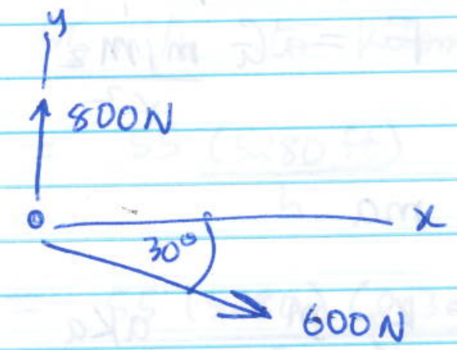
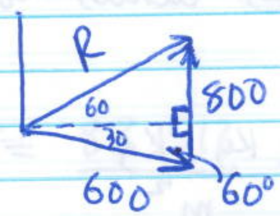
F 2-3





I was fixing to set up Sine Rule, but abandoned it for vertical and horizontal components aka projections

Vertical component of resultant

$$F_V = 800 - 600 \sin 30 = 500 \text{ N}$$

Horizontal component

$$F_H = 600 \cos 30 = 519.62 \text{ N}$$

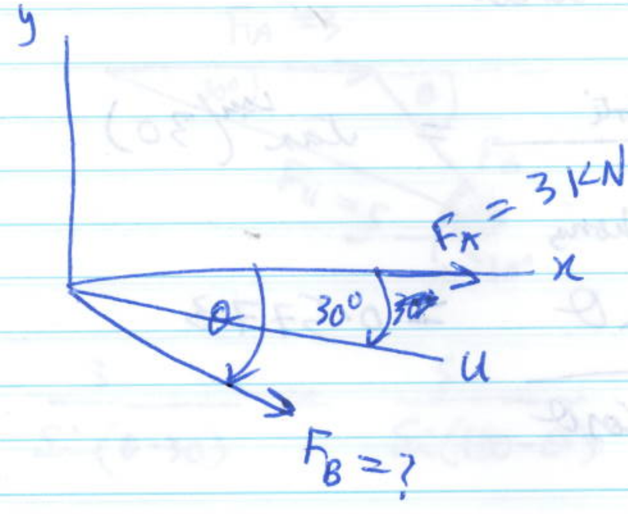
$$|F| = \sqrt{500^2 + 519.62^2} = 721.11 \text{ N}$$

direction : angle $\theta = \tan^{-1}\left(\frac{F_V}{F_H}\right)$

$$= \tan^{-1}\left(\frac{500}{519.62}\right)$$

$$= 43.89°$$

2-8



F_A and F_B act together to produce a resultant

lets call resultant vector F_u

$|F_u| = 5$ kN

x component of $F_u = 3 + F_B \cos\theta$

y component of $F_u = F_B \sin\theta$

$$|F_u| = \sqrt{(3+F_B\cos\theta)^2 + (F_B\sin\theta)^2} = 5$$

$$9 + 6F_B\cos\theta + F_B^2\cos^2\theta + F_B^2\sin^2\theta = 25$$

$$9 + 6F_B\cos\theta + F_B^2\underbrace{(\cos^2\theta+\sin^2\theta)}_{=1} = 25$$

$$9 + 6F_B\cos\theta + F_B^2 = 25$$

$$\cancel{F_B(6\cos\theta + F_B) = 16}$$

$$6F_B\cos\theta + F_B^2 = 16 \quad \text{— (1)}$$

we know that

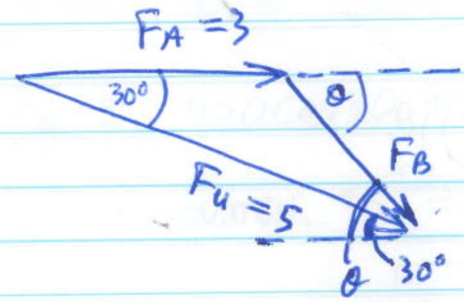
$$\frac{F_{u\,verti}}{F_{u\,horiz}} = \tan(30)$$

$$\frac{F_B \sin\theta}{3 + F_B \cos\theta} = 0.5773$$

$$F_B \sin\theta - 0.5773\, F_B \cos\theta = 1.7319 \quad —(2)$$

$$F_B\,(\sin\theta - 0.5773 \cos\theta) = 1.7319$$

2-8



$$\frac{3}{\sin(\theta-30)} = \frac{5}{\sin(180-\theta)} = \frac{F_B}{\sin 3\theta}$$

~~$3\sin 30 = F_B \sin(\theta-30)$~~

$$\frac{5}{\sin(180-\theta)} = \frac{F_B}{\sin 30}$$

$$\frac{5}{\sin\theta} = \frac{F_B}{\sin 30} \quad \text{— (1)}$$

Also

$$3\sin 30 = F_B \sin(\theta-30)$$

$$= F_B(\sin\theta\cos 30 - \cos\theta\sin 30)$$

$$1.5 = F_B(0.866\sin\theta - 0.5\cos\theta) \quad \text{— (2)}$$

Also

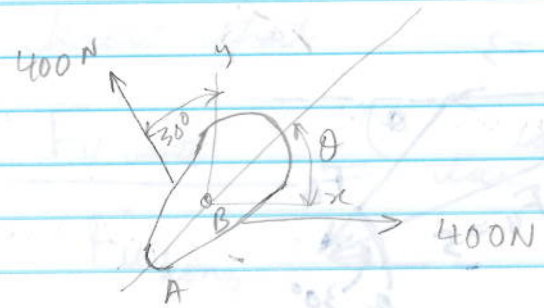
$$3\sin\theta = 5\sin(\theta-30)$$

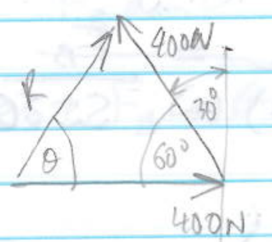
$$3\sin\theta = 5(\sin\theta\cos 30 - \cos\theta\sin 30)$$

$$3\sin\theta = 5(0.866\sin\theta - 0.5\cos\theta) \quad \text{— (3)}$$

We have 3 equations, 3 unknowns, solve simultaneously for the unknowns.

2 — 11





$$\frac{400}{\sin\theta} = \frac{R}{\sin 60} \quad \text{— (1)}$$

$$\frac{400}{\sin(120-\theta)} = \frac{R}{\sin 60} \quad \text{— (2)}$$

$$\frac{400}{\sin\theta} = \frac{400}{\sin(120-\theta)} \quad \text{— (3)}$$

$$\sin\theta = \sin(120-\theta)$$

$$\theta = 120-\theta$$

$$2\theta = 120$$

$$\theta = 60$$

From (1)

$$\frac{400}{\sin 60} = \frac{R}{\sin 60} \Rightarrow R = 400\,N$$

Alternately
We can also use projection

$$\sum F_y = 400\cos 30 = 346.41\,N \quad \text{call it } F_y$$

$$\sum F_x = 400 - 400\sin 30 = 200\,N \quad \text{call it } F_x$$

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

$$= \sqrt{346.41^2 + 200^2}$$

$$= 399.999\ N$$

$$\simeq 400\ N$$

direction (relative to the horizontal)

$$\alpha = \tan^{-1}\left(\frac{346.41}{200}\right) = 59.999 \approx 60^\circ$$

Coplanar Forces

2 – 34

components of the resultant

horizontal

$$F_x = F_1 \cos\phi + 500 \cos 60 - 450\left(\frac{3}{5}\right)$$

$$= F_1 \cos\phi - 20$$

$$F_y = F_1 \sin\phi - 500 \sin 60 - 450\left(\frac{4}{5}\right)$$

$$= F_1 \sin\phi - 793.01$$

Now

$$R^2 = F_x^2 + F_y^2$$

$$600^2 = (F_1 \cos\phi - 20)^2 + (F_1 \sin\phi + 73.01)^2$$

$$= F_1^2 \cos^2\phi - 2(20)F_1 \cos\phi + 400$$
$$F_1^2 \sin^2\phi - 2(73.01)F_1 \sin\phi + 5330.46$$

$$= F_1^2 - 2F_1(20 \cos\phi + 73.01 \sin\phi) + 5730.46$$

Components of resultant given

x: $R \cos\theta = 600 \cos 30 = F_1 \cos\phi - 20$

$$\Rightarrow F_1 \cos\phi = 539.62 \quad \text{— (1)}$$

y: $-600 \sin 30 = F_1 \sin\phi - 793.01$

$$\Rightarrow F_1 \sin\phi = 498.01 \quad \text{— (2)}$$

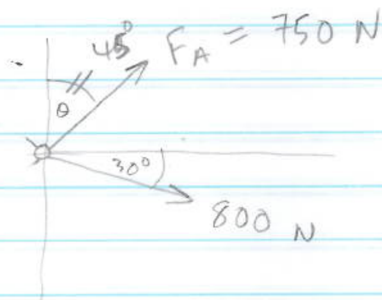
42.4 (2) ÷ (1) : $\tan\phi = \dfrac{498.01}{539.62} =$

$$\phi = 42.71^\circ$$

from (1)

$$F_1 = \frac{539.62}{\cos 42.71^\circ} = 734.38 \text{ N}$$

2-48



lets use vector notation

x: $F_x = 750 \cos 45 + 800 \cos 30 = 1223.15$ N

y: $F_y = -800 \sin 30 + 750 \sin 45 = 130.33$ N

$$\vec{R} = 1223.15\, i + 130.33\, j$$

$$|\vec{R}| = \sqrt{1223.15^2 + 130.33^2} = 1230.07 \text{ N}$$

$$\theta = \tan^{-1}\left(\frac{130.33}{1223.15}\right) = 6.08^\circ$$