2. Chapter Two: Force vectors:

A ***scalar*** is any positive or negative physical quantity that can be completely specified by its *magnitude*. Examples of scalar quantities include length, mass, and time.

A ***vector*** is any physical quantity that requires both a *magnitude* and a *direction* for its complete description. Examples of vectors encountered in statics are force, position, and moment.

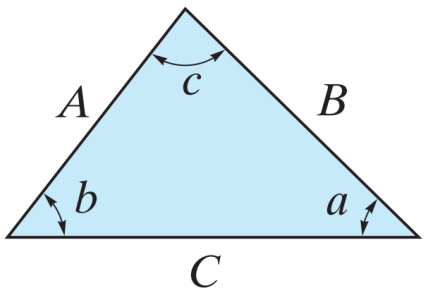
2.1. Vector Operations

Procedure for Analysis:

1. Redraw a half portion of the parallelogram to illustrate the triangular head-to-tail addition of the components.
2. From this triangle, the ***magnitude of the resultant force*** can be determined using ***the law of cosines***, and its ***direction*** is determined from ***the law of sines***. The magnitudes of two force components are determined from the law of sines. The formulas are:

Cosine law:

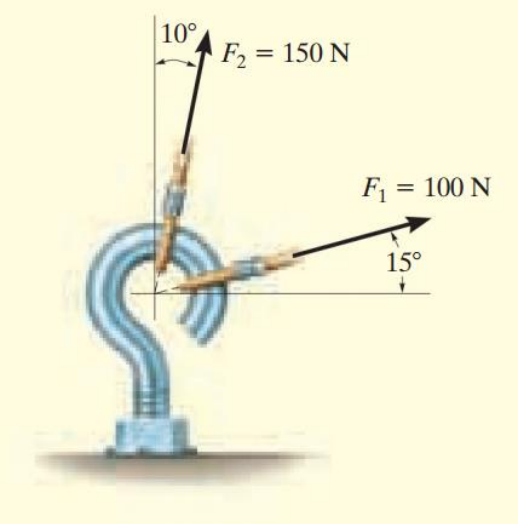
$$C = \sqrt{A^2 + B^2 - 2AB\cos(c)}$$



Sine law:

$$\frac{A}{\sin a} = \frac{B}{\sin b} = \frac{C}{\sin c}$$

Example: The screw eye in Figure below is subjected to two forces, F1 and F2. Determine the ***magnitude*** and ***direction*** of the resultant force.



Solution:

The two unknowns are

The magnitude of F_R and the angle θ (theta).

Using the law of cosines:

$$F_R = \sqrt{(100)^2 + (150)^2 - 2(100)(150)\cos 115^0}$$

$$F_R = \sqrt{10000 + 22500 - 30000\ (-0.4226)}$$

$$F_R = 212.6$$

Applying the law of sines to determine θ,

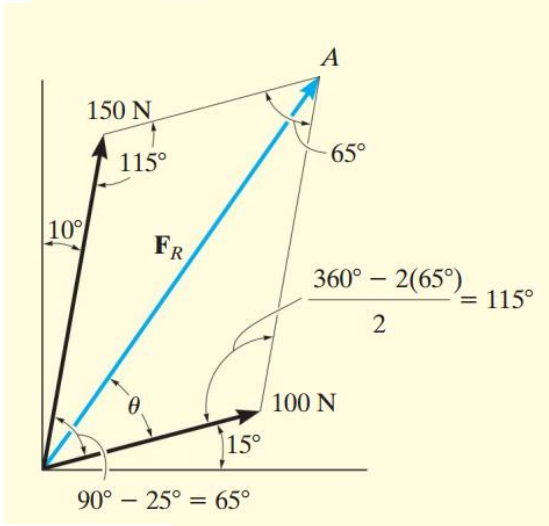
$$\frac{150}{\sin\theta} = \frac{212.6}{\sin 115^0}$$

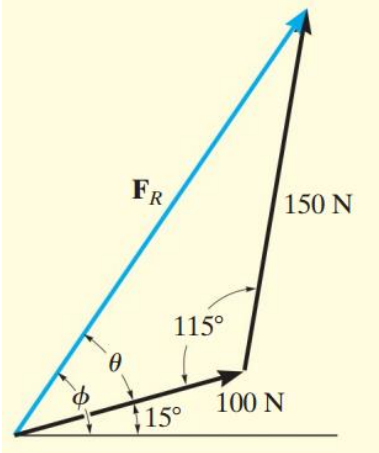
$$\sin\theta = \frac{150\ (\sin 115^0)}{212.6}$$

$$\theta = 39.8^0$$

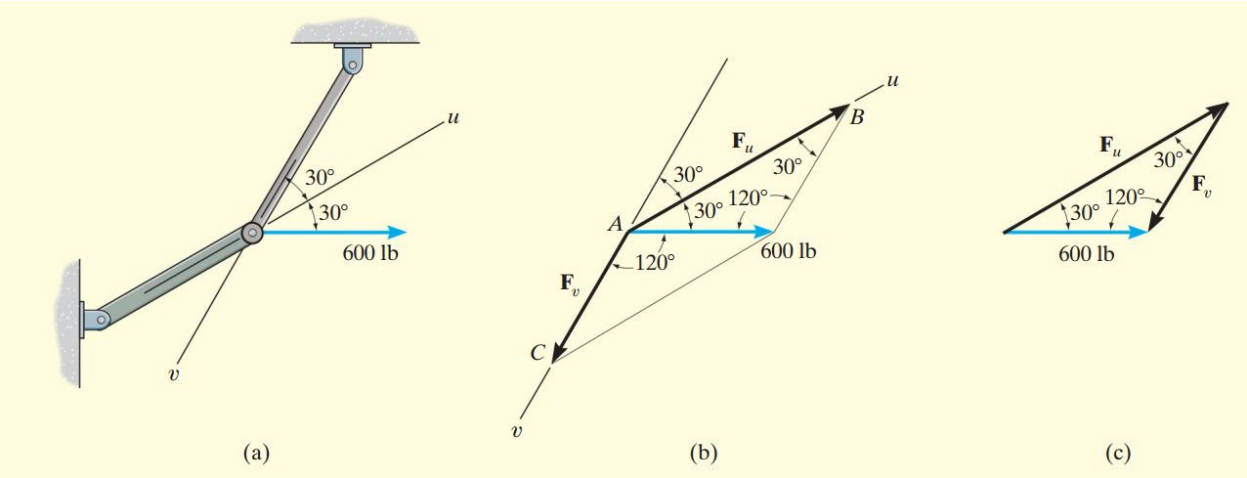
Thus, the direction Φ (phi) of F_R, measured from the horizontal, is:

$$\Phi = 39.8^0 + 15^0 = 54.8^0$$





Example: Resolve the horizontal 600-lb force in Figure (a) below into components acting along the *u* and *v* axes and determine the **magnitudes** of these components.



Solution:

The two unknowns are the magnitudes of $\mathbf{F_u}$ and $\mathbf{F_v}$. Applying the law of sines,

$$\frac{F_u}{\sin 120^0} = \frac{600}{\sin 30^0}$$

$$F_u = 1039 \text{ lb}$$

$$\frac{F_v}{\sin 30^0} = \frac{600}{\sin 30^0}$$

$$F_v = 600 \text{ lb}$$

HW: It is required that the resultant force acting on the eyebolt in Figure below be directed along the positive *x* axis and that **F**2 have a ***minimum*** magnitude. Determine this magnitude, the angle θ, and the corresponding resultant force.