CE 201 - STATICS

(Sections 4 & 6)

First Semester 1429-30 / 2008-09 (081)

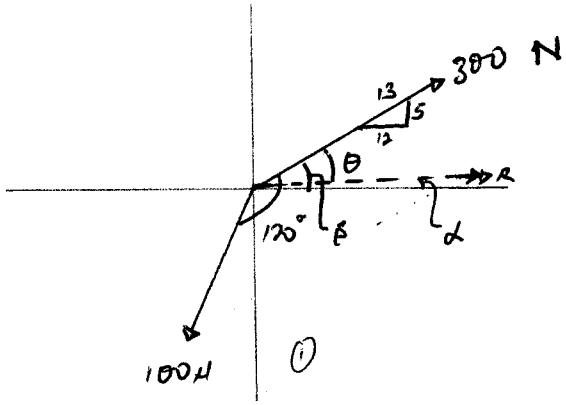
H. W. #1. Solution

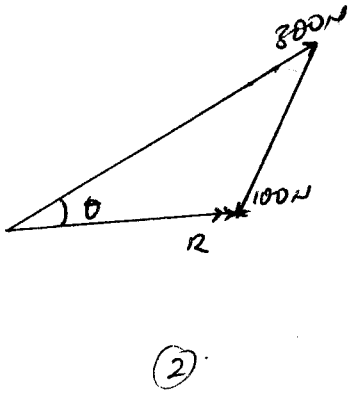
Problem 1

Given: Forces indicated in figure

Required: The value and direction of the resultant.

Soln.





Using the cosine rule in figure ②

$$R^2 = (300^2) + (100^2) - 2(300)(100)\cos 60^\circ$$

$$R^2 = 70,000$$

$$R = 264.575\,N \approx 264.6\ N$$

Using Sine Rule

$$\frac{100}{\sin\theta} = \frac{264.575}{\sin 60^\circ}$$

$$\theta = 19.11^\circ$$

$$\alpha = \beta - \theta$$

$$= \left(\tan^{-1}\frac{5}{12}\right) - 19.11$$

$$= 22.62 - 19.11$$

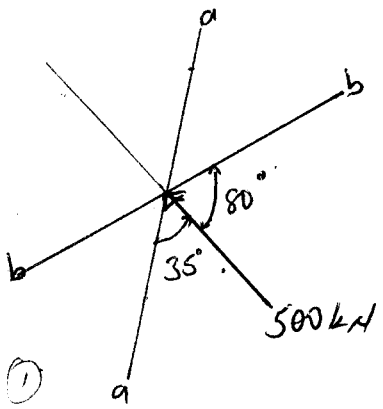
$$\alpha = 3.51^\circ$$

Problem 2.

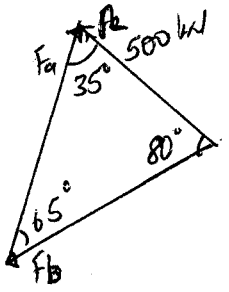
Given: force shown in Fig.

Required: Two components of force along lines a and b.

Soln



(1)



(2)

Using Sine Rule in figure (2)

$$\frac{500}{\sin 65^\circ} = \frac{F_a}{\sin 80^\circ} = \frac{F_b}{\sin 35^\circ}$$

$$F_a = \frac{500(\sin 80^\circ)}{\sin 65^\circ}$$

$$F_b = \frac{500(\sin 35^\circ)}{\sin 65^\circ}$$

$$F_a = 543.31 \text{ kN}$$

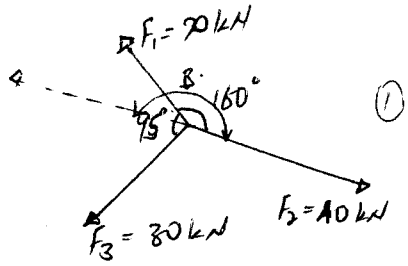
$$F_b = 316.44 \text{ kN}.$$

Problem 3.

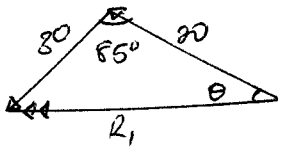
Given: Magnitude and direction of 3 forces

Required: Magnitude and direction of resultant.

Soln.



①



②

Using Cosine Rule.

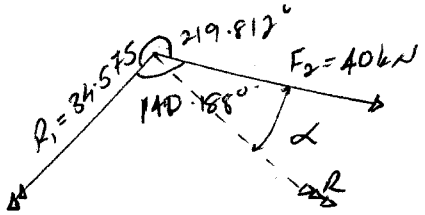
$R_1^2 = (20^2) + (30)^2 - 2(20)(30)\cos 85°$

$R_1 = 34.575$ kN.

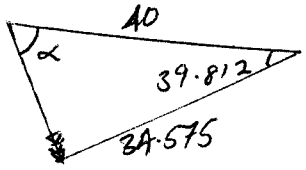
Using Sine Rule.

$\frac{\sin\theta}{30} = \frac{\sin 85°}{34.575}$, $\theta = 59.812°$

$\beta = 160° + 59.812° = 219.812°$



③



Resultant Force, R

$R^2 = (34.575)^2 + (40)^2 - 2(34.575)(40)\cos(39.812)$

$R = 25.90$ kN.

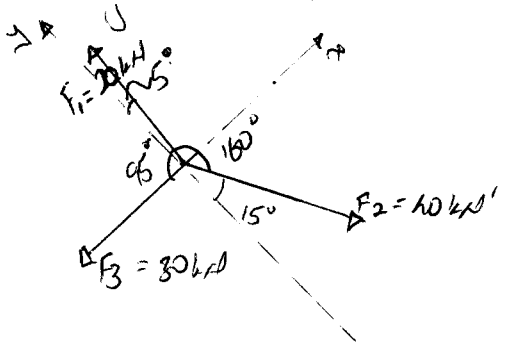
$\frac{\sin\alpha}{34.575} = \frac{\sin 39.812}{25.9}$

$\alpha = 58.73°$

"checking"

Problem 3 - Proving by using Cartesian Vectors.

Required: Magnitude & direction of the resultant.



Resolving the forces in the x and y direction in relation to the figure above

$F_{1x} = 20 \sin 5° = 1.743\ kN$ $\quad F_{1y} = 20 \cos 5° = 19.92\ kN$

$F_{2x} = 40 \sin 15° = 10.35\ kN$ $\quad F_{2y} = 40 \cos 15° = -38.64\ kN$

$F_{3x} = F_3 = -30\ kN$

$\Sigma F_x = (-30 + 10.35 + 1.743)\ kN$ $\quad \Sigma F_y = (19.92 - 38.64)\ kN$

$= -17.907\ kN$ $\quad = -18.72\ kN$

Resultant, $R = \sqrt{F_x^2 + F_y^2}$

$= \sqrt{(17.907)^2 + (18.72)^2}$

$\boxed{R = 25.91\ kN}$ as before

Direction of Resultant, $\theta = \left(\tan^{-1} \frac{F_y}{F_x}\right)$

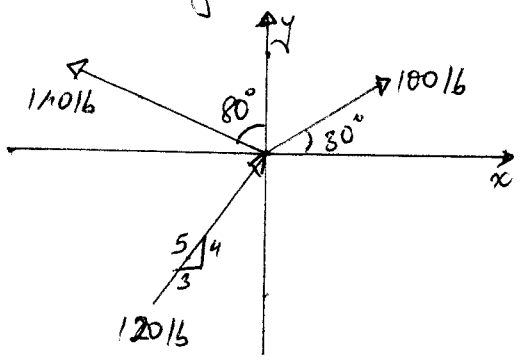
$\theta = \left(\frac{-18.72}{-17.907}\right) \tan^{-1}$

$\boxed{\theta = 46.27°}$ as before

Problem 4

Given: Three forces.

Required: Magnitude and direction of the resultant.



Soln.

$$\Sigma F_x = F_{Rx}$$

$$\xrightarrow{+} F_{Rx} = 100\cos 30^\circ + 120\left(\tfrac{3}{5}\right) - 140\sin 80^\circ$$

$$F_{Rx} = 20.73 \text{ lb}$$

$$\Sigma F_y = F_{Ry}$$

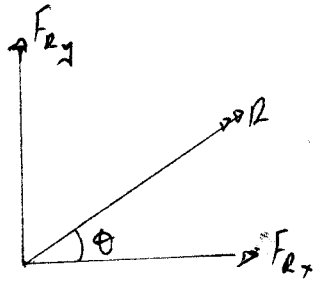
$$+\uparrow F_{Ry} = 100\sin 30^\circ + 140\cos 80^\circ + 120\left(\tfrac{4}{5}\right)$$

$$F_{Ry} = 170.31 \text{ lb}$$

$$R = \sqrt{F_{Rx}^2 + F_{Ry}^2}$$

$$R = \sqrt{20.73^2 + 170.31^2}$$

$$\underline{\underline{R = 171.57 \text{ lb}}}$$



$$\theta = \tan^{-1}\left(\frac{F_{Ry}}{F_{Rx}}\right)$$

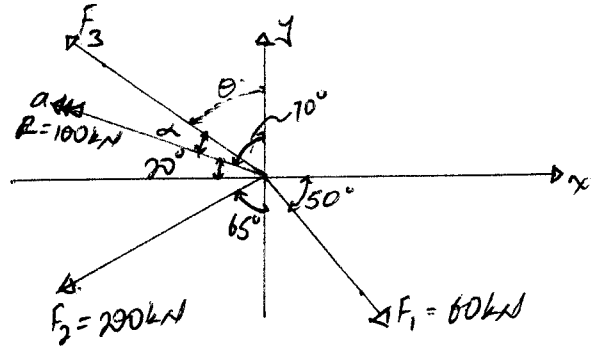
$$\theta = \tan^{-1}\left(\frac{170.31}{20.73}\right)$$

$$\underline{\underline{\theta = 83.06^\circ}}$$

Problem 5

Given: Two forces, Resultant and direction

Required: Magnitude and direction of force, F_3.



Soln.

$$R = \sqrt{R_x^2 + R_y^2}$$

$$R_x = \Sigma F_x$$

$$R_y = \Sigma F_y$$

$$R_x = F_{1x} + F_{2x} + F_{3x}$$

$$-100\cos 20^\circ = 60\cos 50^\circ - 200\sin 65^\circ - F_3 \sin\theta$$

$$F_3 \sin\theta = -48.725\ kN \Rightarrow F_3 = \frac{-48.725}{\sin\theta}$$

$$R_y = F_{1y} + F_{2y} + F_{3y}$$

$$100\sin 20 = -60\sin 50^\circ - 200\cos 65^\circ + F_3\cos\theta$$

$$F_3\cos\theta = 164.688\ kN \Rightarrow F_3 = \frac{164.688}{\cos\theta}$$

$$\frac{-48.725}{\sin\theta} = \frac{164.688}{\cos\theta} \Rightarrow \tan\theta = \frac{-48.725}{164.688}$$

$$\theta = -16.48^\circ$$

$$\therefore F_3 = \frac{-48.725}{\sin(-16.48)} = 171.74\ kN$$

$$\alpha = 90 - 20 - \theta$$

$$\alpha = 90 - 20 + 16.48$$