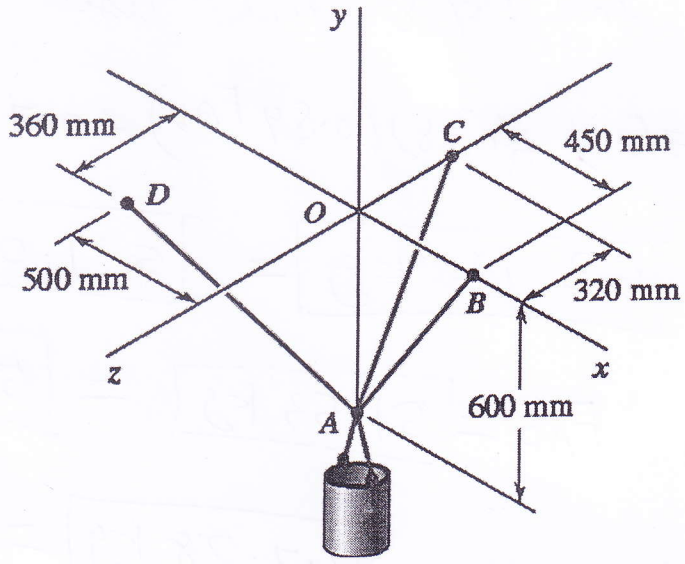
ME 247: Engineering Mechanics-I Time: 20 Mins.

CT# 1 Name: Student #:

A container of mass m = 120 kg is supported by three cables as shown. Determine the tension in each cable.

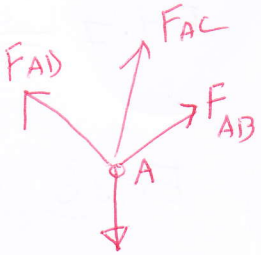


$A = A(0, -600, 0)$

$B = B(450, 0, 0)$

$C = C(0, 0, -320)$

$D = D(-500, 0, 360)$



$\bar{AB} = 450\bar{i} + 600\bar{j}$; $AB = 750$

$\bar{F}_{AB} = \frac{F_{AB}}{750}(450\bar{i} + 600\bar{j}) = F_{AB}(0.6\bar{i} + 0.8\bar{j})$ — (1)

$\bar{AC} = 600\bar{j} - 320\bar{k}$; $AC = 680$

$\bar{F}_{AC} = \frac{F_{AC}}{680}(600\bar{j} - 320\bar{k}) = F_{AC}(0.88\bar{j} - 0.47\bar{k})$ — (2)

$\bar{AD} = -500\bar{i} + 600\bar{j} + 360\bar{k}$; $AD = 860$

$\bar{F}_{AD} = \frac{F_{AD}}{860}(-500\bar{i} + 600\bar{j} + 360\bar{k}) = F_{AD}(-0.58\bar{i} + 0.70\bar{j} + 0.42\bar{k})$ — (3)

$\bar{W} = -W\bar{j} = -120\bar{j}$ — (4)

For equilibrium, $\bar{F}_{AB} + \bar{F}_{AC} + \bar{F}_{AD} + \bar{W} = 0$

$F_{AB}(0.6\bar{i} + 0.8\bar{j}) + F_{AC}(0.88\bar{j} - 0.47\bar{k}) + F_{AD}(-0.58\bar{i} + 0.70\bar{j} + 0.42\bar{k}) - 120\bar{j} = 0$

$$\Rightarrow (0.6F_{AB} - 0.58F_{AD})\hat{i} + (0.8F_{AB} + 0.88F_{AC} + 0.7F_{AD} - 120)\hat{j}$$
$$+(-0.47F_{AC} + 0.42F_{AD})\hat{k} = 0$$

$\hat{i}$: $0.6F_{AB} - 0.58F_{AD} = 0$ — (4)

$\hat{j}$: $0.8F_{AB} + 0.88F_{AC} + 0.7F_{AD} - 120 = 0$ — (5)

$\hat{k}$: $-0.47F_{AC} + 0.42F_{AD} = 0$ — (6)

Eq. (4) $\Rightarrow$ $F_{AB} = 0.97F_{AD}$ — (7)

Eq. (6) $\Rightarrow$ $F_{AC} = 0.89F_{AD}$ — (8)

Eq. (7) and Eq (8) are used in Eq. (5)

$(0.8)(0.97F_{AD}) + (0.88)(0.89F_{AD}) + 0.7F_{AD} = 120$

$F_{AD} = \boxed{53.12 \text{ kg}} = \boxed{521.07 \text{ N}}$ Ans

Eq. 7 $\Rightarrow$ $F_{AB} = \boxed{51.53 \text{ kg}} = \boxed{505.47 \text{ N}}$ Ans

Eq. (8) $\Rightarrow$ $F_{AC} = \boxed{47.28 \text{ kg}} = \boxed{463.79 \text{ N}}$ Ans