A short description of how sundials work.

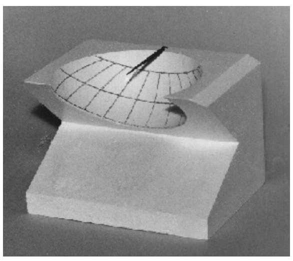
Sundials work by the way that a shadow of an object - or a part of the object - moves against one or more time scales.

The shadow casting element is called 'the gnomon' (pronounced <<No'-Monn>> accent on the No). The gnomon can be the end point of a rod or, if the dial is more scientifically designed it can be the whole of the rod. Dials in Roman times tended to use the end of a rod to trace out a shadow often against the interior of a spherical surface but it's probably fair to say that the dials we see more commonly in the UK (that is dials dating from the 'hey-day of dialling in the 17th and 18th C) generally use the shadow of the whole of a gnomon against a time scale.

Where the gnomon might be a piece of some fairly flat thick material the shadow that is seen might over the course of a day come from either edge of the flat material, in which case each edge is called a 'style' and the time is read from the position of the shadow of the appropriate edge. Most ordinary horizontal dials use thick gnomons.

Some dials though use a rod as a gnomon, In these cases the 'style' is the centre-line of the rod and the time is measured from the centre of the shadow.

If you place a stick vertically in the ground the shadow of its top moves from one side to the other as the sun rises and sets. However that shadow does not move on the same path the next day or the day after that. The fact that the shadow moves from one side to the other each day is caused by the earth's rotation. The fact that it doesn't trace the same path each day is caused by the movement of the earth round its orbit around the sun. The extremities of shift of path are the solstices: mid summer (roughly 21st June) and mid winter (roughly 21st December). At the equinoxes (roughly 21st September and 21st March) the path during the day of the top of a vertical stick in the ground travels in a straight line. The actual dates each year for these events can change and can range from the 20th to the 23rd because our calendar is one which uses leap years. However for our purposes the 21st is a good approximation. If we have sun on the 21st March this year try this out for yourself with a vertical stick.. The earth continues to move in its orbit during the day so at the very ends you may see a slight deviation from this straight line.



The Romans used the shadow of the end of a horizontal rod against the inside of a sphere carved out from stone. Some had several scales of time for different dates of the year. So, in fact such dials were able to tell both time and even an estimate of date. However the shadow of the whole rod on such a dial forms a line that means nothing.

Later (around 1400-1500 AD) it was realised that the erratic movement of the shadow of the whole rod over the day and year could be 'minimised' if the rod was made parallel to the earth's axis. This led to the design of dials that only needed one time scale all the year round. This is what you usually see in dials in gardens or on churches etc and. Some large dials use a stainless steel tubular gnomon carefully set at the angle of the latitude of the site, which is the angle needed for it to be parallel to the earth's axis. Such dials at the poles have vertical gnomons and at the equator have horizontal gnomons.

So, dials using the shadow of the whole gnomon operate by having the gnomon parallel to the earth's axis and having its shadow fall on some flat surface which might be horizontal (as with a sundial on a pedestal in a garden) or vertical (as with a dial on the tower of a church). You can design such dials to work on any other tilted surface but that is not common.

So, how do you design any such dial? Well, in the 'old' days that was done graphically by drawing circles and lines etc in the right way on paper so that you can construct the correct timescale. Alternatively the positions of the hours, half hours etc can be calculated using the mathematical technique of trigonometry. Now, I do not know whether or not you have learned any trigonometry yet but it is the mathematics by which we may understand triangles and it allows you to calculate angles and side lengths as needed. It is that part of mathematics that uses sines, cosines and tangents. This will seem complicated if you haven't yet learned this.

For a horizontal sundial (eg one sitting on a pedestal or a large dial sitting on the ground, the calculation is done in two halves, the lines before noon and those after noon. The dial is set up so that the noon line points to true North (very important that it is not magnetic North) and the angles of the lines from that true North line are calculated by reference to the angle of the sun in the sky before and after noon. To an earth based observer, the sun moves through an angle in the sky of 15 degrees every hour (it makes a full circle in a day and 15 x 24 hours makes 360 degrees or a full circle). A half hour is of course 7.5 degrees and quarters are 3.75 degrees.

The angle of a time line on a horizontal dial plate situated at latitude L corresponding to (say) 1pm or for that matter that corresponding to 11am since both these are 1 hour away from Noon, will be at an angle 'D' from the noon line on the dial plate where:

Tan D= tan (15)/sin(L)

The line at two pm (or 10am) will similarly be at an angle D where:

Tan D = tan (30)/sin (L)