* **Units of volume**:

$in^3 = 16.39\ cm^3$

$ft^3 = 0.02832\ m^3$

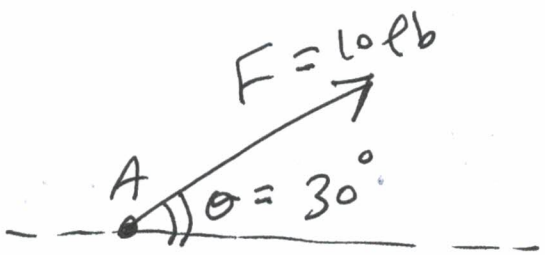
for liquits $gal = 3.785\ L$

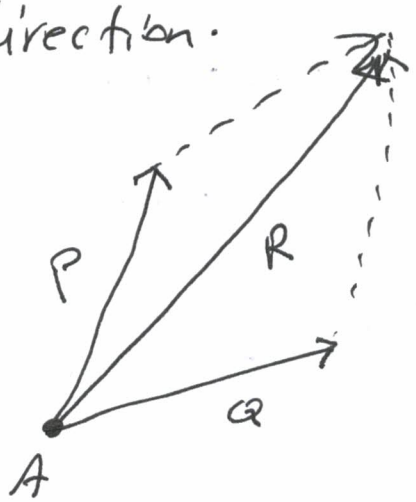
* **Work** $ft \cdot lb = 1.356\ J$.

Chapter 2: "Statics of Particles"

forces on the plane:

A force represents the action of one body on ano
e
and is generally characterized by its point, its magnitude and its direction.





two forces P & Q acting of aparticle A can be replaced by a single force R which has the effect on point A. This force is called as resultant. (1)

of the force P & Q which can be obtained by constructing a parallelogram using P & Q as adjecent sides of the parallelogram. The diagonal that passes through A represent the resultant. This method for finding the resultant is known as the parallelogram law for addition of two forces.

Resolution of a force into Components

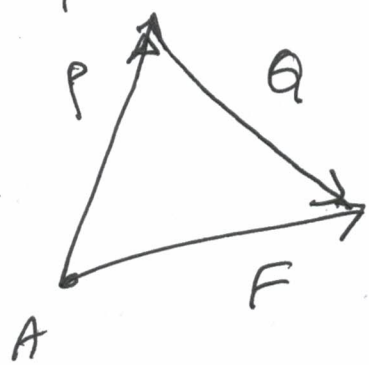
A single force (F) acting o the particle may be replaced by two forces which together have the same effect on the particle. These forces are called the components of original force (F). or resolving the force into components.

There are two approach, with particular interest:

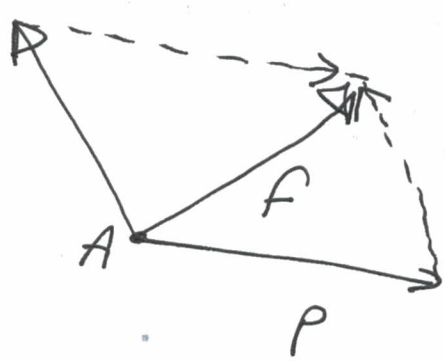
1. one of the two components P is know. the second component Q is

obtained by appling the triangle rule and joining the tip of P to the tip of F.

once Q has been determined, both components P & Q should be applied at A.

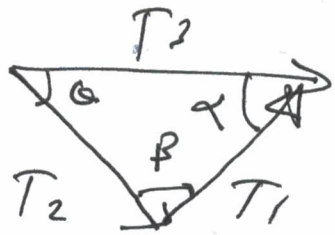


2. The line of action of each component is known. The magnitude and sense of the components are obtained by appling the parallelogram Law and drawing lines through tip of F parallel to the given lines of action. This process leads to two components P & Q which can be determined by appling the Law of sines.



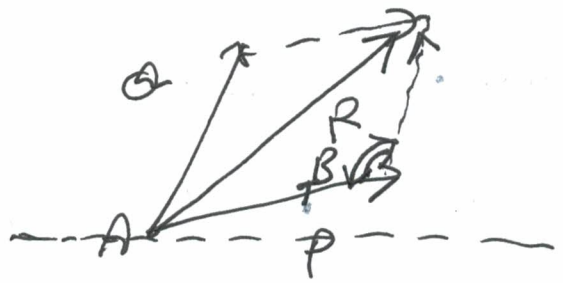
Law of sines is

$$\frac{T_1}{\sin\theta} = \frac{T_2}{\sin\alpha} = \frac{T_3}{\sin\beta}$$



Law of Cosines

$$R^2 = P^2 + Q^2 - 2PQ\cos\beta$$



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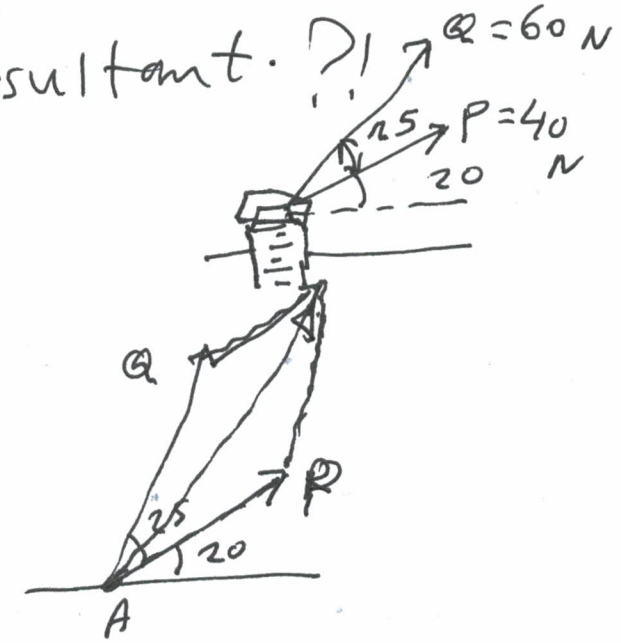
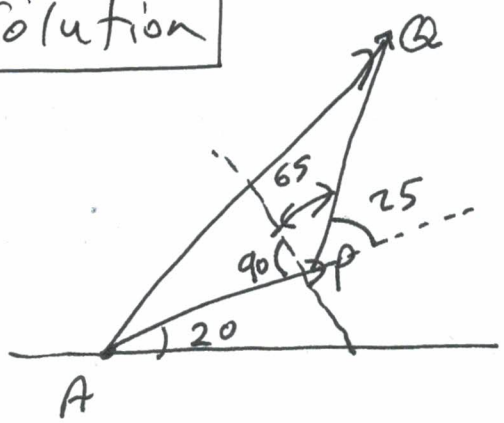
example ① The two forces P & Q act on a bolt A. determine their resultant. ?!



Solution



or

The two sides and the included angle are know on the triangle, we apply the law of Cosines.

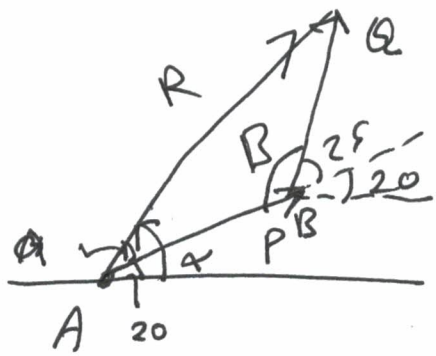
$$R^2 = P^2 + Q^2 - 2PQ\cos(65+90)$$

$$= 40^2 + 60^2 - 2*40*60\cos 155^\circ$$

$$\Rightarrow$$

$$R = 97.73 \text{ N} \quad \hookleftarrow$$

To find the sense of resultant we must be find the angle of direction with X-axis.



$\alpha = 20^\circ + \measuredangle$

Law of

Now, apply sines $\Rightarrow$ we get $\Rightarrow$

$$\frac{\sin A}{Q} = \frac{\sin B}{R} \Rightarrow \frac{\sin A}{60} = \frac{\sin 155}{97.73} \Rightarrow$$

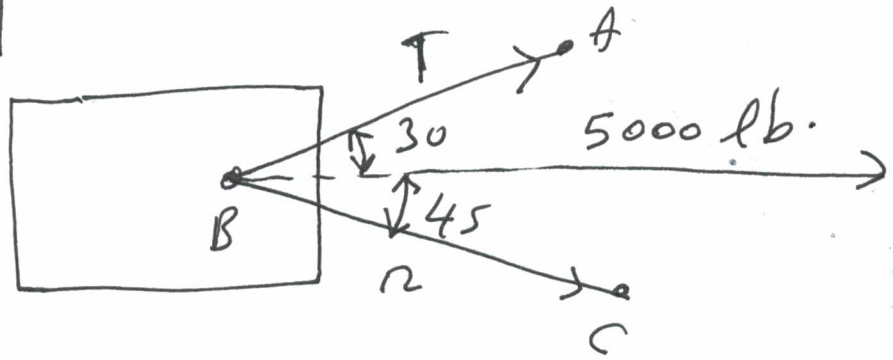
$$\sin A = \frac{60 * \sin 155}{97.73} \Rightarrow A = 15.04^\circ$$

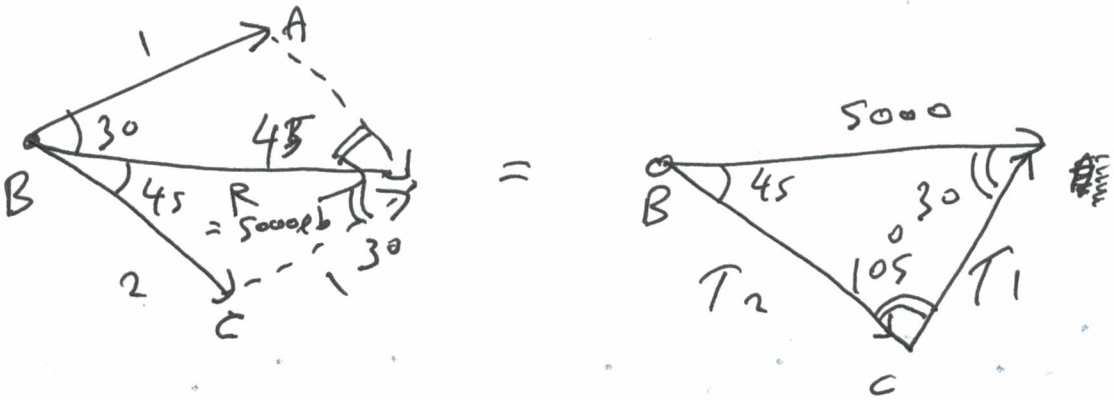
$\therefore \alpha = 20 + 15.04 = 35.04^\circ$.

---

example ②. A barge is pulled by two tugboat if the resultant of the force exerted by the tugboat is 5000 lb force directed along the axis of the barge. determine the tension in each of the ropes knowing that $\alpha = 45^\circ$?!

Solution





The Triangle rule can be used. Using the Sines Law, we get ⇒

$$\frac{T_1}{\sin 45} = \frac{T_2}{\sin 30} = \frac{5000\ lb}{\sin 105^\circ} \Rightarrow$$

$$T_1 = 3660\ lb \quad \& \quad T_2 = 2590\ lb. \ \text{⊿}$$

Rectangular Components of a force.

In many problems it will be found desirable to resolve a force into two components which are perpendicular to each other.