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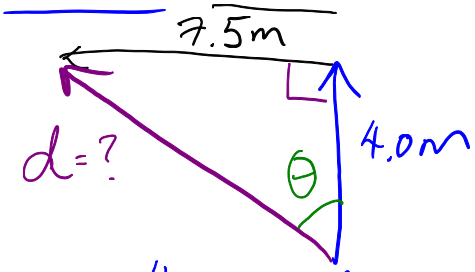
2.2 Vector Addition and Subtraction

Review: Last class we broke vectors down into their components. What happens if the reverse happened?

Ex 1: Leo walked 4.0m North then 7.5m West. What was Leo's displacement?



$d = \sqrt{7.5^2 + 4.0^2}$

$= 8.5\text{m at } 62° \text{ West of North}$

$\tan\theta = \frac{7.5m}{4.0m}$

$\theta = 62°$

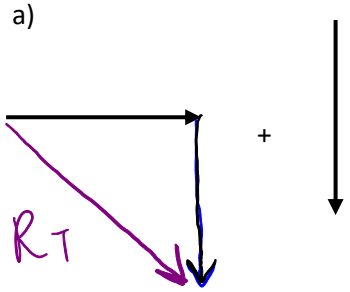
Notice that we used pythagoras and are working backwards compared to last lesson.

Vector Addition

Recall, to add vectors, you connect them tip to tail. In 2D, it's the same thing. You can then draw the resultant vector that connects the tail of your first arrow to the head of your second arrow.

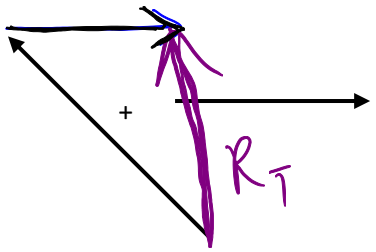
Ex 2: Add the following vectors together.

a)



b)

c)



Component Method

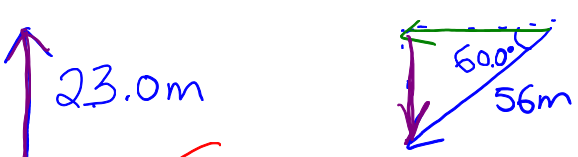
To calculate the resultant vector we need to

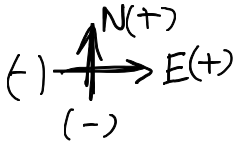
1) Break the vectors down into their horizontal and vertical components (if necessary)
2) Add the horizontal components of each added vector, let's call this new vector $\bar{H}_{total}$.
3) Add the vertical components of each added vector, let's call this new vector $\bar{V}_{total}$.

Make sure to do 2 and 3 independent *of each other!!!!* DIRECTIONS *IMPORTANT!*

4) Add the vectors $\bar{H}_{total}$ and $\bar{V}_{total}$. Calculate the resultant vector using Pythagoras.

Ex 3: Sammy the flying squirrel flew 23.0m North then 56m at 60.0° South of West. What was his final displacement?





$\vec{H}_{total} = -56m\cos 60 = 28m$ West ($\vec{H}$) ← ⊖ sign

$\vec{V}_{total} = 23.0m - 56\sin 60\,m = 25.4974\ldots m$ South ($\vec{V}$) ← ⊖ sign

* don't round!

* don't need to say direction AND use ⊕/⊖ sign.

Adding $\vec{H} + \vec{V}$

$H = 28m$

$V = 25.497\ldots m$

$R_T = \sqrt{28^2 + 25.\ldots^2}$

$= 38m$ at $42°$ South of West

$\tan\theta = \frac{25.4m}{28m}$

$\theta = 42°$

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Trigonometric/Graphical Method

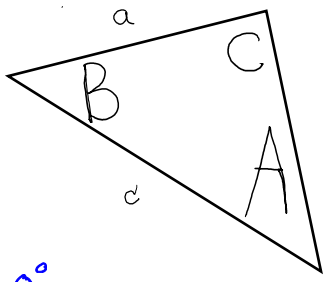
To calculate the resultant vector we need to

1) Draw the vectors connecting them tip to tail.
2) Draw the resultant vector.
3) Depending on what you're given, use the cosine or sine law to calculate your resultant vector.

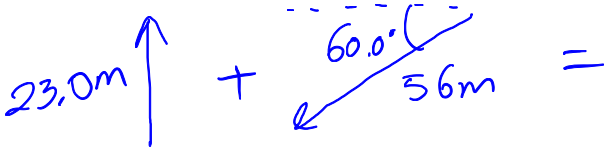
Recall,

Sine Law: $\frac{SinA}{a} = \frac{SinB}{b} = \frac{SinC}{c}$

Cosine Law: $c^2 = a^2 + b^2 - 2ab\cos C$



Ex 4: Redo Ex 3 using the trig method.



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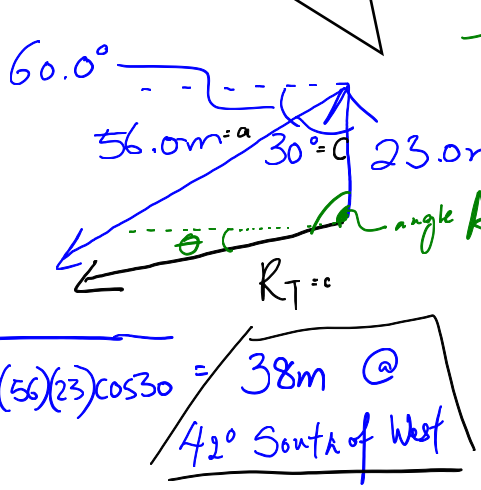


To get θ, we need angle A → sine law

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

$\Rightarrow \frac{\sin A}{56.0m} = \frac{\sin 30}{37.869...m}$ ← did not round

$A = 132...°$

$\theta = A - 90° = 42°$

using cosine law:

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

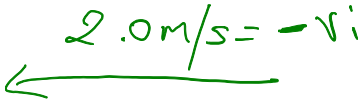
$c = \sqrt{a^2 + b^2 - 2ab\cos C} = \sqrt{56^2 + 23^2 - 2(56)(23)\cos 30} = 38m$ @ 42° South of West

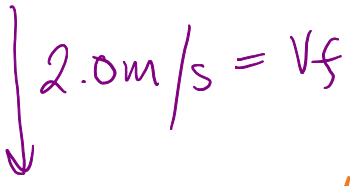
Vector Subtraction

Key Point: Subtracting a number is the same as adding the negative of that number (ex. 3-4 = 3 + (-4)).

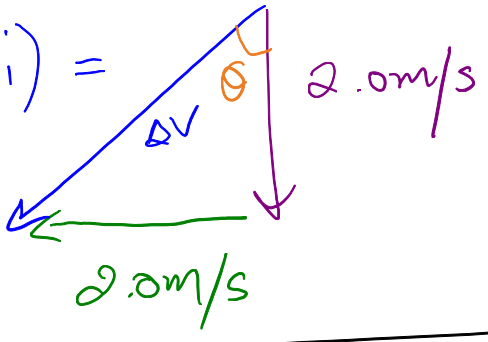
The same idea can be applied to vectors. All you need to do is to flip your subtracted vector in the opposite direction. Then you can add the vectors normally.

Ex 5: Michu was running East at 2.0m/s then changed her directions in 1.0s going 2.0m/s South. What was her acceleration? *Recall that* $a = \frac{v_f - v_i}{\Delta t}$. $= \Delta V$





$\Delta V = V_f - V_i = V_f + (-V_i) =$



$\tan\theta = \frac{2.0m/s}{2.0m/s}$

$\theta = 45°$

$\Delta V = \sqrt{2^2 + 2^2} = 2.82842...m/s$

$a = \frac{2.82842...m/s}{1.0s} =$ **2.8m/s² @ 45° West of South**