Shadows and Sundials

Introduction

In the past it was hard to tell the time – there were no watches or battery powered clocks and clockwork for wind up clocks has only been around for a few hundred years. Without watches, knowing the time was still very important so people had to use something else to measure the passage of time.

One very regular movement that could be measured was the movement of the sun. The sun appears to move to us because the earth spins on its axis and as we rotate, to us it looks like the sun is rotating.

You should start this experiment in the morning on a sunny day

Questions to answer:

- How does the shadow from a fixed point change over time?
- Is it what you expect?
- If not, why not?

Equipment

- 1 stick or pole – at least 30cm long. You could use a ruler or a bamboo garden stick or a garden stick
- Outdoors space
- Paper and/or chalk to mark on a patio.
- Knowledge of which way north is (for optional extension only)

Experiment

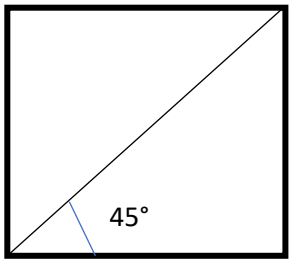
Set up your stick/pole in a place where it is going to be in direct sunlight for most of the day. Make sure it's secure (either stick it into the ground or put it in a plant pot or a bottle weighted down with something else like sand or pebbles or gravel and pointing straight up.

Place your paper underneath your pole and make sure it's not going to blow away. If you're using a patio and have chalk you can mark straight onto the ground with chalk.

On the hour go outside and mark where the shadow for the stick falls. Mark on the line what the time is.

An hour later do the same again and do the same every hour over the course of the day.

Look at your dial – what do you see?



Optional Extension:

Tilt your marker to between 45° – 50° degrees pointing north. An easy way to get a 45° angle is to take a square and draw a line between opposite corners. Cut along this line and you'll get a 45° angle.

Repeat the experiment using your tilted marker.

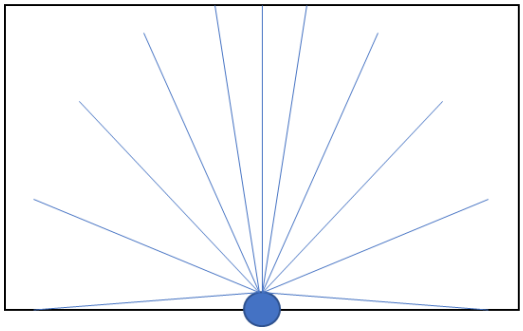
Results:

Look at your paper or your dial drawn out in chalk.

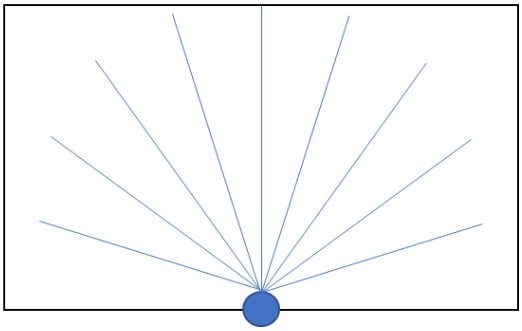
Are the hours all evenly spaced? If your stick was pointing straight up, then the hours should be widely spaced closer to dawn and dusk and quite close together around the middle of the day.

If you did the same for your angled marker **pointing north at 45°** then you should see that your hour lines are more evenly spaced out.

Stick straight up



Stick at 45° angle



Conclusion and Answers

The sun moves around the earth at a constant rate all through the year (about 15° an hour – or a complete circle of 360 in 24h. 360/24 = 15)

The reason the days are longer in the summer and short in the winter is because of the way the earth is tilted and whether we are pointing towards (summer) or away (winter) from the sun. This is also why the seasons are opposite on the North and South hemispheres (Australia is heading towards winter just as we head towards summer in the UK!)

When we use a straight marker, we've got to remember that we're actually on a slightly squashed sphere and not on a flat plane. This means the angle that the sunlight hits us changes depending on where on the earth we are.

We can adjust for this by tilting the pole to the same angle that we are on the earth – in the case of the UK that's about 45°. When we do this, we see more even spacing of our shadows.

If you want to find out more about sundials you can look here: http://sundialsoc.org.uk/old/HDSW.php at the sundial society. This page also talks a bit about why the sun rises higher into the sky in the summer than the winter and why it crosses the horizon at different places across the year.