# Vector and scalar quantities

Content

Scalars measure only a magnitude, a number, and have no direction. For example, temperature or mass. Vectors are described by two measurements: a direction and a magnitude. Velocity is a unique example since it is the only vector where its magnitude has a name, speed. In the diagram below, the car has a velocity of 25km/h East, and a speed of 25km/h. Vectors can also be drawn using diagrams where arrows describe the direction of the vector and the magnitude is written beside it.

N

W

S

E

The direction component of vectors lets us easily add vectors together using trigonometry and Pythagoras’ Theorem.

When describing the motion of an object we use both scalars and vectors. **Speed**, **distance**, , and **time**, , are all **scalars** since they only describe a magnitude. Whereas **displacement**, , **velocity**, , and **acceleration**, are all vector quantities denoted with an arrow above the mathematical symbol to show a direction is included as well.

Example

Determine which of the following quantities are vectors and which are scalars.

|  |  |  |
| --- | --- | --- |
| Quantity | Scalar or Vector | Reasoning |
| 60km/h East | Vector | This is a velocity which has both direction and magnitude |
| 27°C | Scalar | This is a temperature and only has magnitude |
| 9.8m/s downwards | Vector | This is acceleration due to gravity on Earth and has both direction and magnitude |
|  | Vector | This is the mathematical symbol for velocity with an arrow above the symbol to identify it as a vector |

Example

Pair each of the quantities with their name or description.

Velocity

Scalar quantity describing position

Mathematical symbol for displacement

Scalar measurement of heat

Graphical representation of velocity

Speed

6000°F

16m/s

25km/h South

34°S, 151°E

88 miles/hour

It is important to note in this example, 34°S, 151°E is a scalar. While it seems to have a direction relative to the defined zero, 34°S, 151°E is a latitude and longitude so just like (x, y) coordinates on a plane, these are coordinates for the position on the Earth.

Example

Raj is rowing North in a river at a speed of 4m/s but there is a current flowing East at a speed of 3m/s. What is Raj’s final velocity?

* Firstly, we will draw a vector diagram that includes all components.

Row boat: 4m/s

Current: 3m/s

Raj: ?m/s

* Next we will determine the speed of Raj using Pythagoras’ Theorem.

So Raj is travelling at 5m/s

* Lastly we will determine the direction Raj is travelling using trigonometry.   
  So Raj is travelling with a velocity of 5m/s 37° East of North.