PUPIL RESEARCHER INITIATIVE

Ozone Conference

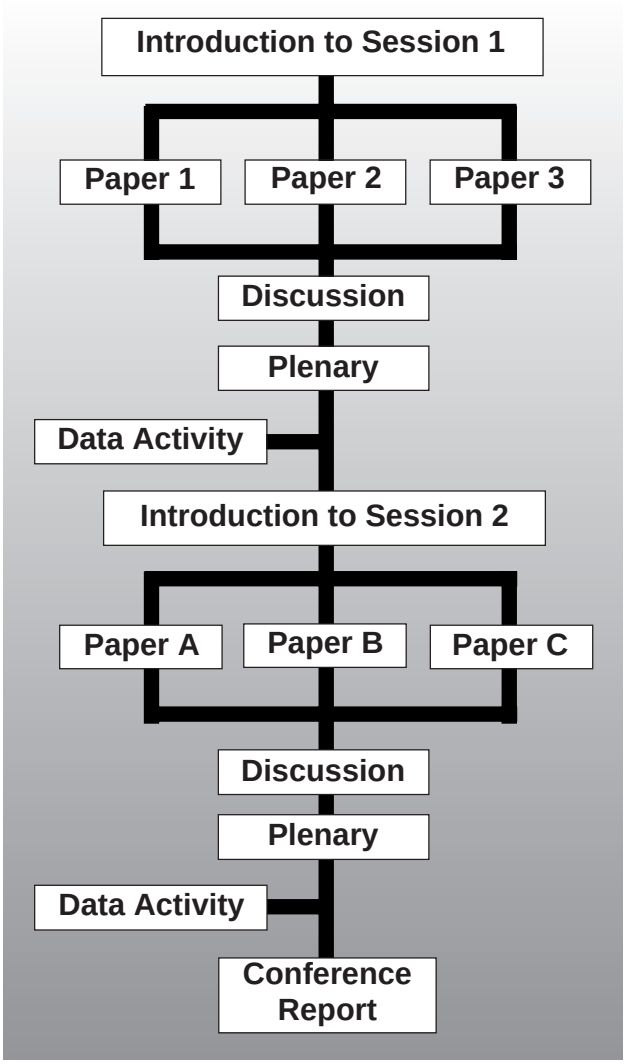
Pupil Research Brief

Teachers' Notes

Syllabus Coverage *Subject Knowledge and Understanding*

- ❑ the formation of oxygen as the Earth's atmosphere evolved resulted in the development of an ozone layer
- ❑ this filtered out harmful ultraviolet radiation from the Sun allowing the evolution of new living organisms
- ❑ the high temperatures produced by burning fuels can cause nitrogen and oxygen from the air to react, forming nitrogen oxides
- ❑ nitrogen oxides can harm plants and animals directly
- ❑ ultraviolet radiation can pass through the skin to deeper tissue
- ❑ high doses can cause normal cells to become cancerous
- ❑ when supplied with appropriate information you should be able to use your scientific knowledge to weigh evidence and form balanced judgements about some of the major environmental issues facing society

Route through the Brief



Introduction

In this Brief pupils attend a conference on the causes, monitoring and consequences of ozone formation in the troposphere and ozone layer depletion in the stratosphere. The first session is on ground-level ozone, where conference delegates hear 3 papers. They split up into groups to discuss the papers and report back to a plenary session. The second session is on the ozone layer, where they repeat the format of session 1.

Information is supplied to allow pupils to gather data from ozone monitoring stations, using the Department of the Environment's Web Site. Alternatively, tables of data are supplied for pupils to use to produce graphs on variations in ozone levels. These data handling activities are optional.

The material supplied in this Brief is based on research being carried out by the National Physical Laboratory, the British Antarctic Survey and the Rutherford Appleton Laboratory. Research is being conducted in universities around the country funded by the EPSRC to find ways of improving car engine design and power station furnace technology to reduce NOx emissions, and to look at the use of ozone-friendly replacements for CFCs and halons as refrigerants.

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Teachers' Notes continued

Prior knowledge

Before attempting the Brief pupils should have some knowledge of chemical bonding and oxidation reactions and an ability to balance simple chemical equations would be useful. Pupils should be aware of the electromagnetic spectrum and the place of ultraviolet radiation and visible light within it.

Running the Brief

Pupil grouping

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

Setting the scene	-	whole class, teacher-led
Preparing summaries of papers	-	threes, fours or fives
First session papers	-	whole class, teacher introduces session, groups of 3 or 4 pupils prepare summaries of papers, 3 pupils deliver papers, rest of class take notes
Discussion groups	-	fours or fives (not the same groups as those preparing the summaries of the papers)
Plenary session	-	whole class, teacher sums up
Data activty	-	individuals or small groups
Second session papers	-	whole class, teacher introduces session, groups of 3 or 4 pupils prepare summaries of papers, 3 pupils deliver papers, rest of class take notes
Discussion groups	-	fours or fives, different groups from the 2 above
Plenary session	-	whole class, teacher sums up
Data activty	-	individuals or small groups
Conference report	-	individual or small groups

Note: other strategies may be preferred. For example, for Session 1, the whole class splits into groups - each one tackling one of the first three papers (Paper 1, 2 or 3). This could be followed by discussion. A similar approach could be taken with Session 2 papers, with pupils working on Paper A, B or C.

Timing

The brief should take about 4 hours to teach. The report writing can be set as homework.

Activities

The teacher should issue the pupils with the **Study Guide**, which provides them with a summary of what they should produce as they work through the Brief. It can also act as a checklist for pupils to monitor their own progress.

The teacher sets the scene by telling pupils they will be presenting papers at the 'Ozone Conference'. First however, they must carefully read 'their' paper and then make summary notes for the presentation. These must be precise and accurate so that other pupil delegates can understand and contribute to the discussions which will follow.

Preparing summaries of the papers

There are six papers to be delivered at the conference. It is suggested that the class be split into six groups, one group per paper, to summarise their allocated paper as concisely as possible. This process is to provide a sort of abstract of each paper. The summary should be written on a poster for display during the relevant session. It is intended that these summaries could be used by the rest of the class to make notes. Each group should choose someone to deliver the paper at the session.The chosen speaker can read out the paper, or make his/her own version of it. Either way, the speaker should rehearse beforehand, perhaps in front of the group, to practice delivery. Each group as a whole should prepare any illustrations that will be used in the talk, either on flip chart paper or on overhead projector transparencies. These could also be used in the poster summaries.

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First session

This session is on tropospheric ozone. The paper **Introduction to the 1st session** is a general introduction to the topic, pointing out that ground-level ozone is harmful to us, but the ozone layer in the stratosphere protects us from strong ultraviolet radiation. The paper is intended for the teacher, who should deliver it or summarise the content at the start of the session.

The 3 papers delivered by elected pupils are:

1. **The formation of ozone in the troposphere**
2. **Monitoring ozone levels in the United Kingdom**
3. **Effects of ozone on humans, vegetation and materials**

The class should take notes or copy out the summaries as these talks are delivered. The summaries should also be available, possibly as posters, for consultation throughout the discussion session. The class splits into groups to discuss the content of the papers and to **make recommendations for further action to reduce ozone levels throughout the UK**. This should take about 20 minutes. The class re-assembles for a plenary session. Each group reports the recommendations formulated in the discussion session and the teacher summarises these on the blackboard or OHP.

* NOTE: the first paper simplifies the role of NOx gases in ozone formation. Nitric oxide (NO) actually converts ozone to O_2. The reaction is

$$NO + O_3 \longrightarrow NO_2 + O_2$$

It's effect is overwhelmed by that of NO_2 , and so it is not mentioned in order to avoid undue confusion.

Second session

The format is similar to that for the first session. The paper **Introduction to the 2nd session** provides a brief explanation of how ultraviolet radiation causes ozone to form. In fact, free oxygen will react with dioxygen molecules only if other molecules are present to take up the kinetic energy transferred in the reaction. These other molecules are usually N_2 , but they can be anything. This paper is intended for the teacher to deliver. The 3 papers delivered by elected pupils are:

A. **Monitoring ozone layer depletion**
B. **The causes of ozone layer depletion**
C. **The consequences of ozone layer depletion**

The session proceeds with group discussions, a plenary session and a summary by the teacher, as before.

The group discussion following the delivery of the papers should focus on **what action should be taken to prevent the ozone layer from being depleted any further**.

In both sessions, pupils should be aware that any recommendations they make have economic and social consequences. The alternatives to CFCs are expensive and there are certain applications for CFCs and halons that don't have alternatives. If pupils decide that drastic reduction in private motor traffic to decrease ground level ozone in cities is the answer, there must be provision of more public transport. There would be opposition from all sorts of pressure groups, and there are economic implications for the oil industry, motor industry, etc., and this would mean job losses.

Using information on ozone levels

At the end of each conference session, optional data handling exercises are available.

Pupils can find out about the levels of ground-level ozone in their vicinity by using CEEFAX pages 404, 410-414 or TELETEXT page 106. Both these services provide information about other pollutants in the atmosphere as well as ozone. They can also use the *Air Quality Helpline*, (free phone: 0800 55 66 77). This is an interactive service that regularly updates information on air quality on a regional basis. Information is also available on a Department of the Environment Web site, the *National Air Quality Archive*:

www.aeat.co.uk/netcen/aqarchive/archome.html

This site contains the records of all the air quality monitoring stations in the UK, and these are updated on a daily basis. So, pupils could access the data on ozone levels and NOx emissions from their nearest station. By using a spreadsheet they can produce tables and graphs of, say, ozone level variations over a day, a week, a month, a year etc. Information gathered in this way could form part of their written report on this topic. This Web site contains a large amount of information on air quality monitoring and is well worth inspecting.

Alternatively, pupils could use the data supplied in this Brief on ozone levels from two monitoring stations during one month in 1996, to produce graphs to compare the levels at these two sites. The two sites are Sheffield City Centre and Ladybower.

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Ladybower is a rural site midway between Sheffield and Manchester. Pupils will notice that the ozone data for Ladybower show considerably higher levels of ozone than the urban site, and they could plot ozone concentrations on the same day for the two sites side by side, or look at ozone concentrations at a particular time of day throughout the month. They could also see how ozone levels change at each site week by week at both sites. In addition a table of ozone layer concentrations over Antarctica for each day of 1987 is included. Pupils can select portions of this data to construct a graph of variation of ozone concentration over the whole year and then write a brief explanation of how and why the ozone layer varies. Another Web site worth looking at is the *Gateway to Antarctica* at:

http://www.icair.iac.org.nz/science/

This has maps of the ozone layer over Antarctica and over the whole world, among many other items of interest. Then there is the NASA Web site at:

http://www.nasa.gov/

Click on the *Mission to Planet Earth* icon, and then on the *Access to Data* link. Then click on the *Total Ozone Mapping Spectrometer (TOMS) Project and Data* link, and this will get you into a huge amount of information and images on the ozone layer and on tropospheric ozone. Other images of the ozone layer above the Antarctic can be found by clicking on the *Gallery* icon on the Homepage and then on the *Photo Gallery* icon. Scroll down until you get to the section headed *Earth* and then go to the *Ozone* heading, where you will find more pictures.

Scottish syllabus coverage

Standard Grade syllabuses do not require the study of ozone, however, this PRB may be useful when covering topics on pollution and/or the environment.

Further pupil research opportunities

It is worthwhile accessing the *Victoria Ozone Monitoring Project* Internet site:

http://netspace.net.au/~vicozone/

This is a scheme set up by the state of Victoria in Australia for schools to take part in a large scale ozone monitoring programme. The site has hot links to a variety of other sites of interest, including the *Global Lab Project* site. This contains detailed information on how to construct a rubber band ozonometer, which is based on an instrument devised in the 1950s to monitor ozone, and it can measure ozone levels between 20 and 2000 ppb.

Ozone test strips form part of an Air Pollution kit available from Philip Harris, but the strips themselves may be purchased separately. They turn blue in the presence of ozone within a few minutes. The strips do not give an indication of ozone concentration, but the speed with which they turn blue could provide a very rough idea of whether there is a high or low concentration of ozone present in the air.
Pupils may also find of interest the article in *PRISM No.1* written by pupils at a school in Oxfordshire, who have been using a kit developed by their teacher to monitor NOx emissions.

The effects of ultraviolet rays on plants can be studied using rye grass. Two batches of rye grass are grown from seed, one batch being grown in natural light and the other under an ultraviolet lamp. Pupils can monitor the progress of these two batches over a period of a fortnight. They should note the number of seeds that have germinated and record the height and any variation in the colour of the plants. They will find that the plants grown in UV light will not be as vigorous or healthy as those grown in natural light.

Acknowledgement

Information contained in this Brief was taken from a wide range of sources, most notably from *Ozone in the United Kingdom* (report from the United Kingdom Photochemical Oxidants Review Group) and from *Stratospheric Ozone* (report of the United Kingdom Stratospheric Ozone Review Group).