

Solutions

2.1

- Vertical: $F_{\text{inclined}} \times (3/5) = 4.5 \rightarrow F_{\text{inclined}} = 7.5 \text{ kN}$.
- Tension – the joint hangs from it.
- Horizontal: $F_{\text{horizontal}} = 7.5 \times (4/5) = 6 \text{ kN}$.
- Compression – it pushes back against the inclined member's horizontal pull.

2.2

- Both are zero.
- Two non-collinear forces can only sum to zero if both are zero – the components cannot cancel in both directions otherwise.

2.3

- Joint at the apex: two symmetric members at 45° , 10 kN down.
- Vertical: $2F \sin 45^\circ = 10$, so $F = 7.07 \text{ kN}$.
- Both members are in compression (they prop the apex from below the load's line).

3.1

(a)

- Moments about A: $R_B \times 6 = 4 \times 2 + 4 \times 4$, so $R_B = 4 \text{ kN}$. Vertically $R_A = 8 - 4 = 4 \text{ kN}$, and $A_x = 0$ because no load is horizontal.
- Check: the truss and its loads are symmetric, so equal reactions are expected.

(b)

- Take tension as positive (a member in tension pulls on the joint). Joint A: vertically $4 + F_{AE} \sin 45^\circ = 0$, so $F_{AE} = -5.66 \text{ kN}$: **5.66 kN compression**.
- Horizontally at A: $F_{AC} + F_{AE} \cos 45^\circ = 0$, so $F_{AC} = +4 \text{ kN}$: **4 kN tension**.
- Joint C: the only vertical member is CE, so $F_{CE} - 4 = 0$ and $F_{CE} = 4 \text{ kN}$: **4 kN tension** – the vertical hangs C's load from the top chord.

(c)

- Moments about E remove EF and ED, which both pass through E. On the left piece, R_A turns clockwise with arm 2 m, the load at C acts along E's vertical line, and F_{CD} acts 2 m below E: $-4 \times 2 + 2F_{CD} = 0$, so $F_{CD} = 4 \text{ kN}$ **tension**.
- Moments about D remove ED and CD: $-4 \times 4 + 4 \times 2 - 2F_{EF} = 0$, so $F_{EF} = -4 \text{ kN}$: **4 kN compression**. The sagging truss stretches its bottom chord and squeezes its top chord, as expected.

(d)

- On the left piece, $R_A = 4 \text{ kN}$ up and the 4 kN load at C already balance, and EF and CD are horizontal, so the vertical component of ED must be zero. The middle panel carries no shear.

3.2

- (a) Truss methods assume every member is a two-force member; a multi-force member carries loads along its length, so its joint forces are NOT directed along the member and the joint equations have the wrong unknowns.
- (b) Dismember the frame: each member gets its own FBD; at each shared pin, the force on member 1 is equal and opposite to the force on member 2 (Newton's third law at the pin).
- Solve the two-force member first (direction known), then the multi-force member with its three equations.