Vectors - An Introduction

- A quantity is something that you measure.
- Vectors are quantities that have a size and a direction.

Some quantities have only size.

For example, a time period can be completely explained and expressed using only a number. That number represents the size/amount/magnitude of the time. As a quantity, the only property time has is its amount. Another quantity that only has a size is the temperature of the room in which you are located. We might say that the temperature is 72 degrees Fahrenheit. The quantity of mass only has a magnitude. We could say, "The mass of the book is 1.2 kilograms." We would be completely stating that quantity of mass with only one number, 1.2 kilograms.

Quantities like these, that only have size, are called **scalars**. Not all quantities are like this. Some have more than size; some also have a direction.

Some quantities have both a size and a direction.

Let us take a look at the concept of velocity as it is used in physics. Velocity can be measured. It is a quantity that can be described as a number. However, in the study of physics we would say that the following statement **does not** completely explain nor express a velocity:

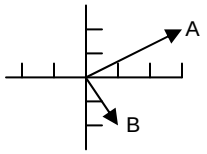
$$v = 25 \text{ m/s}$$

The above statement would read, "The velocity equals 25 meters per second." The magnitude of the velocity would be 25 meters per second. That is not all the information possible, though. Velocities have more that just a size. They also have a direction. For example, a statement correctly states a velocity would say, "The velocity equals 25 meters per second North." *Two* things are necessary to state a velocity: magnitude (25 meters per second), and a direction (North). This is how you talk about velocities when you are studying physics. The magnitude of the velocity is the speed. So, we would say that velocity is made up of a speed and a direction.

Quantities that have sizes and directions are called **vectors**.

Vectors can be represented in 3 ways: polar, components, and arrow

- Arrow: The arrow is the simplest representation of a vector, since there are no numbers. It is purely graphical. It is a scale drawing of the vector, which is accurate as to the magnitude and direction. More on this below…
- Polar notation: the vector is described by its length and direction (angle), where the angle is always measured counterclockwise from the positive X-axis. Below, vector A would be: 3.6 units, 33.7˚. Vector B would be 2.2 units, 296.6˚ or 2.2 units, -63.4˚



- Component notation: the vector is described by how much is in the X direction, and how much is in the Y direction (much like coordinates). Vector A would be: (3 units, 2 units). Vector B would be (1 unit, -2 units).

Vectors are symbolized with arrows.

There is a way to draw vectors. They are drawn, or symbolized, if you like, with arrows. An arrow is a perfect symbol for a vector. An arrow has a size (its length) and a direction (the direction in which it is pointing). So, to draw a vector we need just to draw an arrow:→

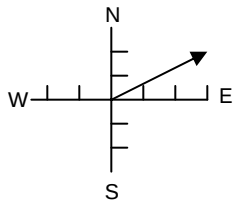
The length of the arrow represents the size of the vector. If we are talking about a velocity vector, then the length of the arrow represents the size of the velocity. The size of the velocity is usually called the speed.

The direction that the arrow is pointing represents the direction of the vector. For a velocity vector used to describe the motion of an object, it would represent the direction in which the object was moving.

The tip of the arrow, that is, its point, is called the head of the vector. The other end of the arrow is called the tail of the vector.

The direction of a vector is often stated in terms of North, South, East, and West.

If you have any confusion concerning the 'North of East' language used above to describe the direction of a vector, let us clear that up now.
First of all, imagine an x, y coordinate system, where up is North, down is South, right is East, and left is West.



Imagine the tail of the vector at the origin of this coordinate system. If the vector lies directly along one of the axes, then it is said to point directly North, South, East, or West, obviously according to what exact direction the vector is pointing. If, though, it lies between two of the axes, which will often be the case, its direction is stated using the two axes between which it lies. For example, a vector pointing up and to the right 30˚ above the east could be called 3.6 units, 33˚ North of East (starting from looking East, you rotate Northward 33˚, or it could be called 3.6 units, 57˚ East of North. (Since you'd start at North as your reference direction, and rotate 57˚ East of there).

The difference between scalars and vectors

If a quantity has only a size, it is called a scalar. Time and temperature are examples of scalars. Mass, too, is an example of a scalar.

If a quantity has a size and a direction, it is called a vector and can be symbolized, or drawn, as an arrow. Velocity is an example of a vector.