

ii) Resolving vertically at D

$$V = 0 \text{ N}$$

Resolving vertically for system

$$V + V = 100$$

$$V + 0 = 100$$

$$V = 100 \text{ N}$$

iii) Moments about D

$$X \times 1 = 100 \times 2$$

$$X = 200 \text{ N}$$

Resolving horizontally

$$U + X = 0$$

$$U = -200 \text{ N}$$

iv) Horiz at D

$$T_{CD} = U = -200 \text{ N}$$

$$T_{CD} = -200 \text{ N} \quad (\therefore \text{compression})$$

Vert at A

$$T_{AC} \sin 45 = Y$$

$$\frac{1}{\sqrt{2}} T_{AC} = 100$$

$$T_{AC} = 100\sqrt{2} \text{ (tension)}$$

Horiz at A

$$X = T_{AB} + T_{AC} \cos 45$$

$$200 = T_{AB} + 100\sqrt{2} \times \frac{1}{\sqrt{2}}$$

$$\Rightarrow T_{AB} = 100 \text{ N (tension)}$$

Vert at B

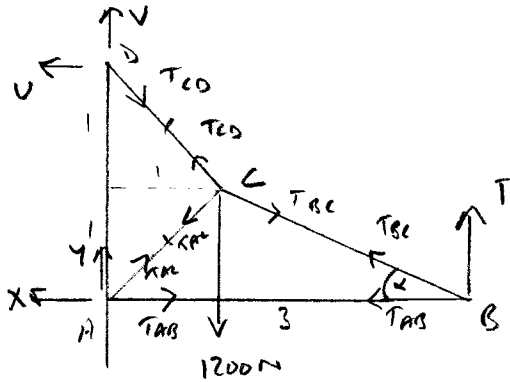
$$100 + T_{BC} \sin 45 = 0$$

$$\frac{1}{\sqrt{2}} T_{BC} = -100$$

$$T_{BC} = -100\sqrt{2} \text{ N}$$

(\therefore compression)

12)



i) Resolving horizontally $X + U = 0$
 $\Rightarrow X = -U$

Moments about A

$$3T + 2U = 1200 \times 1$$

$$2U = 1200 - 3T$$

$$\Rightarrow U = \frac{1}{2}(1200 - 3T)$$

ii) At D vert $V = T_{CD} \cos 45 = \frac{1}{\sqrt{2}} T_{CD}$
 Horiz $U = T_{CD} \sin 45 = \frac{1}{\sqrt{2}} T_{CD}$
 $\therefore U = V$

iii) Resolve vertically

$$V + Y + T = 1200$$

$$Y = 1200 - V - T$$

$$Y = 1200 - \frac{1}{2}(1200 - 3T) - T$$

$$Y = 1200 - 600 + \frac{3T}{2} - T$$

$$Y = 600 + \frac{T}{2}$$

$$Y = \frac{1}{2}(1200 + T)$$

At D

$$U = T_{CD} \cos 45 = \frac{1}{\sqrt{2}} T_{CD}$$

$$T_{CD} = \sqrt{2} U = \frac{\sqrt{2}}{2} (1200 - 3T)$$

Vert at B $T + T_{BC} \sin \alpha = 0$

Now $\sin \alpha = \frac{1}{\sqrt{5}}$

$$\therefore T_{BC} \frac{1}{\sqrt{5}} = -T$$

$$T_{BC} = -\sqrt{5} T$$

Horiz at B

$$T_{AB} + T_{BC} \cos \alpha = 0$$

$$T_{AB} + T_{BC} \times \frac{2}{\sqrt{5}} = 0$$

$$T_{AB} = -T_{BC} \times \frac{2}{\sqrt{5}}$$

$$T_{AB} = 2T$$

Vert at A

$$Y + T_{AC} \sin 45 = 0$$

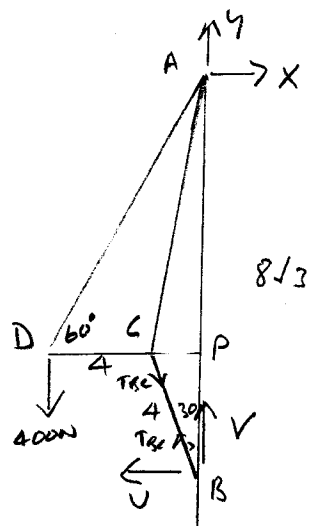
$$\frac{1}{\sqrt{2}} T_{AC} = -Y = -\frac{1}{2}(1200 + T)$$

$$T_{AC} = -\frac{\sqrt{2}}{2} (1200 + T)$$

Only T_{CD} changes sign from + to - as T increases

$$T_{CD} = 0 \text{ when } T = 400 \text{ N}$$

1A)



i) Moments about A

$$400(4 + 4\sin 30) = U \times 8\sqrt{3}$$

$$2400 = U \times 8\sqrt{3}$$

$$\Rightarrow U = \frac{300}{\sqrt{3}} = 100\sqrt{3} \text{ N}$$

Resolving horizontally

$$U = X$$

$$\therefore U = X = 100\sqrt{3} \text{ N}$$

ii)

Horiz at B

$$U + T_{BC} \sin 30 = 0$$

$$\frac{1}{2} T_{BC} = -U = -100\sqrt{3}$$

$$T_{BC} = -200\sqrt{3} \text{ N}$$

\therefore Compression

Vert at B

$$V + T_{BC} \cos 30 = 0$$

$$V = -\frac{\sqrt{3}}{2} T_{BC}$$

$$V = 300 \text{ N}$$

Resolve vertically

$$V + Y = 400$$

$$\therefore Y = 100 \text{ N}$$

iii)

Vert at D

$$T_{AD} \sin 60 = 400$$

$$T_{AD} \times \frac{\sqrt{3}}{2} = 400$$

$$T_{AD} = \frac{800}{\sqrt{3}} \text{ N (tension)}$$

Horiz at D

$$T_{CD} + T_{AD} \cos 60 = 0$$

$$T_{CD} = -\frac{1}{2} T_{AD}$$

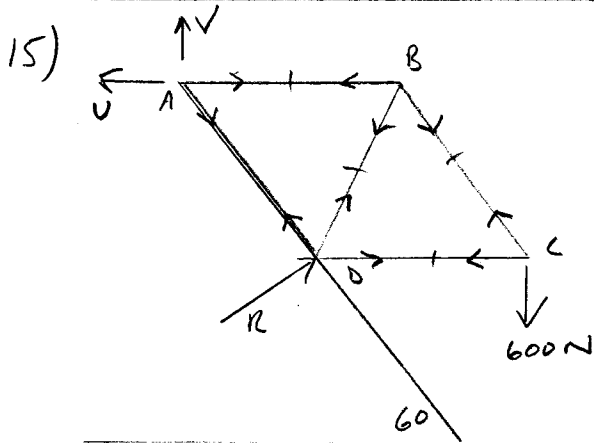
$$T_{CD} = -\frac{400}{\sqrt{3}} \text{ N (compression)}$$

iv)

Since T_{BC} is in compression

T_{AC} also in compression to ensure vertical equilibrium at C

H



i) Vert $V + R \sin 30 = 600$

Horiz $U = R \cos 30^\circ$

ii)

Moments about A

$$3 \times 600 = 2 \times R$$

$$1800 = 2R$$

$$\Rightarrow R = 900 \text{ N}$$

$$U = 900 \cos 30$$

$$U = 900 \times \frac{\sqrt{3}}{2} = 450\sqrt{3} \text{ N}$$

$$V + 900 \sin 30 = 600$$

$$V = 600 - 900 \times \frac{1}{2}$$

$$V = 150 \text{ N}$$

iii)

Vert at A

$$V = T_{AD} \sin 60^\circ$$

$$150 = T_{AD} \times \frac{\sqrt{3}}{2}$$

$$T_{AD} = \frac{300}{\sqrt{3}}$$

$$T_{AD} = 100\sqrt{3} \text{ N (tension)}$$

Horiz at A

$$T_{AB} + T_{AD} \cos 60 = U$$

$$T_{AB} = 450\sqrt{3} - T_{AD} \times \frac{1}{2}$$

$$T_{AB} = 450\sqrt{3} - 50\sqrt{3}$$

$$T_{AB} = 400\sqrt{3} \text{ N (tension)}$$

Vert at C

$$T_{BC} \sin 60 = 600$$

$$T_{BC} \times \frac{\sqrt{3}}{2} = 600$$

$$T_{BC} = \frac{1200}{\sqrt{3}} = 400\sqrt{3} \text{ N (tension)}$$

Horiz at C

$$T_{CD} + T_{BC} \cos 60 = 0$$

$$T_{CD} = -T_{BC} \times \frac{1}{2} = -200\sqrt{3} \text{ N}$$

$$T_{CD} = -200\sqrt{3} \text{ N (compression)}$$

Vert at B

$$T_{BD} \sin 60 + T_{BC} \sin 60 = 0$$

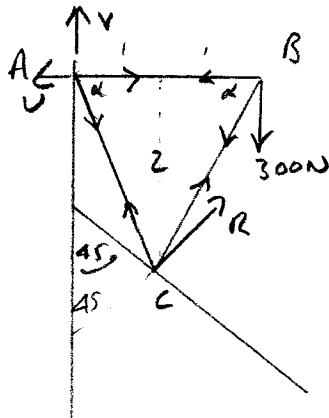
$$T_{BD} = -T_{BC}$$

$$T_{BD} = -400\sqrt{3} \text{ N}$$

(compression)

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16)



$$\sin \alpha = \frac{2}{\sqrt{5}}$$

$$\cos \alpha = \frac{1}{\sqrt{5}}$$

i) Vert

$$V + R \cos 45^\circ = 300$$

Horiz

$$U = R \sin 45^\circ$$

ii)

Resolve R vert and horiz

$$R = R_H + R_V$$

$$R_H = R \cos 45 = \frac{1}{\sqrt{2}} R$$

$$R_V = R \sin 45 = \frac{1}{\sqrt{2}} R$$

Anticlockwise moment at R

$$= 2 \times R_H + 1 \times R_V$$

$$= 2 \times \frac{1}{\sqrt{2}} R + 1 \times \frac{1}{\sqrt{2}} R$$

$$= \frac{3}{\sqrt{2}} R \text{ Nm}$$

Moments about A

$$\frac{3}{\sqrt{2}} R = 300 \times 2 = 600$$

$$R = \frac{600 \sqrt{2}}{3} = 200 \sqrt{2} \text{ N}$$

iii) $U = 200 \sqrt{2} \times \frac{1}{\sqrt{2}} = 200 \text{ N}$

$$V + 200 \sqrt{2} \times \frac{1}{\sqrt{2}} = 300$$

$$V + 200 = 300$$

$$V = 100 \text{ N}$$

iv)

Vert at A

$$V = T_{AC} \sin \alpha$$

$$T_{AC} \times \frac{2}{\sqrt{5}} = 100$$

$$T_{AC} = 50 \sqrt{5} \text{ N (tension)}$$

Horiz at A

$$U = T_{AC} \cos \alpha + T_{AB}$$

$$200 = 50 \sqrt{5} \times \frac{1}{\sqrt{5}} + T_{AB}$$

$$T_{AB} = 200 - 50$$

$$T_{AB} = 150 \text{ N (tension)}$$

Vert at B

$$T_{BC} \sin \alpha + 300 = 0$$

$$T_{BC} \times \frac{2}{\sqrt{5}} = -300$$

$$T_{BC} = -150 \sqrt{5} \text{ N}$$

(compression)