Today's Learning Goal(s):

By the end of the class, I will be able to:

(show powerpoint)

a) understand the "Parallelogram Law" of vector addition

b) solve various vector addition and subtraction problems using a variety of methods

5.9.1: Component Vectors vs. Parallelogram Law

Date: Nov. 26/18

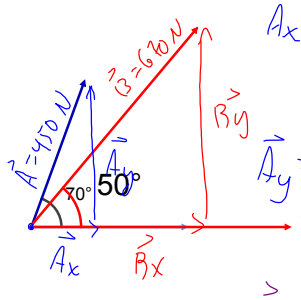
Net Force (Part Two)

Finding the net force, [or resulting force (or resultant, $\vec{R}$)] on an object depends on several separate forces acting on the same object.

Two people each pull a rope that is connected to a boat. Andy, $\vec{A}$, pulls with a force of 450 N at an angle of 70° from the horizontal. Billy, $\vec{B}$, pulls from the ***same side*** of the boat with a force of 670 N 50° from the horizontal. Determine the net force on the boat. (*Note: The bearings are 020° and 040° respectively.*)

Hint: construct a diagram with the boat at the origin.

Method 1: Using horizontal and vertical components



$\vec{A}_x = 450\cos 70°$

$\doteq 153.909$ N

$\vec{A}_y = 450\sin 70°$

$\doteq 422.862$ N

$\vec{B}_x = 670\cos 50°$

$\doteq 430.668$ N

$\vec{B}_y = 670\sin 50°$

$\doteq 513.250$ N

x-direction: $\vec{A}_x + \vec{B}_x$

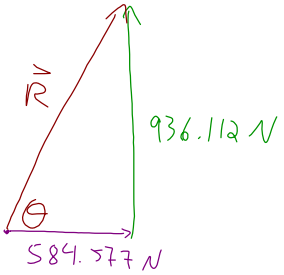
$\doteq 153.909 + 430.668$

$\doteq 584.577$ N

y-direction: $\vec{A}_y + \vec{B}_y$

$\doteq 422.862 + 513.250$

$\doteq 936.112$ N



$|\vec{R}|^2 = 584.577^2 + 936.112^2$

$|\vec{R}| = \sqrt{1\,218\,035.94}$

$\doteq 1103.6466$

$\doteq 1103.647$ N

$\tan\theta = \frac{936.112}{584.577}$

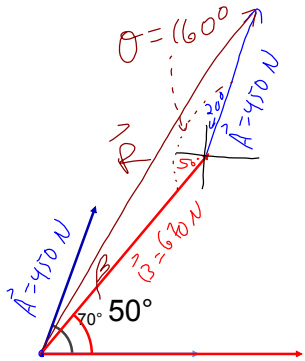
$\theta = \tan^{-1}(\quad)$

$\doteq 58.016$

$\doteq 58.02$

∴ the net force is 1103.647 N acting ∈ 58.02° N.

Method 2: Using the Parallelogram Law



$|\vec{R}| = \sqrt{670^2 + 450^2 - 2(670)(450)\cos 160°}$

$\doteq 1103.647$ N

$\frac{\sin B}{450} \doteq \frac{\sin 160°}{1103.647}$

$B \doteq \sin^{-1}\left(450 \times \frac{\sin 160°}{1103.647}\right)$

$\doteq 8.016$

$\doteq 8.02$

Answer (same side): 1103.646 N, at an angle of 58.02° from the horizontal (or 8.02° ***to the 670 N force*** , or bearing 031.98°)

Net Force (again) Last day's example, but with the Parallelogram Law

Finding the net force, [or resulting force (or resultant, $\vec{R}$)] on an object depends on several separate forces acting on the same object.

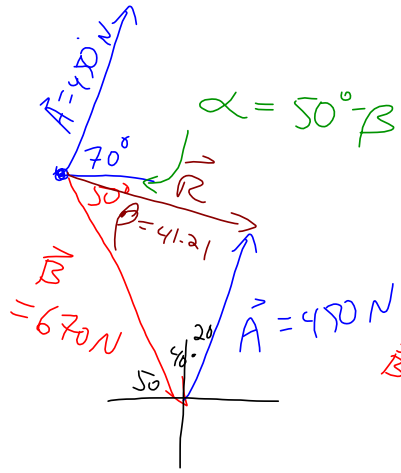
Two people each pull a rope that is connected to a boat. Andy, $\vec{A}$, pulls with a force of 450 N at an angle of 70° from the horizontal. Billy, $\vec{B}$, pulls from the ***other side*** of the boat with a force of 670 N 50° from the horizontal. Determine the net force on the boat. (*Note: The bearings are 020° and 140° respectively.*)

Hint: construct a diagram with the boat at the origin.

$|\vec{R}| = \sqrt{670^2 + 450^2 - 2(670)(450)\cos 60^\circ}$

$\doteq 591.5234$

$\doteq 591.523\ N$



$\vec{B}=670N$ 450

$\frac{\sin\beta}{450} \doteq \frac{\sin 60^\circ}{591.523}$

$\beta \doteq \sin^{-1}\left(450 \times \frac{\sin 60^\circ}{591.523}\right)$

$\doteq 41.210$

$\doteq 41.21$

$\therefore \alpha = 50^\circ - \beta$

$\doteq 50^\circ - 41.21^\circ$

$\doteq 8.79$

$\therefore$ the resultant is 591.523 N acting [E 8.79° S].

Answer: 1103.646 N, at an angle of 58.02° from the horizontal (or 8.02° ***to the 670 N force*** , or bearing 031.98°)
(? or 976.167 N at an angle of E 73.52° N.?)

Answer (opposite side): 591.524 N, at an angle of 8.79° below the horizontal (or E8.79° S, or bearing 098.79°)

Additional Resources:
(***These links are posted on the class website and in our Google Classroom.***)

Plane and Wind question [Parallelogram Method] (12:04)

http://www.youtube.com/watch?v=SGG4i91D0hg

Parallelogram Method (4:22)

http://www.youtube.com/watch?v=2A58m0OZjXU

Be certain to watch the above videos before tomorrow's class.