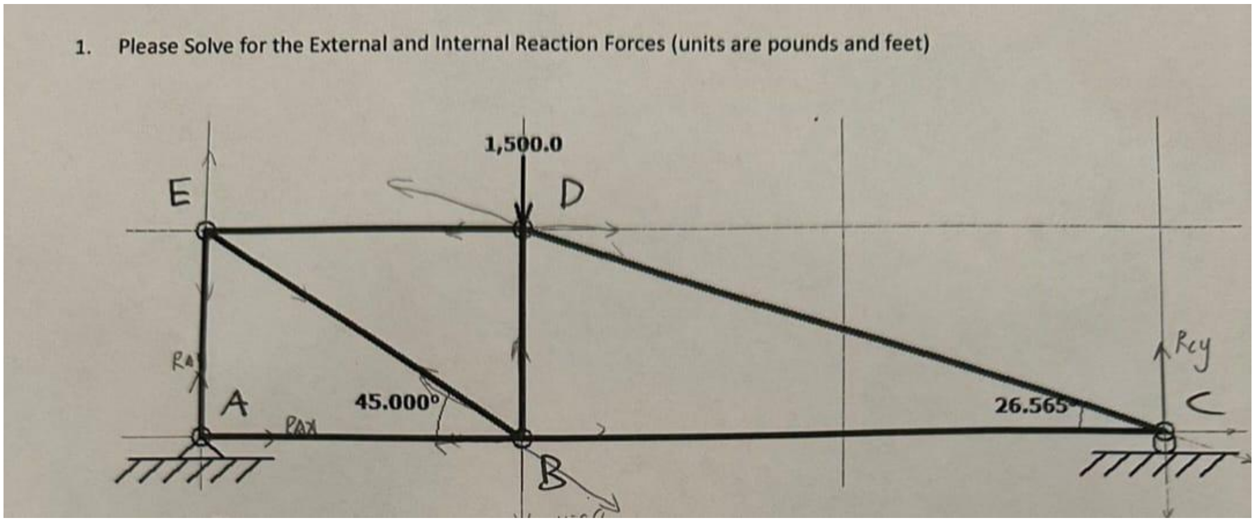
Truss Problem 1 - Forces on and in a truss (Method of Joints)



This truss problem was posted in a math group on Facebook. (By a tutor, although they may only tutor standard high school math and presumably not mechanics or physcis.)

It does not specify a method and since we want all of the internal forces I am using the Method of Joints. First we calculate the external reaction forces at A and C, treating the structure as a single object in static equilibrium. Then each joint is anayzed separately by summing the x-force components and the y-force components and setting those to zero (for static equilibrium).

There is another approach – the Method of Sections. In that method the truss is cut into parts and each part is treated as a complete body. If it is "cut" vertically between C and D we just consider the reaction force at C and the internal forces in DC and BC, treating all of them as external forces on that section. This method is useful if we only need the forces in a few certain elements. In a video walk-through I cover this but only briefly. At least one other problem is done that way as specified. (See Truss Problem IV.)

As a final comment it is possible to immediately see that AB is a zero-force element. At A it is perpendicular to the other two forces. Those are in the y direction and AB is along the x axis. A force sum in the x direction equal to zero immediately shows that AB must have zero force.

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① Assume square grid (which gives correct angles)
② Use Method of Joints (could use sections as well)

Sum $\bar{F}, \bar{T}$ on structure:

$$\circlearrowleft^{+} \sum \bar{T}_A = R_{cy}(3) - 1500(1) = 0 \quad \underline{R_{cy} = 500\,\hat{j}}$$

$$\circlearrowleft^{+} \sum \bar{T}_c = -R_{Ay}(3) + 1500(2) = 0 \quad \underline{R_{Ay} = 1000\,\hat{j}}$$

$$\sum F_y = R_{cy} + R_{Ay} - 1500 = 0$$

Joint C: $\sum F_y = 500 - F_{CD}\left(\frac{1}{\sqrt{5}}\right) = 0$ (500 ↑, ↓ $F_{CD} \sin\theta$)

$$\underline{F_{CD} = 500\sqrt{5} \text{ (CD compression)}}$$

$\sum F_y = F_{CD}\left(\frac{2}{\sqrt{5}}\right) - F_{BC} = 0$ (F_{BC} ← • → $F_{CD}\cos\theta$)

$$\underline{F_{BC} = 1000 \text{ (BC Tension)}}$$

Joint D: $\sum F_x = F_{ED} - F_{CD}\left(\frac{2}{\sqrt{5}}\right) = 0$ ($F_{DC}\cos\theta$ ← • → F_{ED})

$$\underline{F_{ED} = 1000 \text{ (ED Compression)}}$$

($F_{DC}\sin\theta$ ↑, ↓ F_{DB}, 1500)

$$\sum F_y = F_{DC}\left(\frac{1}{\sqrt{5}}\right) - F_{BD} - 1500 = 0$$

$$\underline{F_{BD} = -1000 \text{ (BD Compression)}}$$

Joint E: $\sum F_x = -F_{ED} + F_{EB}\left(\frac{1}{\sqrt{2}}\right) = 0$ (F_{ED} 1000 ← • → $F_{EB}\left(\frac{1}{\sqrt{2}}\right)$)

$$\underline{F_{EB} = 1000\sqrt{2} \text{ (EB Tension)}}$$

Joint B: $\sum F_x = F_{BC} - F_{EB}\left(\frac{1}{\sqrt{2}}\right) - F_{AB} = 0$

($F_{EB}\cos\theta$ ←, F_{AB} ← • → F_{BC} 1000)

$$= 1000 - 1000\sqrt{2}\left(\frac{1}{\sqrt{2}}\right) - F_{AB} = 0$$

$$\underline{F_{AB} = 0}$$

Joint E: $R_{Ay} - 1000\sqrt{2}\left(\frac{1}{\sqrt{2}}\right) = 0$

$$\underline{F_{EA} = R_{Ay} = 1000 \quad \text{(EA Compression)}}$$