MECHANICS

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29/09/20 * Tutorial Sheet 1

① $|\vec{F}| = 100$

$\hat{OP} = \frac{13\hat{i} + 4\hat{j} + 6\hat{k}}{\sqrt{249}}$

$\vec{F} = |F| \hat{OP}$

$\vec{F} = 37.4\hat{i} + 26.9\hat{j} + 40.4\hat{k}$

② $\vec{F} = 15k\hat{i} + 26k\hat{j} - 33k\hat{k}$

$|\vec{F}| = \sqrt{1990 \times 10^6} = 44.61\ kN$

$\alpha = \cos^{-1}\left(\frac{15}{44.61}\right) = 70.35°$

$\beta = \cos^{-1}\left(\frac{26}{44.61}\right) = 54.35°$

$\gamma = \cos^{-1}\left(\frac{-33}{44.61}\right) = 137.71°$

③ $\vec{F_1} = 80 \times 10^3 \left(\frac{5\hat{i} + \hat{j} - 5\hat{k}}{\sqrt{51}}\right)$

$= 21k\hat{i} + 4.2k\hat{j} - 21k\hat{k}$

$\vec{F_2} = 40 \times 10^3 \left(\frac{-5\hat{i} - 4\hat{j} + 2\hat{k}}{\sqrt{45}}\right)$

$= -29.8k\hat{i} - 23.8k\hat{j} + 11.9k\hat{k}$

$\vec{F_3} = 50 \times 10^3 \left(\frac{-4\hat{i} + \hat{k}}{\sqrt{17}}\right)$

$= -48.5k\hat{i} + 12.1k\hat{k}$

$\vec{F_4} = 60 \times 10^3 \left(\frac{3\hat{i} - 5\hat{j} + 3\hat{k}}{\sqrt{43}}\right)$

$= 27.4k\hat{i} - 45.8k\hat{j} + 27.4k\hat{k}$

$\vec{F_{net}} = -29.9k\hat{i} - 65.4k\hat{j} + 30.4k\hat{k}$

④ $F_x = 600\cos 45° - 800\cos 30° - 450\cos 15°$

$= 424.8 - 692 - 434.66$

$= -703.2\hat{i}$

$F_y = 600\sin 45° + 800\sin 30° - 450\sin 15°$

$= 424.3 + 400 - 116.4$

$= +707.8\hat{j}$

$\vec{F} = -703.2\hat{i} + 707.8\hat{j}$

$|\vec{F}| = 997.74\ N$

$\alpha = \cos^{-1}\left(\frac{-703.2}{997.74}\right) = 134.8°$

⑤ $14 = \sqrt{10^2 + 6^2 + 2.10.6\cos\theta}$

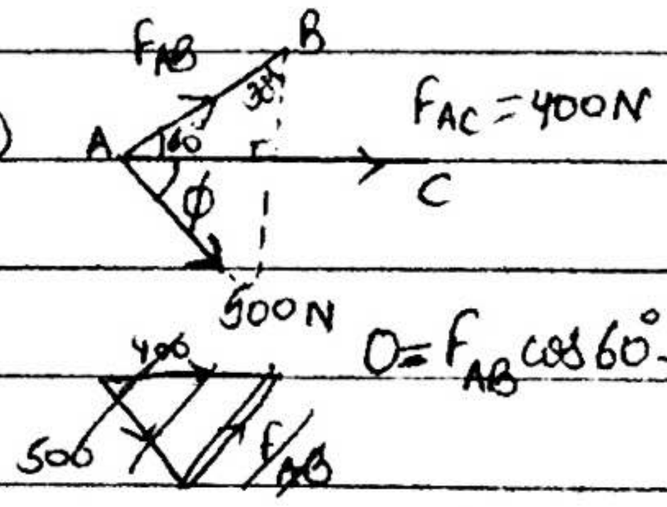
$\Rightarrow 196 = 100 + 36 + 120\cos\theta$

$\Rightarrow 60 = 120\cos\theta$

$\Rightarrow 1/2 = \cos\theta$

$\therefore \boxed{\theta = 60°}$

⑥



$0 = F_{AB}\cos 60° + 400 + 500\cos\phi$ -①

$0 = F_{AB}\sin 60° - 500\sin\phi$ -②

$R = 500$

$500 = \sqrt{(\Sigma F_x)^2 + (\Sigma F_y)^2}$

$F_{AB} = 500\sin\phi \times 2/\sqrt{3} = \frac{1000\sin\phi}{\sqrt{3}}$

$\Rightarrow \frac{1000\sin\phi}{\sqrt{3}} \times \frac{1}{2} + 400 + 500\cos\phi = 0$

$\Rightarrow \frac{500 \times 2}{\sqrt{3}}\left(\frac{\sin\phi}{2} + \frac{\sqrt{3}}{2}\cos\phi\right) = -400$

$\Rightarrow \sin(\phi + 60) = -2\sqrt{3}/5$

$\Rightarrow \boxed{\phi = -103.68 \text{ or } 76.32°}$

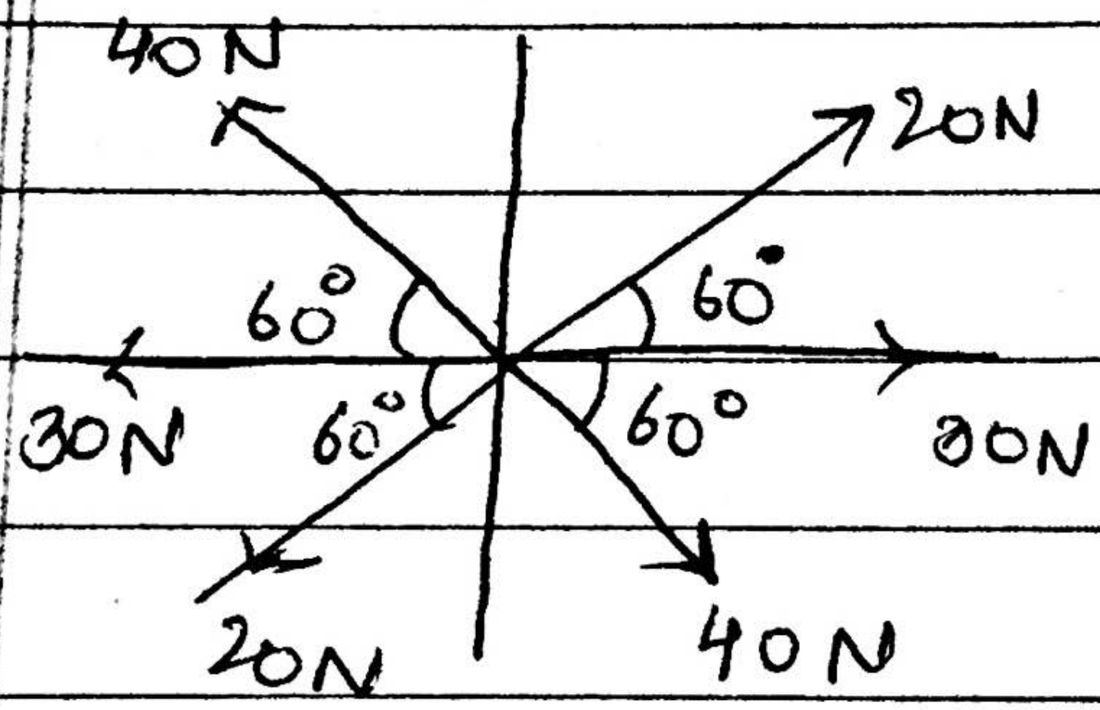
(7) $\vec{R} = 400\cos 60^\circ \hat{i} + 400\hat{i} + 400\sin 60^\circ$

$= 600\hat{i} + 200\sqrt{3}\hat{j}$

$|\vec{R}| = 692.8\ N$

$\theta = \tan^{-1}\left(\frac{200\sqrt{3}}{600}\right) = \boxed{30^\circ = \theta}$

(8)



$\vec{F} = 0$, $\Sigma F_x = 0$, $\Sigma F_y = 0$

$|\vec{F}| = 0$

as all of the forces get cancelled.