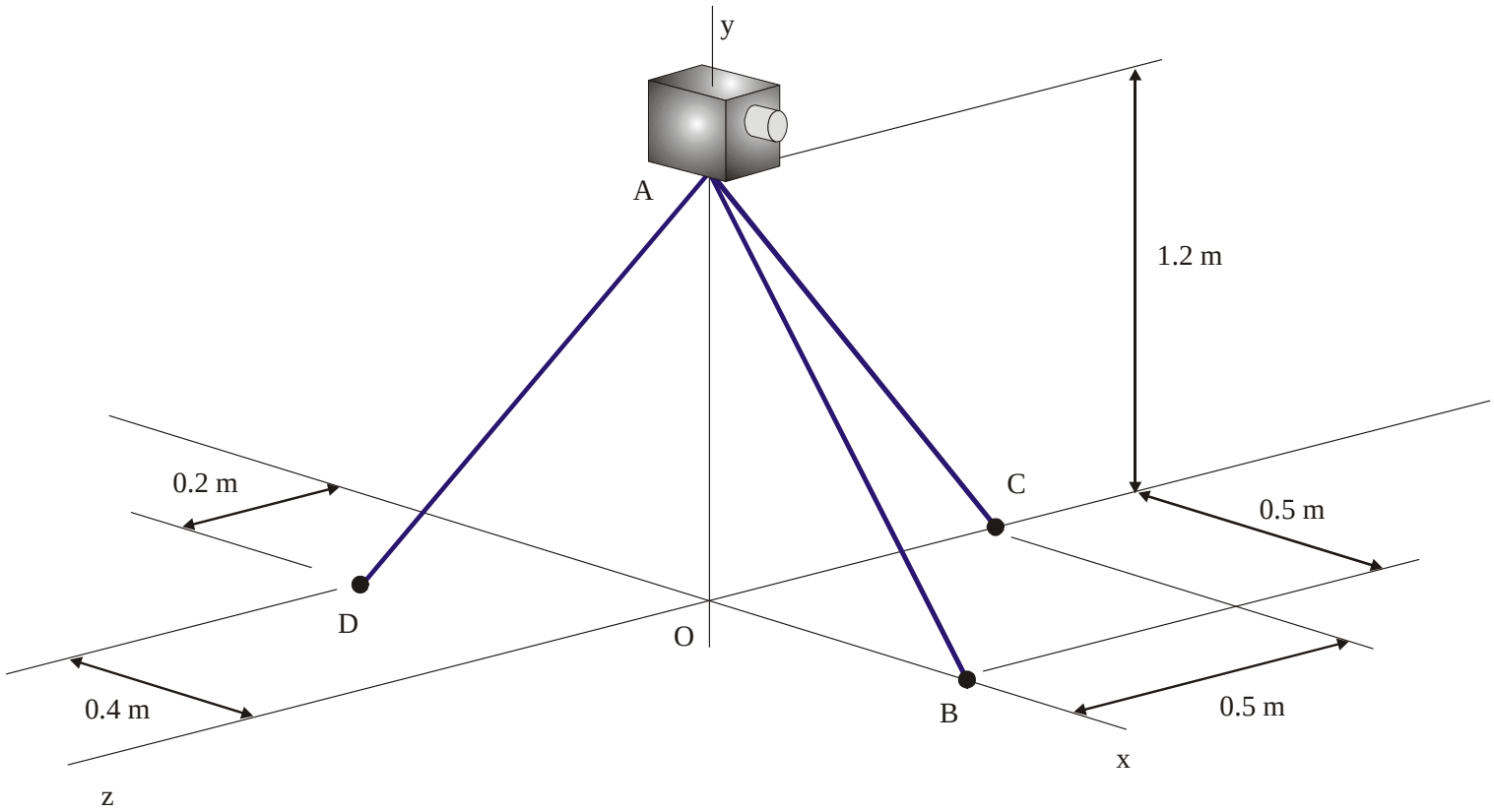
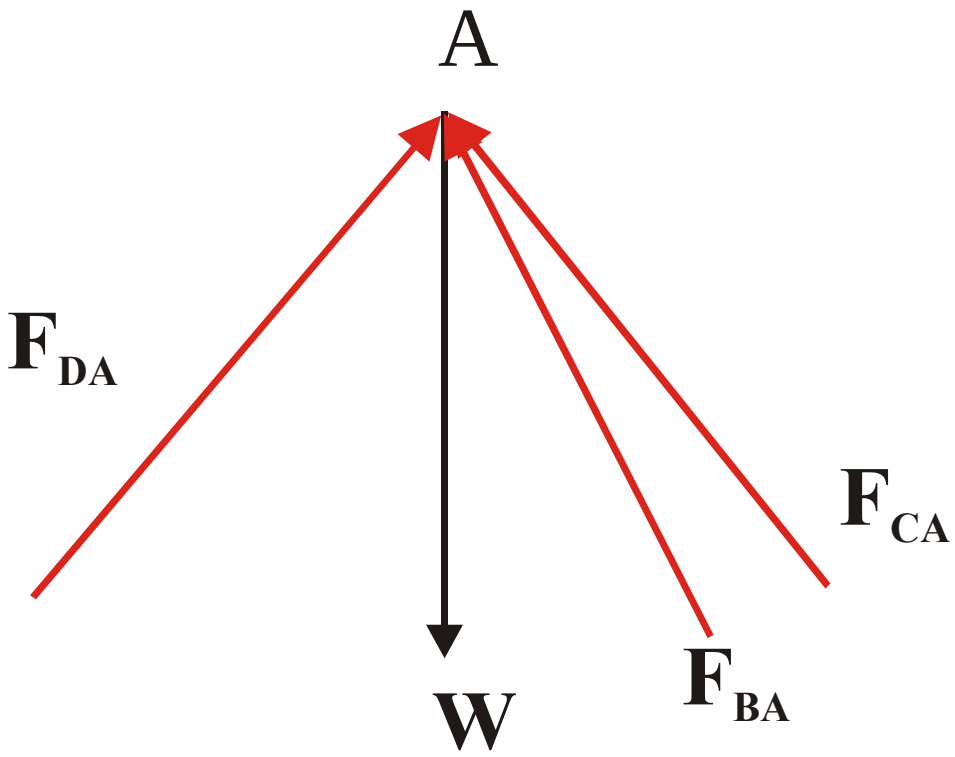
Example 5.4

Page 220 Text/Notes

A police video radar unit is supported by a tripod. Determine the weight of the radar unit and the compressive force in legs AB and AC if we know the compression in leg AD of the tripod is 220 N.

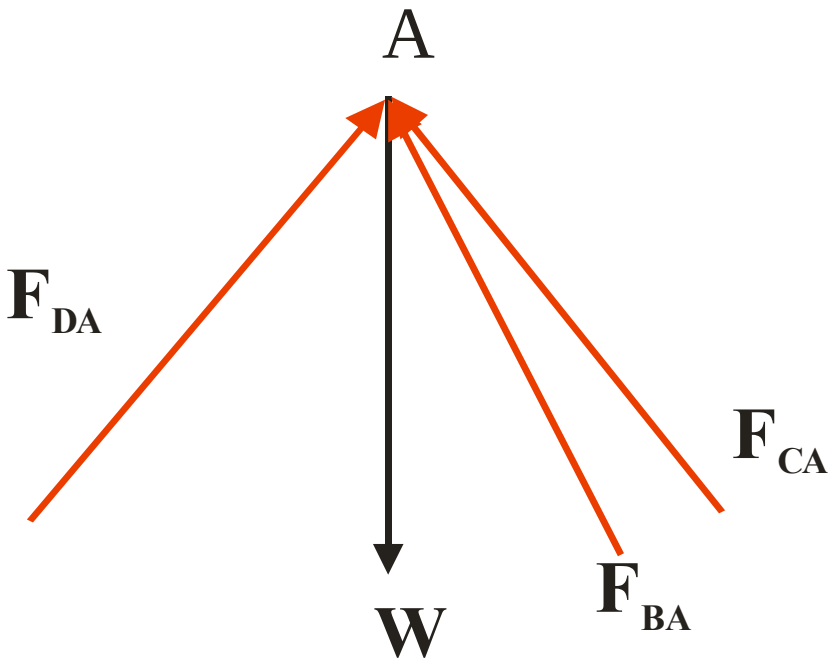


STEP 1 – DRAW THE FBD !!!



FBD of POINT A

STEP 2 – Write Coordinates of Two Points on the Line of Action of Each Force



FBD of POINT A

$$A:(0,1.2,0)$$

$$B:(0.5,0,0)$$

$$C:(0,0,-0.5)$$

$$D:(-0.4,0,0.2)$$

STEP 3 – Put all forces in the FBD in Component Form

$$\mathbf{F} = F\boldsymbol{\lambda}$$

(1) $-W\mathbf{j}$

(2) $\mathbf{F_{DA}} = F_{DA}\boldsymbol{\lambda}_{\mathbf{DA}} = 220\boldsymbol{\lambda}_{\mathbf{DA}}$

$$\boldsymbol{\lambda}_{\mathbf{DA}} = \frac{\mathbf{DA}}{DA} \qquad \mathbf{DA} = 0.4\mathbf{i} + 1.2\mathbf{j} - 0.2\mathbf{k} \quad \text{and} \quad DA = \sqrt{0.4^2 + 1.2^2 + (-0.2)^2} = \sqrt{1.64}$$

$$\mathbf{F_{DA}} = 220\left(\frac{0.4\mathbf{i} + 1.2\mathbf{j} - 0.2\mathbf{k}}{\sqrt{1.64}}\right)$$

$$\mathbf{F_{DA}} = 68.72\mathbf{i} + 206.15\mathbf{j} - 34.36\mathbf{k}$$

(3) $\mathbf{F_{BA}} = F_{BA}\boldsymbol{\lambda}_{\mathbf{DA}}$

$$\boldsymbol{\lambda}_{\mathbf{BA}} = \frac{\mathbf{BA}}{BA} \qquad \mathbf{BA} = -0.5\mathbf{i} + 1.2\mathbf{j} + 0\mathbf{k} \quad \text{and} \quad BA = \sqrt{(0.5)^2 + 1.2^2} = 1.3$$

$$\mathbf{F_{BA}} = F_{BA}\left(\frac{-0.5\mathbf{i} + 1.2\mathbf{j}}{1.3}\right)$$

$$\mathbf{F_{BA}} = \frac{-0.5\mathbf{F_{BA}}\mathbf{i}}{1.3} + \frac{1.2\mathbf{F_{BA}}\mathbf{j}}{1.3}$$

(4) $\mathbf{F_{CA}} = F_{CA}\boldsymbol{\lambda}_{\mathbf{CA}}$

$$\boldsymbol{\lambda}_{\mathbf{CA}} = \frac{\mathbf{CA}}{CA} \qquad \mathbf{CA} = 0\mathbf{i} + 1.2\mathbf{j} + 0.5\mathbf{k} \quad \text{and} \quad CA = \sqrt{(1.2)^2 + 0.5^2} = 1.3$$

$$\mathbf{F_{CA}} = F_{CA}\left(\frac{1.2\mathbf{j} + 0.5\mathbf{k}}{1.3}\right)$$

$$\mathbf{F_{CA}} = \frac{1.2\mathbf{F_{CA}}\mathbf{j}}{1.3} + \frac{0.5\mathbf{F_{CA}}\mathbf{k}}{1.3}$$

STEP 4 – Write Equilibrium Equations

$$\sum F_x = 0$$

$$\sum F_y = 0$$

$$\sum F_z = 0$$

EquilibriumEquations :

$$\sum F_x = 0 \qquad 68.72 - \frac{0.5}{1.3} F_{DA} = 0 \qquad \textbf{(1)}$$

$$\sum F_y = 0 \qquad -W + 206.15 + \frac{1.2}{1.3} F_{BA} + \frac{1.2}{1.3} F_{CA} = 0 \qquad \textbf{(2)}$$

$$\sum F_z = 0 \qquad \text{-}34.36 + \frac{0.5}{1.3} F_{CA} = 0 \qquad \textbf{(3)}$$

From **(1)** $\qquad F_{DA} = 68.72\left(\frac{1.3}{0.5}\right) = 178.67 \text{ N}$

From **(3)** $\qquad F_{CA} = 34.36\left(\frac{1.3}{0.5}\right) = 89.34 \text{ N}$

From **(2)** $\qquad F_{BA} = -W + 206.15 + \frac{1.2}{1.3}(178.67) + \frac{1.2}{1.3}(89.34) = 0$

$W = 453.54 \text{ N}$