Statics of Particles

Particle

Force on Particle

Vectors

Law of Sines

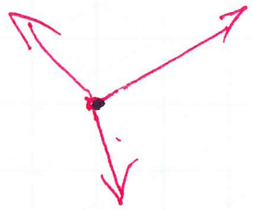
Law of Cosines

Addition of Vectors – Resultants

Resultant of Several (Concurrent) Forces

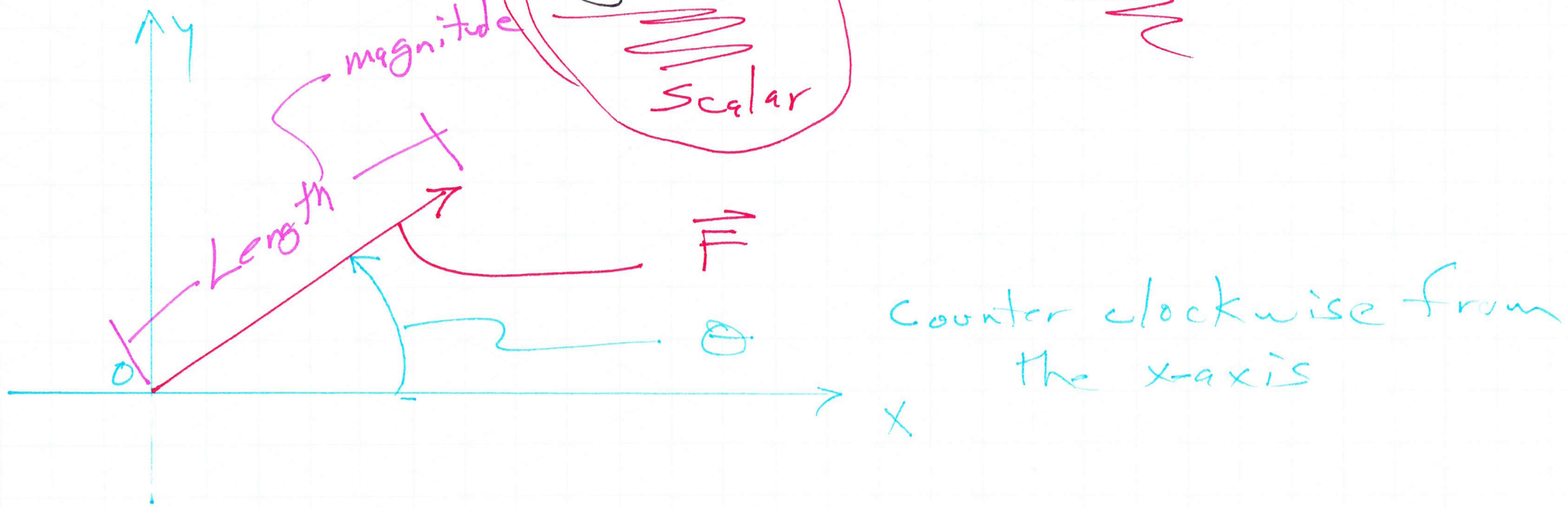
Components

Particle —



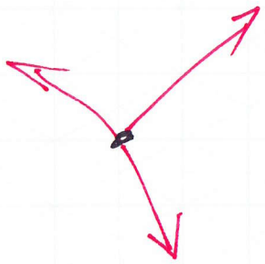
Force on a Particle —

Vector – magnitude and direction

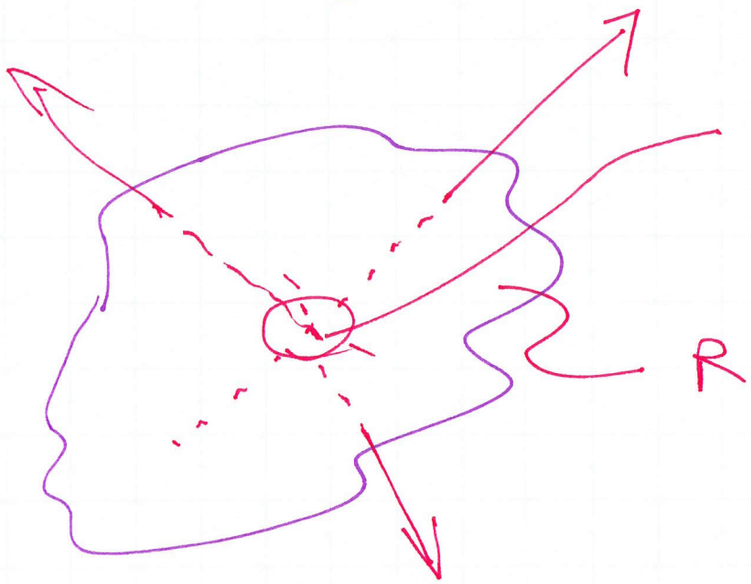


Concurrent Forces

Lines of action of all of the forces would intersect at the same point



or



Point of intersection

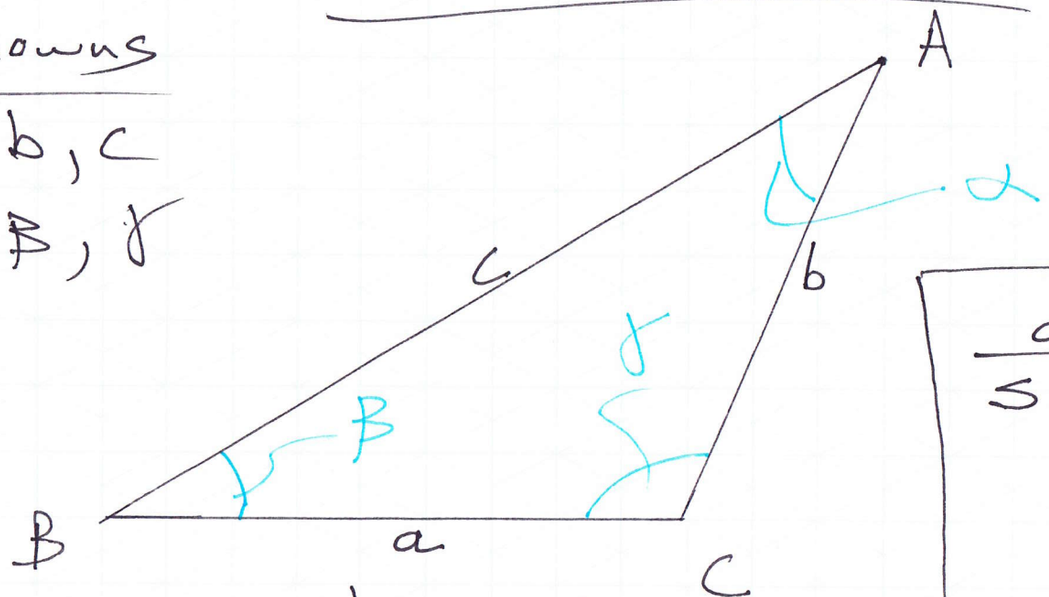
Point of concurrency

Rigid Body

Law of Sines

A, B, C points
a, b, c length of the sides
α, β, γ angles associated with the triangle

6 unknowns
a, b, c
α, β, γ



There must be 3 things specified to fully describe the triangle

One of the things that is known must be a length.

$$\frac{a}{\sin\alpha} = \frac{b}{\sin\beta} = \frac{c}{\sin\gamma}$$

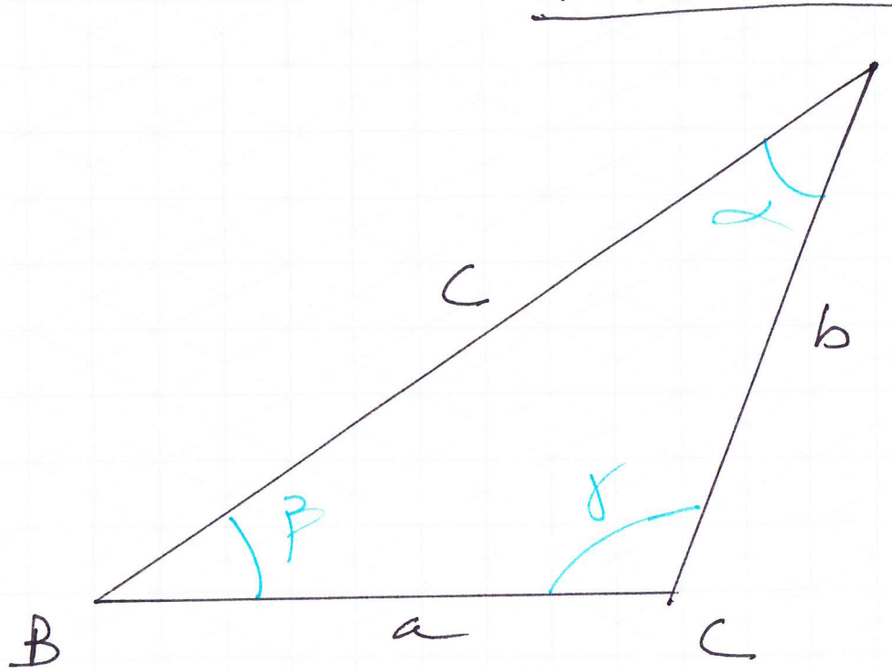
$$\frac{a}{\sin\alpha} = \frac{b}{\sin\beta} \quad (1)$$

$$\frac{b}{\sin\beta} = \frac{c}{\sin\gamma} \quad (2)$$

$$\frac{a}{\sin\alpha} = \frac{c}{\sin\gamma} \quad (3)$$

Three Knowns

Law of Cosines



$$c^2 = a^2 + b^2 - 2ab\cos\gamma$$

$$a^2 = b^2 + c^2 - 2bc\cos\alpha$$

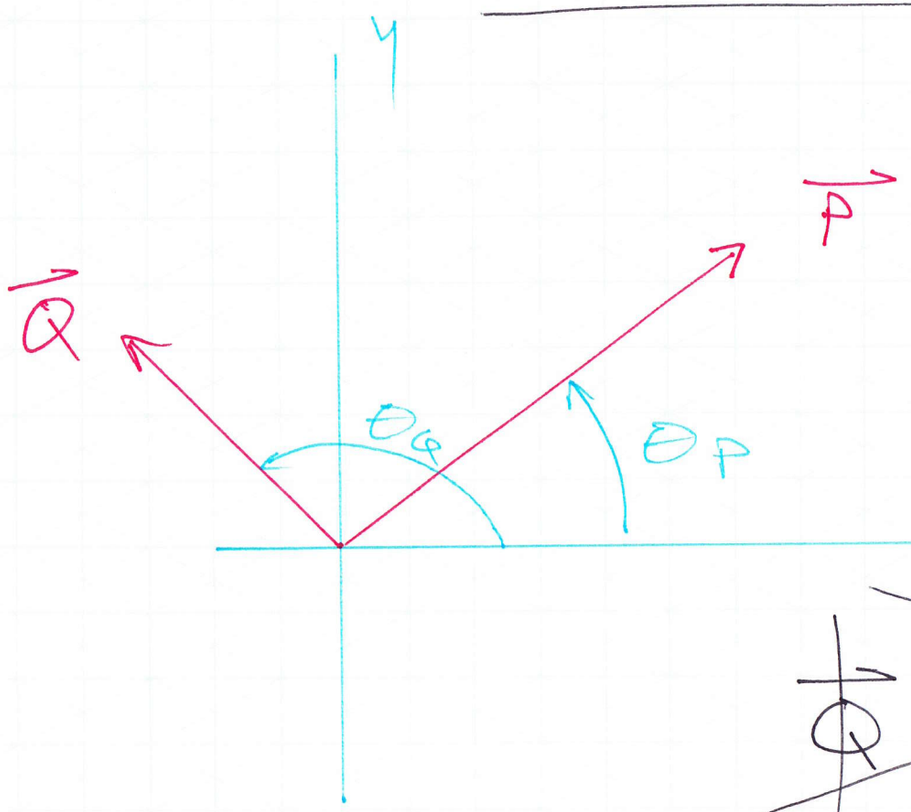
$$b^2 = a^2 + c^2 - 2ac\cos\beta$$

3 equations

6 unknowns

3 equations

Addition of Concurrent Vectors



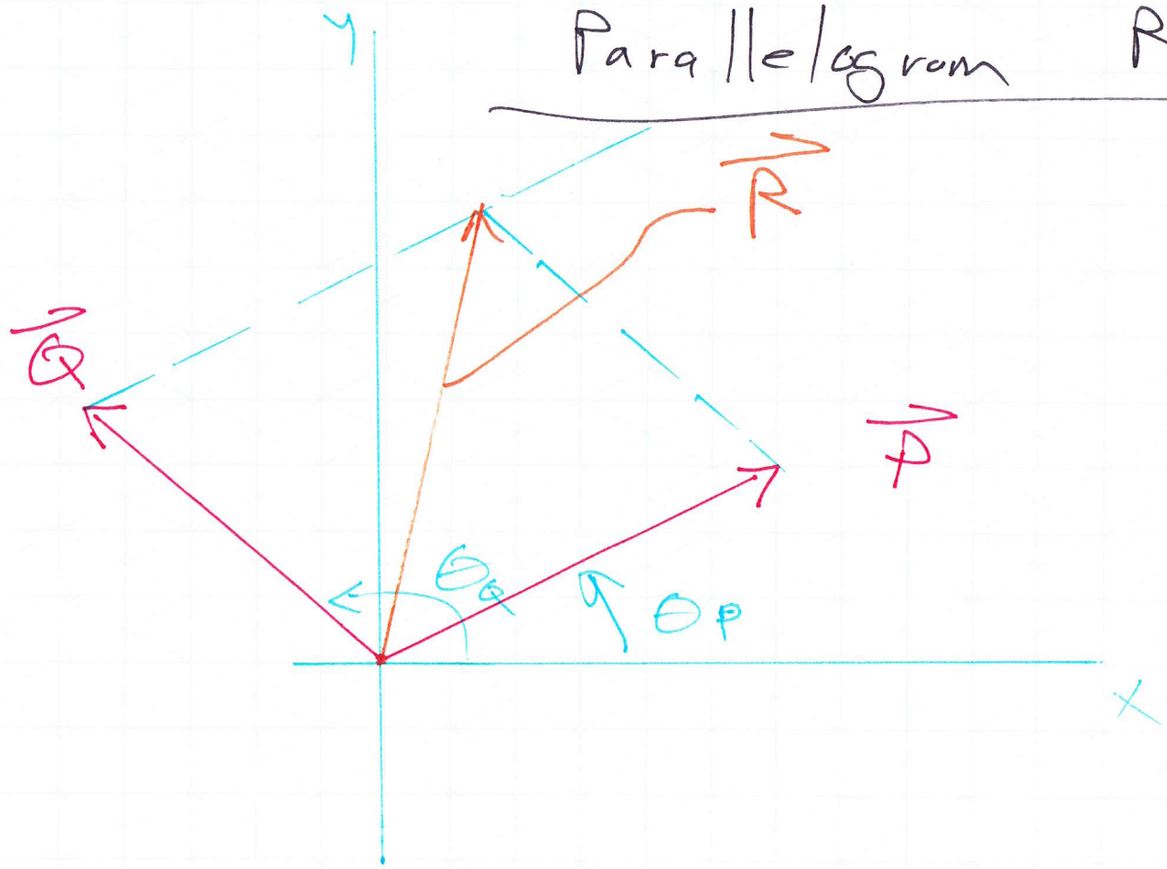
$|\vec{Q}|$ = magnitude of $\vec{Q}$

$|\vec{P}|$ = magnitude of $\vec{P}$

θ_P θ_Q

$\vec{Q} + \vec{P} = |\vec{Q}| + |\vec{P}|$

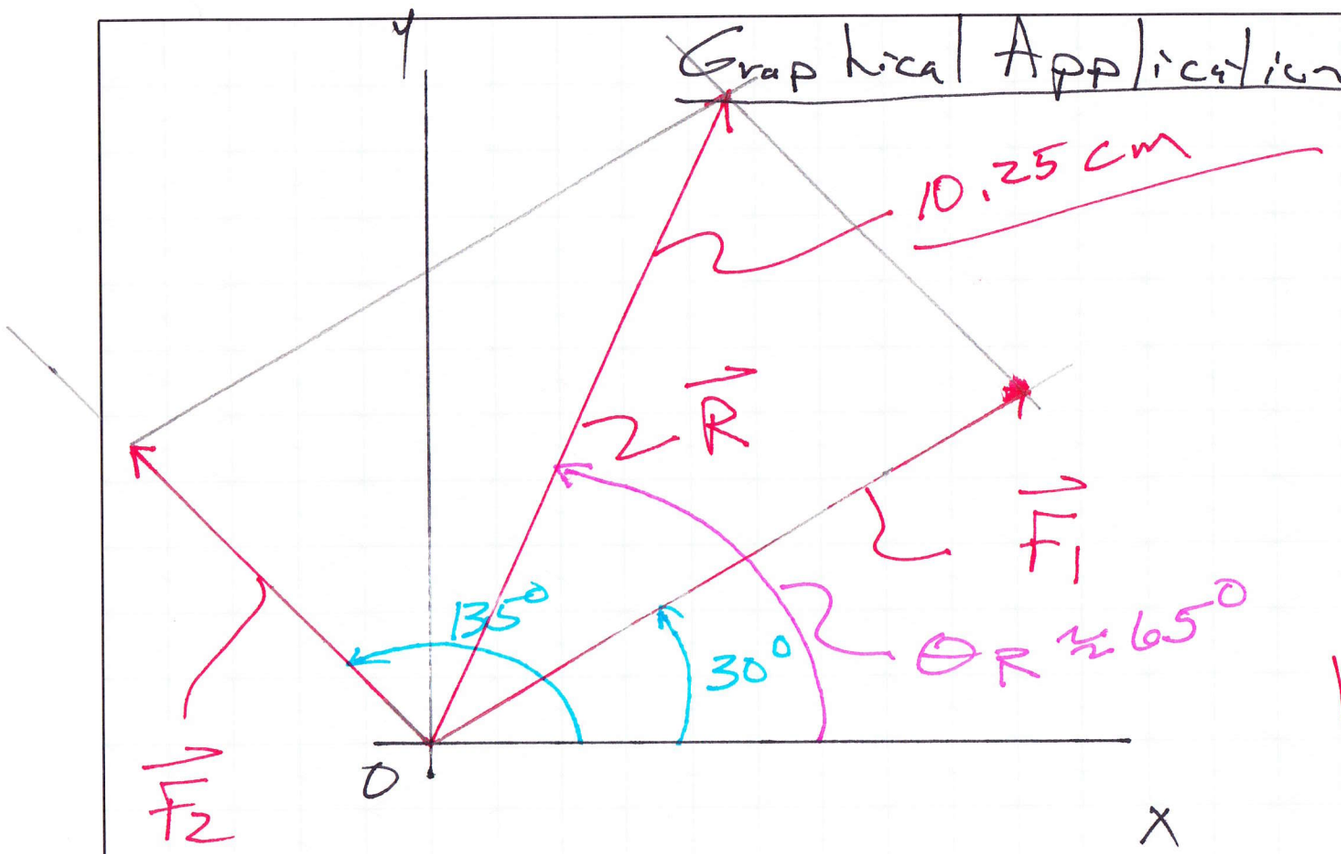
Parallelogram Rule – two concurrent forces



$\vec{R}$ – what you get when you add two vectors

$$\vec{R} = \vec{P} + \vec{Q} = \vec{Q} + \vec{P}$$

Graphical Application of Parallelogram Rule



$\vec{F}_1$: 500 lb, $\theta_1 = 30°$

$\vec{F}_2$: 300 lb, $\theta_2 = 135°$

1 cm = 50 lb

$\vec{F}_1 + \vec{F}_2 = \vec{R}$

$|\vec{R}| \approx (10.25)(50) = 512.5$ lb

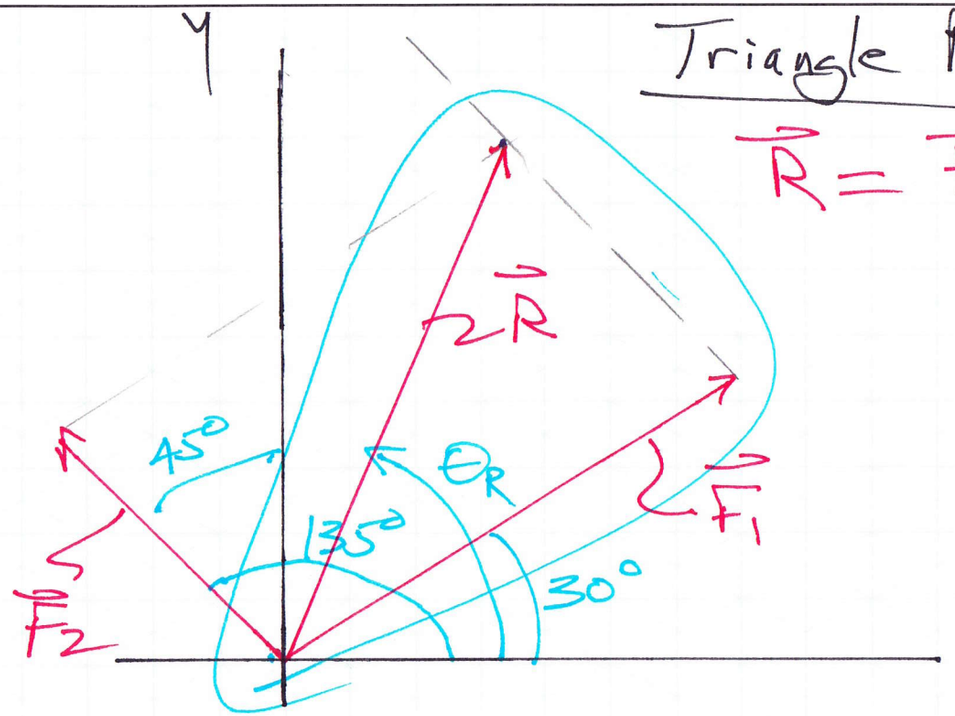
$|\vec{R}| = 512.5$ lb, $65°$

Triangle Rule

$\vec{R} = \vec{F}_1 + \vec{F}_2$

$\vec{F}_1$: 500 lb, $\theta_1 = 30°$

$\vec{F}_2$: 300 lb, $\theta_2 = 135°$



$$\frac{300}{\sin B} = \frac{512.2}{\sin 75^\circ} = \frac{500}{\sin \alpha}$$

$B = 34.5^\circ$

$R^2 = 500^2 + 300^2 - 2(500)(300)\cos 75^\circ$

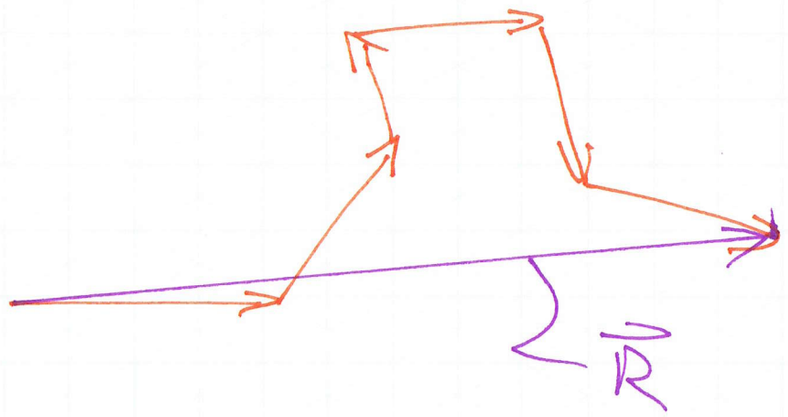
$R = 512.2$ lbs

$30 + 34.5^\circ = 64.5^\circ$

Resultant of Two or more Concurrent Vectors.

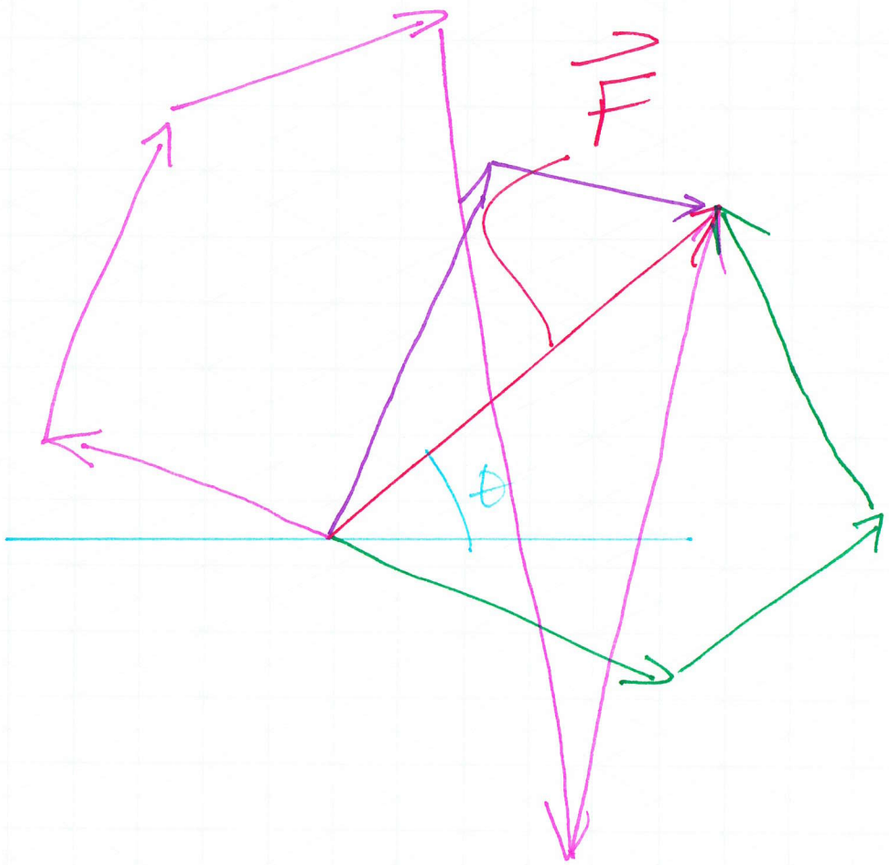
1. Add two vectors get a resultant. Then add the next to the first resultant and keep going.

2. Tip to Tail method

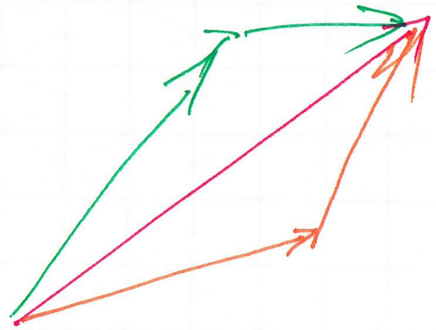


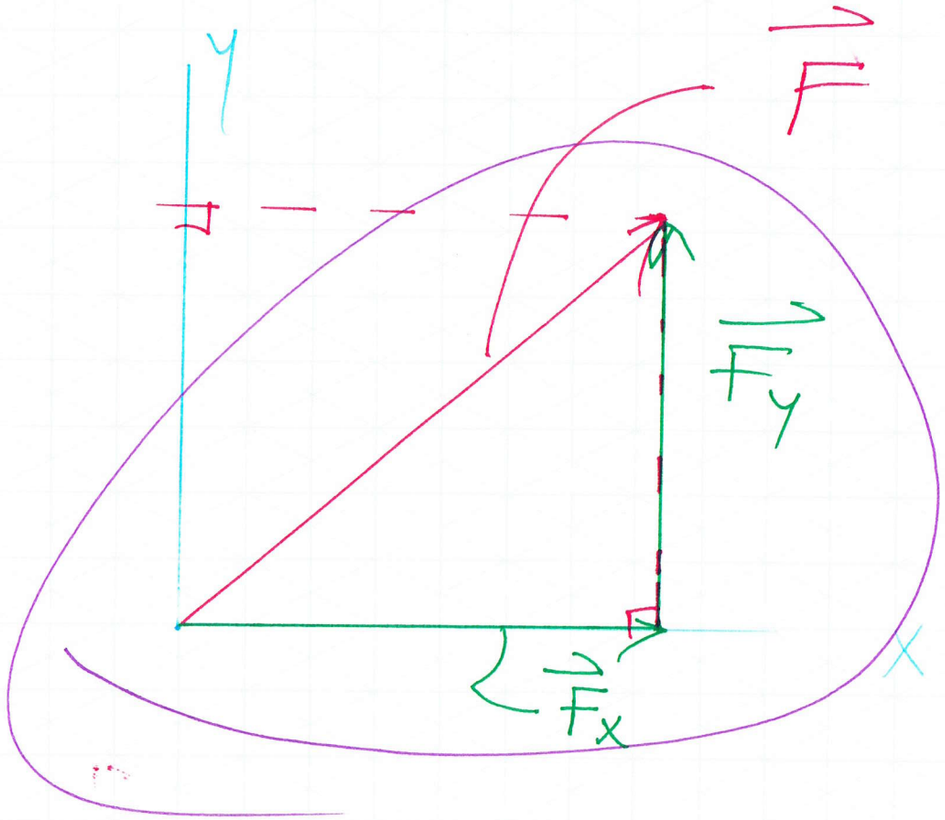
We must find a better way

Components of a Force



The components of a force would be any combination of forces whose resultant is equal to $\vec{F}$





$$|\vec{F}|^2 = |\vec{F}_x|^2 + |\vec{F}_y|^2$$