ABINGDON SCIENCE PARTNERSHIP

Unaided Observation Task A10

Assess the Accuracy of a Sundial

Introduction

As the Earth rotates, the angle of illumination of the Earth's surface due to sunlight changes, shadows get shorter as the Sun gets relatively higher in the sky.

The Sun 'rises' in the East, travels in an upward arc across the sky and 'sets' in the West.

It reaches its highest elevation in the sky at local noon but, because time zones are set to arbitrary reference points such as the Greenwich Meridian, this is not necessarily the same as noon by clock time - only places on the meridian will have local noon at 12:00GMT (or 13:00 in British Summer Time).

The Earth’s rate of rotation

The Earth rotates once on its axis every 24 hours.

Any fixed point on the Earth’s surface therefore rotates through 360º every 24 hours or 360/24 = **15º every hour** (this is a handy number to remember by the way)

In finer detail, this is 15/60 = **0.25º every minute** or about 0.004º every second

(Just for interest, the Earth’s circumference at the equator is 40 075 km so as a speed that works out as 40 075/24 = 1670 km/h which is about twice as fast as the cruising speed of a jet airliner)

Sundials

Sundials have been used for telling the time for millennia - people have always known that shadow directions and lengths change over a regular cycle throughout the day and throughout the year.

The aim of this task is to analyse the accuracy of a sundial, either one that you can make yourself or a ready made one that you have access to.

Beware though - commercial sundials made as garden ornaments are often VERY inaccurate as they are made to a standard pattern and not for individual, local conditions.

The gnomon, or upright part, of the sundial must point upwards at an angle equal to the local latitude - ready made ones often have a standard angle of 45^{o} so would only work accurately at places on that latitude line.

Longitude and Local Noon

Thinking back to the earlier slides then, 15º of longitude represents 1 hour of Earth rotation.

Places along the 15º meridian of longitude have local noon a full hour later than places along the Greenwich Meridian.

Iceland is on this meridian, so they may run their clock time 1 hour later than GMT (Greenwich Mean Time) or they may live with darker mornings and lighter evenings so that they can work at the same time as other countries in Europe.

The further you go from the Greenwich Meridian though, the bigger the local time difference gets and new time zones are needed.

In North America 90º longitude is the reference line for Central Standard Time +6hrs from GMT (as 90 is 6 x 15).

Unaided Observation Task A10 - How to do it

To carry out the full task and to keep a report as required evidence for your GCSE in Astronomy, you will need to carry out the four stages of the task:

DESIGN OBSERVE ANALYSE EVALUATE

Use the two, blank workbooks in the **Observing Project Information and Workbooks** section to work through these stages, filling in each section as you go.

If you have access to a sundial on a building, such as a church, an old school or historic building, you can use that - otherwise the next page lists sites with sundial patterns to download and make.

Sundial patterns

This website gives you full instructions on how to download a sundial template to make yourself:

https://www.blocklayer.com/sundial-pop.aspx

This is a very simple design from NASA:

https://er.jsc.nasa.gov/seh/sundialn.pdf

This one gives you some different designs which might be interesting to compare with each other:

https://www.sundialzone.com/en/sundial

What to do:

When you have made or located a sundial to use you should compare the time it shows with an accurate clock time from a phone, computer or online source.

Set up your sundial to read correctly at a known time when you start your project and then make sure you don't move it at all during the rest of your observation period.

You must plan how often and for how long you are going to do this - take into account time of day, weather conditions and time of year. Record your observations e.g. date, clock time vs. sundial time, weather and anything relevant.

You will find that the sundial's accuracy changes over time if you monitor it for long enough - to find out why, read this: https://www.sundials.co.uk/eot

Enjoy this task if you choose to do it!

Human sundial at Oxford Island