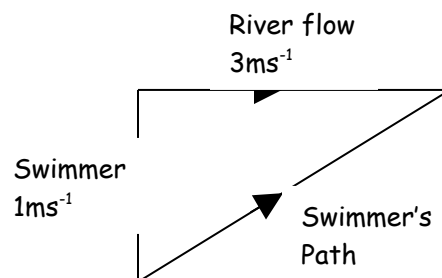


Vectors

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Vectors are first introduced at GCSE and students regularly ask how they apply to the real world. One simple example would be to consider a swimmer attempting to cross a river. If the swimmer can maintain a velocity of 1ms^{-1} and the river is flowing at 3ms^{-1} then the swimmer will obviously move on a diagonal path. The path that the swimmer tackles is said to be the resultant of the two forces (swimmer and current). This idea is explained in the diagram below.



The swimmer will be moving with a speed of $\sqrt{10}\text{ms}^{-1}$

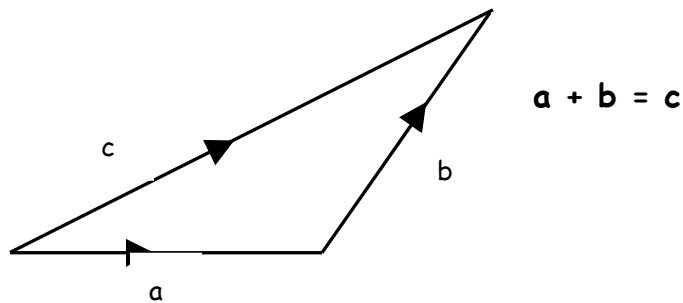
Recap of GCSE content

Vector quantities require direction and magnitude to be truly defined. **Scalar** quantities are completely specified by their magnitude. Examples of each would be a car moving with a velocity of 25ms^{-1} on a bearing of 045° , and a second car traveling along a road with a speed of 15ms^{-1} .

All vectors are represented by a directional line segment



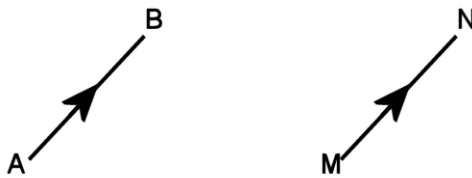
Vectors can also be represented in bold type and the triangle law is written as:



The magnitude (length) of a vector is given as $|PQ|$.

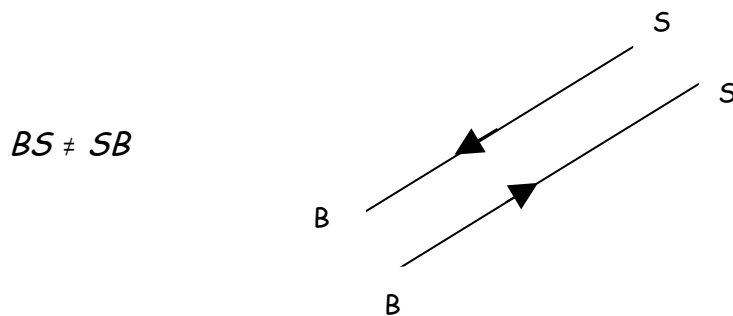
Vectors can only be equal if they have the same magnitude and direction.

e.g.



Vectors parallel and same magnitude $\therefore AB = MN$

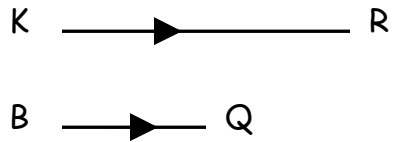
Remember that direction is important



Vectors may have different magnitudes but still be parallel.

e.g.

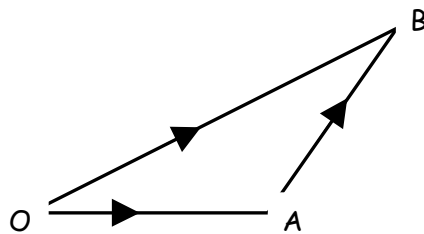
$$KR = xBQ$$



(where x is a scalar quantity).

Adding Vectors

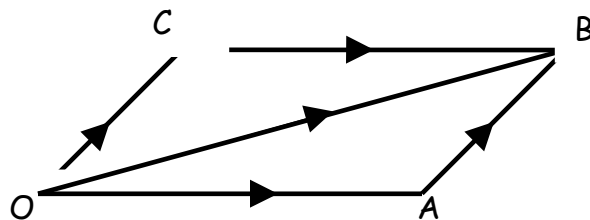
The earlier real world example introduced the triangle law by default. In more formal terms it can be said that for two vectors OA and AB :



$$OA + AB = OB$$

This can be shown quite easily by using column vectors.

The triangle law can be applied to prove the parallelogram law.

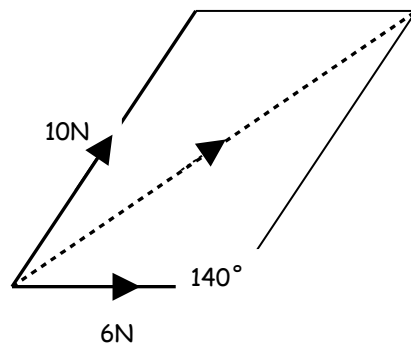


The vector OB is said to be the resultant and is the diagonal of the parallelogram $OACB$

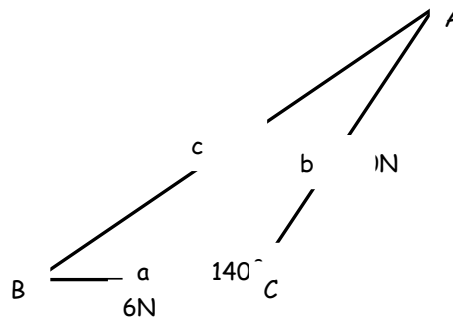
This idea is used in the following example:

Example 1

A particle P is acted upon by two forces P and Q of magnitude 6N and 10N respectively. The angle between the two vectors is 140° . Find the magnitude of the resultant and the angle it makes with the force P.



This problem is solved by applying sine and cosine rule since the diagonal of the parallelogram is the resultant force.



$$c^2 = a^2 + b^2 - 2ab\cos C$$

$$c^2 = 36 + 100 - 2 \times 6 \times 10 \times \cos 140$$

$$c = 15.87\text{N}$$

The resultant has a magnitude of 15.9N.

The resultant makes an angle with force P of:

$$\frac{\sin B}{10} = \frac{\sin 140}{15.87}$$

$$B = 23.9^\circ$$