# PV1.1: ADDITION OF VECTORS

Most physics quantities can be classified into one of two groups. These groups are termed **vector** and **scalar** quantities.

**Scalar quantities** are completely defined by a magnitude and the relevant unit, eg 10 seconds.

**Vector quantities**, on the other hand, require magnitude and direction together with the relevant unit, eg. 10 $kmh^{-1}$ due North.

Some examples of vector and scalar quantities are shown below.

| **Vector** | **Magnitude & direction** | ***Scalar*** | ***Magnitude*** |
|---|---|---|---|
| Velocity: | 90 $ms^{-1}$ South | Temperature: | 7° C |
| Force: | 15 N vertically down | Speed: | 90 $kmh^{-1}$ |
| Displacement: | 100 m to the right | Money: | $44 |
| Acceleration: | 6 $ms^{-2}$ East | Distance: | 100 km |
| | | Current: | 70 amp |

## Representation of vector quantities

Vectors are depicted diagrammatically by an arrow, whose length varies with the magnitude of the vector (drawn to scale!) and which points in the appropriate direction. A negative vector is simply a positive vector pointing the other way. In the diagram below, East is assumed to be positive.


The beginning and end of a vector line may be identified by letters such as **AB** or **XY** (see above). In such cases the vector may be referred to as $\overrightarrow{AB}$ or $\overrightarrow{XY}$. The little arrow above the letters identifies that the symbols represent a vector, but **not** the direction of the vector.

## Magnitude

It is sometimes required to use only the **magnitude** (size) of a particular vector. In such cases, to distinguish that it is only the magnitude that is being used, we use the **modulus** symbol $|\ |$

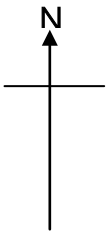
*Example 1*

The magnitude of 30$ms^{-1}$ due South is $\left|\overrightarrow{30ms^{-1}S}\right|$ = 30$ms^{-1}$

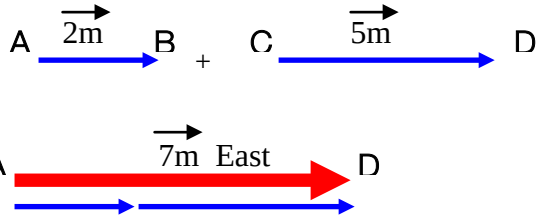
The magnitude of 18 Newtons West is $\left|\overrightarrow{18\,N\,West}\right|$ = 18 Newtons

## Adding vectors

The addition of two vectors is performed by placing the **tail** of the second vector at the **head** (the arrow end) of the first vector. The **vector sum** or **resultant vector** (shown in red) is represented in magnitude and direction by the beginning of vector **AB** to the end of the vector **CD**, i.e. vector **AD**. See examples on the following page.




*Example 2:* 2 metres East + 5 metres East

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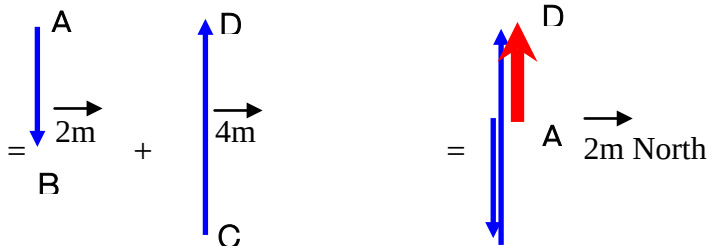
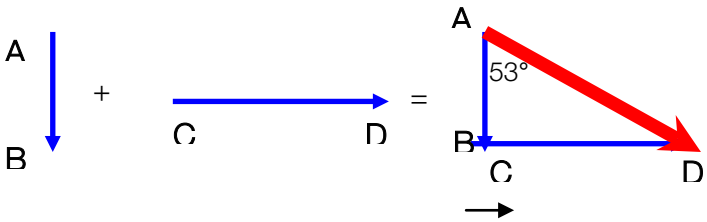
*Example 3:* 2 metres South + 4 metres North




*Example 4:* 3m/s South + 4 m/s East




= 5 m/s South 53° East (127° T)
(use Pythagoras and trigonometry)

## Exercise

1. (a) To 60 km East add 25 km East. (b) To 60 km East add 25 km West.
2. (a) To 30 km West add 40 km North, (b) To 30 km West add 30 km South.
3. A ship sails 40km North East, and then changes direction and sails 40km South East. Find the displacement of the ship (vector sum).
4. Two forces, 100 Newtons North and 100 Newtons East, are acting away from the same point and are at 90° to each other. Find their vector sum.
5. A plane is flying due North at 300 km $h^{-1}$ and a westerly wind of 25 km $h^{-1}$ is blowing it off course. Calculate the true speed and direction of the plane.

## Answers

1. (a) 85 km East, (b) 35 km East (a) 50 km North 37° West (323°T) (b) 42 km South West (225°T)

3. 56 km East 4. 141 Newtons North East. 5. 301 $kmh^{-1}$ North 5° East (005°T).