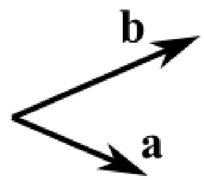
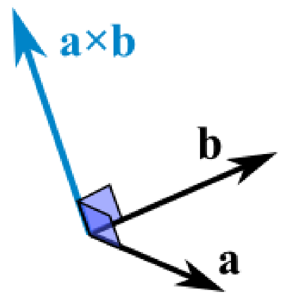
Cross Product

These are two vectors:



They can be **multiplied** using the "**Cross Product**"
(also see Dot Product).

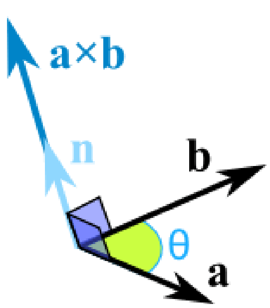
The Cross Product **a × b** of two vectors is another vector that is at right angles to both:



And it all happens in 3 dimensions!

Calculating

You can calculate the Cross Product this way:



a × b = |**a**| |**b**| sin(θ) **n**

|**a**| is the magnitude (length) of vector **a**

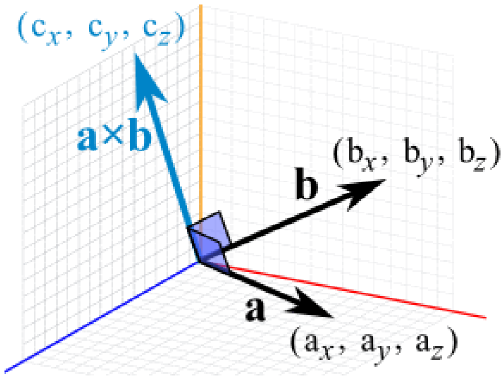
|**b**| is the magnitude (length) of vector **b**

θ is the angle between **a** and **b**

n is the unit vector at right angles to both **a** and **b**

So the **length** is: the length of **a** times the length of **b** times the sine of the angle between **a** and **b**, Then you multiply by the vector **n** to make sure it heads in the right **direction**.

OR you can calculate it this way:



When **a** and **b** start at the origin point (0,0,0), the Cross Product will end at:

- $c_x = a_y b_z - a_z b_y$
- $c_y = a_z b_x - a_x b_z$
- $c_z = a_x b_y - a_y b_x$

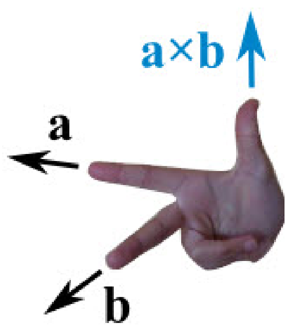
They both work!

Example: What is the cross product of **a** = (2,3,4) and **b** = (5,6,7)

- $c_x = a_y b_z - a_z b_y = 3\times7 - 4\times6 = -3$
- $c_y = a_z b_x - a_x b_z = 4\times5 - 2\times7 = 6$
- $c_z = a_x b_y - a_y b_x = 2\times6 - 3\times5 = -3$

Answer: **a × b** = (-3,6,-3)

Which Way?



The cross product could point in the completely opposite direction and still be at right angles to the two other vectors, so we have the:

"Right Hand Rule"

With your right-hand, point your index finger along vector **a**, and point your middle finger along vector **b**: the cross product goes in the direction of your thumb.

Dot Product

The Cross Product gives a **vector** answer, and is sometimes called the "vector product"

But there is also the Dot Product which gives a **scalar** (ordinary number) as an answer.

Question: What do you get when you cross an elephant with a banana?

Answer: |**elephant**| |**banana**| sin(θ) **n**

Question 1 Question 2 Question 3 Question 4 Question 5 Question 6
Question 7 Question 8 Question 9 Question 10

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