Welcome

Natasha Holmes

Post-doc at Stanford University;
Studying teaching and learning in undergraduate physics lab courses

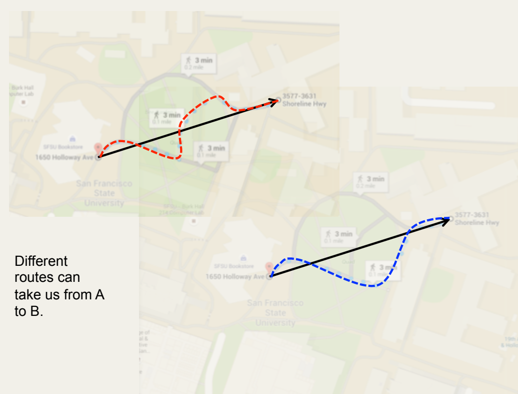
Learning objectives

By the end of this lesson, you should be able to:

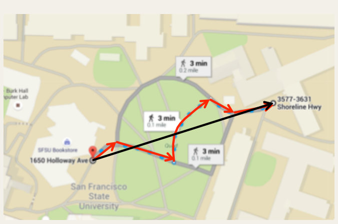
- Add and subtract vectors:
  - graphically, and
  - mathematically by breaking them down into components

$\vec{A}$ denotes a vector **A** – your textbook bolds the letter to represent a vector.

Getting here from the SFSU Bookstore



Different routes can take us from A to B.



Directions:
- Head North on Holloway Ave
- go straight into the Quad
- take the second left
- turn right at the T, and
- then veer to the left at the fork.

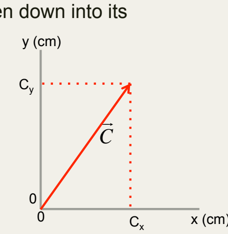
Each route has sub-steps.

By adding up all the little sub-steps, we get from A to B.

Vector components

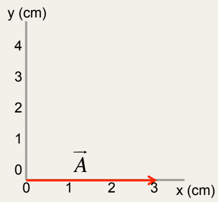
Any vector, $\vec{C}$, can be broken down into its

- *x*-component, C_x, and
- *y*-component, C_y



If the vector $\vec{A}$ is defined as in the diagram below, what is the *y*-component of $\vec{A}$?

A. 0
B. 1
C. 2
D. 3



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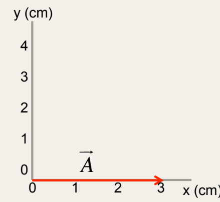
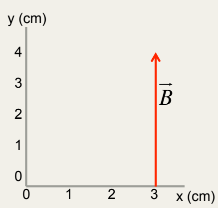


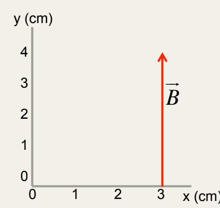
If the vector $\vec{B}$ is defined as in the diagram below, what is the *x*-component of $\vec{B}$?

A. 0
B. 1
C. 3
D. 4



If the vector $\vec{B}$ is defined as in the diagram below, what is the *x*-component of $\vec{B}$?

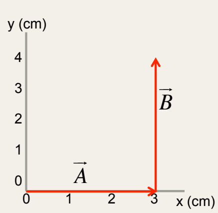
A. 0
B. 1
C. 3
D. 4



$A_x = 3cm$ $\quad B_x = 0$

$A_y = 0$ $\quad B_y = 4cm$

$\vec{A} = A_x$ in the x-direction
$\vec{B} = B_y$ in the y-direction

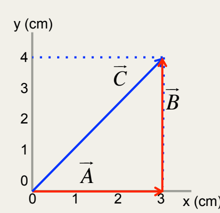


$A_x = 3cm$ $\quad B_x = 0$

$A_y = 0$ $\quad B_y = 4cm$

Therefore, $\vec{C}$ can be broken down into its x- and y-components such that:

$C_x = A_x = \vec{A}$
$C_y = B_y = \vec{B}$

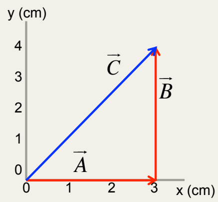


$A_x = 3cm$ $B_x = 0$

$A_y = 0$ $B_y = 4cm$

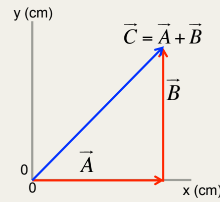
Or, $\vec{C}$ can be made up of vectors $\vec{A}$ and $\vec{B}$ such that:

$$\vec{C} = \vec{A} + \vec{B}$$



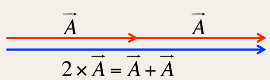
If we were to walk from (0,0) to the end point of $\vec{C}$, we could do so by:

- Walking along $\vec{C}$ or
- By walking along $\vec{A}$ and then turning to walk along $\vec{B}$



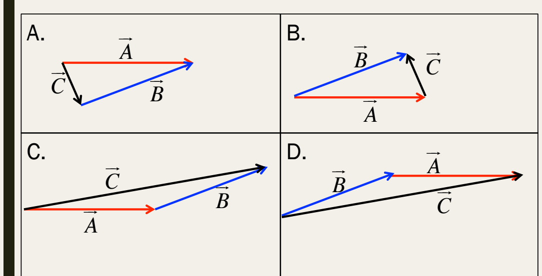
If $\vec{A}$ is

What is $\vec{A} + \vec{A}$?



If $\vec{A}$ is and $\vec{B}$ is 

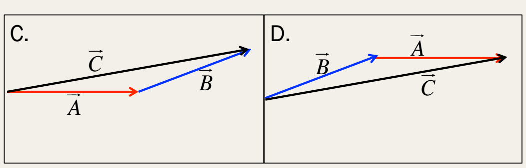
What is $\vec{C} = \vec{A} + \vec{B}$?



If $\vec{A}$ is and $\vec{B}$ is 

What is $\vec{C} = \vec{A} + \vec{B}$?

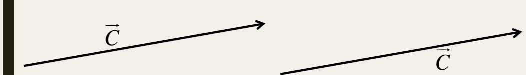
$$\vec{A} + \vec{B} = \vec{B} + \vec{A}$$



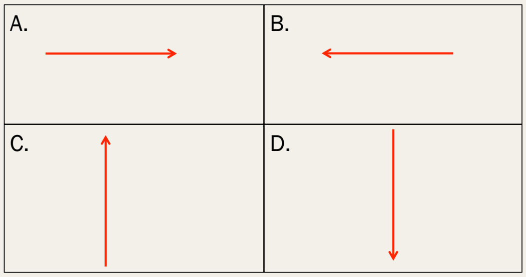
If $\vec{A}$ is and $\vec{B}$ is 

What is $\vec{C} = \vec{A} + \vec{B}$?

$$\vec{A} + \vec{B} = \vec{B} + \vec{A}$$

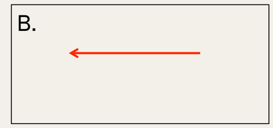


If $\vec{A}$ is , what is $-\vec{A}$?



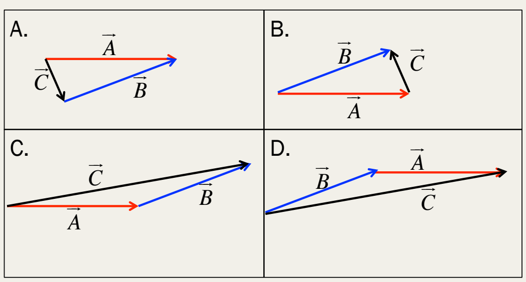
If $\vec{A}$ is , what is $-\vec{A}$?

Magnitude same,
switch direction



If $\vec{A}$ is and $\vec{B}$ is

What is $\vec{C} = \vec{B} - \vec{A}$?



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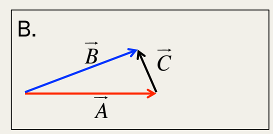
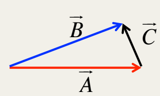


If $\vec{A}$ is and $\vec{B}$ is

What is $\vec{C} = \vec{B} - \vec{A}$?

$$\vec{C} = \vec{B} - \vec{A} = -\vec{A} + \vec{B}$$



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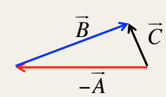
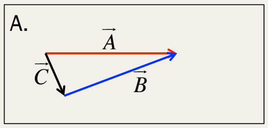


If $\vec{A}$ is and $\vec{B}$ is

What is $\vec{C}$ in terms of $\vec{A}$ and $\vec{B}$?



A. $\vec{C}=\vec{B}-\vec{A}$

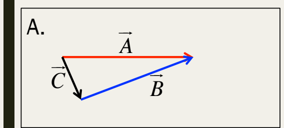
B. $\vec{C}=\vec{A}-\vec{B}$

C. $\vec{C}=-\vec{A}-\vec{B}$

D. $\vec{C}=\vec{A}+\vec{B}$

If $\vec{A}$ is and $\vec{B}$ is

What is $\vec{C}$ in terms of $\vec{A}$ and $\vec{B}$?



A. $\vec{C}=\vec{B}-\vec{A}$

B. **$\vec{C}=\vec{A}-\vec{B}$**

C. $\vec{C}=-\vec{A}-\vec{B}$

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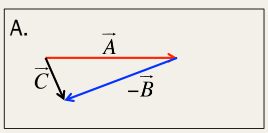
If $\vec{A}$ is and $\vec{B}$ is

What is $\vec{C}$ in terms of $\vec{A}$ and $\vec{B}$?



A. $\vec{C}=\vec{B}-\vec{A}$

B. **$\vec{C}=\vec{A}-\vec{B}$**

C. $\vec{C}=-\vec{A}-\vec{B}$

D. $\vec{C}=\vec{A}+\vec{B}$

That's fine for two or three vectors…

But what if we have lots and lots of vectors?

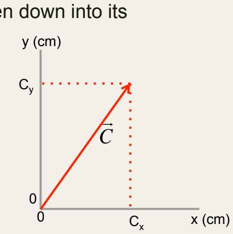
Drawing each connecting line might get tedious.

Not to mention when we get to 3-dimensions!

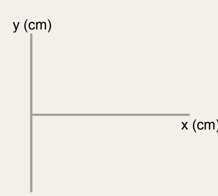
Using components

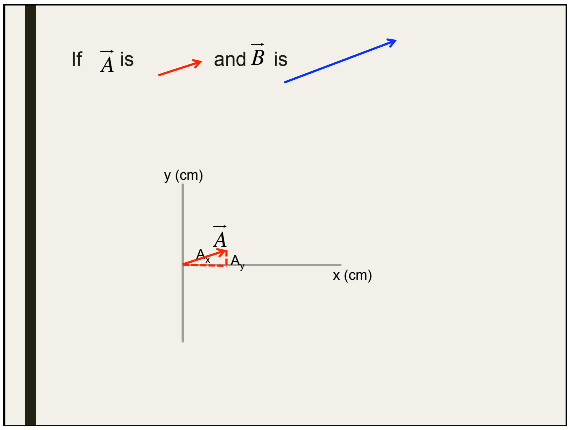
Any vector, $\vec{C}$, can be broken down into its

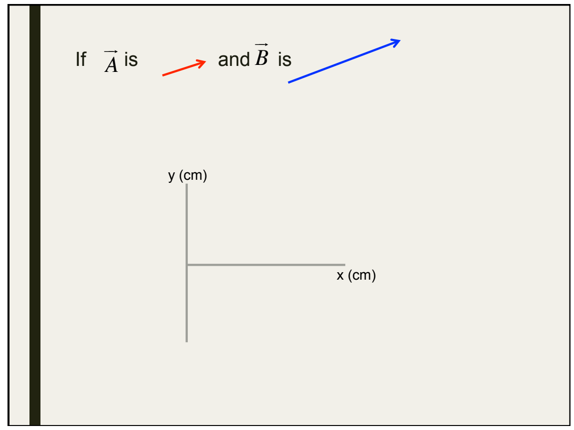
- *x*-component, C_x, and
- *y*-component, C_y

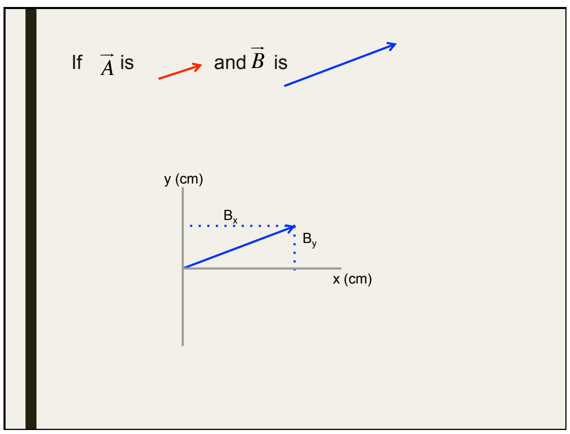


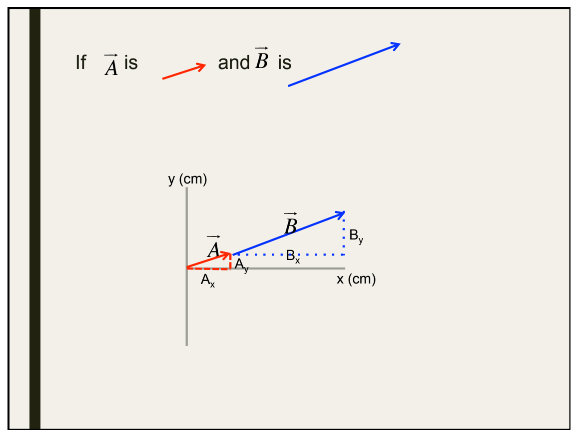
If $\vec{A}$ is and $\vec{B}$ is

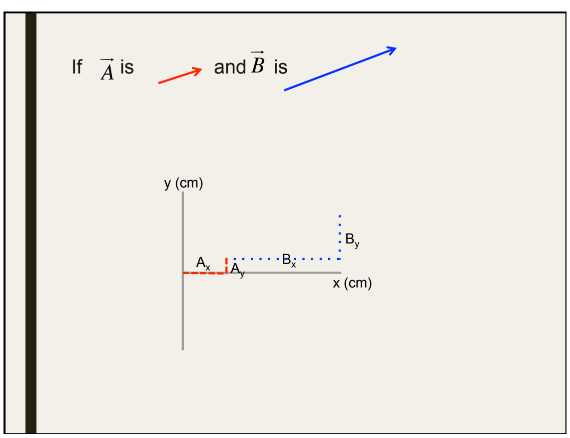


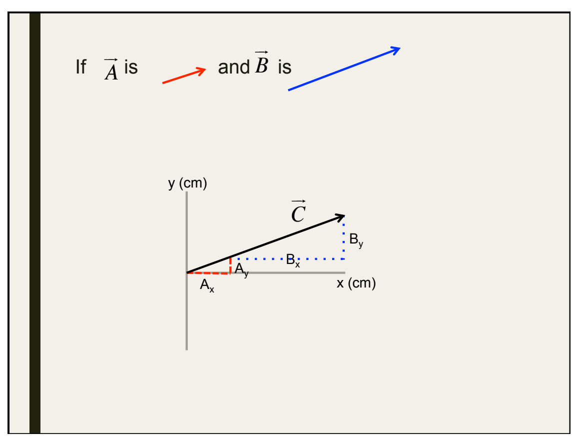

If $\vec{A}$ is and $\vec{B}$ is
y (cm)
$\vec{A}$
A_x
A_y
x (cm)


If $\vec{A}$ is and $\vec{B}$ is
y (cm)
x (cm)


If $\vec{A}$ is and $\vec{B}$ is
y (cm)
B_x
B_y
x (cm)

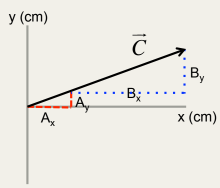

If $\vec{A}$ is and $\vec{B}$ is
y (cm)
$\vec{B}$
B_y
$\vec{A}$
A_y
B_x
A_x
x (cm)


If $\vec{A}$ is and $\vec{B}$ is
y (cm)
B_y
A_x
A_y
B_x
x (cm)


If $\vec{A}$ is and $\vec{B}$ is
y (cm)
$\vec{C}$
B_y
A_y
B_x
A_x
x (cm)

If $\vec{A}$ is and $\vec{B}$ is

$$\vec{C} = \vec{A} + \vec{B}$$
$$C_x = A_x + B_x$$
$$C_y = A_y + B_y$$



If $\vec{A}$ is and $\vec{B}$ is

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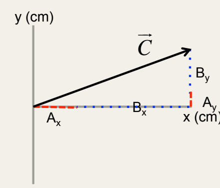
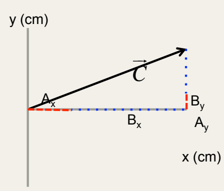


If $\vec{A}$ is and $\vec{B}$ is

such that:
A_x=2, A_y=1
B_x=3, B_y=2

What are the *x*- and *y*-components of $\vec{C}$?



$$\vec{C} = \vec{A} + \vec{B}$$
$$C_x = A_x + B_x = 2 + 3 = 5$$
$$C_y = A_y + B_y = 1 + 2 = 3$$

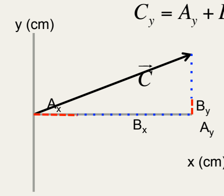
If $\vec{A}$ is and $\vec{B}$ is

$$\vec{C} = \vec{A} + \vec{B}$$
$$C_x = A_x + B_x$$
$$C_y = A_y + B_y$$

such that:
A_x=2, A_y=1
B_x=3, B_y=2

What is the magnitude of $\vec{C}$?

A. 4
B. 6
C. 8
D. 34
Choose the closest answer



If $\vec{A}$ is and $\vec{B}$ is

$$\vec{C} = \vec{A} + \vec{B}$$
$$C_x = A_x + B_x$$
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A_x=2, A_y=1
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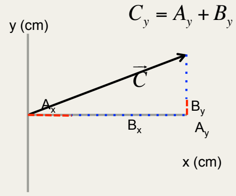

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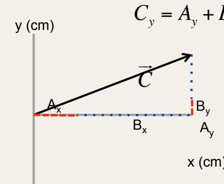
$$C_x = A_x + B_x$$
$$C_y = A_y + B_y$$

such that:
A_x=2, A_y=1
B_x=3, B_y=2

What is the magnitude of $\vec{C}$?

$$\left|\vec{C}\right| = \sqrt{C_x^2 + C_y^2}$$
$$\left|\vec{C}\right| = \sqrt{(A_x + B_x)^2 + (A_y + B_y)^2}$$
$$\left|\vec{C}\right| = \sqrt{(2+3)^2 + (1+2)^2} = \sqrt{34} = 5.8 \approx 6$$



What about the direction angle?

If $\vec{A}$ is  and $\vec{B}$ is 

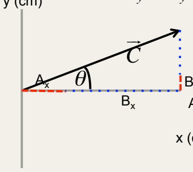
$\vec{C} = \vec{A} + \vec{B}$

$C_x = A_x + B_x$

$C_y = A_y + B_y$

such that:
A_x=2, A_y=1
B_x=3, B_y=2

What is the direction angle, θ of $\vec{C}$?



A. $\tan^{-1}\left(\frac{3}{5}\right)$

B. $\tan^{-1}\left(\frac{5}{3}\right)$

C. $\sin^{-1}\left(\frac{3}{5}\right)$

D. $\sin^{-1}\left(\frac{5}{3}\right)$

If $\vec{A}$ is  and $\vec{B}$ is 

$\vec{C} = \vec{A} + \vec{B}$

$C_x = A_x + B_x$

$C_y = A_y + B_y$

such that:
A_x=2, A_y=1
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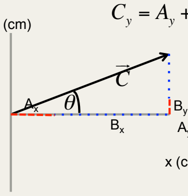
What is the direction angle, θ of $\vec{C}$?



$$\tan\theta = \frac{C_y}{C_x} = \frac{A_y + B_y}{A_x + B_x} = \frac{1+2}{2+3} = \frac{3}{5}$$

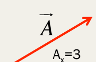
$$\theta = \tan^{-1}\frac{3}{5} = 30.96° \approx 31°$$

Learning objectives

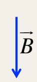
By the end of this lesson, you should be able to:

- Add and subtract vectors:
  - graphically, and
  - mathematically by breaking them down into components

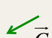
Practice



$\vec{A}$ A_x=3 A_y=2



$\vec{B}$ B_x=0 B_y=-2



$\vec{C}$ A_x=-1 A_y=-1

Find:

1. $\vec{A} + \vec{B}$
2. $\vec{B} - \vec{C}$
3. $\vec{A} + \vec{B} + \vec{C}$
4. $\vec{A} + \vec{B} - \vec{C}$

Graphically and by breaking them into components (magnitude and direction)