

## Introduction

This unit provides a template for studying a public issue that has a science dimension, and is both contemporary and controversial. It exemplifies the links between science, politics and business. The structure and activities suggested are designed so that they might be applied to any science-related issue, typically on a national or international scale. Ozone depletion is used here purely as an example. This series of lessons can either evolve into group research work done by pupils or more structures tasks directed by the teacher, depending on the group and the teacher's preferences. Initially the aim is to get pupils to see how the interaction between science, politics and business shapes many key modern issues. This material was written for use with pupils aged 14-16 years.

## Key ideas

Key science and citizenship ideas relating to this material follow these notes.

## Glossary

This is a general reference including citizenship and science key words. It can help to discuss the terms with the class before embarking on this topic. You may want to issue a copy of the glossary to every pupil when introducing (or reviewing) the relevant science. Alternatively, make enlarged copies for the walls.

## Running the activities

Give pupils a short overview of the ozone layer, including the need for action to prevent further depletion. Pupils could act out a drama of ozone depletion with pupils taking on different roles, for example, sun, ozone molecule or CFC molecule.

Once pupils are aware of the key issues they should brainstorm possible solutions to the problem, creating a class spider diagram displayed on the board or OHT. They may suggest the idea of cooperation. The point should be made that the need for what could be called 'international regimes' (agreements to respect certain principles and take action over certain issues that cross the boundaries of nation states and can only be solved by international cooperation) is 'increasingly important in a globalised world, where many environmental problems are transnational, in that by nature they cross state boundaries, even if they are not entirely global' (Baylis and Smith, 2001). Drawing up rules with respect to environmental issues is therefore an immensely complex process, needing widespread agreement and incentives. This is where the interaction between science, politics and business becomes crucial.

Go through the PowerPoint flow diagram on ozone depletion. Alternatively this could be printed for pupils, but it does need to be a colour copy. If this is not possible, pupils could be asked to read the information and highlight using the colour code those statements that they think are scientific, those that are political and those that are business. Pupils could be given a cut-up version of the flowchart to piece together. The flowchart highlights the interplay between science, politics and business in decisions taken to reduce emissions of ozone depleting substances. Draw out the interaction between these three factors to see how they work together, contributing to or halting progress in banning ozone depleting substances. As they listen and contribute, pupils should note down what the key issues are for each area, i.e. their motivations. This could be done in a table format, for example:

Interested party	Motivation
BUSINESS	CFC sales form large % of company profits.

Pupils then discuss in small groups the conflicts they see between the key issues of each interested party. A spokesperson for each group should feedback to the class. Pupils could draw some conclusions as to which interest is the most powerful in this scenario.

In preparation for the next lesson pupils should be asked to think of other issues where they think that this interaction is significant. If they are going to conduct a research project this could be their topic.

## More ideas

Pupils could research the scientific concepts in greater depth. An excellent website for this is [www.epa.gov/docs/ozone/science](http://www.epa.gov/docs/ozone/science). To target their research, ask pupils to list scientific questions that they feel were not adequately addressed in the PowerPoint presentation, therefore appreciating that they should be questioning the source of information that they base decisions upon.

## Learning outcomes

- Develop understanding of the key issues of ozone depletion.
- Develop understanding of how science, politics and business interact to influence action taken on major world issues.
- Develop pupils' ability to think critically about contemporary issues.

## Prior learning

Pupils should be given an overview of ozone function, in the context of greenhouse gases and global warming.

## Where the activities fit in

These resources may be used at appropriate places in your curriculum. Advice on teaching controversial issues can be found in appendix 9 of the QCA Citizenship Teachers' Guide, which you can download from <http://www.standards.dfes.gov.uk/schemes>

## Citizenship

- 1c) The work of parliament, the government and the courts in making and shaping the law.
- 1e) How the economy functions, including the role of business and financial services.
- 1f) The opportunities for individuals and voluntary groups to bring about social change locally, nationally, in Europe and internationally.
- 1i) The United Kingdom's relations in Europe, including the European Union, and relations with the Commonwealth and the United Nations.
- 1j) The wider issues and challenges of global interdependence and responsibility, including sustainable development and Local Agenda 21.
- 2c) Contribute to group and exploratory class discussions, and take part in debates.
- 3a) Use their imagination to consider other people's experiences and be able to think about, express and explain views that are not their own.

## Key ideas

### Science

Chlorofluorocarbons (CFCs), along with other chlorine and bromine containing compounds, have been implicated in the accelerated depletion of ozone in the Earth's stratosphere. CFCs were developed in the early 1930s and are used in a variety of industrial, commercial, and household applications. These substances are non-toxic, non-flammable, and non-reactive with other chemical compounds. These desirable safety characteristics, along with their stable thermodynamic properties, make them ideal for many applications: as coolants for commercial and home refrigeration units, aerosol propellants, electronic cleaning solvents, and blowing agents. Not until 1973 was chlorine found to be a catalytic agent in ozone destruction. Catalytic destruction of ozone removes the odd oxygen species [atomic oxygen (O) and ozone (O<sub>3</sub>)] whilst leaving chlorine unaffected. This process was known to be potentially damaging to the ozone layer, but conclusive evidence of stratospheric ozone loss was not discovered until 1984. Announcement of polar ozone depletion over Antarctica in March 1985 prompted scientific initiatives to discover more about ozone depletion processes, along with calls to freeze or diminish production of chlorinated fluorocarbons. A complex scenario of atmospheric dynamics, solar radiation, and chemical reactions was found to explain the anomalously low levels of ozone during the polar springtime. Recent expeditions to the Arctic regions show that similar processes can occur in the northern hemisphere, but to a somewhat lesser degree due to warmer temperatures and erratic dynamic patterns.

### Citizenship

**Precautionary Principle** Understanding the value and use of the precautionary principle (in essence, what could go wrong will go wrong) in personal, social, economic, scientific and technological decision-making in the light of uncertainty.

'Observe before you project yourself on a parabolic trajectory. The weight of 28.35 grams of prevention is worth 454 grams of cure. Science certainly has much to say on taking precautions. But for the enormously complex and serious problems that now face the world - global warming, loss of biodiversity, toxins in the environment - science doesn't have all the answers, and traditional risk assessment and management may not be up to the job. Indeed, given the scope of such problems, they may never be.

Given the uncertainty, some politicians and activists are insisting on caution first, science second. Although there is no consensus definition of what is termed the precautionary principle, one oft-mentioned statement, from the so-called Wingspread conference in Racine, Wis., in 1998 sums it up: "When an activity raises threats of harm to human health or the environment, precautionary measures should be taken even if some cause and effect relationships are not fully established scientifically."

In other words, actions taken to protect the environment and human health take precedence. Therefore, some advocates say, governments should immediately ban the planting of genetically modified crops, even though science can't yet say definitively whether they are a danger to the environment or to consumers.' *Scientific American*, David Appell, January 2001.

**Rights and responsibilities** Individual, national and international choices affect ozone depletion. People and organisations that refuse to engage in reducing ODS impact on the environment.

**Real conflicts of interest arise** How should a democratic government respond? Is there such a thing as 'the public interest?', or is this term used to cover up action taken on behalf of a sectional interest (for example, the chemical industry)?

**Information** Is all the relevant factual information in the public domain?

**Critical thinking** When pupils are considering the PowerPoint exercise, encourage them to consider whether they want more evidence of any points raised before they accept the material as fact. This aims to help them become more autonomous, not simply accepting statements from 'experts', but trying to evaluate these for themselves.

### Science

Various aspects of the science curriculum may be covered, depending on where the materials are used:

1.1.d) Consider the power and limitations of science in addressing industrial, social and environmental questions, including the kinds of questions science can and cannot answer, uncertainties in scientific knowledge, and the ethical issues involved.

2.4.b) How the impact of humans on the environment depends on social and economic factors, including population size, industrial processes and levels of consumption and waste.

2.4.c) About the importance of sustainable development.

4.5.d) The beneficial and harmful effects of radiation on matter and living organisms.

## Group research and presentation

If you wish to develop the previous lesson, or use the PowerPoint as stimulus material rather than follow the detailed lesson outlined above, recap the interaction and conflict of interests between science, politics and business over this issue and suggested solutions before introducing the group projects.

Pupils can use the planning sheet to guide them through their research. After considering what topic they would like to research, they should ideally carry out this work in groups of three, with one member of the group taking responsibility for looking at a particular perspective. Pupils can spend a considerable amount of time, particularly with Internet research, looking for information, rather than analysing it for their own needs. It is therefore helpful if you know in advance what topics they are interested in pursuing, and spend a little time searching for up-to-date, accessible websites for each group, perhaps three or four different ones.

Pupils should aim to produce a piece of work similar to the ozone presentation, although they could choose to present their work in a different way, for example, a PowerPoint presentation of the key issues and how they interact, a puzzle or quiz, a drama. However, they should be clear that their work must include some basic information about the science behind their topic, so that their audience can understand the key issues. They should also include some analysis of how science, politics and business interact over their issue.

Pupils should draw up their research plan first, to clarify responsibilities and the information that they require. This also enables the teacher to ensure that the issue is a realistic choice.

This process will require one to two hours of lesson and homework time. The resulting work should ideally be presented to the class in order to draw parallels between the interactions affecting different issues.

## More ideas

Pupils may choose to take action on a chosen issue by sending their findings to an MP, local councillor, MEP or by writing to their local newspaper.