_A = \left(\frac{F}{A}\right)_B.$$

$$\frac{w - \frac{wx}{l}}{1\ mm^2} = \frac{\frac{wx}{l}}{4\ mm^2} \to 1 - \frac{x}{l} = \frac{1}{4}\frac{x}{l} \to x = \frac{4}{5}l = 1.05 \cdot 0.8 = 0.84 \text{ m from A.}$$

b) equal strains in A and B:

$$\frac{\Delta L}{L_0} = \frac{\left(\frac{F}{A}\right)}{Y}.$$

$$\frac{\left(\frac{F}{A}\right)_A}{Y_A} = \frac{\left(\frac{F}{A}\right)_B}{Y_B}.$$

$$\frac{w - \frac{wx}{l}}{1\ mm^2 \cdot 2.4 \cdot 10^{11} Pa} = \frac{\frac{wx}{l}}{4\ mm^2 \cdot 1.6 \cdot 10^{11} Pa} \quad 1 - \frac{x}{l} = \frac{2.4}{1.6 \cdot 4}\frac{x}{l} \rightarrow x = \frac{3}{8}l = 1.05 \cdot \frac{3}{8} = 0.39 \text{ m from A.}$$