The Solar Detectives

Investigating the science, maths and technology behind engineering

Maths for Solar Engineers

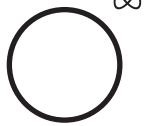
We hope that you enjoy designing, building, then finding out about your solar buggy. This booklet is aimed at helping you with the mathematics behind the science and designing. A good understanding of maths is very important to engineers. In fact maths is the most important school subject to getting on an engineering course at college or university.

Without good maths it is hard to become an engineer. In this booklet there are sections on the circle and how to find the centre of a circle. This is very important if you are going to make your buggy wheels so that they do not wobble.

There is also information about making good graphs, algebra, handling data and measuring speed. We hope they will help you get the most from the science tasks.

1 Circles

Here are the meanings of some of the vocabulary used when talking about circles.

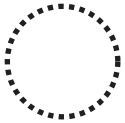


First of all, a **circle** is a flat shape where every point on the edge of the shape is always the same distance from the centre of the shape.

The straight line from the centre of a circle to the edge of a circle is called the **radius**. In any particular circle one radius is always the same length as another radius.

A straight line drawn from one side of a circle to the other side passing through the centre of the circle is called the **diameter**. Can you find a fact about the length of the radius and the length of the diameter in a circle?

The distance around the edge of a circle is called the **circumference**.

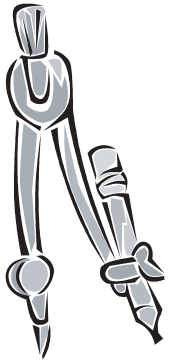


A part of the edge of a circle is called an **arc**.

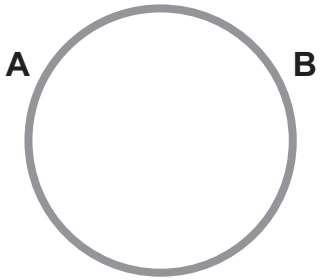
A straight line drawn from one point on the edge of a circle to another point on the edge of a circle is called a **chord**. The diameter is a special chord which goes through the centre of the circle.

1 Circles

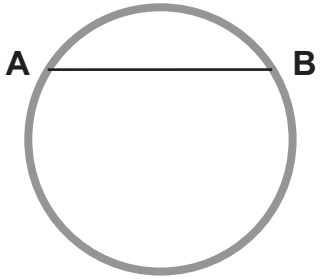
Finding the centre of a circle using constructions with a compass and a ruler.

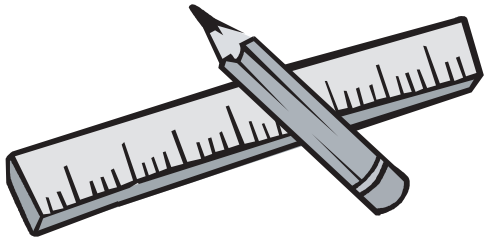


1 Mark **2** points on the circumference of the circle. Label these point **A** and **B**.



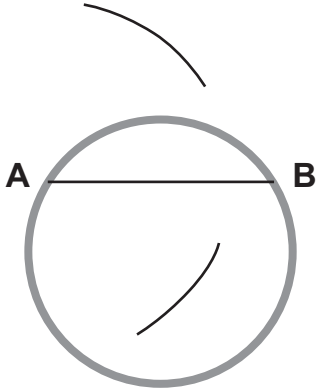
2 Join **A** to **B** using a straight line. The line **AB** is called a chord of the circle.





3 Open your compass to a width more than half the length of **AB**. You will need to keep your compass width the same and not change it.

4 Put the pointed end of your compass on point **A** and mark **2** arcs, one above the line **AB**, and one below the line **AB**.



4 Speed

Speed is a compound measure. This means it is made from 2 other measures, distance and time.

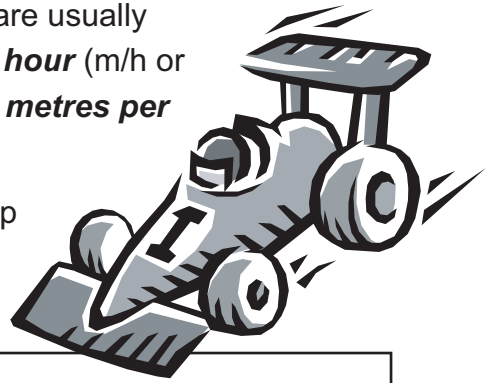
You can calculate the speed of an object by dividing the distance travelled by the time taken.

The equation for this is:

Speed = Distance ÷ Time

The units of measurement for speed are usually ***metres per second*** (m/s), ***miles per hour*** (m/h or mph), ***kilometres per hour*** (km/h) or ***metres per minute*** (m/min).

Thinking about the units used can help you to remember which way to divide your measurements.



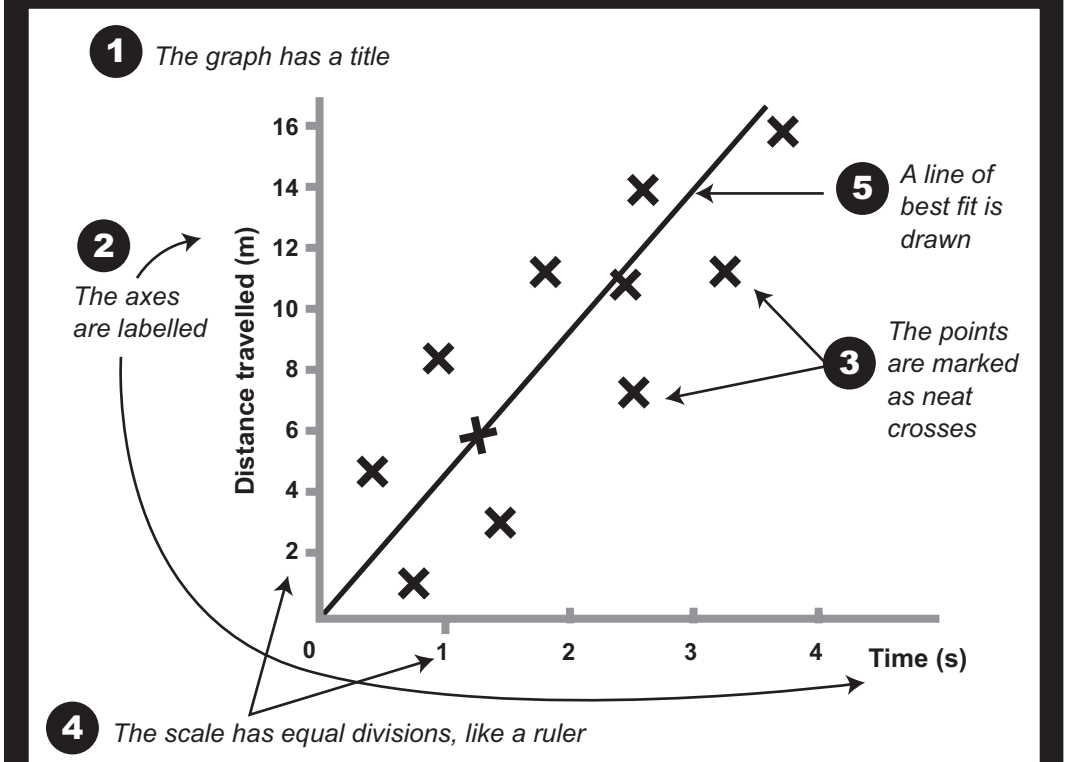
For example, speed in metres per second is distance (m) ÷ time (second).

- An easy way to calculate the speed of an object is by ***measuring how far it travels over a fixed period of time***, for example, 10 seconds. This allows you to divide the distance travelled (in metres) by the number of seconds, 10 in this case.
- Dividing by 10 is easy to do as you just move each digit in the number one place to the right.
- This will give you the speed of the object in m/s.

2 Handling data

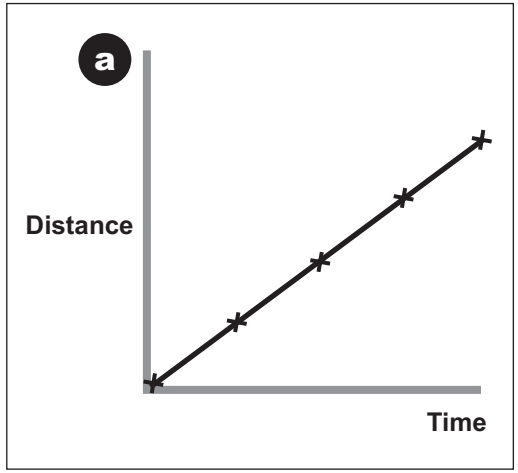
Graph to show the distances travelled by a solar car

Here are the points which make a good graph:

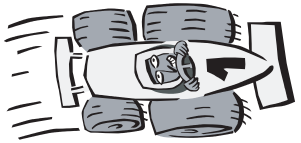


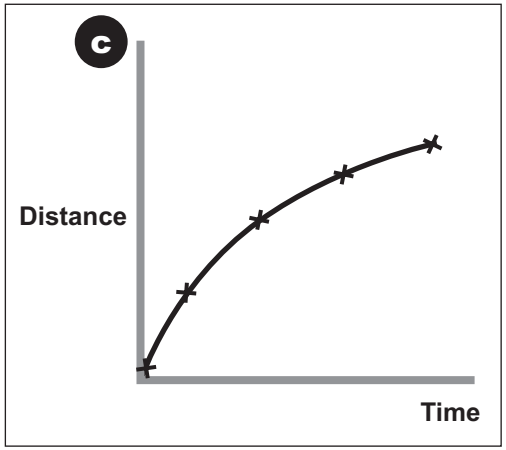
Graphs are useful because they are a physical representation of data. The axes show the measurements of the variables. You can often look at a graph and see the relationship between 2 variables more clearly than looking at a table of values.

Graph **a** shows a constant relationship between 2 variables as you get a straight line when you join the points. An example of this is a car travelling at a constant speed.

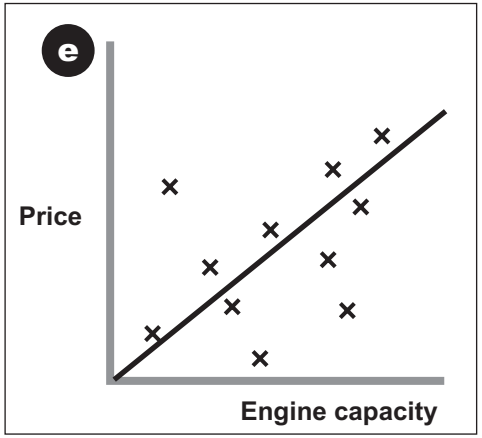


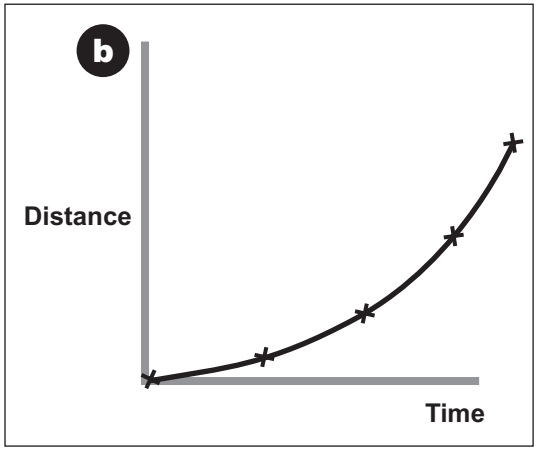
Graph **b** shows an increasing relationship between 2 variables as you get an upward sloping curve. An example of this is a car travelling at an accelerating speed.



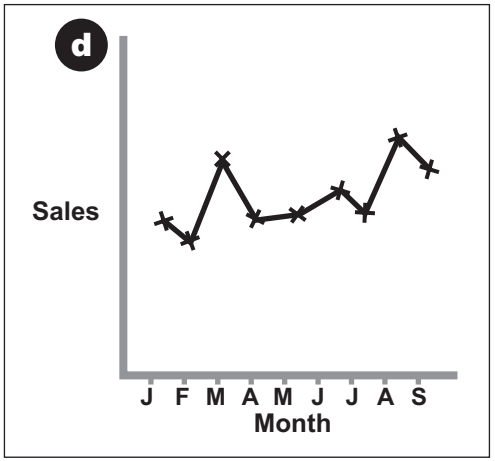


Graph **d** shows no relationship between the 2 variables as you get a jagged line when you join the points. Sometimes jagged line graphs can show trends even if there is no actual relationship between the variables. An example of this is sales of cars in different months of the year.





Graph **c** shows a decreasing relationship between the 2 variables as you get a downward sloping curve. An example of this is a car travelling at a decreasing speed.



Graph **e** shows a weak increasing relationship between the 2 variables. You cannot join the points with a straight line, but you can draw in a straight line which best fits the data (the 'line of best fit'). An example of this is the price of a car compared to the engine capacity of the car.

3 Algebra

Algebra is a shorthand way of writing.
It involves using letters to stand in for unknown variables.

A **variable** is a quantity which can have a variety of values such as the *height of a person*, or the *length of a piece of string*.

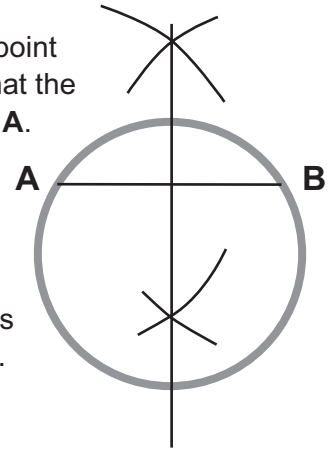
A **term** is one part of an *expression* or *equation,* containing only one variable. For example, 12V.

An **expression** is what you get when you link together *two or more variables*. For example, *7w–12 or w/3a.*

An **equation** shows you the relationship between variables and must contain. *an equals sign.* For example, P=VxI.

Substitution means replacing one thing with another. In algebra, substitution involves *replacing actual values* for the letters in an equation, to find the value of *the equation*.

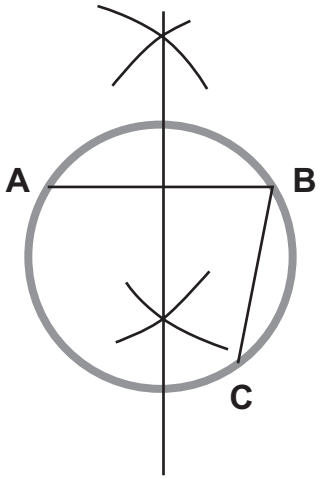
5 Now put the pointed end of your compass on point **B** and mark **2** arcs above and below **AB**, so that the arcs drawn from B cross the ones drawn from **A**.



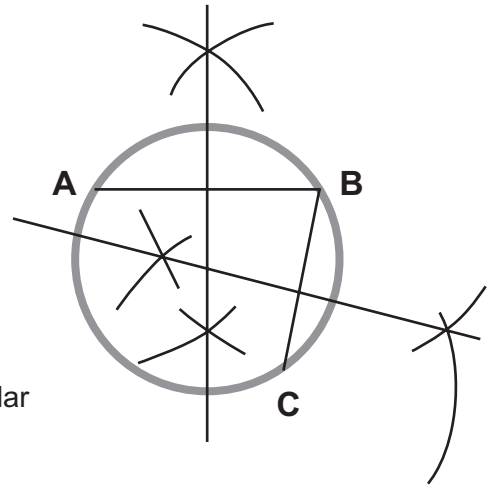
6 Join the two points where the arcs cross with a straight line. This line is the perpendicular bisector of line **AB** as it cuts the line **AB** (and the circle) exactly in half.

TIP

If your arcs do not cross, make them longer until they do cross. If they still do not cross, you have not opened your compass wide enough at the start.



7 Now mark a point on the bottom right hand of the circumference of the circle. Label this point **C**. Join **B** to **C** using a straight line.



8 Using the same method as above, find the perpendicular bisector of the line **BC**.

The point where the perpendicular bisector of AB crosses the perpendicular bisector of BC is the centre of the circle.