CE 201-9 (061)

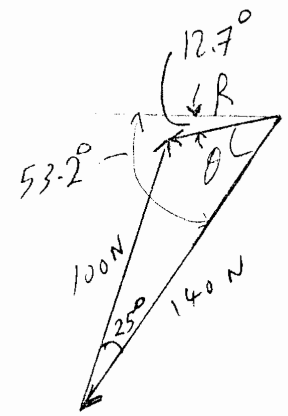
HW # 1

Problem # 1

Given: The force shown in the figure.

Required: The value and direction of the resultant force.

Solution: Using the cosine law




$$R = \sqrt{140^2 + 100^2 - 2 \times 100 \times 140 \times \cos 25}$$
$$= 65 \text{ N}$$

Using the sin law

$$\frac{65}{\sin 25} = \frac{100}{\sin \theta} \Rightarrow \theta = 40.5^\circ$$

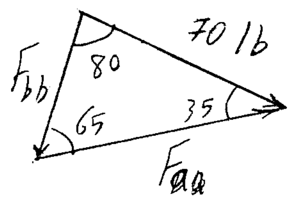
$\therefore$ The resultant force has an angle of $12.7^\circ$ $(53.2 - 40.\ldots$ of the horizontal line

Problem # 2

Given: The force shown in figure for problem 2-11 in the textbook.

Required: Resolve this force (70 lb) into two components acting along the lines aa and bb.

Solution: Let this force to be the resultant force of two components one along aa and the other along bb as shown in the figure




Using the sine law

$$\frac{70}{\sin 65} = \frac{F_{bb}}{\sin 35} \Rightarrow F_{bb} = 44.3 \text{ lb}$$

$$\frac{70}{\sin 65} = \frac{F_{aa}}{\sin 80} \Rightarrow F_{aa} = 76.06 \text{ lb}$$

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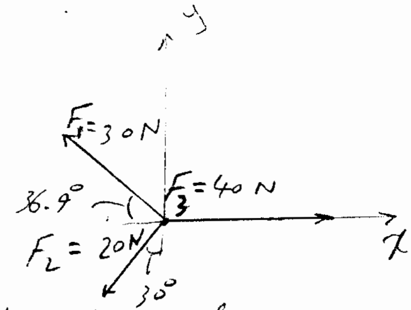
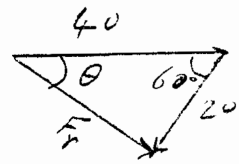
## Problem # 3

Given: the three forces shown in the figure




Required: Determine the magnitude and direction of the resultant force.

Solution: First, we find the resultant of $F_2$ and $F_3$ by using the cosine law



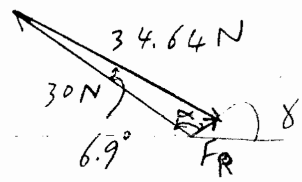

$$F_r^2 = 40^2 + 20^2 - 2 \times 40 \times 20 \cos 60$$

$$\Rightarrow F_r = 34.64 \text{ N}$$

and

$$\frac{20}{\sin\theta} = \frac{34.64}{\sin 60} \Rightarrow \theta = 30^\circ$$

Now, using the cosine law we find the resultant of $F_r$ and $F_1$




$$R = \sqrt{34.64^2 + 30^2 - 2 \times 30 \times 34.64 \cos 6.9}$$

$$= 6.05 \text{ N}$$

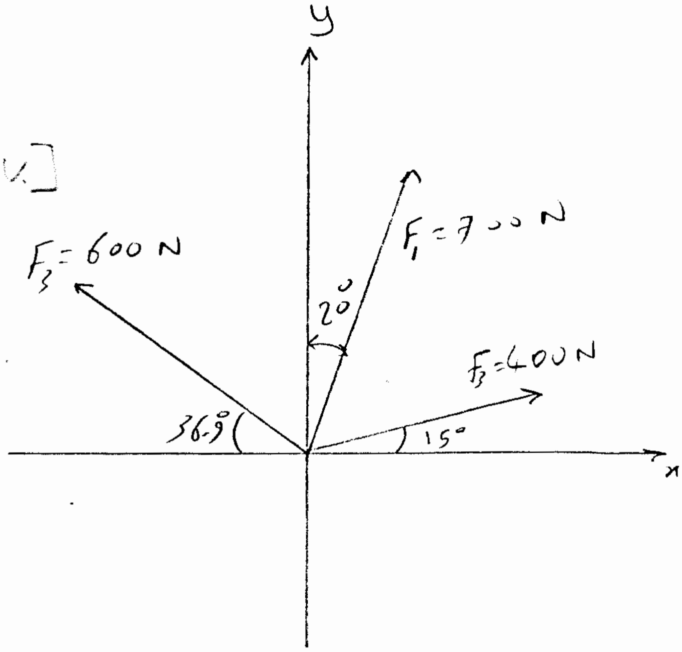
and

$$\frac{34.64}{\sin\alpha} = \frac{6.05}{\sin 6.9} \Rightarrow \alpha = 136.5^\circ$$

$\therefore$ the resultant force has an angle of $\gamma = 180 - 136.5 - 36.5 = 7^\circ$ with the x axis #

## Problem # 4

[Method I: Sec. 2.4 - Cartesian]




Given: The force shown in the figure

Required: The magnitude and direction of the resultant force

Solution:

$$\sum F_x = 400 \cos 15 + 700 \sin 20 - 600 \cos 36.9 = 145.97 \text{ N}$$

$$\sum F_y = 400 \sin 15 + 700 \cos 20 + 600 \sin 36.9 = 1121.56 \text{ N}$$

$$\therefore F_R = \sqrt{145.97^2 + 1121.56^2} = 1131.02 \text{ N}$$

$$\theta = \tan^{-1}\left(\frac{1121.56}{145.97}\right) = 82.58^\circ$$

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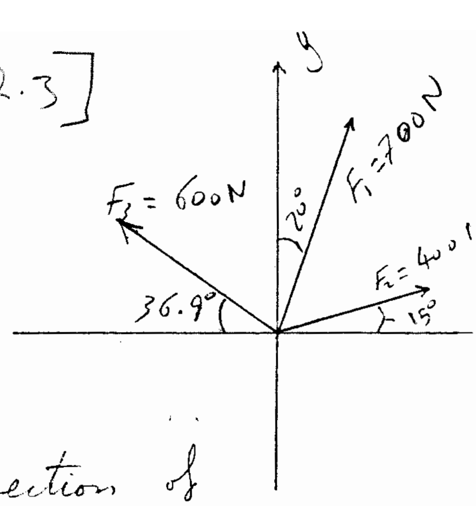
Problem # 4 [method II : Sec. 2.3]




Given:

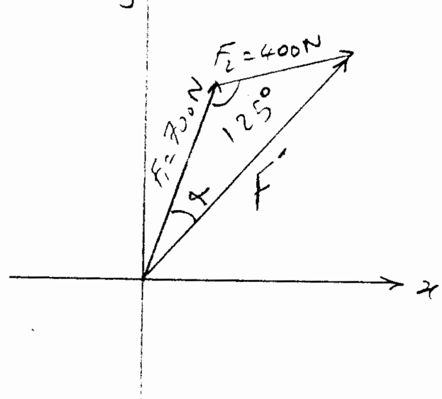
The three forces shown in the figure.

Required:

The magnitude and direction of the resultant force.

Solution:

First we add $F_1$ and $F_2$ using the cosine law



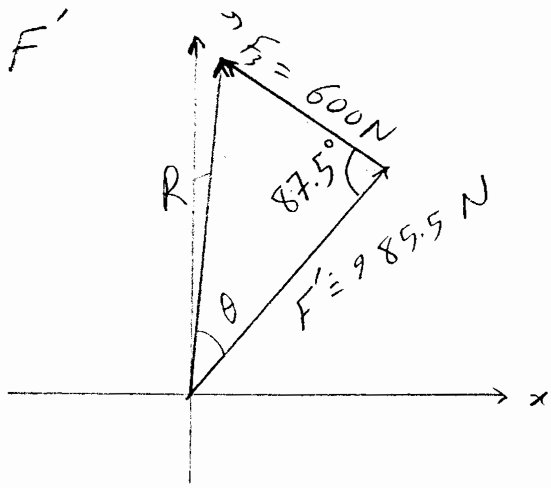

$$F' = \sqrt{700^2 + 400^2 - 2 \times 700 \times 400 \cos 125}$$

$$F = 985.5 \text{ N}$$

and $\dfrac{985.5}{\sin 125} = \dfrac{400}{\sin\alpha}$

$\Rightarrow \alpha = 19.4°$

Now, add $F_3$ and $F'$



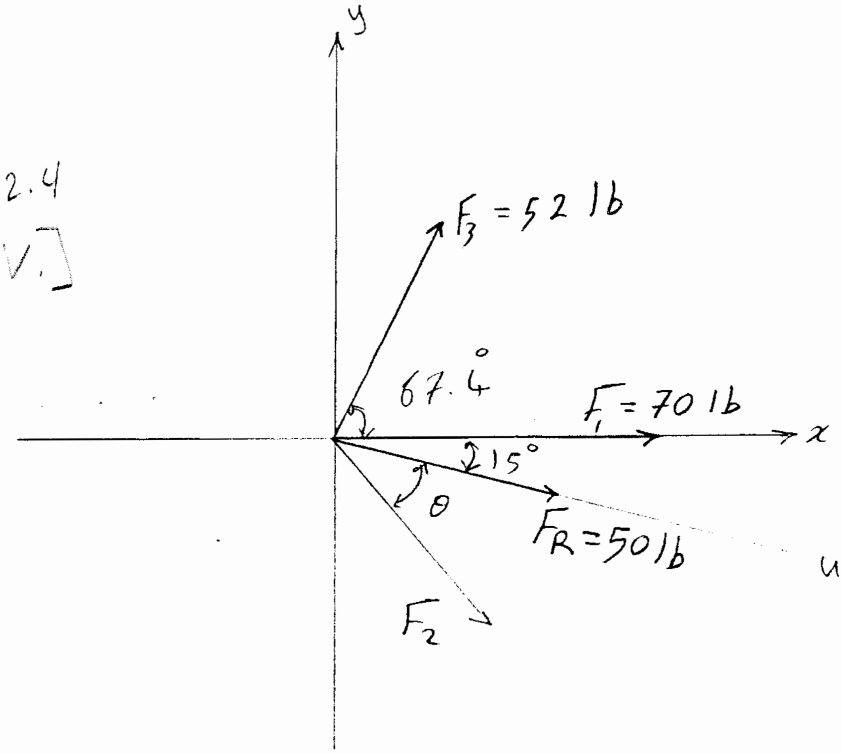

$$R = \sqrt{985.5^2 + 600^2 - 2 \times 600 \times 985.5 \cos 87.5} = 1131.03 \text{ N}$$

and $\dfrac{1131.03}{\sin 87.5} = \dfrac{600}{\sin\theta} \Rightarrow \theta = 32°$

The angle of R with x is $32 + 50.6 = 82.6°$ #

## Problem #5

[Method I: sec 2.4 Cartesian V.]




Given: The force shown in the figure and the resultant force

Required: The value and direction of force $F_2$

Solution $\sum F_x = 70 + 52 \cos 67.4 + F_{2x} = 50 \cos 15$

$\Rightarrow F_{2x} = -41.69$ lb

$\sum F_y = 52 \sin 67.4 + F_{2y} = -50 \sin 15$

$\Rightarrow F_{2y} = -60.95$ lb

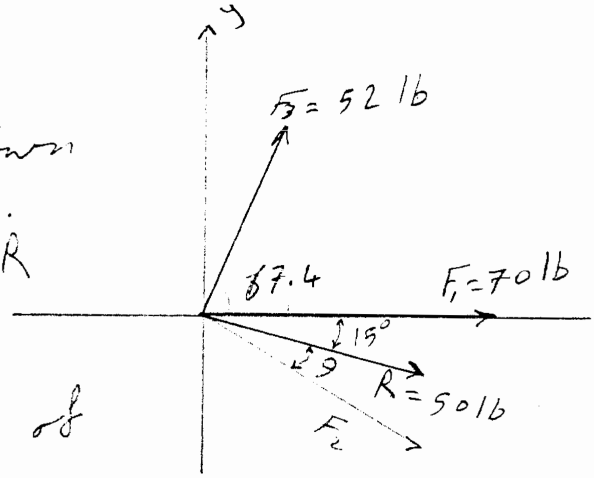
$\therefore F_2 = \sqrt{41.69^2 + 60.95} = 73.8$ lb

$\tan(\theta + 15) = \frac{-60.95}{-41.69} \Rightarrow \theta + 15 = 124.37°$

$\Rightarrow \theta = 109.4°$

Note: when you use the calculator you get that $\theta + 15 = 55.63°$, but we know that both sine and cosine are negative.

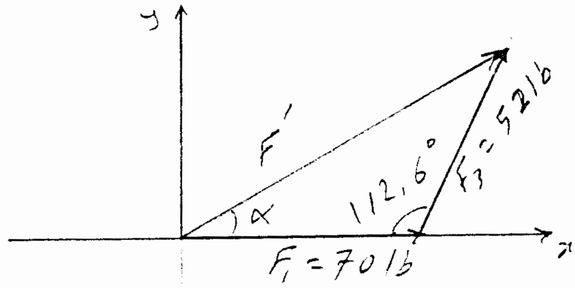
Problem # 5 [Method II : Sec. 2.3]




Data: The two forces shown in the figure, $F_1$ and $F_3$. and the resultant force $R$

Required:
The value and direction of the third force $F_2$.

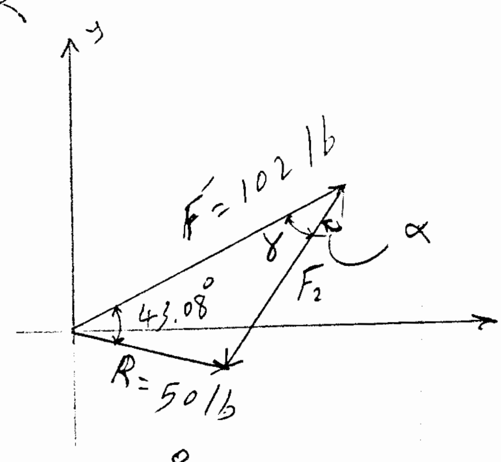
Solution: First we add $F_3$ and $F_1$ using the cosine law




$$F' = \sqrt{52^2 + 70^2 - 2 \times 52 \times 70 \cos 112.6} = 102 \text{ lb}$$

and $\dfrac{102}{\sin 112.6} = \dfrac{52}{\sin \alpha} \Rightarrow \alpha = 28.08°$

Now, we find the force $F_2$ which should be added to $F'$ to get $R$




$$F_2 = \sqrt{50^2 + 102^2 - 2 \times 50 \times 102 \cos 43.08}$$
$$= 73.85 \text{ lb}$$

and $\dfrac{73.85}{\sin 43.08} = \dfrac{50}{\sin \gamma}$

$\Rightarrow \gamma = 27.5°$

and $\alpha = 90 - 28.08 - 27.5 = 34.38°$

$\therefore \theta = 90 - 15 + 34.38 = 109.38°$ #