

## GCSE Astronomy Coursework

### A6 & B6 Shadow Stick or Sundial

**A6:** Use a shadow stick to record the direction of the Sun at different times on at least two days and hence determine (a) the time of local noon and (b) the observer's longitude. **B6:** On at least three widely-spaced dates, compare the time shown on a correctly-aligned sundial with local mean time. Use these data to determine the accuracy of the sundial used.

**A6 only:** For the **shadow stick** experiment record data on two or more days spaced out by at least a few weeks if possible. Allowing a few months separation means the equation of time will be different (time difference between mean Sun and actual Sun). Each experiment should be treated separately. Think carefully about what you use for your shadow stick and how you will check it is perpendicular to the ground and stable. Think about the edge of your shadow – you need to ensure consistency between length measurements and there will be an uncertainty in your results that depends on the precision of your ruler and where you mark the edge of the shadow.

1) Use the equation of time to find the mean solar time that corresponds to local noon (apparent solar time) at your location (as measured with the shadow stick).

2) The difference between the mean solar time and GMT (clock time) gives the longitude of your location. A difference of 4 minutes is equivalent to  $1^\circ$  longitude. If your mean solar time is ahead of clock time (later than GMT) you are east of Greenwich and if you are behind clock time (earlier than GMT) you are located west of Greenwich.

**B6 only:** For the **sundial** experiment use your sundial on three widely spaced days. Each experiment should be treated separately. The sundial should be orientated towards true north not magnetic north. Find true north by using a shadow stick – at local noon the shadow points north. Think about the precision of your sundial – how far apart are the markers on the dial? This will give you an uncertainty in your time reading.

1) Convert the sundial time (apparent solar time) to mean solar time using the equation of time.

2) Correct the mean solar time for your local longitude ( $1^\circ = 4$  minutes) to get GMT. Compare this to the actual GMT value taken from a reliable clock.

Check the weather forecast and plan ahead: [www.metoffice.gov.uk](http://www.metoffice.gov.uk)

### **A6 & B6: Error analysis**

Think carefully about sources of error in your experiment and always use the most accurate values in your calculations (don't round up any numbers until the very end). Repeating the experiment  $n$  times enables you to obtain an average of your measurements = sum of measurements/ $n$ .

Obtaining an average also reduces uncertainty in your measurements. Any error in a measurement is reduced by a factor of  $1/\sqrt{n}$  when the measurement is repeated  $n$  times.

For examples of reports with moderator comments visit the Edexcel GCSE Astronomy website: <http://www.edexcel.com/quals/gcse/gcse09/astronomy/Pages/default.aspx>

Here you will find two documents that will help you write a report: Under 'Controlled assessment' download 'Controlled Assessment Teacher Support Book' and under 'Teacher Support Materials' download 'GCSE Astronomy Teachers Guide'.

Below is a checklist of points that you should include in your report. Remember to reference all sources of information and to label all images, diagrams and tables and refer to them in the text e.g. Table 1, Figure 1 etc.

### **Design (5 marks)**

- > All equipment listed
- > Astronomical terms explained
- > Mention of equation of time
- > Planned frequency of measurements
- > Choice of location, latitude & longitude
- > Limits of location noted
- > Alternative locations suggested
- > Mention of the weather forecast
- > Range of dates and times to observe & why

Edexcel marking guidelines:

0	No procedure designed.
1	Outline a simple procedure for the observations, using basic astronomical terminology.
2-3	Astronomical knowledge and understanding used to decide on the most appropriate site,time, equipment for observations.Spelling, punctuation and grammar used with reasonable accuracy. Limited use of astronomical terminology.
4-5	Detailed astronomical knowledge and understanding used to design the most appropriate observing programme with a range of sites, times and instruments evaluated. Spelling, punctuation and grammar used with considerable accuracy. Good range of astronomical terminology used correctly.

## Observation (5 marks)

- > Location stated (latitude & longitude)
- > Weather
- > **A6 only:** At least two spaced out dates and times stated
- > **A6 only:** Shadow stick perpendicular to surface
- > **A6 only:** Photos of shadow stick set up with explanation
- > **A6 only:** Shadow stick results drawn out
- > **B6 only:** At least three spaced out dates and times stated
- > **B6 only:** Appropriate sundial used
- > **B6 only:** Photos of sundial with labels and with shadow
- > Table of results for all observations
- > Time stated in GMT and BST taken into account (March to October)
- > All figures labelled and referenced in text

Edexcel marking guidelines:

0	No observations completed.
1	Simple observations completed, providing some data. A few observational details included.
2-3	Sound observations completed and recorded, providing adequate data for the task. Clear and accurate observational details included.
4-5	Excellent programme of observations completed and recorded, providing conclusive data for the task. Full observational details included clearly and accurately.

## Analysis (5 marks)

- > **A6 only:** Graph of shadow length vs time plotted
- > **A6 only:** Shortest shadow found from the dip in the graph
- > **A6 only:** Equation of time taken into account to get mean solar time from apparent (sundial) time
- > **A6 only:** Time difference between MST and GMT (clock) time found
- > **A6 only:**  $1^\circ = 4$  mins, longitude found
- > **A6 only:** Comparison with actual longitude
- > **B6 only:** Graph of AST vs MST plotted
- > **B6 only:** Difference between measurements on different dates due to EoT
- > **B6 only:** Longitude taken into account (diff between MST and GMT)
- > Comparison of all observations

Edexcel marking guidelines:

0	No analysis on the observations.
1	Simple comments on what is shown by the observations, using basic astronomical terminology.
2-3	Conclusions or calculations derived from observational data used to address the task set. Spelling, punctuation and grammar used with reasonable accuracy. Limited use of astronomical terminology.
4-5	Full analysis of the observational data, resulting in clear conclusions related to the task set. Spelling, punctuation and grammar used with considerable accuracy. Good range of astronomical terminology used correctly.

## Evaluation (5 marks)

- > Accuracy of measurements evaluated
- > Error in measurements stated (time, length)
- > Limitations of project explored
- > Suggested improvements to project
- > Suggested extension to project

Edexcel marking guidelines:

0	No evaluation of the observation.
1	Simple comment on the accuracy of the observations, using basic astronomical terminology.
2-3	Supported statement of the accuracy of the observational data obtained. Feasible suggestions for improvements or extensions to the observations. Spelling, punctuation and grammar used with reasonable accuracy. Limited use of astronomical terminology.
4-5	Clearly reasoned quantitative assessment of the accuracy of the observational data obtained. Detailed suggestions for improvements or extensions to the observations. Spelling, punctuation and grammar used with considerable accuracy. Good range of astronomical terminology used correctly.