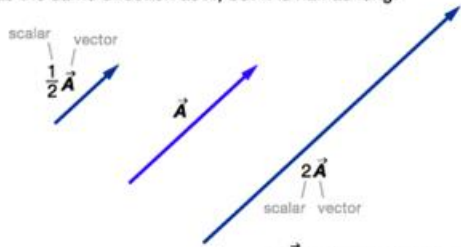


The Basics of Vectors

- 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.

<p>Q? How do you describe the fly's movement?</p> <p>This arrow is a physical representation of the displacement of the fly. It is a vector, denoted by the arrow over its symbol. The symbols \vec{A} and A represent the magnitude of the vector \vec{A}.</p> <p>A? It went one foot in a straight path at an angle of 45 degrees.</p>	<p>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.</p>
<p>$\vec{A} + \vec{B} = \vec{C}$</p> <p>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.</p> <p>Q? Is $\vec{A} + \vec{B} = \vec{C}$ the same as $A + B = C$?</p> <p>A? No. $A + B = C$ represents the sum of the magnitudes of the vectors (7 mi).</p>	<p>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.</p> <p>Question: What is his displacement vector?</p> <p>Answer: It is the vector sum of \vec{A} and \vec{B}, where \vec{A} is the displacement vector from Prof. Pollock's house to the physics building, and \vec{B} is the displacement vector from the physics building to the restaurant: $\vec{A} + \vec{B} = \vec{C}$. 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.</p>
<p>To remember the direction of the vector difference, $\vec{B} - \vec{A}$, note that $\vec{A} + (\vec{B} - \vec{A}) = \vec{B}$.</p> <p>Q? How do you subtract two different vectors? $\vec{B} - \vec{A}$</p> <p>A? You can write $\vec{B} - \vec{A}$ as $\vec{B} + (-\vec{A})$.</p> <p>A? You can slide the vectors so that their tails touch. The vector difference is the vector between the tips that points towards the tip of the first vector.</p>	<p>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.</p> <p>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, $\vec{B} - \vec{A} = \vec{B} + (-\vec{A})$.</p>

$\frac{1}{2} \vec{A}$ has the same direction as \vec{A} , but it is half as long.



$2\vec{A}$ has the same direction as \vec{A} , but it is twice as long.

* This is known as **scalar multiplication**.

The image on the left shows some examples of how to scale vectors, also known as scalar multiplication. When you multiply a vector by a scalar, the result is also a vector in the same direction 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.