Example 4.6

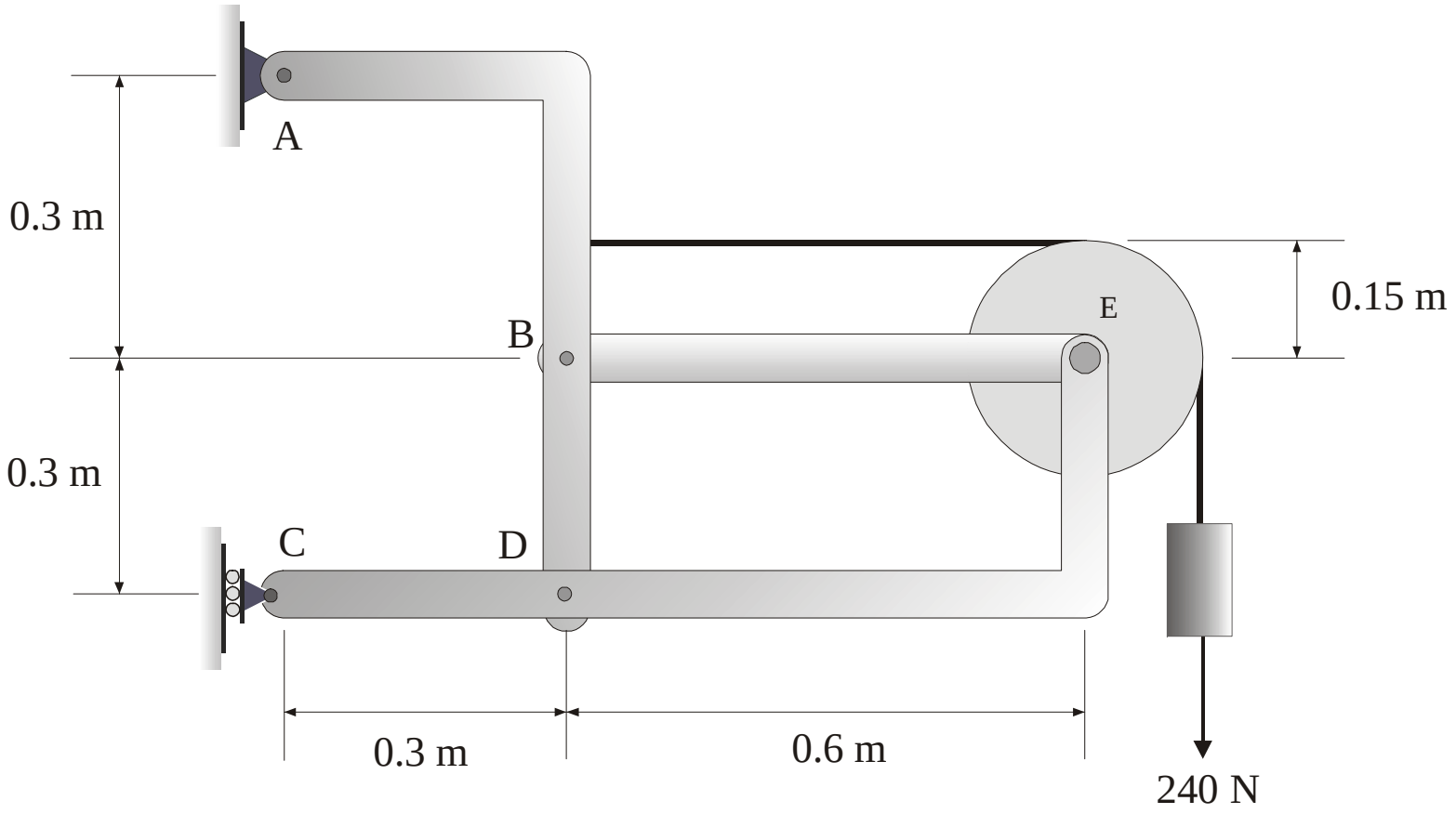
J. Frye

Steps

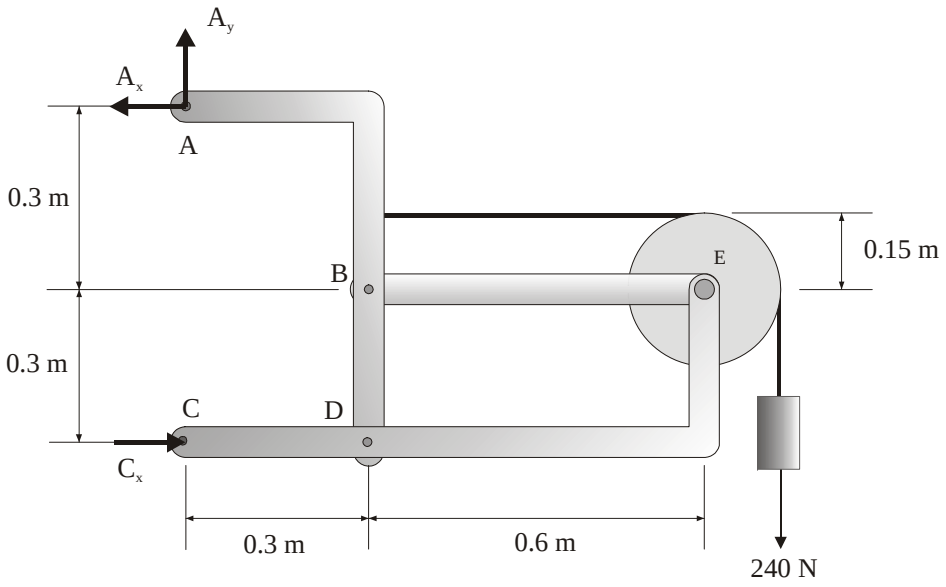
1. Draw a FBD of the entire structure and apply the equilibrium equations – solve for **as many unknowns** support reactions as you can.
2. **Identify any Two-Force members in the frame. (Identifying 2-Force members greatly simplifies the analysis.)**
1. Substructure – draw separate FBDs of each member of the frame. If three members are attached by a pin or if two members and an external support reaction are attached at a pin draw separate FBDs of these pins.
2. Apply the equilibrium equations to each FBD until all forces are determined.
3. CHECK!!!!!!!

Example 4.6:

Determine the forces on member *CDE*.



Draw the FBD of the entire frame and solve equilibrium equations for whatever reactions you can.



$$\sum F_x = 0 \rightarrow$$

$$-A_x + C_x = 0 \quad (1)$$

$$\sum F_y = 0 \uparrow$$

$$A_y - 240 = 0 \quad (2)$$

$$A_y = +240\text{N}$$

$$\therefore \mathbf{A_y} = 240\text{N} \uparrow$$

$$\sum M_A = 0$$

$$C_x(0.6) - 240(1.05) = 0 \quad (3)$$

$$C_x = +420\text{N}$$

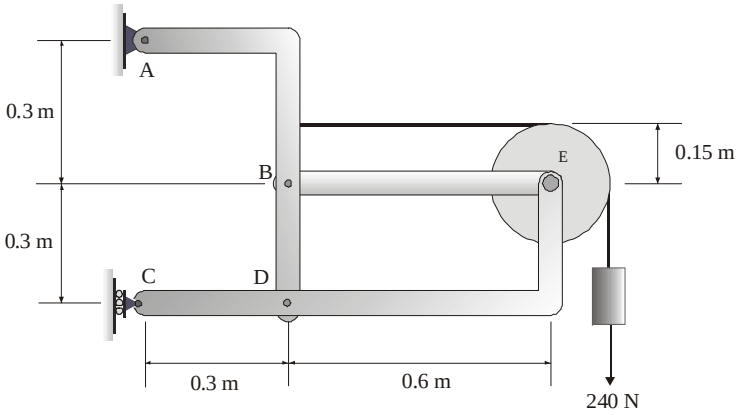
$$\therefore \mathbf{C_x} = 420\text{N} \rightarrow$$

Substitute in (1):

$$-A_x + 420 = 0$$

$$A_x = +420\text{N} \quad \text{(Direction in FBD is correct)}$$

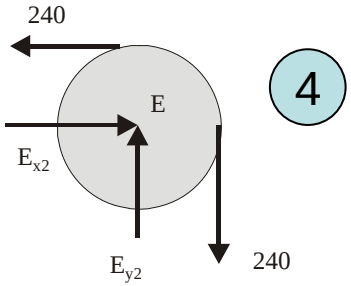
$$\therefore \mathbf{A_x} = 420\text{N} \leftarrow$$

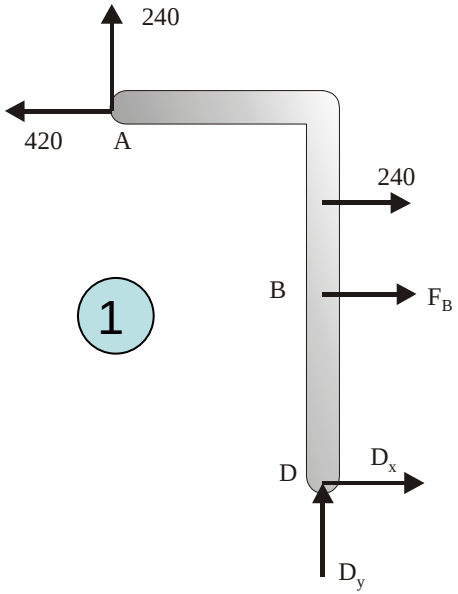


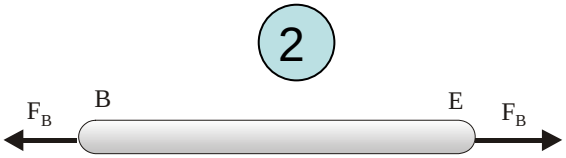
SUBSTRUCTURE:

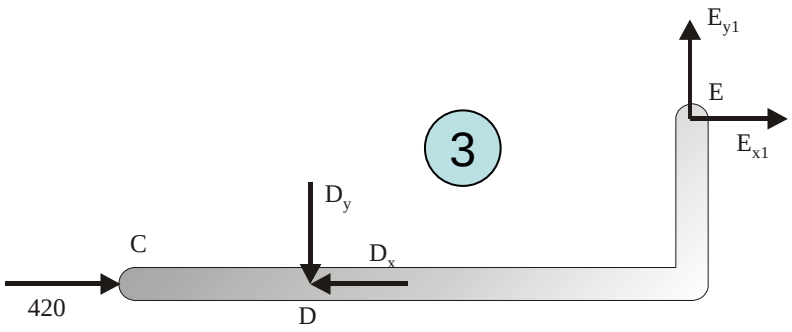
When sub-structuring, identify any 2-Force members (Member BE is a 2-Force member.)

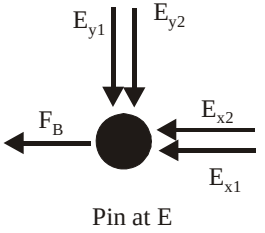
Since 3 Rigid Bodies are connected by a pin at E we will draw a separate FBD of the pin at E.

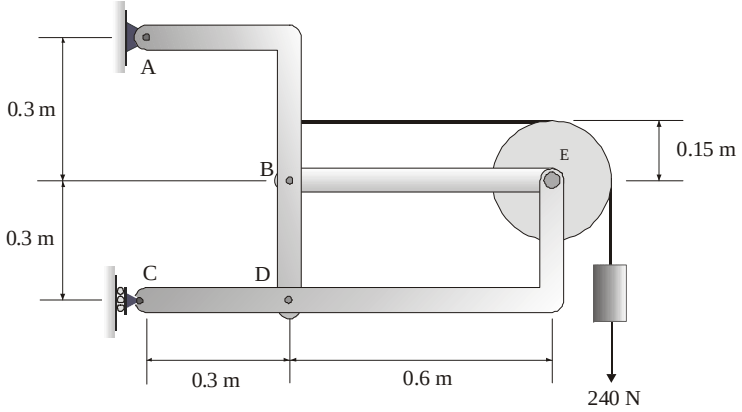




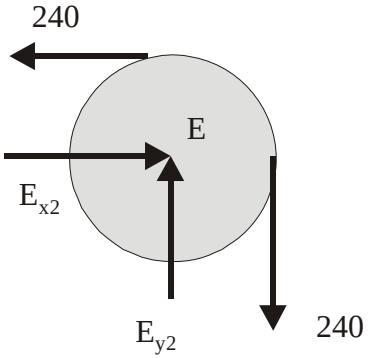








Equilibrium of the pulley



$$\sum F_x = 0$$

$$-240 + E_{x2} = 0$$

$$E_{x2} = +240\text{N}$$

$$\therefore \mathbf{E_{x2}} = 240\text{N} \rightarrow \text{on the pulley}$$

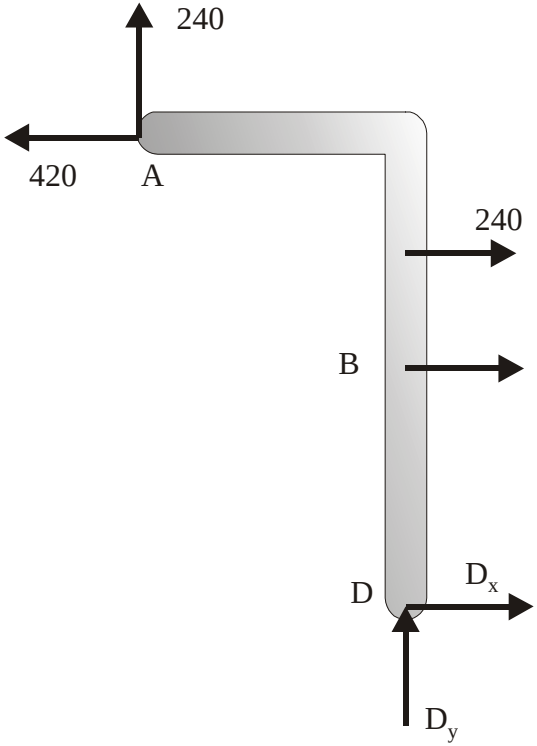
$$\sum F_y = 0 \uparrow$$

$$E_{y2} - 240 = 0$$

$$E_{y2} = +240\text{N}$$

$$\therefore \mathbf{E_{y2}} = 240 \uparrow \text{ on the pulley}$$

Equilibrium of ABD



$$\sum F_x = 0 \rightarrow$$

$$-420 + 240 + F_B + D_x = 0 \quad (1)$$

$$\sum F_y = 0 \uparrow$$

$$240 + D_y = 0$$

$$D_y = -240\text{N}$$

$$\therefore \mathbf{D_y} = 240\text{N} \downarrow \text{ on member ABD}$$

$$\sum M_D = 0$$

$$420(0.6) - 240(0.3) - 240(0.45) - F_B(0.3) = 0$$

$$F_B = \frac{72}{0.3} = 240\text{N}$$

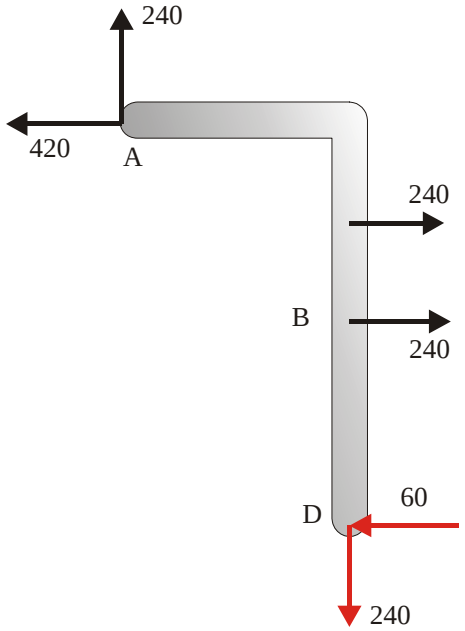
$$\therefore \mathbf{F_B} = 240\text{N} \rightarrow \text{on member ABD}$$

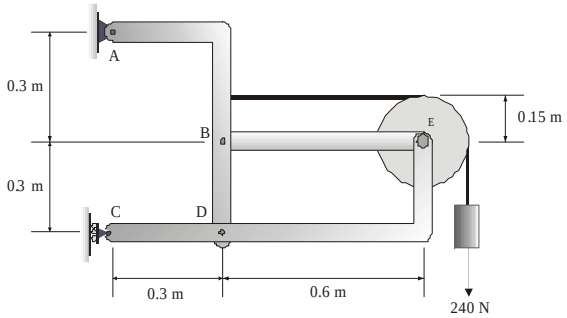
Substitute in (1):

$$-420 + 240 + 240 + D_x = 0$$

$$D_x = -60\text{N}$$

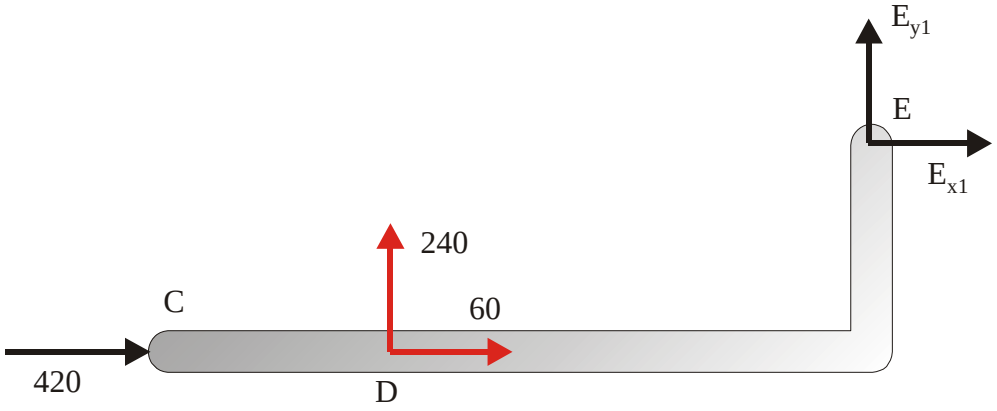
$$\therefore \mathbf{D_x} = 60\text{N} \leftarrow \text{on member ABD}$$





Equilibrium of Member BE

We re-draw member CDE indicating the pin reactions at D in their correct directions and apply the equilibrium equations.



$$\sum F_x = 0 \rightarrow$$

$$420 + 60 + E_{x1} = 0$$

$$E_{x1} = -480\text{N}$$

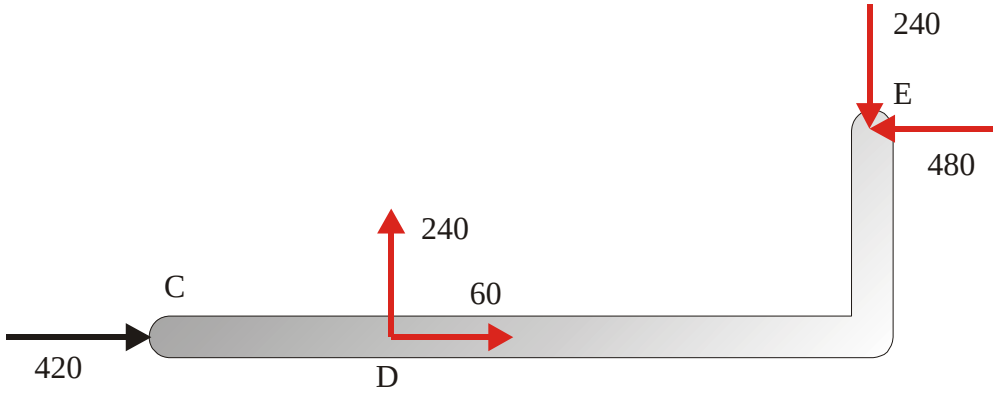
$$\therefore \mathbf{E_{x1}} = 480\text{N} \leftarrow \text{ on member CDE}$$

$$\sum F_y = 0 \uparrow$$

$$240 + E_{y1} = 0$$

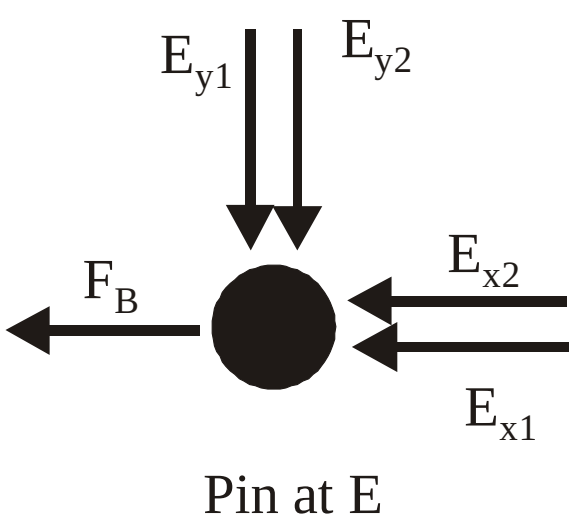
$$E_{y1} = -240\text{N}$$

$$\therefore \mathbf{E_{y1}} = 240\text{N} \downarrow \text{ on member CDE}$$

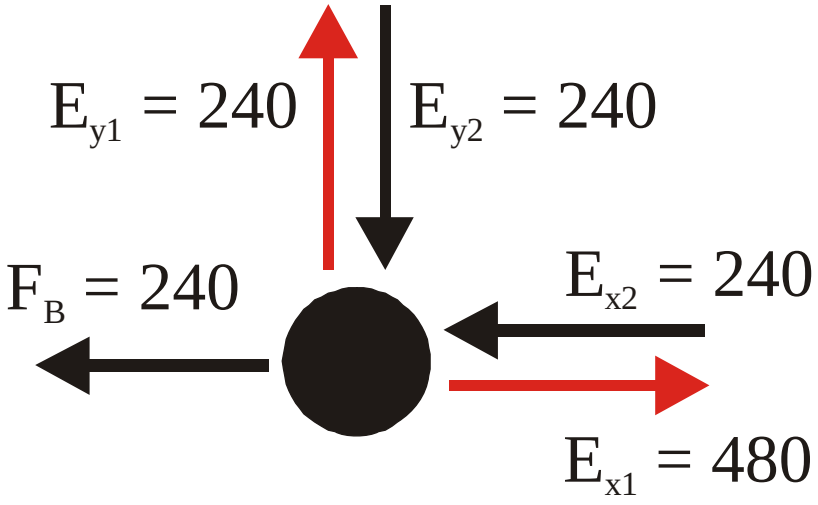


Equilibrium of Member CDE

Equilibrium of Pin at E:



Pin at E



Pin at E