PUPIL RESEARCHER INITIATIVE

Star Trail

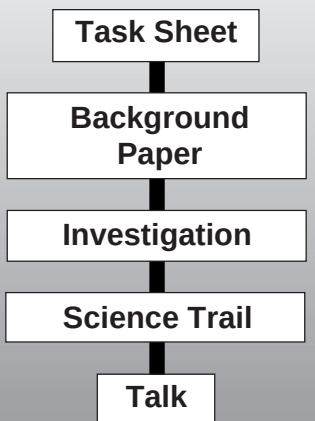
Pupil Research Brief

Teachers' Notes

Syllabus Coverage *Subject Knowledge and Understanding*

- ❑ the stars in the night sky stay in fixed patterns, called constellations
- ❑ our Sun is just one of many millions of stars in a group of stars called a galaxy
- ❑ the stars in a galaxy are often millions of times further away from each other than the planets in the solar system
- ❑ the universe as a whole is made up of at least a billion galaxies
- ❑ galaxies are often millions of times further apart than the stars within a galaxy
- ❑ stars, including the Sun, form when enough dust and gas from space is pulled together by gravitational attraction
- ❑ individual stars do not stay the same for ever
- ❑ stars are very massive so that the force of gravity, which tends to draw the matter from which they are made, is very strong
- ❑ the very high temperatures create forces which tend to make them expand
- ❑ during the main, stable period of a star these forces are balanced
- ❑ the Sun is at this stage of its life
- ❑ the star then expands to become a red giant
- ❑ at a later stage it contracts under its own gravity to become a white dwarf
- ❑ the matter from which the star is made may then be millions of times denser than any matter on Earth
- ❑ if the star is massive enough, it may explode (become a supernova) throwing dust and gas into space
- ❑ a very dense neutron star often remains
- ❑ during a star's lifetime, nuclei of light elements (mainly hydrogen and helium) gradually fuse to produce nuclei of heavier elements
- ❑ these nuclear fusion reactions release energy which is radiated by stars

Route through the Brief



Introduction

In this Brief pupils are presented with information about stars, constellations, galaxies and the Sun, which they are to use as the basis for producing a poster display or science fair event. They are to split into groups to concentrate on providing materials for one topic, allocated by the teacher. They are required to give a short talk to the rest of the class on their topic and to provide questions that could be used by visitors to the display to make a *science trail*. The science trail, or more precisely the *Star Trail*, could be set up and left for a week or two as an exhibition in the science department. Pupils would be required to use the display and associated questions over a fixed time period as a way of learning about the topics they had not covered themselves. Teachers could also use the display to support their own approach to teaching the subject content of this part of the syllabus.

Pupil Research Brief

Teachers' Notes continued

Experimental and investigative skills

This Brief does not contain a standard scientific investigation, although there is an activity contained on the investigation sheet *Observing sunspots.* This provides pupils with the opportunity to use one or more methods to observe sunspots and produce images of the Sun. Some teachers may wish to use this to teach about planning experimental procedures and how scientists obtain, analyse and evaluate evidence.

- planning experimental procedures
- obtaining evidence
- analysing evidence and drawing conclusions
- evaluating evidence

Prior knowledge

Before attempting this Brief pupils should be familiar with the Solar System and know that the Sun is a star. Knowledge of the electromagnetic spectrum, the speed of light and basic atomic structure would also be useful. Pupils tackling the topic of nuclear fusion should be familiar with the process of radioactive decay and nuclear fission.

Running the Brief

Pupil grouping

Pupils could work in a number of groupings during the Brief. Suggestions are:

Task Sheet	-	whole class, teacher introduces the topic and goes through this introduction with pupils
Briefing papers	-	groups of two or three pupils tackle one paper each (or several short papers) and produce display materials, questions and a presentation about their topic(s)
Preparing Star Trail	-	groups of two or three pupils
Talks	-	whole class, individual pupils give very short talks
Using the Star Trail	-	whole class, pupils go around in pairs with set of questions, writing down the answers

Timing

This Brief is likely to take at least six hours to run, depending on how much detail pupils go into. Some of the preparatory work can be set for homework.

Activities

Pupils should be issued with the **Study Guide**, which provides them with a summary of what they should produce as they work through the Brief. It can also be used as a checklist so that they can monitor their own progress.

Preparing displays

The material supplied is meant to provide most of the information pupils will need to cover the section of the syllabus which covers the Sun, stars and galaxies. The pupils should use the **Briefing papers** as the basis of their work, but they should supplement the information presented by consulting other sources available to them, including CD-Roms, library books, video material (such as *Encyclopedia Galactica*) and magazines. Several astronomy magazines are readily available in large newsagent shops and *New Scientist* regularly features items on the latest astronomical discoveries. There are several World Wide Web sites that give information, including pictures, on a range of astronomical topics, and these may well be worth looking at. Further advice on preparing displays can be found in the PRI book *Celebrating Science*, sent to all UK secondary schools with the first set of Pupil Research Briefs.

The Briefing papers

1. The night sky

This paper deals with the constellations and names of individual stars. It is divided into shorter topics:

Constellations
Seasonal changes
False patterns

Constellations: this deals mainly with the circumpolar constellations that can be readily identified anywhere. Pupils living in cities will see far fewer stars than those living in the country, because light pollution blots fainter stars out. The circumpolar constellations are visible throughout the year, and so pupils can go out on any clear night to locate them.

Pupils concentrating on this topic could draw up a large star chart, or find photographs of various constellations for a display board. They could make a small star chart on thick card, punch holes through

Teachers' Notes continued

where the stars are and place it on an overhead projector. The stars will be seen as bright dots on a dark screen. These could be used during the short talk on constellations.

Seasonal changes: this shows how constellations change their positions throughout the year, appearing to rotate around the Pole Star. Some constellations are only visible at certain times of the year, and four readily identified ones are presented.

Pupils could construct a planisphere to show how the night sky changes during the year. Commercially produced planispheres can be obtained from large bookshops, but the teaching materials accompanying *Science in Process* (Heinemann) contains a worksheet for making a simple planisphere. *How the Universe Works* by Heather Cooper and Nigel Henbest also contains instructions for making a planisphere and a simple planetarium.

False Patterns: this shows that constellations consist of patterns of stars that only *appear* to be close to each other, but which in reality can be hundreds of light-years away from each other. Pupils could make a 3-D model of a familiar constellation inside a cardboard box lined with black paper. The stars could be represented by small beads or balls made of modelling clay mounted on sticks and placed at appropriate places within the box. A square cut out of the front of the box will show the constellation as it appears to us, but by looking from above we can see the true spatial relationship between the constituent stars.

2. Photographing Stars

This is an *optional* activity on photographing star trails. It is a relatively simple procedure, but a good quality camera with a cable release is required, as well as a tripod. If pupils do this they should not go out alone, but with several friends and a responsible adult.

3. Star Life Cycles

Pupils could include in their display pictures of a nebula, an open cluster and a supernova remnant, and a star map showing the locations of these, plus examples of a red giant, main sequence star, white dwarf, red supergiant.

4. Classifying stars

This explains how stars can be grouped by colour (the Harvard Classification) which is related to surface temperature, and how they can be plotted on a graph of magnitude/luminosity against surface temperature (Hertzsprung - Russell diagram). The proper definitions of luminosity and magnitude are not gone into and are not necessary for a general appreciation of the diagram.

5. Star distances and sizes

For astronomical distances and sizes pupils could make models of the Earth, Jupiter and the Sun (as, say, flat discs) in a convenient scale to show their relative sizes. To show the distances between stars they could mark out the places where the Sun, Pluto and Proxima Centauri would be across the school hall, down a long corridor, across the school yard, or any place where the display is shown, using a scale appropriate to the venue.

6. Nuclear Fusion

This is *optional.* Pupils are required to know that nuclear fusion takes place inside stars, but they do not need to know details of how nuclear fusion takes place. The material is included to provide further stimulation for higher-achieving pupils.

7. The Sun

This deals with the structure of the Sun, solar prominences, solar flares and the solar wind. Pupils can draw a large poster of the Sun in cross-section and transfer the main points from the given information onto it. They could also find pictures of prominences, X-ray photographs etc, of the Sun and copy them for the display.

The part about sunspots contains instructions for observing sunspots in 3 different ways. There are almost always sunspots to observe, and so pupils could carry out a practical exercise on a sunny day to observe sunspots. There is a warning about looking directly at the Sun at the beginning of the instruction sheets, and pupil's attention should be drawn to this before they start.

8. Eclipses

Pupils could demonstrate how solar and lunar eclipses occur using a lamp and two balls, one roughly six times bigger than the other, to represent the Sun, the Earth and the Moon.

9. Solar-terrestrial research

This is a paper which covers current research into the Sun, the solar wind and its interaction with the Earth's magnetic field. Pupils could use this as well as

Teachers' Notes continued

any new information from newspapers and magazines to show that there is a tremendous amount of work going on to learn more about the Sun and solar activity.

10. Galaxies

Pupils can collect photographs of galaxies for the display, particularly of the different types of galaxy in the Hubble classification. Also, they could make a 3-D model of our local group of galaxies with sticks, beads and card using the information in the diagram, figure 1 in this section.

Pupils will doubtless come up with other ideas of their own for the displays, and they should be allowed to be as creative as possible within the constraints of time and resources.

For the questions for the science trail, pupils should be directed towards the Syllabus Targets list in the Study Guide and told to make sure that the questions they devise include ones that take in all of the statements relevant to the section they have worked on.

Thus, by going round the display and answering the questions fully they will have written work that can be used during their revision.

Safety issues

Under no circumstances should pupils look directly at the Sun either with with the naked eye, through binoculars or a telescope.

Assessment issues for *Experimental and Investigative Science* (National Curriculum for England and Wales)

P	Planning	O	Obtaining evidence
A	Analysing evidence	E	Evaluating evidence

This Brief could be used to teach about **Skill Area P**, but is not suitable for assessment purposes. Pupils who successfully produce images of the Sun, perhaps showing the distribution of sunspots, and changes over time, may be able to gain high marks in **Skill Areas O, A** and **E.** Issues which pupils might address to gain high marks include making predictions about sunspot movement and comparing their predictions with observed evidence, and commenting on the reliability of the evidence.

Assessment issues for *Experimental and Investigative Science* (Northern Ireland Curriculum)

P	Planning	O	Obtaining evidence
I	Interpreting and Evaluating		

This Brief could be used to teach about **Skill Area P**, but is not suitable for assessment purposes. Pupils who successfully produce images of the Sun, perhaps showing the distribution of sunspots, and changes over time, may be able to gain high marks in **Skill Areas O** and **I.** Issues which pupils might address to gain high marks include making predictions about sunspot movement and comparing their predictions with observed evidence, and commenting on the reliability of the evidence.

Scottish syllabus coverage

Standard Grade Physics - *Space Physics*

Further pupil research opportunities

Pupils could adapt the Brief by turning it into World Wide Web pages, or a paper simulation of a Web Site similar to the approach set out in the Brief *Cosmic Web Site*, included in the first set of Pupil Research Briefs, sent to all UK secondary schools in November 1996.

Pupils could contact a local university astronomy department or a local astronomy club, inviting someone to be a visitor to the science department. The class could plan a session with the visitor, preparing appropriate questions, and finding out background information about the visitor's work.

Pupils could try to book time on Bradford University's Robotic Telescope, details of which are found in issue 1 of *PRISM* in the article *Remote Observation*. The Web address for the telescope is

http://www.telescope.org/rti/index.html

Pupils could read an article in issue 2 of *PRISM* describing the work of Taunton School's Radio Astronomy Observatory. They could also access the school's Web site for more detailed information at

http://www.mplc.co.uk/eduweb/sites/trao/index.html