



## Chapter Two: Resultant of Force Systems

**Resultant:** simplest force system which have same external effect of the original system.

### 2.1 Resultant of Coplanar Concurrent Force System

In x-y plane, the resultant of coplanar concurrent force system where the lines of action of all forces pass through a common point can be found by the following formulas:

$$R_x = \sum F_x \rightarrow +$$

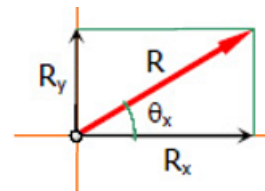
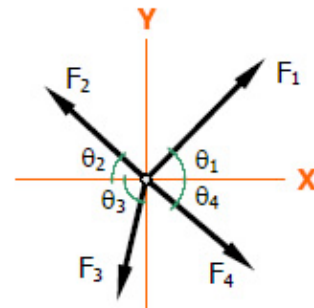
$$R_x = F_{1x} - F_{2x} - F_{3x} + F_{4x}$$

$$R_y = \sum F_y \uparrow +$$

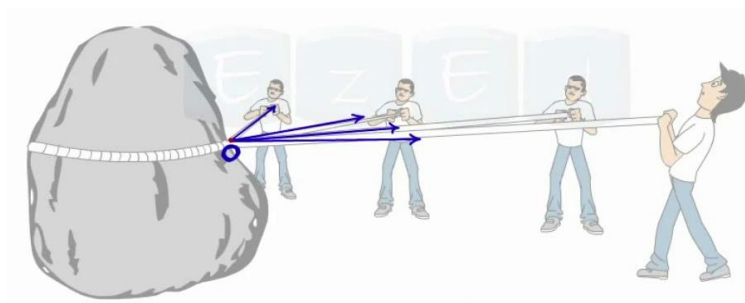
$$R_y = F_{1y} + F_{2y} - F_{3y} - F_{4y}$$

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

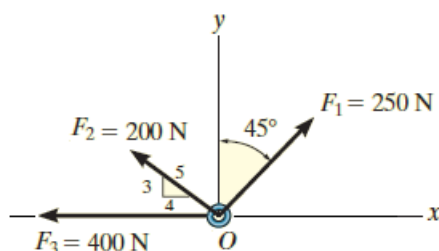
$$\theta_x = \tan^{-1} \left( \frac{R_y}{R_x} \right)$$



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**Example No. 1:** Determine the magnitude and direction of the resultant forces system shown in Figure.



**Solution:**

$$F_{1x} = 250 \times \sin 45 = 176.8 \text{ N} \rightarrow$$

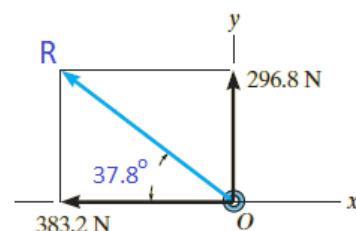
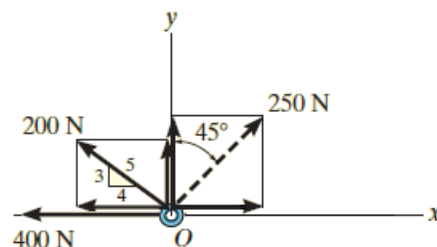
$$F_{1y} = 250 \times \cos 45 = 176.8 \text{ N} \uparrow$$

$$F_{2x} = 200 \times \frac{4}{5} = 160 \text{ N} \leftarrow$$

$$F_{2y} = 200 \times \frac{3}{5} = 120 \text{ N} \uparrow$$

$$F_{3x} = 400 \text{ N} \leftarrow$$

$$F_{3y} = 0$$





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$$\rightarrow^+ R_x = \sum F_x = 176.8 - 160 - 400$$

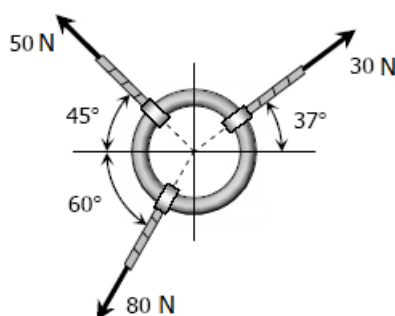
$$R_x = -383.2 \text{ N} = 383.2 \text{ N} \leftarrow$$

$$\uparrow^+ R_y = \sum F_y = 176.8 + 120 + 0 = 296.8 \text{ N} \uparrow$$

$$R = \sqrt{R_x^2 + R_y^2} = \sqrt{(383.2)^2 + (296.8)^2} = 484.7 \text{ N}$$

$$\theta_x = \tan^{-1} \left( \frac{R_y}{R_x} \right) = \tan^{-1} \left( \frac{296.8}{383.2} \right) = 37.8^\circ$$

**Example No. 2:** Find the resultant force on the ring due to the three applied forces.





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**Solution:**

$$\rightarrow^+ R_x = \sum F_x$$

$$R_x = 30 \cos 37 - 50 \cos 45 - 80 \cos 60$$

$$R_x = -51.40 \text{ N} = 51.40 \text{ N} \leftarrow$$

$$\uparrow^+ R_y = \sum F_y$$

$$R_y = 30 \sin 37 + 50 \sin 45 - 80 \sin 60$$

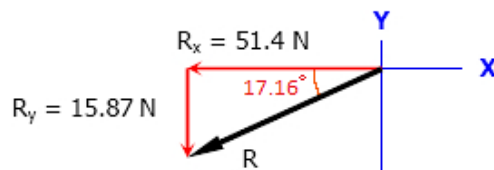
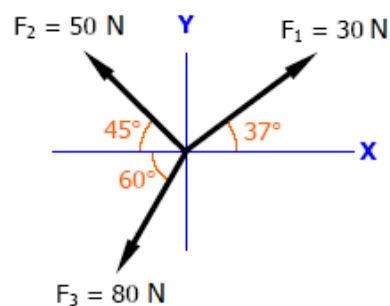
$$R_y = -15.87 \text{ N} = 15.87 \text{ N} \downarrow$$

$$R = \sqrt{R_x^2 + R_y^2} = \sqrt{(51.40)^2 + (15.87)^2}$$

$$R = 53.79 \text{ N}$$

$$\theta_x = \tan^{-1} \left( \frac{R_y}{R_x} \right)$$

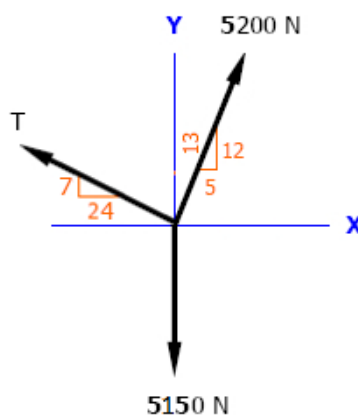
$$\theta_x = \tan^{-1} \left( \frac{15.87}{51.40} \right) = 17.16^\circ$$





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**Example No. 3:** The resultant of the three forces is horizontal. Determine the magnitude of the resultant.



**Solution:**

Since the resultant is horizontal, therefore:

$$R_y = 0, \quad R = R_x$$

$$c = \sqrt{24^2 + 7^2} = 25$$

$$\uparrow^+ R_y = \sum F_y$$

$$0 = T \times \frac{7}{25} + 5200 \times \frac{12}{13} - 5150$$

$$\therefore T = 1250 \text{ N}$$

$$\rightarrow^+ R_x = R = \sum F_x$$



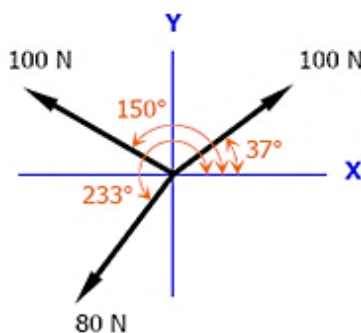
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$$R = -T \times \frac{24}{25} + 5200 \times \frac{5}{13}$$

$$R = 800 \text{ N} \rightarrow$$

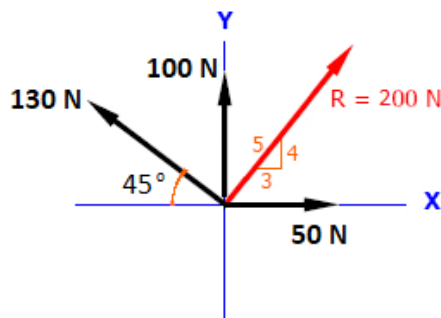
**Problems:**


1. Determine the magnitude and direction of the resultant forces system shown in Figure.



**Answer:**  $R = 71.8 \text{ N}$ ,  $\theta_x = 40.15^\circ$  

2. If the resultant of fourth forces is 200 N as shown in figure. Find the unknown for the force.

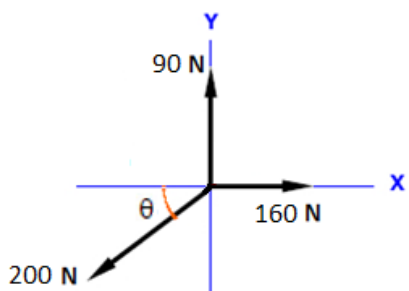


**Answer:**  $F_4 = 165 \text{ N}$ ,  $\theta_x = 11.153^\circ$  



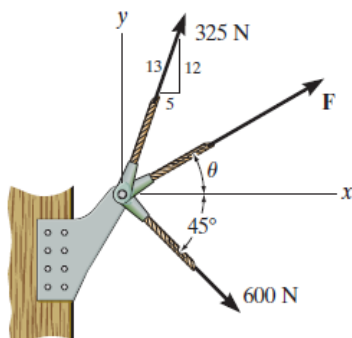
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3. The resultant of the three forces as shown in figure is vertical. determine the angle  $\theta$ , and magnitude of the resultant.



**Answer:**  $R = 30\text{ N} \downarrow$ ,  $\theta = 36.87^\circ$

4. If the resultant force acting on the bracket is to be 750 N directed along the positive  $x$  – axis, determine the magnitude of  $\mathbf{F}$  and its direction  $\theta$ .



**Answer:**  $F = 236.1\text{ N}$ ,  $\theta = 31.76^\circ$



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