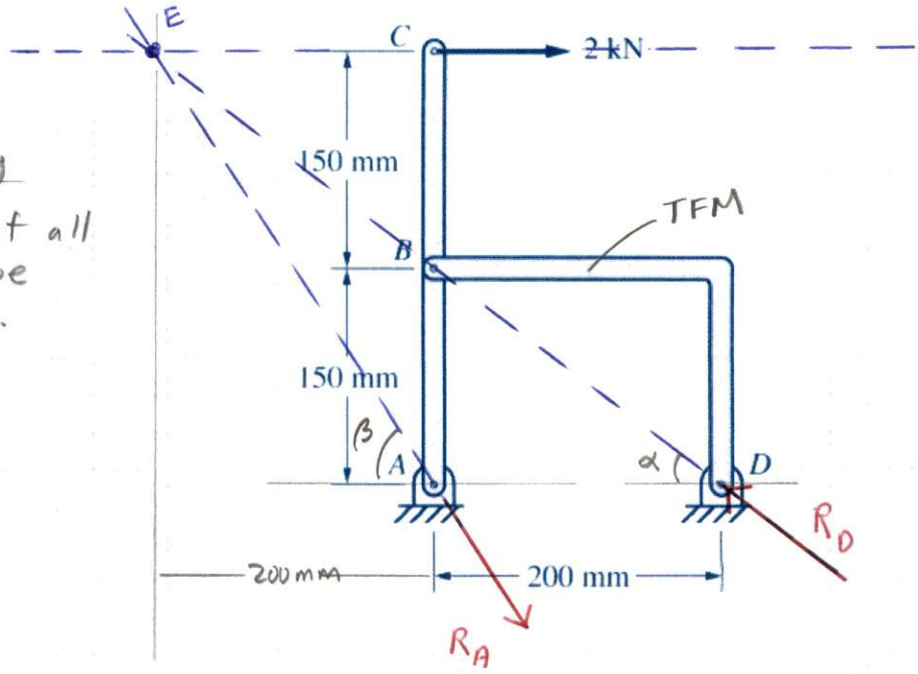
3-41

Refer to Fig. P3-41. Determine the reactions at A and D due to the 2-kN force shown by (a) the force triangle and (b) equilibrium equations.

Solution.



Three-Force Body

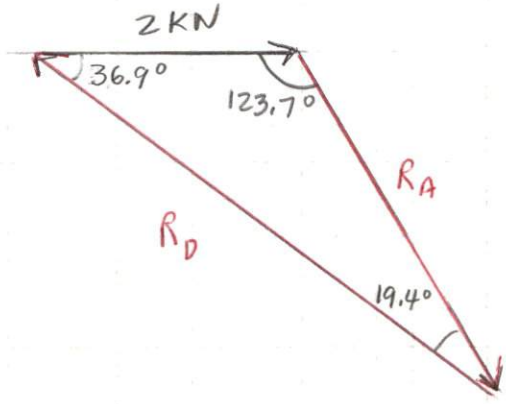
The Lines of Action of all three forces must be concurrent at E.

(a) Force-Triangle

FBD

$\alpha = \tan^{-1} \frac{150\,mm}{200\,mm} = 36.9°$

$\beta = \tan^{-1} \frac{300\,mm}{200\,mm} = 56.3°$



Force-Triangle

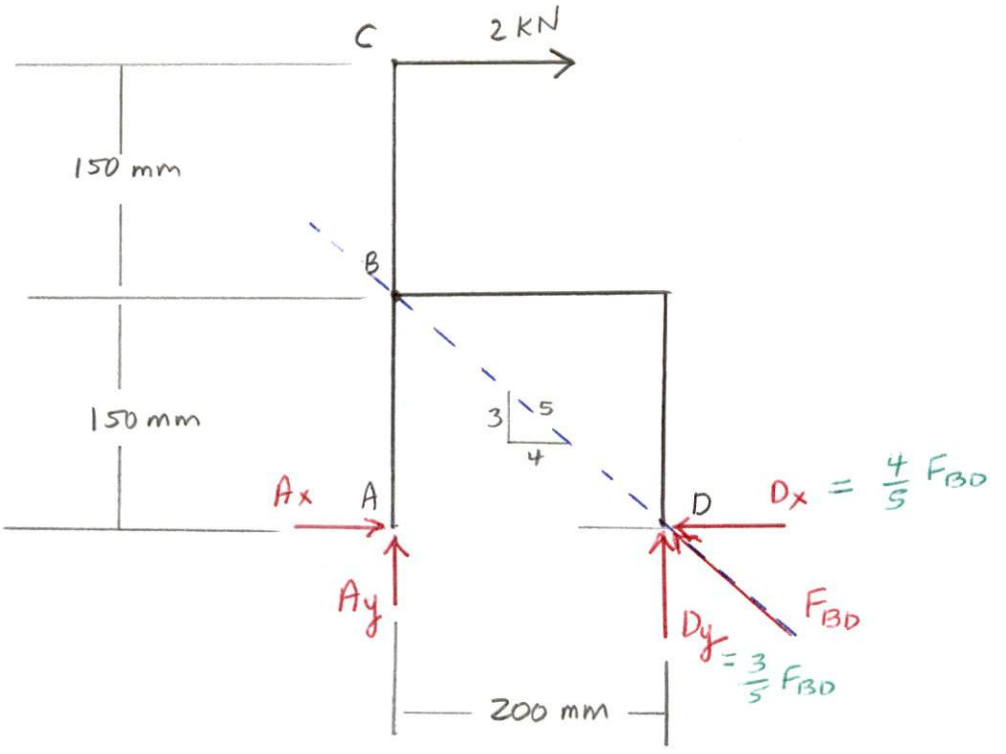
Law of Sines

$$\frac{R_A}{\sin 36.9°} = \frac{R_D}{\sin 123.7°} = \frac{2\,KN}{\sin 19.4°}$$

$$R_A = \frac{\sin 36.9° \,(2\,kN)}{\sin 19.4°} = 3.62\,kN \measuredangle 303.7°$$

$$R_D = \frac{\sin 123.7° \,(2\,kN)}{\sin 19.4°} = 5.0\,kN \measuredangle 143.1°$$

(b) Equilibrium Equations



FBD

CCW +M ↻
CW −M ↺

How many unknowns?

Ax
Ay
Dx
Dy
} 4 unknowns

can only solve for 3

Member BD is a TFM

Dx and Dy can be written in terms of F_{BD}

Equilibrium Equations

$$(\Sigma M_A = 0) \quad -2\,kN(300mm) + \frac{3}{5}F_{BD}(200mm) = 0$$

$$F_{BD} = \frac{5}{3}\left(\frac{2\,kN(300mm)}{200mm}\right) = 5\,kN$$

$$[\Sigma F_x = 0] \quad 2\,kN + A_x - \frac{4}{5}F_{BD} = 0$$

$$A_x = \frac{4}{5}(5\,kN) - 2\,kN = \underline{\underline{2\,kN}} \rightarrow$$

$$[\Sigma F_y = 0] \quad A_y + \frac{3}{5}F_{BD} = 0$$

"Guessed" incorrectly

$$A_y = -\frac{3}{5}(5\,kN) = -3\,kN \uparrow$$

and $\boxed{A_y = 3\,kN \downarrow}$ + scalar, True direction

check $R_A = \sqrt{A_x^2 + A_y^2}$

$= \sqrt{2\,kN^2 + 3\,kN^2} = 3.6\,kN$ ✓