Estimating the rotation of the Sun

How long is a solar day? In this activity you will be looking at and analysing real sunspot data from the Solar Dynamics Observatory (SDO) to estimate how long it takes the Sun to rotate once.

You will need:

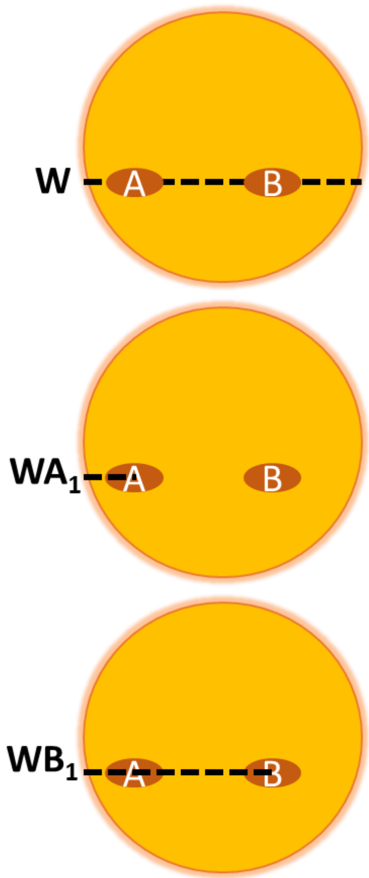
- Solar Dynamic Observatory data webpage: https://sdo.gsfc.nasa.gov/data/aiahmi/
- A ruler
- A scientific calculator or protractor (a protractor will be less accurate)

1. Get your data

You need to request enough solar data to track a sunspot. The sunspot will need to be relatively constant (doesn't change much over time) and visible. You may need to try out different dates, different times of year, different lengths of time. If you aren't satisfied with the result first time, have another go.

1. Follow the weblink to view the SDO data page.
2. Choose a range of dates (be aware that the website uses the date format yyyy/mm/dd).
3. In the Telescope/Wavelength field: Choose 'HMI Intensitygram (gray)'.
4. Click *Submit (you do not need to change any other options).* You should now see a short video of the Sun's activity. If you do not see a video – try some different dates.
5. Check that your video contains a visible sunspot. If not, go back and choose some different dates.

2. Measure the angle your sunspot has travelled around the Sun



To measure the length of a solar day, you need to work out how far around the Sun your chosen sunspot moves in a known period of time. The easiest way to do this is to **measure the distance as an angle**.

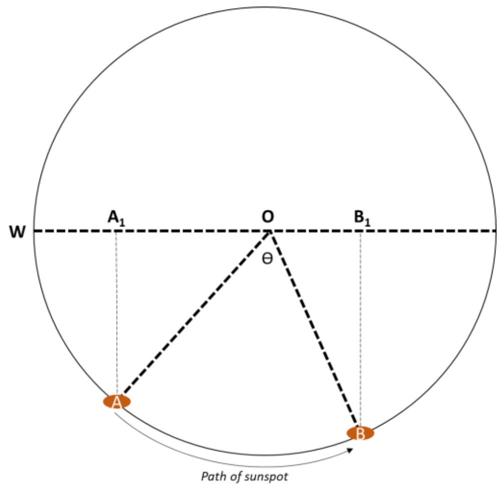
The diagram on the left shows a sunspot in two different positions (**A** and **B**). **W** is the width of the Sun at the latitude of your sunspot.

To calculate your results, you will need to measure the distances **W**, **WA_1** and **WB_1** on your screen using a ruler. You must also record when your sunspot reached those positions (the date and time will be shown at the bottom of the data video in the format yyyymmdd hhmmss).

Complete the distance and time measurement tables for your data.

Distance	
W (width)	
WA_1	
WB_1	

Time	
Date & Time at position A	
Date & Time at position B	
Time taken to move from A to B	



Remember that the Sun is spherical, but your screen is flat.

When measuring **WA_1** and **WB_1**, you have projected the positions A and B back onto a line running through the centre of a circle with diameter W. *(This is shown in the diagram on the left)*

We have also assumed that the Sun is a perfect sphere.

Now calculate the angle **AOB** using your measurements and the equations in the table below:

$AOB = WOB - WOA$	*Angle AOB =*
$WOB = cos^{-1}\left(\frac{W - (2 \times WB_1)}{W}\right)$	*WOB =*
$WOA = cos^{-1}\left(\frac{W - (2 \times WA_1)}{W}\right)$	*WOA =*

3. Estimate the rotation period of the Sun (a solar day)

You know how long it took the sunspot to travel around angle AOB from position A to B. A full rotation is 360°. Use the following equation to calculate the length of time it would take your sunspot to travel all the way around the Sun.

$$Rotation\ period = \left(\frac{Angle\ AOB}{360}\right) \times time\ taken\ to\ move\ from\ A\ to\ B$$

One Rotation of the Sun (days) =

Extension Task

Use the same method to try and track sunspots that are further away from the equator of the Sun and closer to its north and south poles. Do you find different rotational periods at different latitudes? Explain why this might be the case…

