As you come in today pull out a piece of paper and take 1 minute to respond to the following prompts:

Think about a time when you have struggled. How strongly would you agree/disagree with following statements?

1. I didn't give up easily when I felt frustrated.
2. When I felt frustrated I took a step back to make sure my approach made sense.
3. I tried multiple approaches until I found one that worked.
4. I tried new things even if I was uncertain what the outcome might be.
5. When I was struggling I felt comfortable asking someone for help.

- Failure is a routine part of science: computer programs will be buggy, equipment won't work, and experiments will yield weird results. Scientists are characterized by their ability to use these setbacks as opportunities to improve their work.

- As a budding scientist, you can prepare yourself for dealing with failure in the lab by working to develop a healthy attitude towards setbacks in the classroom. This can mean building skills to help you struggle through a difficult problem set or figure out how to move forward from a low grade.

A worked solution to Wednesday's scaling problem is in the lecture slides posted on LON-CAPA and on the course calendar

Announcements

- Hands-On materials will be online in LON-CAPA before hands-on every week
- Use the LAs/TA in lecture – they're here to help!
- I moved some dates forward on the course calendar, Ch3 reading questions are due next Thursday. Homework stays the same.
- Help room opens next Tuesday! Hours are posted in LON-CAPA.
- If you've indicated you want to do an honors option meet down front at the end of class (so you can know who else is interested!)

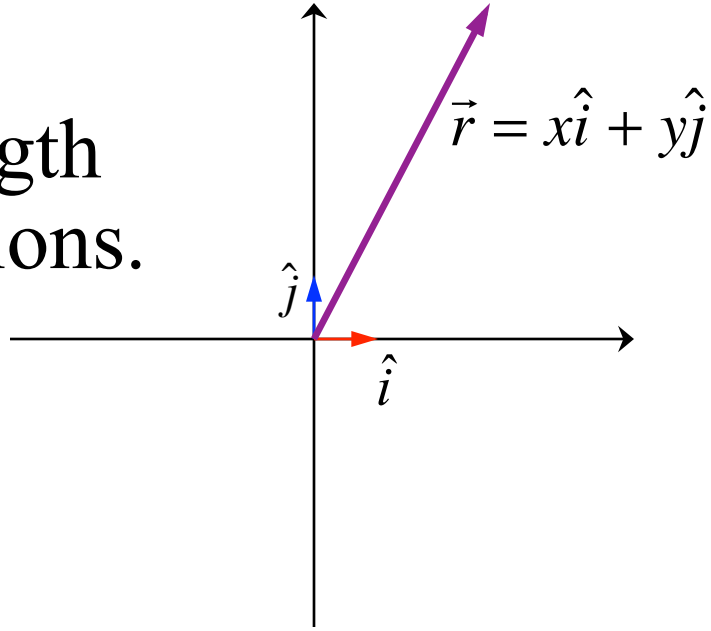
Foothold ideas: Measuring "where"

- In order to specify where something is we need a coordinate system. This includes:
  1. Picking an origin
  2. Picking perpendicular directions
  3. Choosing a measurement scale
- Each point in space is specified by three numbers: (x, y, z), and a position vector– an arrow showing the displacement from the origin to that position.
- Vectors add like successive displacements or algebraically by $\vec{A} = A_x\hat{i} + A_y\hat{j}$ $\vec{B} = B_x\hat{i} + B_y\hat{j}$

$$\vec{A} + \vec{B} = \left(A_x + B_x\right)\hat{i} + \left(A_y + B_y\right)\hat{j}$$

Notation

- We specify the directions we are talking about by drawing two little arrows of unit length in two perpendicular directions.
- "x" and "y" are called the coordinates and can be positive or negative.



- Note that if x is negative, it means $x\hat{i}$ is a vector pointing in the direction opposite to $\hat{i}$

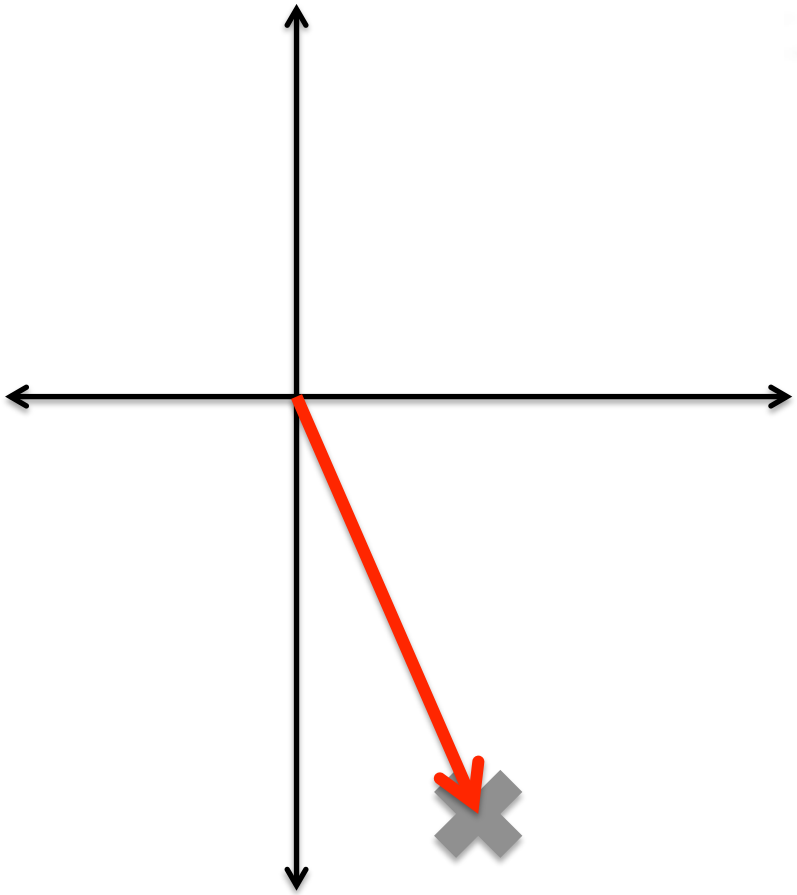
Which of the options below is the best match for the red vector shown?

A. $\begin{pmatrix} 1 \\ -2 \end{pmatrix}$

B. $\begin{pmatrix} -1 \\ -2 \end{pmatrix}$

C. $\begin{pmatrix} -1 \\ 2 \end{pmatrix}$

D. $\begin{pmatrix} 1 \\ 2 \end{pmatrix}$



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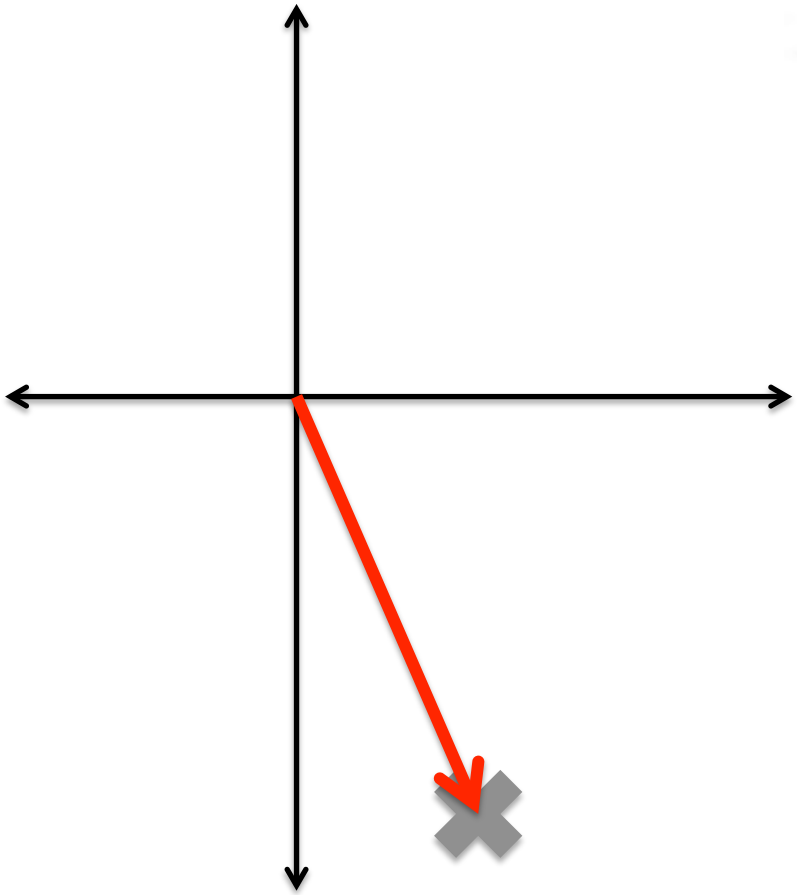


The point X moves to a distance, 4 times away along the same path. How would you describe it's position now?

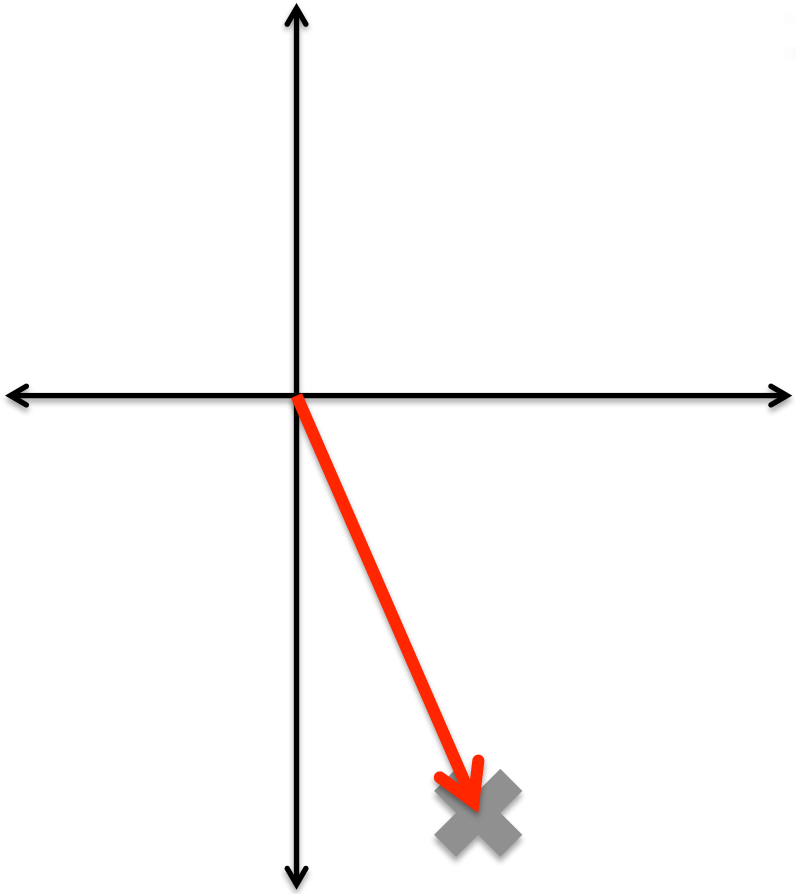
A. $\begin{pmatrix} 4 \\ -8 \end{pmatrix}$

B. $\begin{pmatrix} 4 \\ -2 \end{pmatrix}$

C. -4

D. 12

E. None of these



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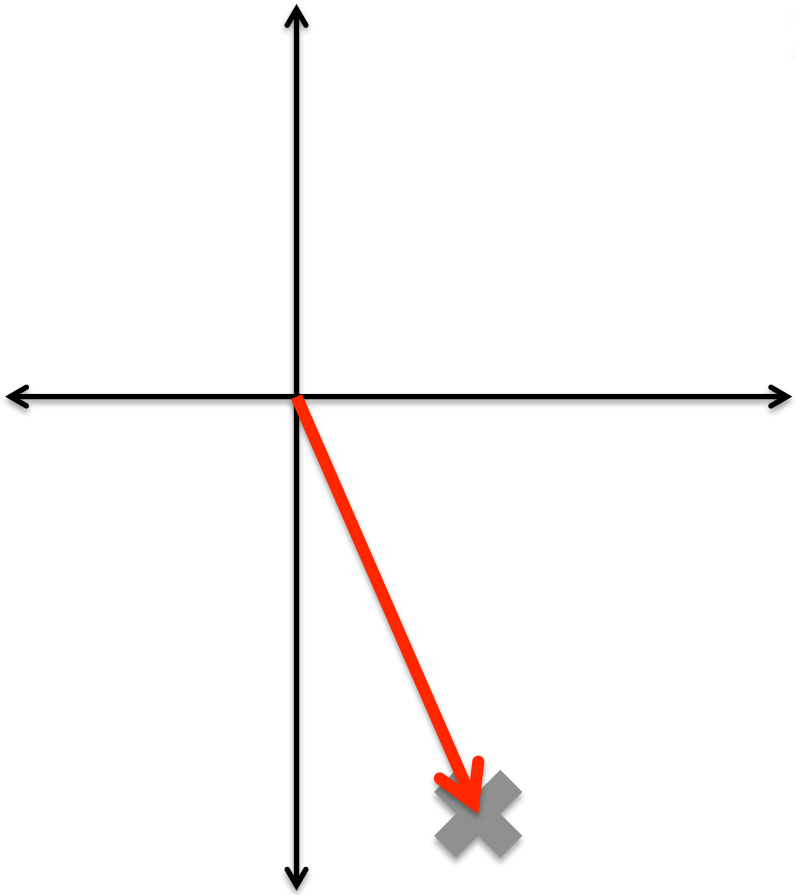

You have a vector $\vec{a} = (1, 2, 1)$.
What is $4\vec{a} = ?$

A. 16
B. (4, 2, 1)
C. (4, 8, 4)
D. 7
E. None of these

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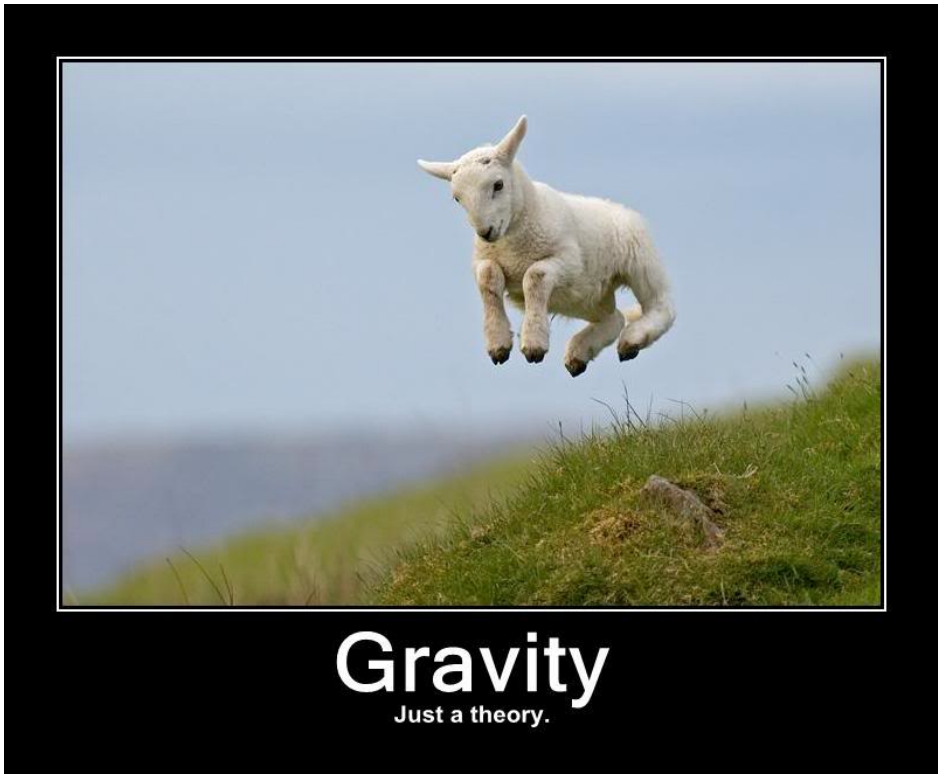
The dot product and cross product – What do they really mean?

Nothing really, they are a mathematical tool for modeling the world



The dot product and cross product – What do they really mean?

- Dot product: growth in a direction
  - Let's take the x-axis and the y-axis to mean really different things like "bananas" and "oranges"
  - Suppose (3,0) means "triple your bananas, destroy your oranges)
  - Suppose (0,4) means "destroy your bananas, quadruple your oranges"
  - So (3,0)•(0,4) would say to "triple your banana growth, quadruple your orange growth", but there was no bananas or oranges originally, so it's really say, "destroy all your fruits

Given two vectors A and B (shown in the picture), whose directions are separated by 60 degrees. Vector A has length 3, and vector B has length 4. What is $\vec{A} \bullet \vec{B}$?

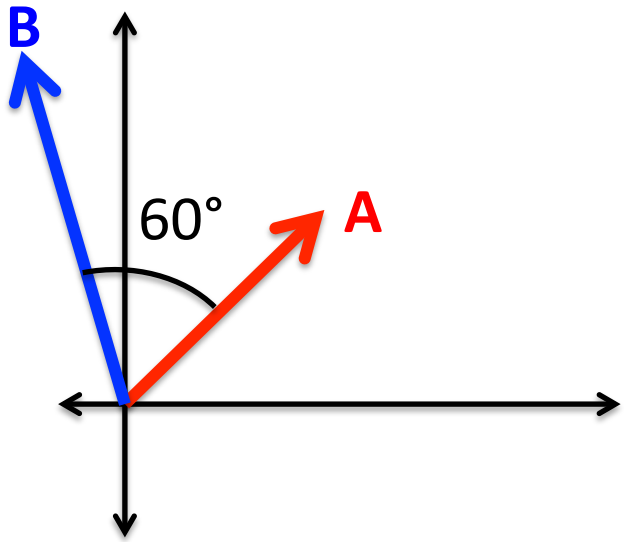
A. .5

B. 2

C. 4

D. 12

E. None of these

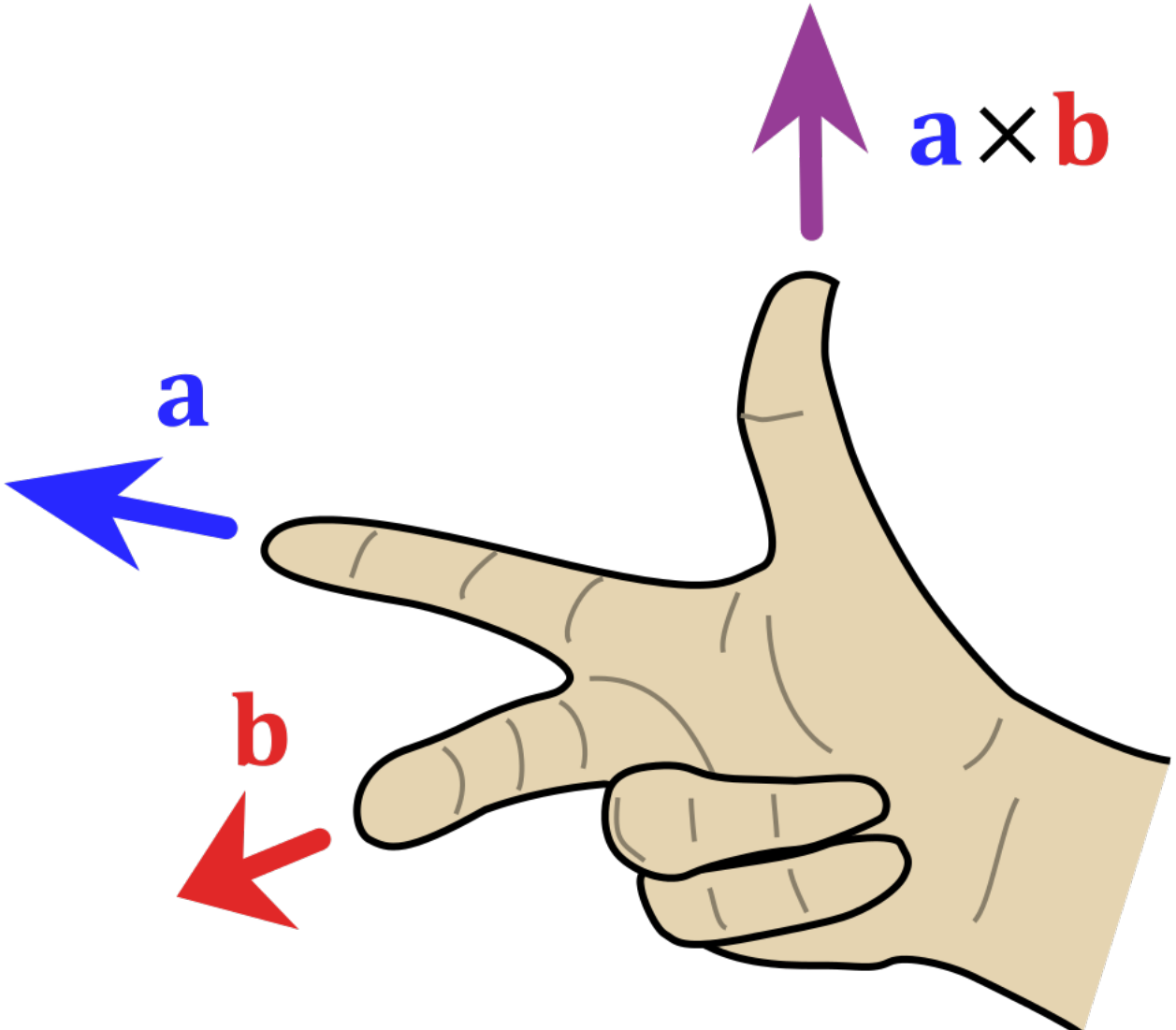


The dot product and cross product – What do they really mean?

- Cross product: area created between two vectors
- Two vectors aligned?
  - 0 area

- The order is important because you still get a vector.
  - How do you know what direction?

Right hand rule!



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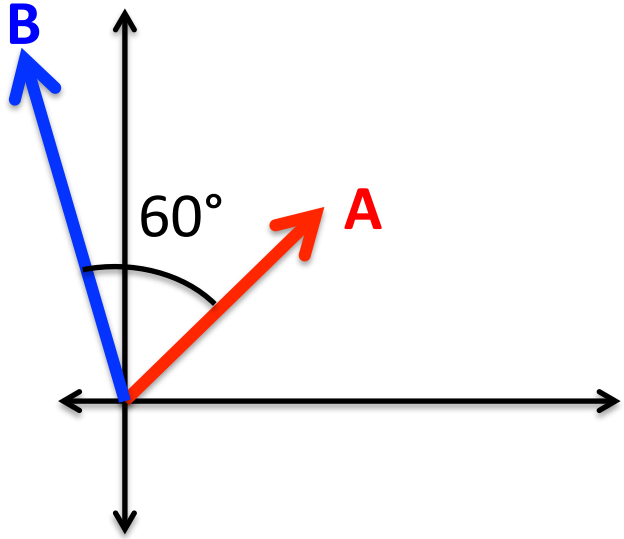
A. 10.4
B. 12
C. 8.5
D. 6
E. None of these



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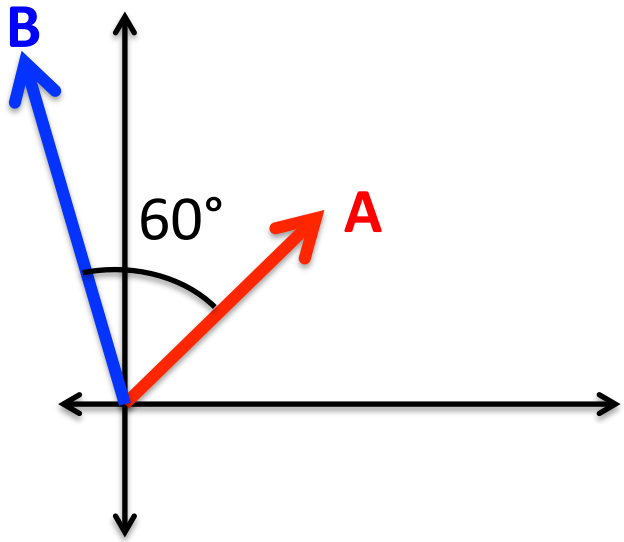
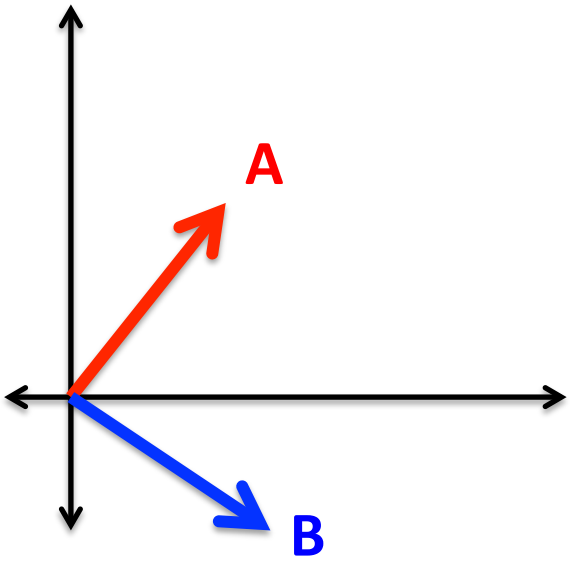


Now consider vectors A and B. What direction will $\vec{A} \times \vec{B}$ point?

A. Into the screen
B. Out of the screen
C. Up and to the left
D. Down and to the left
E. The cross product is zero



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