The Basics of Vectors

- A vector is a quantity that has both magnitude and direction.
- When you add two vectors, place the tip of the first next to the tail of the second. The vector starting at the tail of the first and ending at the tip of the second is the vector sum.
- To subtract vectors, slide the vectors so that their tails touch. The vector difference is the vector between the tips in the direction of the first vector.
- In scalar multiplication, the magnitude of the vector is scaled according to the scalar, but the direction remains the same.

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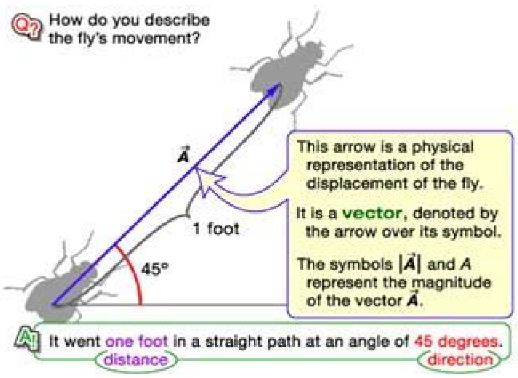

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<td>Consider a fly with length of 10 mm, height of 3 mm, and mass of 0.2 g. All these measurements are scalars. They are well determined with just a numerical value and a unit. Now suppose the fly moves and you want to specify its displacement as shown in the picture on the left. A scalar is not enough. You need to specify both the fly's distance and direction from the original position. This is called the displacement vector. In the example on the left, this vector has a magnitude of one foot and is in the (anti-clockwise) direction of 45 degrees with respect to the horizontal.</td>
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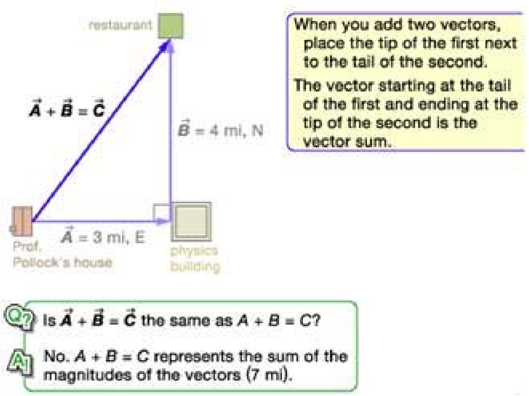

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<td>Suppose Prof. Pollock walks from his house to the physics building located 3 mi (East), and from there to a restaurant located 4 mi (North) from the physics building, as shown on the left.
Question: What is his displacement vector?
Answer: It is the vector sum of $\overline{A}$ and $\overline{B}$, where $\overline{A}$ is the displacement vector from Prof. Pollock's house to the physics building, and $\overline{B}$ is the displacement vector from the physics building to the restaurant: $\overline{A}+\overline{B}=\overline{C}$. To add two vectors, place the tip of the first next to the tail of the second. The vector starting at the tail of the first and ending at the tip of the second is the vector sum.</td>
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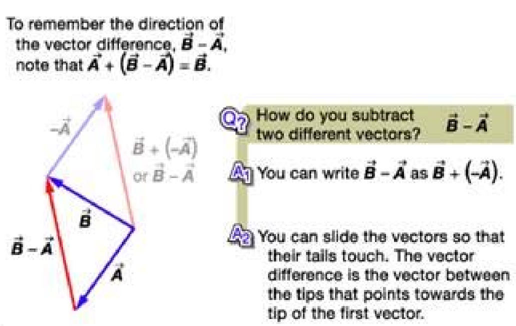

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<td>To subtract vectors, slide the vectors so that their tails touch. The vector difference is the vector between the tips in the direction of the first vector.
Another way to look at subtraction is first multiply by (-1) the vector that needs to be subtracted and add this result to second vector. In other words, $\overline{B}-\overline{A}=\overline{B}+(-\overline{A})$.</td>
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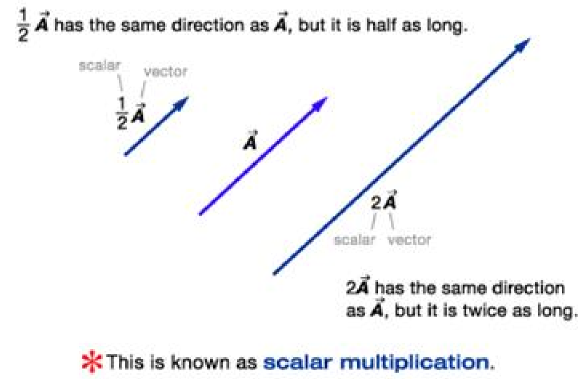

The image on the left shows some examples of how to scale vectors, also kown as scalar multiplication. When you multiply a vector by a scalar, the result is also a vector in the same ditrection but with a magnitude equal to the original vector's magnitude times the scalar.
Remember, in scalar multiplication, the magnitude of the vector is scaled according to the scalar, but the direction remains the same.