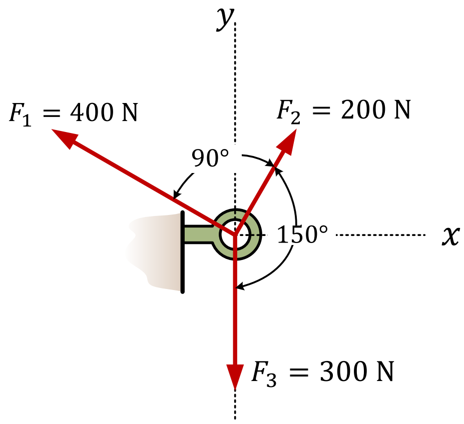
Question 1.6.

Determine the magnitude and direction of the resultant force.



Solution

Resolve force F_1 into x and y components

$$F_1 = F_{1x}\,\underline{i} + F_{1y}\,\underline{j}$$

$$F_1 = (-400\,sin\,60°)\,\underline{i} + (400\,cos\,60°)\,\underline{j}$$

$$F_1 = (-346.4)\,\underline{i} + (200)\,\underline{j}$$

Resolve force F_2 into x and y components

$$F_2 = F_{2x}\,\underline{i} + F_{2y}\,\underline{j}$$

$$F_2 = (200\cos 60°)\,\underline{i} + (200\sin 60°)\,\underline{j}$$

$$F_2 = (100)\,\underline{i} + (173.2)\,\underline{j}$$

Resolve force F_3 into x and y components

$$F_3 = F_{3x}\,\underline{i} + F_{3y}\,\underline{j}$$

$$F_3 = (0)\,\underline{i} + (-300)\,\underline{j}$$

$$F_3 = -(300)\,\underline{j}$$

Sum the x and y components

$$F_R = (-346.4 + 100 + 0)\;\underline{i} + (200 + 173.2 - 300)\;\underline{j}$$

$$F_R = (-246.4)\;\underline{i} + (73.2)\;\underline{j}$$

Thus the magnitude of the resultant force is

$$|\mathrm{F_R}| = \sqrt{F_x{}^2 + F_y{}^2} = \sqrt{(-246.4\ \mathrm{N})^2 + (73.2\ \mathrm{N})^2}$$

$|\mathrm{F_R}| = 257$ kN (Answer)

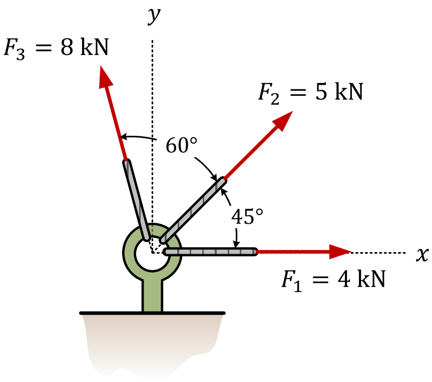
and the direction $\emptyset$ of F_R measured counterclockwise from the positive x - axis, is

$$\emptyset = 180° - \tan^{-1}\left(\frac{73.2}{246.4}\right)$$

$\emptyset = 163.45°$ (Answer)

Question 1.7.

A bracket is subjected to three forces as shown. Determine the magnitude of the resultant force and its direction, measured counterclockwise from the positive x - axis.



Solution

Resolve force F_1 into x and y components

$$F_1 = F_{1x}\, \underline{i} + F_{1y}\, \underline{j}$$

$$F_1 = (4)\, \underline{i} + (0)\, \underline{j}$$

$$F_1 = (4)\, \underline{i}$$

Resolve force F_2 into x and y components

$$F_2 = F_{2x}\, \underline{i} + F_{2y}\, \underline{j}$$

$$F_2 = (5\cos 45°)\, \underline{i} + (5\sin 45°)\, \underline{j}$$

$$F_2 = (3.535)\, \underline{i} + (3.535)\, \underline{j}$$

Resolve force F_3 into x and y components

$$F_3 = F_{3x}\, \underline{i} + F_{3y}\, \underline{j}$$

$$F_3 = (-8\sin 15°)\, \underline{i} + (8\cos 15°)\, \underline{j}$$

$$F_3 = (-2.07)\, \underline{i} + (7.727)\, \underline{j}$$

Sum the x and y components

$$F_R = (4 + 3.535 - 2.07)\ \underline{i} + (0 + 3.535 + 7.727)\ \underline{j}$$

$$F_R = (5.465)\ \underline{i} + (11.262)\ \underline{j}$$

Thus the magnitude of the resultant force is

$$|\mathrm{F_R}| = \sqrt{F_x{}^2 + F_y{}^2} = \sqrt{(5.465\ \mathrm{N}\ )^2 + (\ 11.262\ \mathrm{N}\ )^2}$$

$|\mathrm{F_R}| = 12.517$ kN (Answer)

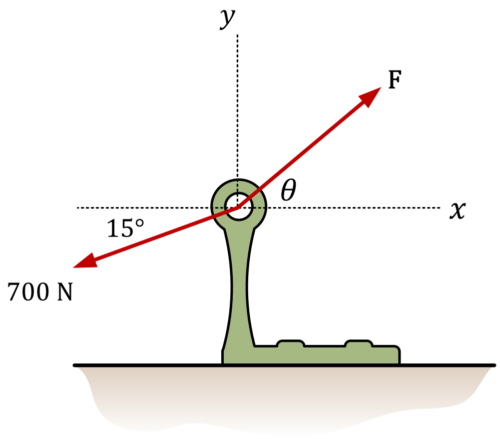
and the direction θ of F_R measured counterclockwise from the positive x - axis, is

$$\theta = \tan^{-1}\left(\frac{11.262}{5.465}\right)$$

$\theta = 64.1°$ (Answer)

Question 1.8.

If the magnitude of the resultant force is to be 500 N, directed along the positive y - axis, determine the magnitude of force **F** and its direction θ.



Solution

The parallelogram law of addition and the triangular rule are shown in Figs. a and b, respectively.

Applying the law of cosines to Fig. b,

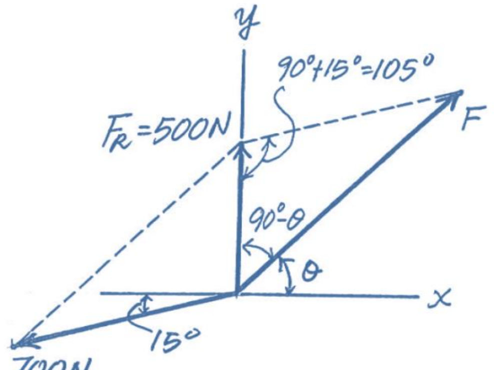
$$F_R = \sqrt{(700)^2 + (500)^2 - 2(700)(500)\cos 105°}$$

$F_R = 960$ N (Answer)

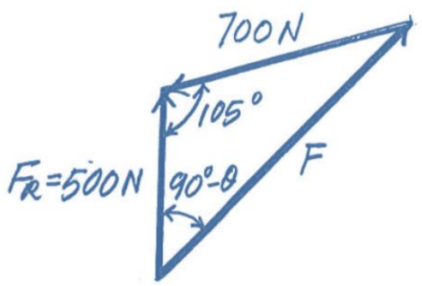
Applying the law of sines to Fig. b,

$$\frac{\sin(90° + \theta)}{700} = \frac{\sin 105°}{960}$$

$\theta = 45.2°$ (Answer)

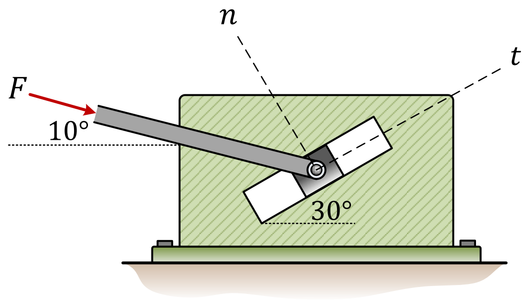


(a)



(b)

Question 1.9.



If the tangential component of the force F is known to be 75 N, determine the magnitude of F and the n - component.

Solution

From Fig. (a)

$$\frac{F_n}{F_t} = \tan 40°$$

$$F_n = F_t \tan 40°$$

$$F_n = 75 \tan 40°$$

$$F_n = -62.7 \text{ N}$$ (Answer)

also from Fig. (a)

$$\frac{F_n}{F} = \cos 40°$$

$$F = \frac{F_t}{\cos 40°}$$

$$F = \frac{75}{\cos 40°}$$

$$F = 97.9 \text{ N}$$ (Answer)

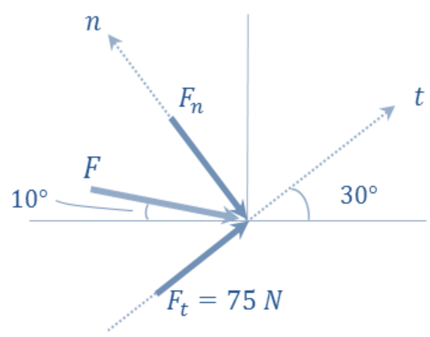
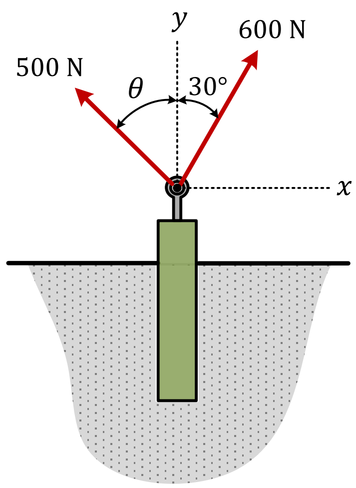


Fig. (a)

Question 1.10.

Two forces act on the screw eye as shown. Determine the magnitude of the resultant force and the angle if the resultant force is directed vertically upward.



Solution

The parallelogram law of addition and the triangular rule are shown in Figs. a and b, respectively.

Applying the law of sines to Fig. b,

$$\frac{\sin\theta}{600} = \frac{\sin 30°}{500}$$

$$\sin\theta = 0.6$$

$\theta = 36.87°$ (Answer)

Using this result

$$\emptyset = 180° - 30° - 36.87°$$

$$\emptyset = 113.13°$$

Applying the law of sines using the above result,

$$\frac{\sin\theta}{F_R} = \frac{\sin 30°}{500}$$

$F_R = 930$ N (Answer)