ABINGDON SCIENCE PARTNERSHIP

Unaided Observation Task A9

Finding Longitude Using a Shadow Stick

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)

Longitude

Longitude lines run from the Earth’s geographic North Pole to its geographic South Pole.

These are the points through which the Earth’s axis of rotation lies.

Lines of longitude are therefore parallel to the Earth’s terminator - the line separating day from night - and everywhere along a line of longitude has the same local time.

Some lines of longitude have been chosen, for reasons of politics or convenience, to be reference lines to define clock times - the Greenwich Meridian is internationally recognised as 0^{o} of longitude and everywhere along it has local noon at 12:00GMT

Longitude and Local Noon

Thinking back to the last two 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 A9 - 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.

This is an American video but it gives an excellent and simple summary of a suggested method - just remember that your reference line is 0^{o} of longitude and not 90^{o} (also think about whether your current clock time is GMT or BST):

Finding longitude with a shadow stick (4:13)

Alternative methods and tips

This is a fairly similar method - any stick that you can be sure is vertical will work.

https://www.space.fm/astronomy/earthmoonsun/shadowstick.html

An easy way to check if anything is vertical is to make a plumb line - this is any heavy weight, like a metal nut or washer or a lump of plasticine, on the end of a long piece of string. Let it swing freely and it will always come to rest in a vertical line - use this as a reference line to check that your shadow stick is vertical

This is an extension challenge for finding Latitude as well:

https://www.pbs.org/weta/roughscience/series1/challenges/latlong/page4.html

ENJOY THIS UNAIDED OBSERVATION TASK IF YOU CHOOSE TO DO IT !