UNEP
United Nations Environment Programme

unicef

United Nations Educational, Scientific and Cultural Organization

UNESCO Associated Schools

WHO

Multilateral Fund
for the Implementation of the Montreal Protocol

HIGH SKY: OZONACTION EDUCATION PACK FOR SECONDARY SCHOOLS

TEACHER'S BOOK

ACKNOWLEDGEMENTS

This book was developed by the OzonAction Programme of the Division of Technology, Industry and Economics of the United Nations Environment Programme (UNEP DTIE) under the Multilateral Fund of the Montreal Protocol.

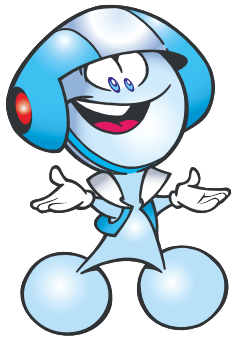
Head of OzonAction Programme: Rajendra M. Shende
Information Manager: James Curlin
Project Manager: Anne-Maria Fenner
Author: Wayne Talbot
Research Assistant: Saija Heinonen
Project Assistant: Mugure Kibe Ursulet
English Editor: Janet Sackman
Illustrator: Glasshouse
Review Panel: Lynnis Abbey, Luton LYTE; Vinitaa Apte, Bank of Maharashtra; Gustavo Arnizaut, HEAT International; Atul Bagai, UNEP; Luis Betanzos de Mauleon, UNEP; Ezra Clark, UNEP; Bernard Combes, UNESCO; James Curlin, UNEP; Julia Anne Dearing, UNEP; Emilie van Deventer, WHO; Artie Dubrie, UNEP; R. Gopichandran, Centre for Environment Education, India; Donna Goodman, UNICEF; Eva Hamilton, UNESCO; Cecilia Iglesias, ACRA, Argentina; Tim Kendall, John Hampden Grammar School; Tariq Khan, Luton LYTE; Ryan Kirchner, Ruamrudee International School, Thailand; Halvart Koeppen, UNEP; Ana Rosa Moreno, National University of Mexico; Sigrid Niedermayer, UNESCO; Akpezi Ogbuigwe, UNEP; Fabienne Pierre, UNEP; Livia Saldari, UNESCO; Craig Sinclair, Cancer Council Victoria, Australia; Janet Snow, Endangered Wildlife Trust; Morgan Strecker, UNEP; Bridget Vickers, Putteridge High School; Beatrice Vincent, UNEP.

The Ozzy Ozone character is a registered trademark of the government of Barbados. UNEP would like to thank the government of Barbados for its permission to use this character.

ISBN: 978-92-807-2934-4

This publication is linked to UNEP's TUNZA strategy for Children and Youth.

CONTENTS



1 PREFACE

This book, designed for teachers of secondary schools, represents the start of a success story. It is an example of what happens if everyone tries to do something positive to help solve an environmental problem – in this case, the depletion of the Earth's protective ozone layer.

The problem was discovered in the 1970s when scientists found the first evidence that chemicals we thought were harmless actually had a negative impact on our environment. These chemicals, including chlorofluorocarbons (CFCs), were destroying part of our natural filter – the layer of ozone gas that filters harmful radiation from the Sun before it can reach the surface of the planet and threaten human health and ecosystems. These same chemicals are also linked to climate change.

Scientists investigated and found a seasonal "ozone hole" over Antarctica. The seriousness of this discovery produced worldwide concern. Since then, actions have been taken by the international community through the adoption of the Montreal Protocol on Substances that Deplete the Ozone Layer (1987), an agreement aimed at the severe restriction of the production and consumption of ozone-depleting chemicals. Thanks to this agreement, the first signs of a recovery of the ozone layer are now becoming noticeable. However, the weakening of the ozone layer and its consequences on human health are expected to last until the middle of the 21st century.

The Montreal Protocol shows what can be achieved by the mobilisation of international agencies, governments, businesses, communities and individuals. Our positive actions can indeed solve environmental problems. These positive actions must be continued and sustained from the individual to the intergovernmental level. This means you can play a part too. This book is designed to help you in the classroom and encourage actions outside of it that help all of us contribute to the continued improvement and solution of our ozone problem.

Read on to find out how your class or school can devise, develop and implement its own form of the Montreal Protocol. This book is part of the High Sky - Ozone Layer Education Pack for Secondary Schools, which has been developed by United Nations Environment Programme (UNEP) OzonAction Programme under the Multilateral Fund for the Implementation of the Montreal Protocol. It forms an integral part of the global Ozzy Ozone campaign and it is a follow-up activity to the OzonAction Education Pack for Primary Schools, which was developed in 2006 as a joint activity between United Nations Educational, Scientific and Cultural Organization (UNESCO), World Health Organization (WHO) and UNEP. You can see other OzonAction resources by visiting the Ozzy Ozone web site: www.ozzyozone.org.

2 WELCOME

Welcome to the Ozone Layer Education for Secondary Schools Teacher's Book. It is a simple introduction to ozone issues for young people aged 13-16 years. Think of it as a Mini-Montreal Protocol guide.

The education pack aims to raise awareness and encourage the active participation of young people in the debate on ozone depletion, its potential effects on them, the place in which they live and the planet. It also offers them a chance to design their own projects for taking action. These materials build upon ideas and activities in our OzonAction Education Pack for Primary Schools and other Ozzy Ozone materials.

The pack offers your students a chance to:

- develop their understanding of ozone issues
- introduce the links between ozone depleting chemicals and climate change
- express what they believe needs to be done locally
- design and create their own projects to protect the ozone layer in their school and community
- present ideas at their own mini-Montreal Protocol meeting
- implement their own version of the Montreal Protocol
- contribute to UNEP's Ozzy Ozone web site: www.ozzyozone.org where their ideas will be available for National Ozone Units (NOUs) to see and use.

The pack provides a set of related puzzles and activities. Throughout the pack, your students will be developing ideas and background knowledge. This will enable them to develop a mini protocol and action plan that can be sent to the Ozzy Ozone web site for publication and used to enter an international environmental competition – the Volvo Adventure. See their website at www.volvoadventure.org

In effect, it is a chance to develop a report that allows the UNEP OzonAction Programme and NOUs to review and see the changes your school or youth group is making to help protect our ozone layer.

3 WHY IS THE UNITED NATIONS DOING THIS?

The depletion of the Earth's protective ozone layer needs action. The United Nations Environment Programme provides leadership and encourages partnership in caring for the environment. We are doing this to further empower both teachers and students and to enable young people to help transform global environmental challenges into local actions. This is their chance to send ideas directly to the Ozzy Ozone website and receive recognition for their efforts. It also allows young people to:

- develop an understanding of the scientific concepts involved in ozone issues.
- develop "policy" ideas and put them into practice.

The expected outcomes include young people:

- Feeling encouraged to participate in the construction of practical action plans after carrying out research, seeking information and analysing it.
- Becoming active in the protection of the ozone layer, and developing a sense of responsibility towards their environment.
- Understanding the health issues at stake and knowing how to protect themselves from dangerous ultraviolet (UV) radiation.

4 How the Teacher's Book works

We have designed a programme of short sessions that can fit various lesson lengths or extra-curricular programmes. The sessions can be completed over a six to twelve weeks period depending on lesson lengths and student ability. These sessions will allow young people to define the problems, explore solutions and test them.

To take part, you simply:

1. Work through the activities in this pack to help your students develop action plans of their own and test the action plan ideas, working in small groups.
2. Share the results with their fellow students.
3. Submit their ideas to the Ozzy Ozone web site www.ozzyozone.org.
4. Receive an acknowledgment from UNEP and Ozzy and a chance for them to publish their ideas on the Ozzy Ozone web site.
5. Enter their action plans into an international award (Volvo Adventure) where they could win an award of up to US$ 10,000.

5 Curriculum relevance

This is a teaching resource that endeavours to produce curriculum guidance at all levels: globally, regionally, nationally and locally. The material in this pack should be useful in programmes relating to your curriculum, particularly within science, geography and citizenship, such as:

- Communication skills including discussion, reporting and structured debate.
- Collecting, recording and interpreting data.
- Understanding the needs and values of other people.
- Applying knowledge to understand and control risks.
- Understanding the conflict of social, economic and natural issues in designing solutions.
- Experimenting with presenting data and visions of the future.
- Understanding environmental change and sustainable development.
- Exploring the idea of sustainable development and recognising its implications for people, places and environments and how this relates to their own lives.

The following specific learning outcomes are also included:

- The role of the ozone layer.
- The causes and consequences of ozone layer depletion.
- The dangers of sun exposure.
- The importance of the protection of the ozone layer.
- How to prevent ozone layer depletion.
- How to protect the skin and eyes from over-exposure to UV radiation.
- The links between the ozone issue and climate change.

6 How to use the education pack

The Ozone Layer Education for Secondary Schools pack contains:

- This Teacher's Book, which provides a sequence of activities in preparation for students to devise and develop their own mini Montreal protocol and action plan.
- A Student Book to assess students' understanding of issues after they complete the activities in this book – not as a test, but through the completion of a role-playing exercise.
- The Ozzy and Zoe Ozone Collection that contains materials in local languages, for example the Ozzy Ozone cartoon books and animated film.

The activity sessions provide the students with the knowledge they need before producing their own Protocol-style report ready to present for an in-school mini Montreal Protocol event. From this presentation, the students will develop an action plan for implementation. Electronic versions of the activities are available online at www.ozzyozone.org so you can download and adapt them to suit your group.
The following table indicates our suggested order of activities, broken down into lesson-length sessions.

Session	Summary	Activity titles	Description
Session 1: Introduction	60 minute session Group work with possible homework exploring ozone issues.	What do you think you know?	The group explores their knowledge about the ozone issue.
Session 2: Investigating misconceptions	Each session has a number of activities or 'missions' that teachers place inside envelopes for each group to work through. They are given 10 to 20 minutes per activity but this can vary depending on group ability levels. The aim is to provide the group with a constant stream of activities they can work through at their own pace. For advanced students, there are extension ideas given in the Annexes at the end of this book.	Mission 1 – The basics Mission 2 – The Earth's ozone filter Mission 3 – What is ozone? Mission 4 – Ground-level ozone Mission 5 – Ozone-depleting substances Mission 6 – Ozone layer depletion today	A series of problem-solving exercises to introduce basic science concepts.
Session 3: Protecting ourselves and the ozone layer	Each session has a number of activities or 'missions' that teachers place inside envelopes for each group to work through. They are given 10 to 20 minutes per activity but this can vary depending on group ability levels.	Mission 1 - Why and how are UV rays dangerous? Mission 2 - When, where and for whom is the risk highest? Mission 3 - Personal protection action plan Mission 4 - Ozone layer protection	A series of problem-solving exercises to introduce basic health issues.

Section	Summary	Activity titles	Description
Session 4: Climate change and ozone layer depletion	Each session has a number of activities or 'missions' that teachers place inside envelopes for each group to work through. They are given 10 to 20 minutes per activity but this can vary depending on group ability levels.	Mission 1 – Carbon corner Mission 2 – Too hot or not? Mission 3 – Sources and sinks Mission 4 - Action lists	A series of problem-solving exercises to introduce the basic links between climate change and ozone depletion.
Session 5: Protocol briefing	Working in groups to develop their report and design a basic set of actions. This should take approximately 60 minutes.	Mission 1 - What experts say Mission 2 - Now think about the priority Mission 3 - Design your own surveys and surveying Mission 4 – Produce your questionnaire	An outline briefing built upon the previous sessions, with research tasks for participants to further develop their ideas.
Session 6: Starting the write-up	Use the Student book to reinforce ideas from the pack and provide a means to construct a simple article that will help with their report production.	Mission 1 - The write-up Mission 2 – The write-up	Using the student's book to see if participants' knowledge is correct.
Session 7: Organise a mini United Nations-style debate	Takes up to half a day depending on group size.	Mission 1 - Mini Montreal Protocol Planning Sheet Mission 2 – Policy Mission Mission 3 – Whose actions? Mission 4 - Planning Exercise Mission 5: Organise and implement your action plan!	Debating and building a consensus of ideas. Producing a set of action plans. The practical experience of trying to implement an environmental protocol.

SESSION 1: INTRODUCTION - WHAT DO YOU THINK YOU KNOW?

TEACHER BRIEFING

Objectives

- To introduce the project students are undertaking.
- To find out what students know about the common misconceptions about the ozone issue.
- To let students know that they are producing a mini-Protocol to be sent to the Ozzy Ozone web site – and that this is their opportunity to create, test and implement a plan that allows them to tell adults what needs to happen on an important global issue.

Equipment:

Pens, paper, Ozzy and Zoe Ozone Collection, project file.

Preparation:

Groups of 3-4 students who will form teams at your debate event. Review the Ozzy and Zoe Collection for background information.

Instructions

1. Use the student briefing and the third objective above to introduce the project. You can use the Ozzy and Zoe Ozone collection included in this pack to provide background materials appropriate for your students. In some cases it can prove interesting to ask students to provide ideas - with no materials - depending on their ability levels.

2. Using the handout overleaf, start by asking them the 'true and false' questions provided that introduce common misconceptions. Then provide them with key questions and get them to discuss their answers in small groups.

3. Remind students that they will need the answers and notes from the activities to help them complete the project. They should keep the results of discussions and activity answers in their file.

4. Conclude by saying they have the structure for their mini Protocol - now they need to see if they are correct. They have to work on their ideas before they can send them to the Ozzy Ozone web site.

5. Use the following briefing to explain what the Montreal Protocol is:
The Montreal Protocol on Substances that Deplete the Ozone Layer is an international treaty designed to protect the ozone layer. By April 2008, the Protocol had been ratified by 191 countries. In so doing, these countries have agreed to eliminate their production and consumption of ozone depleting substance according to the timetable set out in the Protocol. If all countries continue to meet their obligations under the Montreal Protocol, the ozone layer will recover to pre-1980 levels towards the middle of the 21st century.

SESSION 1: INTRODUCTION – WHAT DO YOU THINK YOU KNOW?

STUDENT BRIEFING (FOR THE FRONT OF THE ENVELOPE)

This term, you are going to voice your collective concerns about ozone depletion. It will be helpful if your group has thought about or researched background information around the subject. Here are some activities to help.

ACTIVITY – FOR INSIDE THE ENVELOPE

Let's see what you know already – decide which of these statements are true or false:

1. All the ozone in the atmosphere is in the stratosphere i.e. the ozone layer. *True / False*
2. Ozone layer depletion and climate change are the same problem. *True / False*
3. The Sun's ultraviolet radiation harms only human beings. *True / False*
4. Dark skin cannot burn and is therefore protected from the Sun's UV rays. *True / False*
5. If you put sunscreen on at midday it is enough to protect you until the evening. *True / False*
6. Producing too much carbon dioxide (CO_2) by burning fossil fuels, using cars and producing excessive garbage causes ozone layer depletion. *True / False*
7. Ozone layer depletion causes a health risk only near the North and South Poles, as the "holes" are over the Arctic Circle and Antarctica. *True / False*

You now have 30 minutes to discuss your initial ideas within your group.
Your teacher will give you support materials from the Ozzy and Zoe Ozone collection.

1. What is ozone depletion?
2. What effects does ozone depletion have where you live?
3. What effects does ozone depletion have in other places around the world?
4. What actions should you take and why?
5. What should governments do and why?

Keep a record of your answers and ideas – you will be able to change, evaluate and develop them throughout the project.

During the next sessions you will be working through a series of puzzles in envelopes to discover if your answers are correct or not.

SESSION 1: INTRODUCTION – WHAT DO YOU THINK YOU KNOW?

ACTIVITY ANSWERS

1. All the ozone in the atmosphere is in the stratosphere i.e. the ozone layer.
   FALSE – low level ozone near the Earth's surface is dealt with further in this pack.
2. Ozone layer depletion and climate change are the same problem.
   FALSE – the two things are linked as some chemicals responsible for ozone depletion are also greenhouse gases.
3. The Sun's ultraviolet radiation harms only human beings.
   FALSE – most plants and animals are at risk.
4. Dark skin cannot burn and is therefore protected from the Sun's UV rays.
   FALSE.
5. If you put sunscreen on at midday it is enough to protect you until the evening.
   FALSE.
6. Producing too much carbon dioxide (CO_2) by burning fossil fuels, using cars and producing excessive garbage causes ozone layer depletion.
   FALSE.
7. Ozone layer depletion causes a health risk only near the North and South Poles, as the 'holes' are over the Arctic Circle and Antarctica.
   FALSE.

SESSION 2: FINDING OUT THE TRUTH

TEACHER BRIEFING

Objectives

- To introduce the misconceptions commonly held about ozone issues.
- To introduce basic science behind ozone in the upper and lower atmosphere.

Equipment:

Envelopes (to put the 'missions' into, explained below), pens, paper, materials reproduced from this book as appropriate, glue.

Preparation:

Groups of 3-4 students who will be teams at your debate event.

Instructions

1. There are six missions for the students to complete. Each group has to complete them in a set time. They are working against the clock – completion gives more time and reduces the risk of having to complete the work in their own time.

2. Copy the student briefing for the mission and stick it onto envelopes. Put the activity puzzles into the envelopes. Remember that some of the puzzles require pieces to be cut out prior to you placing anything in the envelope. Answer sheets are provided where needed, and any specific preparation instructions are included in the activity.

3. Provide each envelope in turn so that groups can work at their own pace through the different 'missions' until they are all completed. Those that complete the missions quickly can then look at their answers from Session 1 and begin to discuss the questions, answers and any changes.

4. Finish the activity by giving ten minutes for them to revise their answers to the Session 1 questions:
   a. What is ozone depletion?
   b. What effects does ozone depletion have where you live?
   c. What effects does ozone depletion have in other places around the world?
   d. What actions should you take and why?
   e. What should governments do and why?

5. Finish by saying they will have to complete their investigations of background information in the next session. They should research answers to questions a-c.

6. Make sure that the students keep their activity results in a folder with the work from the first session.

SESSION 2: FINDING OUT THE TRUTH

MISSION 1 - THE BASICS

STUDENT BRIEFING (FOR THE FRONT OF THE ENVELOPE)

1. The Earth and all its living systems are powered almost entirely by radiation from the Sun.

2. This radiation is transferred from the Sun to our planet as electromagnetic (EM) waves.

3. Shorter wavelength carry much more energy than longer ones.

4. The whole range of radiation of different wavelengths is collectively described as the electromagnetic spectrum.

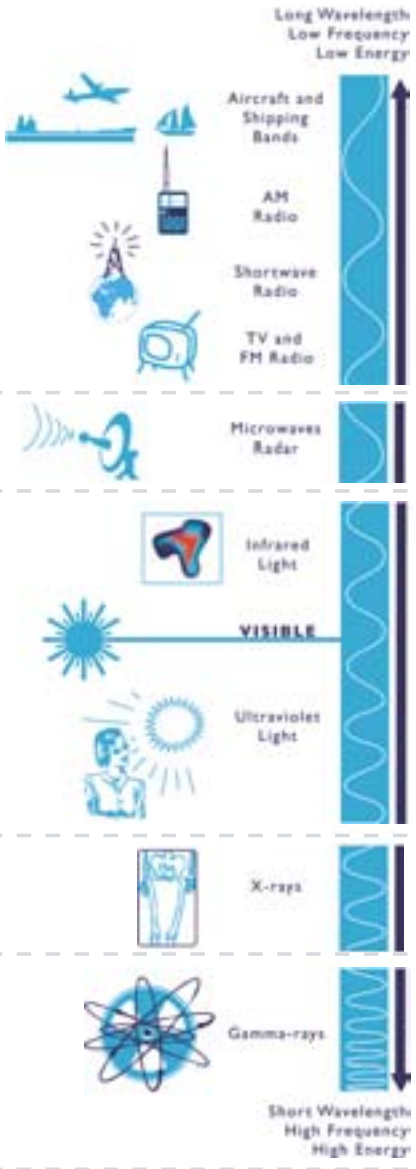
5. Visible light that comes from a lamp in your house or radio waves that come from a radio station are two types of electromagnetic (EM) radiation. Other examples of EM radiation are microwaves, infrared and ultraviolet light, X-rays and gamma rays. Hotter, more energetic objects create higher energy radiation than cool objects. Only extremely hot objects and particles moving at very high velocities can create high-energy radiation like x-rays and gamma rays.

MISSION INSTRUCTIONS

1. Use the blocks in this envelope to create an illustration of the spectrum.
2. Place the text blocks in this envelope next to the correct part of the illustration.
3. When it is correct, glue the spectrum onto a sheet of paper and keep it in your folder.

ACTIVITY – FOR INSIDE THE ENVELOPE

Preparation required by the teacher: copy the sheet below, cutting each sheet down the central line. Then cut each of the definition blocks out, leaving the pictures in a strip. The group has to put the correct definition or text next to the correct picture, to create an illustration of the spectrum.



Radio waves are emitted by stars and gases in space.

Microwaves are used in microwave ovens and mobile phones.

The invisible part of light with longer wavelengths that are felt as heat radiation. Visible radiation is emitted by everything that you can see.
The Sun is a source of ultraviolet (or UV) radiation. It is the UV rays that cause our skin to burn.

Your doctor uses X-rays to look at your bones and your dentist to look at your teeth.

Gamma-rays can be natural or man-made in nuclear reactors.

MISSION 2 - THE EARTH'S OZONE FILTER

STUDENT BRIEFING (FOR THE FRONT OF THE ENVELOPE)

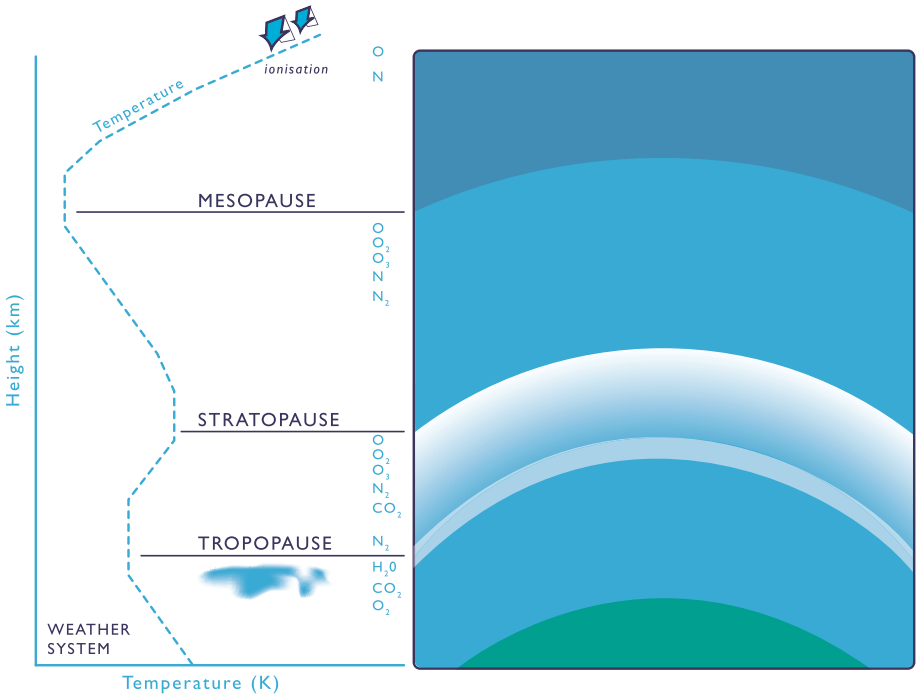
Variations in temperature and pressure divide the Earth's atmosphere into layers. You can see the layers in the diagram below – if you label it correctly.

As the Sun's radiation approaches the planet's surface it can be scattered, reflected, or absorbed, intercepted and re-emitted. At the top of the stratosphere a thin layer of ozone scatters and reflects harmful high energy ultraviolet radiation. This stratospheric ozone contains 90% of all ozone gas on the Earth but it is spread thinly and unevenly.

ACTIVITY – FOR INSIDE THE ENVELOPE

What happens to the sunlight in the Earth's atmosphere system?

1. Look at the image below.
2. Use the information in the table to correctly label it.
3. Keep the completed sheet in your folder.



SESSION 2: FINDING OUT THE TRUTH

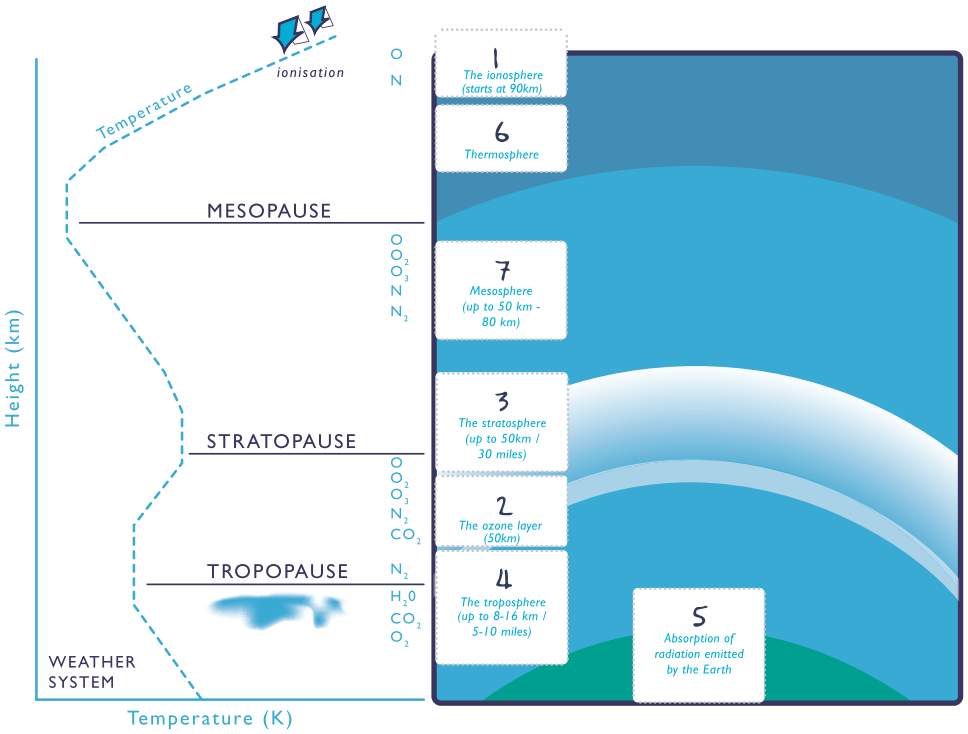
MISSION 2 - THE EARTH'S OZONE FILTER

ACTIVITY – FOR INSIDE THE ENVELOPE

Label	Clue
1 *The ionosphere (starts at 90km)*	Most high energy radiation is absorbed here.
2 *The ozone layer (50km)*	This thin layer at the top of the stratosphere absorbs most of the UV radiation. Too much UV radiation can cause damage to living things so the ozone layer is very important in protecting life on Earth.
3 *The stratosphere (up to 50km / 30 miles)*	Ozone depletion relies on the clouds in the stratosphere: polar stratospheric clouds (PSCs), also known as nacreous clouds, are found at altitudes of 15,000–25,000 metres.
4 *The troposphere (up to 8-16 km / 5-10 miles)*	The troposphere contains most of the air molecules, including nearly all the water vapour so most of the climatic events occur in this layer. All these particles mean that a lot of sunlight is scattered. Shorter violet and blue wavelengths are scattered more than longer wavelengths, making the sky appear blue.
5 *Absorption of radiation emitted by the Earth*	The Earth emits long wavelength radiation from its surface and much of this is absorbed and scattered in the troposphere. Greenhouse gases are responsible for most of this absorption, raising the temperature around the Earth and enabling life as we know it.
6 *Thermosphere*	This literally means "heat sphere". It is the outer layer of the atmosphere.
7 *Mesosphere (up to 50 km - 80 km)*	Is the third highest layer in our atmosphere.

MISSION 2 - THE EARTH'S OZONE FILTER

ANSWER SHEET

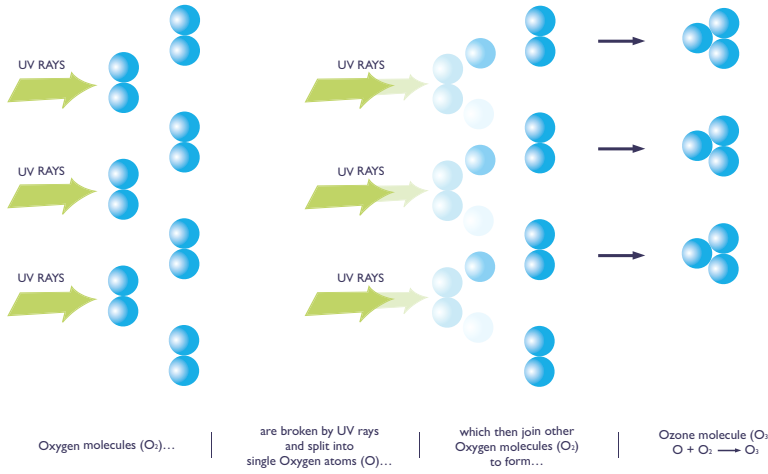


MISSION 3 - WHAT IS OZONE?

STUDENT BRIEFING (FOR THE FRONT OF THE ENVELOPE)

Ozone molecules are made of three atoms of oxygen. The ozone molecules together create an ozone layer in the stratosphere, in the upper atmosphere. The ozone layer is a thin invisible shield that blocks the Sun's harmful ultraviolet radiation and is therefore vital for all life on Earth. Ozone molecules are constantly formed and destroyed in the layer. The total amount, however, remains relatively stable. Ozone can be produced naturally in thunderstorms by the electrical charges from lightning. In the ozone layer, ozone molecules are created by:

1. The Sun's energy breaking apart oxygen molecules so an (O_2), splits apart into two single oxygen atoms (O and O).
2. One of these single oxygen atoms combined with an oxygen molecule to form an ozone molecule ($O + O_2 \rightarrow O_3$).



MISSION 3 - WHAT IS OZONE?

ACTIVITY – FOR INSIDE THE ENVELOPE

Now you need to show how well you understand the ozone system by deciding how these factors feed back into the planetary ozone system. Tick the box you believe to be correct:

Affect	Increase ozone	Decrease Ozone	No effect
Lightning in the upper atmosphere.			
The Sun's high energy radiation.			
Hydrochlorofluorocarbons (HCFCs) are replacement chemicals for ozone-depleting substances used in a variety of industrial, commercial and household applications. They harm the ozone layer.			
Major volcanic eruption, providing the catalyst for ozone depletion.			
The results of burning fossil fuels leading to increased carbon dioxide in the atmosphere.			

MISSION 3 - WHAT IS OZONE?

ANSWER SHEET

Affect	Increase ozone	Decrease Ozone	No effect
Lightning in the upper atmosphere provides energy for the formation of ozone.	✓ correct		
Sun's high energy radiation provides energy for ozone formation.	✓ correct		
Hydrochlorofluorocarbons (HCFCs), which are replacement chemicals for ozone-depleting CFCs, used in a variety of industrial, commercial, and household applications. HCFCs were necessary for a quick transition away from CFCs but these chemicals also damage the ozone layer (though less than CFCs). HCFCs are also greenhouse gases.		✓ correct	
Major volcanic eruption. Volcanic eruptions can play a significant role in reducing ozone levels since particles released from volcanoes act as a catalyst for ozone depletion.		✓ correct	
The results of burning fossil fuels lead to increased carbon dioxide in the atmosphere. Linked to global warming rather than ozone depletion, although global warming can make ozone depletion worse.			✓ correct

MISSION 4 - GROUND LEVEL OZONE

STUDENT BRIEFING (FOR THE FRONT OF THE ENVELOPE)

Ozone plays a major role in maintaining the Earth's living systems. However, that's when it is in the stratosphere, in the ozone layer. Tropospheric or ground-level ozone is a health risk for human beings and animals, causing shortness of breath, headache, asthma and eye and throat irritation. Normally these effects stop soon after exposure to the ozone stops, but long-term exposure can cause permanent breathing problems.

Tropospheric ozone is also a pollutant that harms plant cells. The ozone damage can be seen on leaves where they create brown spots. Ozone is an ingredient of smog in our cities and other areas of the country.

The formation of ground-level ozone is a result of a chemical reaction between sunlight and two groups of chemical pollutants:

- Nitrogen oxides (NOx), a combination of nitrogen and oxygen, formed by bacterial action in the soil, lightning, volcanoes, forest fires and the burning of fossil fuels.
- Volatile organic compounds (VOC), which are gases and vapours that are released by the decay of organic materials and during industrial processes that involve combustion, and the evaporation of solvents or organic chemicals (e.g. nail varnish remover, barbecue fluid, gasoline/petrol fumes).

Fossil fuels and their by-products are responsible for 95% of nitrogen oxide and 60% of VOC emissions. The most efficient way to reduce the quantity of tropospheric ozone is to reduce the emissions of these chemicals.

SESSION 2: FINDING OUT THE TRUTH

MISSION 4 - GROUND LEVEL OZONE

ACTIVITY – FOR INSIDE THE ENVELOPE

Your teacher will give you a sequence of cards. To uncover which cards will give you the environmental circumstances that produce low-level ozone, you need to solve the puzzle inside. The correct numbers tell you which card to take. You are only allowed to choose six cards.

			10
			16
4	5		18
	1		7
13	8	20	20

Try to fill in the missing numbers.

The missing numbers are integers (whole numbers) from 0 to 10.

The numbers in each row add up to the totals to the right.

The numbers in each column add up to the totals along the bottom.

The diagonals of the three by three square also add up to the totals to the right.

MISSION 4 - GROUND LEVEL OZONE

ANSWER SHEET

			10
9	2	5	16
4	5	9	18
0	1	6	7
13	8	20	20

ACTIVITY CARD TEXTS

These need to be copied and cut out to provide the answers.
Provide each group with the cards answers face down.
Cut out the cards and fold them so that the numbers are on one side and the answers are on the other.

Wind conditions	9		1
Slow moving air	2		3
High traffic	5		4
Low traffic	6		7
Fossil fuel burning	9		8
Sunlight	0		

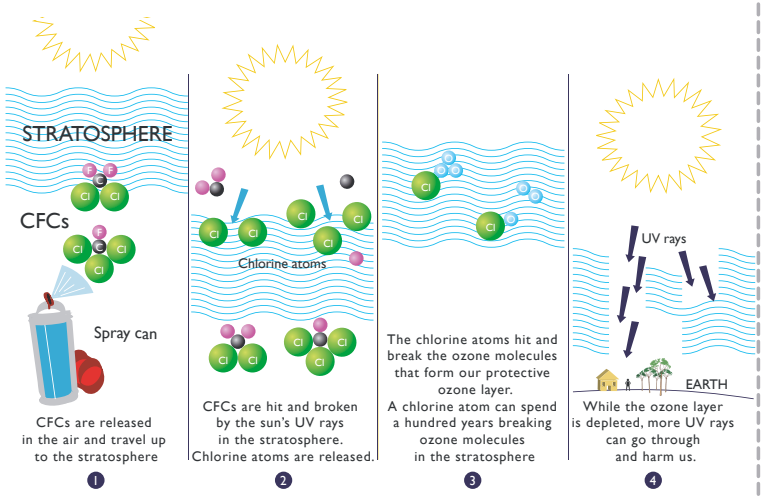
MISSION 5 - OZONE DEPLETING SUBSTANCES (ODS)

STUDENT BRIEFING (FOR THE FRONT OF THE ENVELOPE)

The chemicals that destroy stratospheric ozone layer are called ozone depleting substances or ODS, for short. These chemicals are man-made. The main types are:

1. Chlorofluorocarbons or CFCs, created in 1928 as safe, stable, non-flammable, low-toxicity, and inexpensive to produce. Over time, CFCs were used as refrigerants (in refrigerators, air conditioners) as propellants in aerosol sprays, as solvents, foam-blowing agents, and in other smaller applications.
2. Hydrochlorofluorocarbons or HCFCs are widely used in refrigeration, foam, solvent, aerosol and fire-fighting products as a substitute for CFCs in the 1990s. HCFCs are also used as a raw material in the production of other chemical products. Although having considerably lower ozone depleting potential than CFCs, many HCFCs have high global warming potential, of up to 2000 times that of carbon dioxide.
3. Halons, extremely effective fire extinguishing agents.
4. Methyl bromide, an effective fumigant that kills fungi and other pests in soil, plant and vegetable commodities.

They are all very stable molecules, meaning they do not react easily and can be carried to the upper atmosphere. The CFCs are actually so stable that only exposure to strong UV radiation breaks them down (remember the information in Mission 1). When that happens, the CFC molecule releases its chlorine atom which is then free to attack an ozone molecule, breaking it apart and destroying the ozone. This picture shows the chemical cycle:



These chemicals can be released into the air during their manufacture, from leakage of equipment and when appliances or cars containing ODS are abandoned or not disposed of properly. This highlights the importance of systematic recovery and recycling of old appliances and automobiles to ensure that the ODS are removed and either re-used or destroyed. ODS can also be found in insulating foams which should be recovered in an environmentally-sound way.

MISSION 5 - OZONE DEPLETING SUBSTANCES (ODS)

ACTIVITY– FOR INSIDE THE ENVELOPE

Here is a survey of potential sources of ODS - complete these for your classroom or school. Think of all the places where you might have to check if the products are depleting ozone and perhaps change if the school can afford to.

Do you know if your school uses any of the following products?
Do you know if they are ozone-friendly?

CFC	Tick if your school uses any of these products	Ozone-friendly (tick if it is, or cross if it is not, and 'U' for Unsure)
Flexible and rigid foam in furniture		
Carpet underlay		
Polystyrene chips used for packaging		
Refrigerators		
Freezers		
Dry cleaning clothes		
Air conditioning		
Polystyrene cups		

HCFC	Tick if they are used in your school	Ozone-friendly (tick if it is, or cross if it is not, and 'U' for Unsure)
Flexible and rigid foam in furniture		
Fire extinguishers		
Refrigerators		

Halon and methyl bromide	Tick if they are used in your school	Ozone-friendly (tick if it is, or cross if it is not, and 'U' for Unsure)
Pesticides		
Refrigerators		
Fire extinguishers		

Now add up the number of ticks, crosses and unsure responses from the right column. If you have more ticks, well done! If you have crosses, not so well done. If you have 'unsure', then think about how you might find out. Can you think of a reference or source that would have helped you to know?

You can buy products that are ozone-friendly. What do you think will help you to identify them?

It is important to keep the results of this mission to help with a task later on: a full school survey.

SESSION 2: FINDING OUT THE TRUTH

MISSION 6 - OZONE LAYER DEPLETION TODAY

STUDENT BRIEFING (FOR THE FRONT OF THE ENVELOPE)

Use the Morse code to find the missing words and find out key facts for your report.

ACTIVITY– FOR INSIDE THE ENVELOPE

The --- --.. --- -. . .-.. .- -.-- . .-. is severely thinning over many regions and countries where people live. Depletion is generally worse at .... .. --. .... . .-. .-.. .- .. - ..- -.. . ..., but the ozone levels have fallen almost everywhere in the world. In the southern .... . -- .. ... .--. .... . .-. . parts of South America, Australia, New Zealand and South Africa are particularly affected . In the northern hemisphere, in North America, Europe and Asia the ozone layer is also getting - .... .. -. -. . .-. .-.-.-

What people call the ozone hole is actually a -.. .-. .- -- .- - .. -.-. - .... .. -. -. .. -. --. of the ozone layer. The biggest ozone hole forms over Antarctica, where the ozone hole was first detected.
The ozone-destroying chemical process works mainly in very cold temperatures conditions (less than - 80°C) and the stratosphere above the Antarctic continent .... .- ... -.-. --- .-.. -.. . .-. -.-. --- -. -.. .. - .. --- -. ... - .... .- -. the Arctic, which has no land-mass.

As the UV radiation is normally stronger near the Equator, the net quantity of radiation reaching the Earth is bigger and therefore even small decreases in the ozone level will have .... .. --. .... . .-. .. -- .--. .- -.-. - ... . Ozone depletion is not constant through the year. The ozone hole appears over Antarctica normally only - .-- --- -- --- -. - ....- -.-- . .- .-. September and October, and the level varies also over other continents depending on the season.

MISSION 6 - OZONE LAYER DEPLETION TODAY

MORSE CODE KEY – FOR INSIDE THE ENVELOPE

Letter	Morse	Letter	Morse	Letter	Morse	Digit	Morse	Punc-tuation Mark	Morse
A	.-	N	-.	Ä	.-.-	0	-----	Full-stop (period)	.-.-.-
B	-...	O	---	Á	.--.-	1	.----	Comma	--..--
C	-.-.	P	.--.	Å	.--.-	2	..---	Colon	---...
D	-..	Q	--.-	Ch	----	3	...--	Ques-tion mark (query)	..--..
E	.	R	.-.	É	..-..	4	....-	Apos-trophe	.----.
F	..-.	S	...	Ñ	--.--	5	.....	Hyphen	-....-
G	--.	T	-	Ö	---.	6	-....	Slash ("/")	-..-.
H	....	U	..-	Ü	..--	7	--...	Brackets (paren-theses)	-.--.-
I	..	V	...-			8	---..	Quota-tion marks	.-..-.
J	.---	W	.--			9	----.	At sign	.--.-.
K	-.-	X	-..-					Equals sign	-...-
L	.-..	Y	-.--						
M	--	Z	--..						

MISSION 6 - OZONE LAYER DEPLETION TODAY

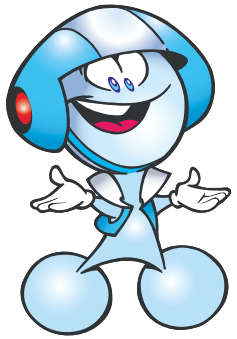
ANSWER SHEET

The missing text is highlighted.

The **ozone layer** is severely thinning over many regions and countries where people live. Depletion is generally worse at **higher latitudes**, but the ozone levels have fallen almost everywhere in the world. In the southern **hemisphere**, parts of South America, Australia, New Zealand and South Africa are particularly affected. In the northern hemisphere, in North America, Europe and Asia the ozone layer is also getting **thinner**.

What people call the ozone hole is actually a **dramatic thinning** of the ozone layer. The biggest ozone hole forms over Antarctica, where the ozone hole was first detected. The ozone-destroying chemical process works mainly in very cold temperatures (less than - 80°C) and the stratosphere above the Antarctic continent **has colder conditions than** the Arctic, which has no land-mass.

As the UV radiation is normally stronger near the Equator, the net quantity of radiation reaching the Earth is bigger and therefore even small decreases in the ozone level will have **higher impacts**. Ozone depletion is not constant through the year. The ozone hole appears over Antarctica normally only **two months a year**, September and October, and the level varies also over other continents depending on the season.



SESSION 3: PROTECTING OURSELVES AND THE OZONE LAYER

TEACHER BRIEFING

Objectives

- To introduce the potential health risks from the depleted ozone layer.
- To find out what actions students can take to protect themselves.

Equipment:

Envelopes (to put the 'missions' into, explained below), pens, paper, materials reproduced from this book as appropriate, glue.

Preparation:

Groups of 3-4 students who will be delegate teams at your debate event.

Instructions

1. There are four missions for the students to complete. Each group has to complete them in a set time. They are working against the clock – completion gives more time and reduces the risk of having to complete the work on their own time.

2. Copy the student briefing for the mission and stick it onto envelopes. Put the activity puzzles into the envelopes. Remember that some of the puzzles require pieces to be cut out prior to you placing anything in the envelope. Answer sheets are provided where needed, and any specific preparation instructions are included in the activity.

3. Provide each envelope in turn so that groups can work at their own pace through the different 'missions' until they are all completed. Those that complete the missions quickly can then look at their answers from Session 1 and begin to discuss the questions, answers and any changes.

4. Finish the activity by giving ten minutes for them to revise their answers to the Session 1 questions:
   a. What is ozone depletion?
   b. What effects does ozone depletion have where you live?
   c. What effects does ozone depletion have in other places around the world?
   d. What actions should you take and why?
   e. What should governments do and why?

5. Finish by saying they will have to complete their investigations of background information in the next session. They should research answers to questions a-c.

6. Make sure that the students keep their activity results in a folder with the work from the first session.

7. If there is computer access, quicker students can investigate the following, or it can be given as a linking research exercise if needed.

Find out when your country joined the Montreal Protocol:
http://ozone.unep.org/Ratification_status/list_of_article_5_parties.shtml

Contact your country's National Ozone Units to find out what actions are being taken by your government to protect the ozone layer:
http://www.unep.fr/ozonaction/information/contacts.htm

MISSION 1 - WHY AND HOW ARE UV RAYS DANGEROUS?

STUDENT BRIEFING (FOR THE FRONT OF THE ENVELOPE)

UV rays are dangerous to human beings, animals and plants because they burn. They can penetrate our skin and eyes and weaken our body's immune system. That is why we should avoid long periods in the Sun. Most people get enough exposure to UV radiation to enable adequate vitamin D production, simply by going about their day-to-day activities. We need vitamin D for strong bones and good immune system.

During the summer months, exposing the face, arms and hands or the equivalent area of skin to a few minutes of sunlight on either side of the peak UV periods on most days of the week will give enough UV exposure; during the winter months, 2-3 hours of sunlight exposure to the face, arms and hands or equivalent area of skin over a week is enough. More than that and we might get sunburnt.

Repeated sunburns and frequent tanning can cause premature ageing of the skin and, at worst, skin cancer such as melanoma (because of UV-A and UV-B rays). UV-B rays can cause a cataract (clouding of the eye lens) and eye damage. Most of the serious health problems appear only many years later; however, it is essential to protect your skin and eyes now to avoid the cumulative effects of UV exposure.

SESSION 3: PROTECTING OURSELVES AND THE OZONE LAYER

ACTIVITY– FOR INSIDE THE ENVELOPE

The different categories of UV rays and their possible effects on plants and animals can be placed in the following grid. You need to transform it into a puzzle! Place the squares correctly on the grid using the answer sheet. You'll notice there is one piece missing; don't panic! Your teacher has it and it will be handled to your group once you have finished the activity.

You must mix up the rest of the pieces, but you cannot take them from the grid. You are only allowed to slide them up and down, and to the sides, using the empty square. When the puzzle is well mixed and the pieces are out of their corresponding place, it is time to exchange grids with another group. Your mission is to take the pieces to their original positions but once again you cannot lift them, you can only slide them to the empty square. Little by little this puzzle will reveal the information you need to know about each category of UV rays. Once you're done, ask your teacher the piece that completes the puzzle.

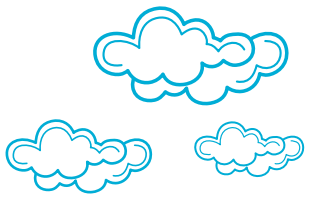
Category	Wavelengths (nanometres)	Reactions in, and with, the stratosphere	The effect upon humans, plants etc.
UV-A:			
UV-B:			
UV-C:			

MISSION 1 - WHY AND HOW ARE UV RAYS DANGEROUS?

ANSWER SHEET
TEACHER PREPARATION

Copy this answer sheet and use it to cut out the cards the groups need to place on the blank grid. Place the cards in an envelope, removing one square from each of the envelopes!

Category	Wavelengths (nanometres)	Reactions in, and with, the stratosphere	The effect upon humans, plants etc.
UV-A:	315/320 - 400 nm	Not a lot is absorbed by the stratospheric ozone layer.	10-15% of 'burning': Responsible for 'tanning' & skin ageing. Considered carcinogenic.
UV-B:	280 – 315/320 nm	Mainly absorbed by ozone in the stratosphere.	85 – 90 % 'burning'; connected to cancerous growths and eye cataracts. Strong radiation kills plankton, which is the main food supply for fish.
UV-C:	200 - 280 nm	Highly absorbed by oxygen molecules and ozone: involved with formation of ozone.	Thought to be smaller problem because it is efficiently absorbed at high-altitudes.



MISSION 2 - WHEN, WHERE AND FOR WHOM IS THE RISK HIGHEST?

STUDENT BRIEFING (FOR THE FRONT OF THE ENVELOPE)

The Global Solar UV Index, developed by the WHO in collaboration with UNEP and the World Meteorological Organisation (WMO), is a tool to help inform people about the risks of UV exposure. It uses a range of values from zero upwards, taking into account all the factors to indicate the potential for adverse health effects due to UV radiation. The higher the value, the greater the amount of dangerous UV rays. In some countries you can see the UV index also in the media.

Remember - all people are at risk, although some more than others. A fair skin is more easily sunburnt than a dark skin, but a dark skinned person can also develop skin cancers and cataracts which are often found in a later, more dangerous phase. The higher the UV Index level, the higher the amount of UV that can cause skin and eye damage.

UV Index	Exposure category and risk for health
0 - 2	Low
2 - 5	Moderate
6 - 7	High
8 - 10	Very high
11+	Extreme

http://www.who.int/docstore/peh-uv/UVIndex_Graphics/gif/C_colour/

MISSION 2 - WHEN, WHERE AND FOR WHOM IS THE RISK HIGHEST?

ACTIVITY (FOR INSIDE THE ENVELOPE)

Now use the scenarios in the grid to decide when someone is running a risk of UV damage. Simply work through the clues given here. Then read down each column of the grid and decide your exposure risk using the UV Index. Is it low, high, or very high?

Clues

- UV radiation is the highest between 10 am and 4 pm especially in hot seasons, so these times increase the risk and increase the UV Index number.
- The shorter the distance the Sun's rays pass through the atmosphere, such as in the northern hemisphere between April and September, and in the southern hemisphere between September and April, the stronger the radiation is.
- Ozone layer depletion is not so serious at the Equator. However, as the Sun's rays have less atmosphere to travel through and tend to be hitting the Earth's surface all year round, so the UV Index is always high at the Equator.
- On mountains, the Sun's rays have less atmosphere to travel through and therefore the radiation level is higher. The amount of UV rays reaching the Earth increases about 8% with every 1000 meters (3280 feet) above sea level.
- Sand, snow, and ice reflect the rays. These surfaces act like mirrors and increase the amount of UV rays. UV radiation is very strong by the sea, on the beach and on glaciers. The fresh snow reflects as much as 80% of UV radiation, sea foam about 25%, dry beach sand about 15% and grass, soil and water less than 10% of UV.
- Cloudy days offer some protection but up to 90% of UV radiation can still reach the Earth's surface. That's why it is possible to still be sunburnt on a cool overcast day. Thick, dark clouds block the UV rays more efficiently.
- The longer you are exposed to UV radiation, the higher the risks.
- Remember infrared is what we feel as heat, we do not feel UV radiation burning us in the same way!

SESSION 3: PROTECTING OURSELVES AND THE OZONE LAYER

MISSION 2 - WHEN, WHERE AND FOR WHOM IS THE RISK HIGHEST?

ACTIVITY (FOR INSIDE THE ENVELOPE) TEACHER PREPARATION

Copy this sheet and place in the envelope.

Factors affecting exposure – grid

Time of day	Midday	14.00	11.00	Midnight	09.00	10.00	06.00
Month of year	April	November	June	December	August	October	January
Country	France	Australia	Brazil	Finland	Argentina	Kenya	Mexico
Elevation above sea level	On a mountain skiing	By a beach sunbathing	Planting crops in the forest	Walking in the snow	In a city walking to school	By a lake fishing	Hiking up a mountain
Cloud cover	Low	High	High	Low	High	Low	Low
Predicted UV index							

MISSION 2 - WHEN, WHERE AND FOR WHOM IS THE RISK HIGHEST?

ANSWER SHEET

Time of day	Midday	14.00	11.00	Midnight	09.00	10.00	06.00
Month of year	April	November	June	December	August	October	January
Country	France	Australia	Brazil	Finland	Argentina	Kenya	Mexico
Elevation above sea level	On a mountain skiing	By a beach sunbathing	Planting crops in the forest	Walking in the snow	In a city walking to school	By a lake fishing	Hiking up a mountain
Cloud cover	Low	High	High	Low	High	Low	Low
Predicted UV index	Very high	Very high	High	Low	Low	High	High

MISSION 3 - PERSONAL PROTECTION 4-POINT ACTION PLAN

STUDENT BRIEFING (FOR THE FRONT OF THE ENVELOPE)

These are the factors that increase your risks to exposure to UV-B. Look at them; they are clues you need, perhaps with information from Mission 2.

Maximum exposure to UV-B occurs when:

UV factors	High UV radiation
Time of the day	Between 10 am to 4 pm
Time of the year	Summer or hot season
Location	Especially close to the Equator and North and South Poles
Elevation	At increasing altitude above sea level
Reflection	Sand, snow, water and ice
Weather	No dark clouds in front of the Sun

ACTIVITY– FOR INSIDE THE ENVELOPE

Fortunately there are many easy ways to protect ourselves from UV radiation. Use the information in the briefing to write a four-point action plan to protect you from sunlight and high UV radiation exposure.

Then compare your plan to the one inside the envelope.

MISSION 3 - PERSONAL PROTECTION 4-POINT ACTION PLAN

ACTION PLAN (TO BE PLACED IN THE ENVELOPE)

1. During the hot season avoid the Sun between 10 am and 4 pm when the UV Index is the highest.

2. Search for shade when you're outside. Under a tree there might be up to 60% less radiation than in a sunny place.

3. Cover your skin and eyes. Wear long sleeves, trousers, a hat or something to cover your head and sunglasses to protect your eyes.

4. Use sunscreen with a Sun Protection Factor (SPF) of at least 30, applied 20 minutes before going outdoors. If you want to go swimming, avoid the midday hours and use sunscreen for the whole body as the water reflects the rays efficiently and increases the radiation. Also while wearing a long-sleeved shirt, use some sunscreen on your hands or other parts that are not covered. Sunscreen should also be reapplied every 2 hours, or more often if swimming or perspiring heavily.

MISSION 4 - OZONE LAYER PROTECTION

STUDENT BRIEFING (FOR THE FRONT OF THE ENVELOPE)

The most efficient way to protect the ozone layer is to stop releasing the dangerous chemicals into the atmosphere. Some nations banned the use of CFCs soon after the findings in the 1970s and 1980s but the most successful programme to eliminate ODS is the Montreal Protocol on Substances that Deplete the Ozone Layer. This international agreement was promoted by the United Nations and signed by 24 countries and the European Economic Community on 16 September 1987. The Montreal Protocol called for those who signed it (known as "Parties") to phase out the chemicals responsible for ozone depletion. By the beginning of 2008 more than 190 countries have already ratified the Montreal Protocol and more than 95% of all ozone depleting substances has been phased out in the world. That makes it the most successful environmental agreement in history.

The Montreal Protocol has set a time limit for the consumption and production of different ODS. For developed countries, most of the deadlines of total phase-out have been already met in the 1990s except for HCFCs, methyl bromide and some essential uses. Developing countries have been given more time to find replacement products and methods and most have their phase out deadlines fixed for between 2010 and 2030.

At the meeting of Parties of the Montreal Protocol in September 2007, it was decided to accelerate the phase-out of production of HCFCs in developed and developing countries and reduce progressively the consumption of HCFCs in developing countries.

Despite the success of the Montreal Protocol, there are still some obstacles on the way to the complete disappearance of ODS. One obstacle is the illegal trade i.e. smuggling. Some CFC-products for example are being smuggled across borders. It is a question of money; substitutes for ODS are often more expensive and the converting of the equipment to use these substitutes also costs money. Environmental organisations like UNEP and Environmental Investigation Agency (EIA) fight against this illegal trade by training customs officers in different countries.

SESSION 3: PROTECTING OURSELVES AND THE OZONE LAYER

MISSION 4 - OZONE LAYER PROTECTION

ACTIVITY– FOR INSIDE THE ENVELOPE

Use your work from the previous mission to investigate possible products containing ODS. Use your previous survey from Session 2 Mission 5 and the questions below to look for evidence of action that is happening locally. Convert it into a survey for use around the school using these questions as a starting point.

1. Does your school have any of the following?
   ☐ fire extinguishers ☐ refrigerators ☐ air-conditioners
2. If yes, how old are each of the pieces of equipment? Check the fire extinguishers labels and try to find out if they contain ODS, and if so what kind. Do the same for air conditioners and refrigerators. Do they use ozone-friendly technology?
3. Is there a local company who can recycle these products correctly?
4. Some spray cans have labels saying 'ozone safe' or something similar. Can you find any cans with such labels?

SESSION 4: CLIMATE CHANGE AND OZONE LAYER DEPLETION

TEACHER BRIEFING

Objectives

- To introduce the misconceptions commonly held about ozone linking with climate change.
- To introduce the basic science behind climate change in the atmosphere.

Equipment:

Envelopes (to put the 'missions' into, explained below), pens, paper, materials reproduced from this book as appropriate, glue.

Preparation:

Groups of 3-4 students who will be delegate teams at your debate event.

Instructions

1. There are four missions for students to complete. Each group has to complete them in a set time. They are working against the clock – completion gives more time and less homework.
2. Set out each of the activity puzzles in envelopes, using the student briefing on the outside of the envelopes to define the 'mission' they will complete.
3. Provide each envelope in turn so that groups can work at their own pace. Those that complete quickly can then look at their answers from Session 1 and begin to discuss the questions, answers and any changes.
4. Finish the activity by providing the key and giving ten minutes for them to revise their answers to the Session 1 questions:
   a. What is ozone depletion?
   b. What effects ozone depletion has where you live?
   c. What effects ozone depletion has in other places around the world?
   d. What actions should you take and why?
   e. What should governments do and why?
5. Finish the session by saying they will have to complete their investigations of background information in the next session. They should research answers to question a-e. How would they change their answers? What additional information would they add?
6. Make sure that students have their activity results in a folder with the work from the previous sessions.

MISSION 1 - CARBON CORNER

STUDENT BRIEFING (FOR THE FRONT OF THE ENVELOPE)

Can you identify parts of the carbon cycle around you? Look for examples of the following elements and draw an example of them on a sheet of paper

Our current energy supply relies largely on solar radiation. The food you eat is "solar powered" since plants need sunlight to grow; the fuels we use are "solar powered" as they are made from fossil plants and animals, and wind power is also "solar powered" in the sense that the differences in temperature in the global climate system creates wind. Hydroelectric power also relies on the sun to drive the global water cycle. There are exceptions such as geothermal energy, nuclear energy, and tidal power.

The solar energy, that plants use for photosynthesis which allows them to convert carbon dioxide and water into sugars, triggers the carbon cycle. The carbon making up our bodies comes from carbon dioxide captured by plants and used to build their leaves, stems and other structures. We eat plants to build our carbon-based bodies.

You are now challenged to find parts of this solar-powered carbon cycle.

SESSION 4: CLIMATE CHANGE AND OZONE LAYER DEPLETION

MISSION 1 - CARBON CORNER

ACTIVITY– FOR INSIDE THE ENVELOPE

Can you identify parts of the carbon cycle around you?

a. Plants, through photosynthesis, absorb carbon dioxide and turn it into stems, leaves and roots. They also release oxygen during this process.

b. Animals are also made of carbon, water and other components (most of them coming directly or indirectly from plants).

c. Deep underground carbon is stored as oil, coal and gas, all of these fossil fuels.

d. Fossil fuels are stores of carbon, since they come from once living organisms. Burning those stores releases carbon dioxide into the atmosphere.

e. Since most cars are powered by fossil fuels, car exhausts emit carbon and carbon dioxide into the atmosphere.

f. Factories and homes often have energy produced by carbon burning.

g. Dead plants and animals decay when they are dead, releasing carbon into the soil and to the atmosphere.

h. Rich woodland soils contain carbon from decayed trees and plants.

i. The plankton in the ocean trap carbon through photosynthesis which 'soaks' up lots of carbon dioxide.

j. Trees convert carbon dioxide into oxygen and wood. The carbon is then stored as wood, which can then be used to make products.

List all of the items in your classroom made from wood:

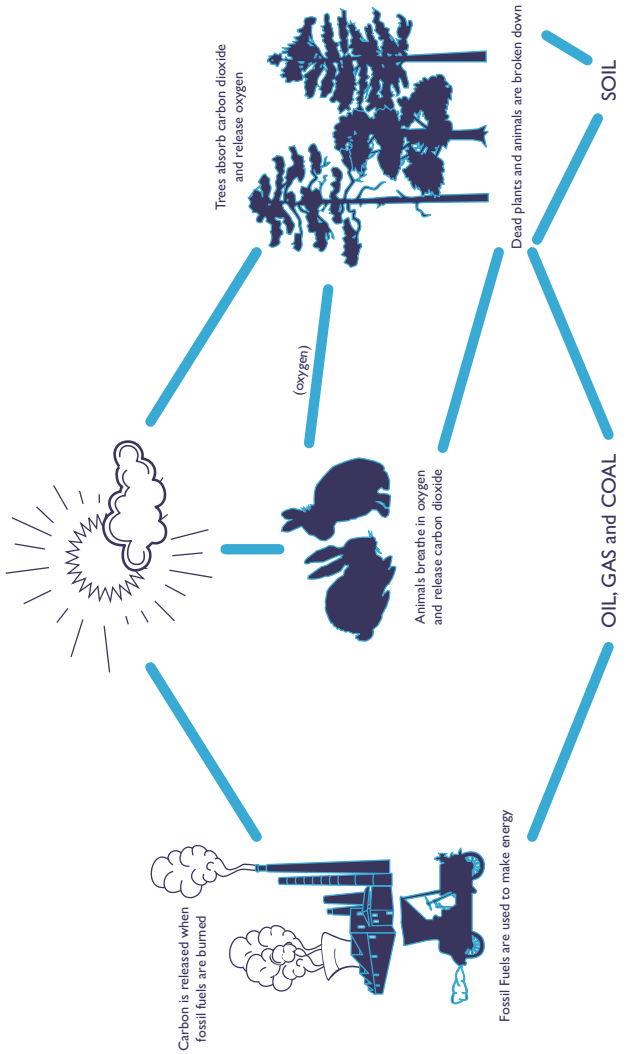
l. Methane and nitrous oxide in the atmosphere also contribute to global warming.

Using this information you can complete the carbon cycle. Draw in the arrowheads on the Carbon Cycle sheet to indicate how carbon is flowing from source to sinks - think of a sink as a place that stores up carbon.

MISSION 1 - CARBON CORNER

ACTIVITY– FOR INSIDE THE ENVELOPE

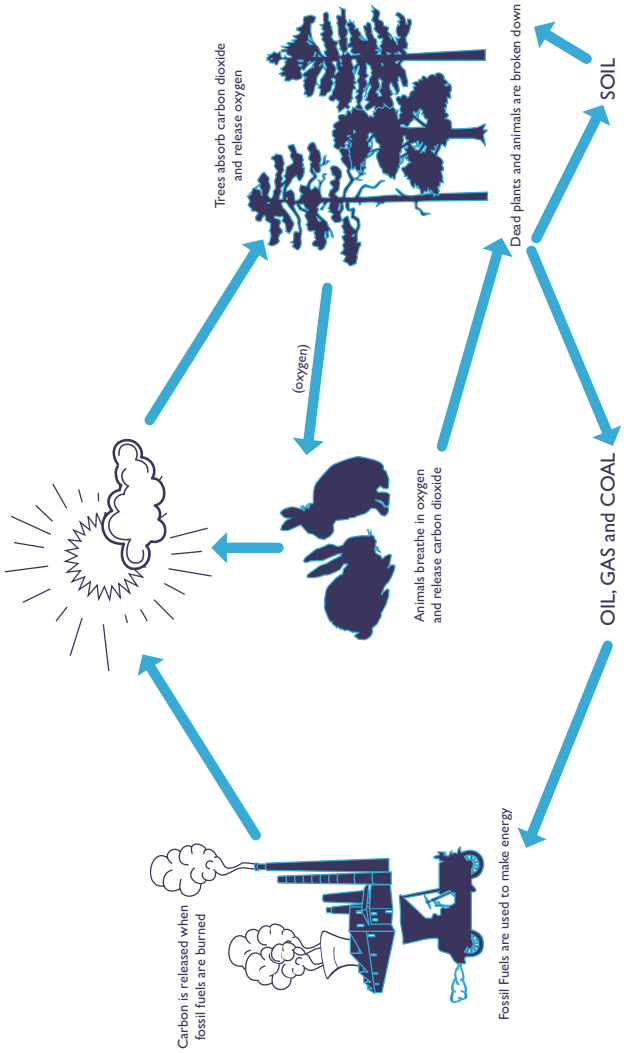
Notice all the things in the carbon cycle and the differences between them and ozone depleting substances. The differences are that most parts of the carbon cycle are natural resources that we are exploiting, whereas the ODS are greenhouse gases that have been introduced into the planetary system by people, and only by people.



SESSION 4: CLIMATE CHANGE AND OZONE LAYER DEPLETION

MISSION 1 - CARBON CORNER

ANSWER SHEET



MISSION 2 - TOO HOT OR NOT?

STUDENT BRIEFING (FOR THE FRONT OF THE ENVELOPE)

The Earth has a natural temperature control system. The Earth's surface becomes warm as a result of incoming solar radiation and then emits infrared radiation. Certain atmospheric or 'greenhouse' gases trap some of the infrared radiation which in turn warms the atmosphere. Naturally-occurring greenhouse gases include water vapour, carbon dioxide, ozone, methane and nitrous oxide: together they create a natural greenhouse effect. Without this phenomenon the Earth's average temperature would be more than 30°C (60 °F) lower throughout the year, triggering very cold nights and very hot days.

The balance of incoming and outgoing radiation and the way energy is transferred maintain the temperature of the planet. This is known as the heat budget. The heat budget is dynamic – it is changing. For example: at the time of the dinosaurs there was more carbon dioxide in the atmosphere, trapping more heat, creating a higher planetary temperature.

Many of the ozone depleting substances are also very potent greenhouse gases, for example CFCs and their replacement HCFCs. The phase out of CFCs, HCFCs and other chemicals under the Montreal Protocol has helped us fight climate change as well as protect the ozone layer. Climate change might also slow down the ozone layer's recovery. As the temperature rises in the troposphere, global warming may cool the air in the stratosphere, which is likely to increase ozone layer depletion.

Another cause of climate change is the emission of the very potent greenhouse gas HFCs, which however have no ozone depletion effect.

MISSION 2 - TOO HOT OR NOT?

ACTIVITY– FOR INSIDE THE ENVELOPE

Now you need to show how well you understand the planetary power system by deciding how these factors feedback into the planetary system to heat or cool it. Tick the box you believe is correct.

Affect	Increase Earth's Temperature	Decrease Earth's Temperature
Cutting down forests will:		
A major volcanic eruption will:		
Burning fossil fuels leading to increased carbon dioxide in the atmosphere will:		
The addition of CFCs will:		
The addition of HCFCs will:		
The addition of HFCs will:		

ANSWER SHEET

Affect	Increase Earth's Temperature	Decrease Earth's Temperature
Cutting down forests will:	X	
A major volcanic eruption will:	X	X (May also offer some cooling as particles in the atmosphere reflect suns rays)
Burning fossil fuels leading to increased carbon dioxide in the atmosphere will:	X	
The addition of CFCs will:	X	
The addition of HCFCs will:	X	
The addition of HFCs will:	X	

MISSION 3 - SOURCES AND SINKS

STUDENT BRIEFING (FOR THE FRONT OF THE ENVELOPE)

Many power stations use coal, gas and oil to make electricity. When coal, gas and oil are burned, carbon dioxide is released into the atmosphere. Too much carbon dioxide is released when electricity is used carelessly. Releasing ODS also adds to greenhouse gases. Think back to Session 2, Mission 5 on ozone depleting substances.

Remember that some of the chemicals such as HCFCs have the potential to act as greenhouse gases. In fact, their effect is greater than that of carbon dioxide. This creates a link between tackling ozone issues and climate change issues. If we reduce ODS, we also help to reduce man-made greenhouse gas emissions in the atmosphere.

SESSION 4: CLIMATE CHANGE AND OZONE LAYER DEPLETION

MISSION 3 - SOURCES AND SINKS

ACTIVITY– FOR INSIDE THE ENVELOPE

1 These activities waste electricity – which do you do? – be honest!

- ☐ Leaving lights on
- ☐ Leaving computers on [or in standby mode] when not in use
- ☐ Leaving TVs and other electrical equipment on [or in standby mode] when not in use
- ☐ Leaving windows open when the heating is on
- ☐ Leaving doors open when the heating is on
- ☐ Leaving the air conditioner on

2 Can you think of any other activities which waste electricity?

_____

3 Cars use petrol for energy (petrol is made from oil) and when petrol is burnt, carbon is released from their exhausts. Which does your household use?

☐ Cars ☐ Motorbikes

4 Buses and trucks use diesel for energy (diesel is made from oil) and when diesel is burnt carbon is released from their exhausts. Which do you use?

☐ Buses ☐ Trucks

5 Some factories use lots of energy and release carbon dioxide through their chimney stacks. Given the way you consume, would you say that you contribute to the need for more production and therefore more energy consumption? How much do you contribute?

☐ Not too much ☐ Enough ☐ A lot

6 Methane production is linked to organic waste being put in landfill sites. Reducing the amount of organic waste piling up in landfills can reduce the problem. Do you reduce or recycle your organic waste?

☐ Yes ☐ No

MISSION 3 - SOURCES AND SINKS

ANSWER SHEET

These questions have been written so that students can work out the answers for themselves.

- Note that they all rely on trucks to deliver food and other goods to the shops.
- They may travel in cars even if they do not own one.

MISSION 4 - ACTION LISTS

STUDENT BRIEFING (FOR THE FRONT OF THE ENVELOPE)

The missions you have completed so far have given you ample information about the ozone, greenhouse gases and global warming. You can use all this information to create lists of actions to help reduce damage to the ozone layer and greenhouse gas emissions.

ACTIVITY– FOR INSIDE THE ENVELOPE

LIST 1: What can you do to reduce ODS use?

LIST 2: What impacts could you take to reduce greenhouse gas emissions?

LIST 3: What could governments do to reduce ODS?

LIST 4: What could governments do to reduce greenhouse gas emissions?

SESSION 5: PROTOCOL BRIEFING

TEACHER BRIEFING

Objectives

- To understand the short-listed options for controlling ozone depleting substances.
- To understand the proposed policy criteria.
- To work out what the group will be doing to consult their peers.
- To introduce the criteria and potential protocol actions.

Equipment:

Pen, paper.

Preparation:

Groups of 3-4 students who will be delegate teams at your debate event.

Instructions

1. Use the student briefing to introduce the project.
2. Provide them with the activity sheets and get them to discuss their answers in their group.
3. Conclude by saying they have the structure for their mini protocol - now they need to see if they are correct. They cannot send their ideas to the Ozzy Ozone web site if they are wrong.
4. If there is computer access, quicker students can investigate the following, or it can be given as a linking research exercise if needed.

Find out when your country joined the Montreal Protocol:
http://ozone.unep.org/Ratification_status/list_of_article_5_parties.shtml

Contact your country's National Ozone Units to find out what actions are being taken by your government to protect the ozone layer:
http://www.unep.fr/ozonaction/information/contacts.htm

MISSION 1 - WHAT THE EXPERTS SAY

ACTIVITY

As you know, the Montreal Protocol has been very successful reducing ODS emissions. In order to do so, the experts developed a set of policy options that have been implemented worldwide. You need to analyse some of them in order to start building your our Action Plan, according to local conditions and community needs.

1. Look at the first column below and read the different Montreal Protocol policy options. Think about policy options as aims or actions that decision makers might get people to do to reach a specific goal.
2. Decide how you think they could be done. Then decide who should do them – is it something you can do or something decision makers need to do?

Policy	Specific actions	Who does the action?
Provide and use products without ODS.		
Create National Ozone Units to strengthen cooperation between countries.		
Buy local products wherever possible.		
Avoid products containing ODS and use special labels so we know which are harmful, such as fridges or air conditioners.		

MISSION 1 - WHAT THE EXPERTS SAY

Policy	Specific actions	Who does the action?
Transfer technology (machinery, equipment etc).		
Transfer information (technical and commercial).		
Establish public awareness programmes.		
It's better to take your old equipment for recycling so that CFCs can be removed properly and are not released in the atmosphere.		
Establish taxes or fees on ODS.		
Finance local projects, such as the adaptation of a new technology.		

MISSION 2 - NOW THINK ABOUT THE PRIORITY

ACTIVITY

Now put the options in order and put in your own reasons for positioning them. You can cut out the policy cards, and use the blank ones for any criteria you have written. Which criteria are most important?

Policy	Ranking	Reason for ranking
Provide and use products without ODS.		
Create National Ozone Units to strengthen cooperation between countries.		
Buy local products wherever possible.		
Avoid products containing ODS and use special labels so we know which are harmful, such as fridges or air conditioners.		
Transfer technology (machinery, equipment etc).		
Transfer information (technical and commercial).		
Establish public awareness programmes.		
It's better to take your old equipment for recycling so that CFCs can be removed properly and are not released in the atmosphere.		
Establish taxes or fees on ODS.		
Finance local projects, such as the adaptation of a new technology.		

MISSION 2 - NOW THINK ABOUT THE PRIORITY

ACTIVITY

Policy cards

Provide and use products without ODS.
Create National Ozone Units to coordinate and oversee the national strategy to implement the Montreal Protocol.
Buy local products wherever possible.
Avoid products containing ODS and use special labels so we know which are harmful, such as fridges or air conditioners.
Transfer technology (machinery, equipment etc).
Transfer information (technical and commercial).
Establish public awareness programmes.
It's better to take your old equipment for recycling so that CFCs can be removed properly and are not released in the atmosphere.
Establish taxes or fees on ODS.
Finance local projects, such as the adaptation of a new technology.

MISSION 3 - DESIGN YOUR OWN SURVEYS AND SURVEYING

ACTIVITY

You need to find out if people agree with your action plans from the previous sections, and your ideas for implementing the policy options. One of the best ways is to develop your own research questionnaire. Here is some guidance.

1. What are your objectives?
2. What is your target group? Who are you going to ask? You need to decide who the groups that you're going to investigate are.
3. How are you going to contact your target group? There are many ways to contact your target group and ask them to take part, including:
   Circular letters or e/mails
   Leaflets, posters, newsletters
   Presentations
4. Which approach is best for the groups you wish to work with? Check safety issues with your teacher or group leader.
5. Use the available policy options to find out what people think would encourage them to implement them.
6. Find out what people do at the moment.
7. How will you ensure your results are reliable and valid? This is about making sure you ask appropriate questions in the best way. You will need to decide how to get the information you need (e.g. questionnaires or interviews), then test your questions with a suitable audience, i.e. one that closely resembles your target group.

   For example:
   This was agreed to be a two-stage process
   Initially: 'test' the method with one group, e.g. students aged 14
   Second stage: undertake research with another group, e.g. students aged 15

8. Now create your plan. Look at what you have decided to do; work out which order it has to be done in. This plan will help you to get started and serve as a guide. The following questions should be part of this discussion:
   - Are you getting more than one perspective on the subject?
   - Are you using enough / too many different sources?
   - How reliable are your sources?
   - Are you straying too far from your topic?
   - Are you asking the right questions?
   - Are you asking the questions in the best way?
   - How much work can you get done each day / week?
   - How will you know when you have enough information?
   - Have you created a timetable?
9. Evaluate your initial test results before doing the main research. What questions will you need to ask in order to do that? How will you present your data?

MISSION 4 - PRODUCE YOUR QUESTIONNAIRE

STUDENT BRIEFING (FOR THE FRONT OF THE ENVELOPE)

Use the activities to decide what you are going to ask your target group. This is an example of a questionnaire.

ACTIVITY (SAMPLE QUESTIONNAIRE)

1. What do you think ozone depletion is?
2. From this list, what do you think damages the ozone layer?
   Include your own table of ODS sources from Session 2 Mission 5.
3. Which of these measures will protect you from UV rays?
   Include your own protection plan from Session 3 Mission 3.
4. Which of these measures would you be willing to implement?
5. Rank these options for reducing ozone depletion in order of importance (or usefulness) from 1 to 10, with 1 being the best.

Tip for questionnaire writers: You will be able to add the ranking numbers together. Remember the lowest score will be the most popular – for the obvious reason!

Option	Rank (from 1 to 10)
Provide and use products without ODS.	
Create National Ozone Units to coordinate and oversee the national strategy to implement the Montreal Protocol.	
Buy local products wherever possible.	
Avoid products containing ODS and use special labels so we know which are harmful, such as fridges or air conditioners.	
Transfer technology of (machinery, equipment etc).	
Transfer information (technical and commercial).	
Establish public awareness programmes.	
It's better to take your old equipment for recycling so that CFCs can be removed properly and are not released in the atmosphere.	
Establish taxes or fees on ODS.	
Finance local projects, such as the adaptation of a new technology.	

SESSION 5: PROTOCOL BRIEFING

MISSION 4 - PRODUCE YOUR QUESTIONNAIRE

ACTIVITY (SAMPLE QUESTIONNAIRE)

6. Age categories (we suggest 5-year intervals or year groups if you are working in schools or youth groups).
7. Location or postcode data – it is helpful if this can be given in full.
8. Gender.
9. Occupation (what people do).

Now do your survey to investigate who agrees with your plans and actions.

SESSION 6: STARTING THE WRITE UP

TEACHER BRIEFING

Objectives

- To reinforce the lessons learned so far.
- To surprise the group with extra time to do their research.
- To evaluate the learning process through a role-playing exercise.

Equipment:

Pen, paper, the Ozone Layer Education for Secondary Schools - Student Book

Preparation:

Groups of 3-4 students who will be delegate teams at your debate event

Instructions

1. Give out copies of the Student Book and ask students to complete the tasks.
2. Set the scene for the students. They are journalists who have to complete their article with a deadline or lose their jobs. They need the results of all their missions so far. 'Notebooks' in the Student Book help them to focus on key questions.
3. Finish by reminding them that they have to produce a report. Introduce them to the writing frame that follows and explain that their article may help them summarise key facts. Tell them it needs to be completed before the debate takes place. They will need to present their report, ideas and actions at the mini-Montreal Protocol debate.

SESSION 6: STARTING THE WRITE UP

MISSION 1 - THE STUDENT BOOK

STUDENT BRIEFING (TO GIVE OUT WITH THE STUDENT BOOK)

You are journalists who have to complete your article with a deadline or lose your jobs. You need the results of all your missions so far. 'Notebooks' in the Student Book help you to focus on key questions.

Now start working on the Student Book. The clock is ticking!

MISSION 2 - WRITING UP YOUR REPORT

YOUR ARTICLE

Complete the sections of your report by adding in your text.

1. Introduction
This is your introduction to the problem:

2. What we did
This is where you describe your method.

3. Who we consulted
Exactly who did the group talk to, is it 9th grade, or 8th grade?
Are your results reliable and valid?
Have you asked enough people for your results to represent the student body views?

> For example:
> This was agreed to be a two stage process.
> Initially 'test' the method with 10th grade students.
> Second stage with 8th grade.

4. Reasons for this choice

> For example:
> To provide a range of ages to give a comparison of their options.
> Practicalities – it would be possible to get data from 10th grade students at the end of term.

5. What is it you were trying to find out?

> For example:
> Which policy is considered important and why, for each age group?

6. What method did you use?
Describe the activity method and sampling.

> For example:
> Pyramid activity with small groups from each class.
> 10 groups per class.
> Number of sample: (30 minimum)

SESSION 6: STARTING THE WRITE UP

MISSION 2 - THE WRITE-UP

7. Question results
Insert your analysis for each question here.

8. The final scores
After undertaking our research we concluded that the following scores should be given to each policy option, our reason for each score is given in the table below:

Policy	Score	Reason

9. Conclusion
The following recommendations for reducing ozone depletion are important because:

SESSION 7: ORGANISE A MINI UNITED NATIONS-STYLE DEBATE!

TEACHER BRIEFING

Objectives

- To collate the results and ideas from the previous session.
- To let them know they are producing a mini-protocol that can be sent to the Ozzy Ozone web site, as well as an action plan that may be entered into an international award and that this is their opportunity to create, test and implement a plan that allows them to tell adults what needs to happen on an important global issue.

Equipment:

Pen, paper.

Preparation:

Groups of 3-4 students who will be delegate teams at your debate event.

Instructions

1. Introduce the debate explaining that the results of their discussions will be an action plan for them to implement and test.
2. Explain that each group will be asked to present their report and ideas.
3. Collate the action plans at the end of the debate and ask for volunteers to form an OzonAction team to implement the school action plan. Based on the actions list, select the ones that take into account the priorities established with the survey, choose one or two and create a plan that can be implemented by students.

MISSION 1 - MINI MONTREAL PROTOCOL PLANNING SHEET

TEACHER PLANNING

1. Objective
To review and consolidate results from all participating groups.

2. Outcomes
- For students to discuss their priorities and reasoning with other young people and create an ozone action team.
- To enable students to listen to one another's views and explore particular aspects of the issue in greater depth.
- To collate students' views of suggested options for the creation of an ozone action plan.

3. Running order for the day
Prior to the day explain the sequence of events and that you will want them to present the results of their research and suggestion for policy priorities and implementation.

Use the following sequence of events and suggestions to develop their ideas over the day. Adapt the times to suit your class.

4. Preparation
Copy the student reports from Session 6 Mission 2 and place into a folder for each student.
Copy the activity sheet on page 65 and add that to each folder

.../...

SESSION 7: ORGANISE A MINI UNITED NATIONS-STYLE DEBATE!

MISSION 1 - MINI MONTREAL PROTOCOL PLANNING SHEET

Time	Element
09:30	Delegates arrive and receive a folder containing copies of the student reports from Session 6, Mission 2, and a name badge.
10:00	Welcome by the person who is hosting the day.
10:10	Introduction to explain the day and give an outline of the overall project.
10:20	Presentation of reports by groups – their key recommendations - which policies are considered important and why.
10:30	Policy session - using the activity sheet on page 66, work in groups to: Review the results summary of the consultation. Discuss how the results of their school/group differ. Discuss why there were differences. Describe the main issues that arose during the project. Record the key points and recommendations. Which priority do they put on policies, and how should they be implemented?
11:15	Plenary for working groups to present the results of their discussions – the key policies.
12:00	LUNCH
13:00	Review previous session and decide which actions are for government, industry, school and community, using the activity sheet on page 67.
13:15	Produce an action plan for implementation using the activity sheet on page 67 as a guide
14:00	Plenary presentation of the action plans.
14:30	The policy vote – using large sheets of paper, one for each option, give each person three dots to vote for the three most important policies.
14:50	Conclusion – ask for volunteers to take the conference results and create the ozone action plan for the school, and implement it. Identify the students responsible for each task. Build commitment. Implementation should be done as a class. Everyone should be involved!
15:00	End

MISSION 2 - POLICY SESSION

STUDENT BRIEFING

Work through the activity to produce details of how you're planning to implement your policy options, putting the top priority items first.

ACTIVITY

Look at the results from your reports. Decide which policies are priorities and why, and how these can be implemented.

Priority	Policy	Reason	Mechanism to implement
	Provide and use products without ODS.		
	National Ozone Units to strengthen cooperation between countries.		
	Buy local and seasonal products wherever possible.		
	Products containing ODS specially labelled so we know which are harmful, such as fridges or air conditioners.		
	Technology transfer of (machinery, equipment etc).		
	Transfer information (technical and commercial).		
	Public awareness programmes.		
	It's better to take your old equipment for recy-cling so that CFCs can be removed properly and are not released in the atmosphere.		
	Taxes or fees on ODS.		
	Finance local projects, such as the adaptation of a new technology.		

MISSION 3 - WHOSE ACTIONS?

STUDENT BRIEFING

Work through the activity to produce a list of what can be done by different groups of people.

ACTIVITY

Look at the mechanisms you have come up with and decide how the different groups can answer these questions:

What can governments do?

What can industries do?

What can schools do?

What can communities do

MISSION 4 - PLANNING EXERCISE

STUDENT BRIEFING

Work through the activity to produce your action plan.

ACTIVITY

1. Choose an action for your school or group.

The action:

2. How it will be done? Define the tasks

1.

2.

3.

4.

3. When will these things be done? Put them in order

1.

2.

3.

4.

MISSION 5 - ORGANISE AND IMPLEMENT YOUR ACTION PLAN!

STUDENT BRIEFING

Work through the activity to produce your action plan, after your debate day.

ACTIVITY

The planning phase contains three major aspects: defining objectives, research and fact-finding to know more about your own local situation concerning ozone layer depletion and sun protection and defining the accurate actions that can be taken at school.

Step 1: What is your objective?
Look at the information and activities from the previous sections. Decide what you need to tell people about ozone protection and sun-safe behaviours. This is your objective.

Step 2: Research and fact-finding
It is always useful to find out what people already know to inform them in the best possible way. Review the results of people research. The objective is that people understand what you mean and see clearly how they can be involved. Finding out more about local situations will help develop the most efficient Ozone and Health Action Plan according to what the people need to be informed about.

- What do people think and do?
  - Find out what other people think and do. What do people already know about ozone protection and sun protection?
  - You can do a survey among friends, school members, and families.
  - Students could develop their own questions that are relevant to the population's living conditions and habits (climate, life-styles, etc.)
  - What are the results of your survey?

- What's the situation at a collective level?
  - Carry out research among local authorities, local companies and/or non-governmental organisations to find out about these issues.
  - Speak to policy makers and find local ideas to solve the ozone issue and encourage sun protection.

Step 3: Make an action plan
The action plan should be a list of practical actions to be taken for the ozone layer protection and for sensitisation to sun-safe habits and behaviours. Bring together and put the actions from the conference in a sensible order. A simple way is write each action on a card or piece of paper, then move them around to work out what order you need for each task.

Enter your action plan for an award
Your action plan can now be placed on the Ozzy Ozone website for review and comment by UNEP and then forwarded to the National Ozone Units. You will also be automatically entered in the annual Volvo Adventure environmental award programme and you could have the chance to win an all-expenses paid trip to Sweden to present your project, and potentially win prizes to help to implement your ideas.

When you've completed your action plan, go to www.volvoadventure.org to register your group's project and upload it to the web site. Check the web site for the competition deadline.

ANNEX 1: OTHER ACTIONS

UNEP

Your school can also participate in other UNEP Tunza activities for children and youth such as: the annual Children's Painting Competition, the "Plant for the Planet" Campaign and the International Conference for Children on the Environment, GEO for Youth Africa or GEO for Youth for Latin America and the Caribbean. Details of these activities are given here. For more details and more information, you can visit: www.unep.org/Tunza or e-mail: children.youth@unep.org

THE INTERNATIONAL CHILDREN'S PAINTING COMPETITION

The International Children's Painting Competition on the Environment is held annually for children between the ages of 6 and 14 years. It is organized by the United Nations Environment Programme (UNEP), Japan-based Foundation for Global Peace and Environment (FGPE), Bayer AG and Nikon Corporation. Each Competition focuses on the theme selected for the following World Environment Day (5 June). The main winners are invited to the city where the celebrations of World Environment Day are held. The Competition has been held since 1990 and has received over 160,000 entries from children in over 100 countries. Its goal is to increase environmental awareness and actions among children, and to inspire them to participate in community environmental activities. Winning paintings have been used for posters including those of World Environment Day, calendars, postcards for worldwide distribution and publications as well as on the UNEP website.

PLANT FOR THE PLANET CAMPAIGN

The Plant for the Planet Campaign was launched by UNEP in February of 2003. The five-year Campaign aims to promote reforestation and inspire communities to embark on major forestation projects in their communities. The Campaign also seeks to develop a culture of planting and caring for trees, among children and in schools. Plant for the Planet mainly targets schools and children of 14 years and below and solicits the participation of other members of the community and the private sector to become involved in tree planting. The Campaign was initiated in Kenya, which continues to organize major tree planting events every year. The Campaign aims to plant over five million trees globally by 2008. For more details, see the web site www.unep.org/billiontreecampaign.

TUNZA INTERNATIONAL CHILDREN'S CONFERENCE

The Tunza International Children's Conference is the largest United Nations event for children, enabling them to discuss and learn about their rights and responsibilities regarding the environment as well as meet children from other parts of the world. The Conference targets children between the ages of 10 and 14 who are nominated by their schools and/or community organizations. The Conference provides a unique opportunity for children to present their environmental projects, inspire each other with their active environmental work, and become active environmental citizens and to contribute towards the future of the planet. Each Conference culminates in an environmental petition to world leaders and the United Nations and personal commitments which the children will pursue when they return home.

The International Children's Conference is held every two years; the first was held in 1995 in Eastbourne, England. Other conferences have been held in Canada, Kenya, USA, Japan and Malaysia. A Tunza Junior Board works with UNEP and the local organizing committee to ensure that the Conference reflects the needs of the children. The Board, elected every two years, consists of six representatives from UNEP regions: North America, Europe, Latin America and the Caribbean, Africa, West Asia, and Asia and the Pacific; and four members from the country hosting the Conference. For more details, see the web site www.unep.org/tunza.

GEO FOR YOUTH AFRICA

The GEO for Youth Africa project was initiated by the Regional Office for Africa of UNEP with the aim of increasing awareness of the findings of African Environment Outlook Report among African youth and to involve them in the publication of the AEO-for-Youth, creating a product that is by youth for youth. Now days this is the most important youth network regarding youth and environment in Africa devoted to create a positive change by providing a forum for discussing environmental issues and exchanging ideas, and promoting effective networking amongst youth. For more details, see the web site www.unep.org/DEWA/africa/youth/index.htm.

GEO FOR YOUTH FOR LATIN AMERICA AND THE CARIBBEAN

The GEO for Youth in Latin America and the Caribbean project is nowadays the most mportant project regarding youth and the environment in the LAC region. It started in 1999 by the Regional Office for Latin America and the Caribbean of UNEP as an awareness raising project that enabled youth to create their own version of the GEO reports, exchange ideas and discuss their concerns regarding the state of the environment and emerging issues. The network has partners in different countries of the region developing environmental assessment reports and sustainable development projects. For more details, see the web site www.pnuma.org/geojuvenil.

YOUTHXCHANGE.NET

YouthXchange, a joint UNEP/UNESCO initiative, is a tool that aims to promote sustainable consumption patterns among young consumers worldwide. The toolkit provides statistics, case studies, games, examples of real companies adopting more sustainable practices, and direction on how explain sustainable lifestyles to a young audience. The topics are tackled under youth-oriented headings: clothing, leisure, travels, underground culture, experiences of other young people etc.

The fundamental message that the youthXchange training kit delivers is: there is a trend worldwide that tries to make the world more sustainable also through consumer actions, change is possible through day to day actions and networks among people that are engaged locally and globally.
This group is composed of young people - in both developed and developing countries – that have access to education, media, and the Internet; they are likely to shape attitudes, values and behaviour and the habits they develop now will influence the future consumption patterns. They are the future decision makers. For more details, see the web site www.youthxchange.net.

ANNEX 2: PARTNER ORGANISATIONS

UNICEF

UNICEF works in over 150 countries and territories to help children survive and thrive, from early childhood through adolescence. The world's largest provider of vaccines for developing countries, UNICEF supports child health and nutrition, good water and sanitation, quality basic education for all boys and girls, and the protection of children from violence, exploitation, and AIDS. UNICEF is funded entirely by the voluntary contributions of individuals, businesses, foundations and governments.

The "Environmental Education Resource Pack for Child-Friendly Schools and Learning Spaces" promotes an intersectoral "One UN" approach, integrating resource developments from the family of UN agencies and partners, coordinated by UNICEF as Chair of the UN Interagency Committee on the Decade of Education for Sustainable Development. The resource pack provides guidance and support to policy-makers, teachers, youth facilitators and students by integrating facilities based solutions with child-centred skills-based curriculum and participatory tools to support empowerment and community-based action. Website: www.unicef.org

UNESCO

UNESCO (United Nations Educational, Scientific and Cultural Organization) was created in 1945 to contribute to peace and security by encouraging collaboration between countries through education, science, culture and communication. Web site: www.unesco.org.

About the UN Decade of Education for Sustainable Development

The United Nations Decade of Education for Sustainable Development (DESD, 2005-2014) aims to integrate the values inherent in sustainable development into all aspects of learning to encourage changes in behaviour which will enable a more viable and fairer society for everyone. During this decade, education for sustainable development will contribute to preparing citizens better prepared to face the challenges of the present and the future, and decision-makers who will act responsibly to create a viable world. Thus, five types of fundamental learning will be enhanced: learning to know, learning to do, learning to be, learning to live together, and learning to transform oneself and society.

About UNESCO Associated Schools

UNESCO — the United Nations Educational, Scientific and Cultural Organization — was founded in 1945 with a mandate to contribute to peace through international cooperation within its fields of competence. The UNESCO Associated Schools Project was launched as an educational pilot project based on pedagogical innovation and international cooperation. Today it is one of the largest truly international school networks in the world working under the auspices of the United Nations towards international understanding.

Created in 1953, the UNESCO Associated Schools Project Network (ASPnet) is a worldwide network which in 2008 covers 177 countries and more than 8000 schools and colleges ranging from pre-school to secondary and teacher training institutions. ASPnet's aims are to promote UNESCO's ideal of peace and contribute to improving the quality of education.

WORLD HEALTH ORGANISATION (WHO)

The WHO was established in 1948 as the United Nations specialized agency for health. WHO's goal is the attainment by all peoples of the highest possible level of health, defined as a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity.

WHO INTERSUN

The 1992 United Nations Conference on Environment and Development (UNCED) concluded that under Agenda 21 that there should be activities on the effects of UV radiation. In response, WHO in collaboration with other UN agencies and international partners set up INTERSUN, the Global UV project. INTERSUN aims at providing scientifically sound information on the health impact and environmental effects of UV exposure and at providing guidance about effective sun awareness programmes. The project encourages countries to take action to reduce UV-induced health risks.

ANNEX 3: SUPPLEMENTARY ACTIVITIES

1: FINDING OUT ABOUT OTHER PEOPLE'S OPINIONS

Learning objectives	Activities	Tips
Ask questions. Suggest appropriate sequences of investigation. Collect, record and present evidence. Analyse and evaluate evidence and draw and justify conclusions. Consider an issue from different points of view. Identify how and why patterns change with time.	Introduce the topic with a brainstorming session and activities to determine why ozone issues are important, and examine perceptions or knowledge of them. Ask students (in groups) what sorts of questions would need to be asked to find out about other people's understanding of the issues. Discuss whether these are perceptions (e.g. from interviews) or facts. Groups pool ideas and discuss the best selection of questions or surveys to obtain the information they seek. Ask students to identify the groups (parents/grand-parents) they will need to interview, recording their results on a database or wall chart. In groups, they can ask questions about the data to evaluate the extent to which the questionnaire worked and to identify any need for improvement. Help students to compile a class summary and identify the main changes or perceptions of the environment.	Collect record and evaluate data about people's perceptions of environmental issues. Analyse their findings and suggest reasons for changes in perceptions. Explain how changes can benefit some people/groups more than others locally/ within the region. Developing a questionnaire could be a whole-class activity. Agree the questions to include, e.g. what, where, how often, cost, mode of transport.

2: SURVEYING THE CURRENT ENVIRONMENTAL STATUS

Learning objectives	Activities	Tips
To map environmental factors. To undertake a series of surveys to describe a current situation in a school or community. To use fieldwork techniques.	Use support activities to undertake surveys to identify the current situation; this can include secondary sources of information, maps and representation of survey results. Discuss what factors associated with the topic are appropriate for mapping – for example the location of waste disposal sites, litter bins, habitats, transport routes. Discuss and identify what is being surveyed and why – be clear about the objectives and discuss limitations of the methods proposed by students.	The teacher will need to have some resources to facilitate activity and surveys, e.g. bus/train timetables, local newspapers.

3: DEVELOPING ACTION PLANS FOR SUSTAINABLE DEVELOPMENT

Learning objectives	Activities	Tips
To explore the concept of environmental or sustainable development. To examine how the environment may change in the future, and the effects of such changes. To explore the ideas of environmental change in a community for a specific environmental theme or topic	Discuss with students whether things are getting better or worse. Consider with them the concept of change/progress as development. In groups, using school computers or individually at home using personal computers, students can research one particular action plan, finding out what effect it might have.	Describe how 'development' may favour some people more than others. All off-site visits must be carried out in accordance with school guidelines.

GLOSSARY

Atmosphere – The Earth's atmosphere is the gaseous layer that surrounds the planet Earth. It contains about 4/5 nitrogen and 1/5 oxygen, with a few other gases including ozone. The atmosphere protects life on Earth and it moderates the temperature between day and night.

Atom – An atom is the smallest quantity of an element. Everything around us is made up of atoms. Atoms join together to make molecules, and the molecules join together to make compounds in specific ways to make everything we can see (materials, objects, living beings).

Carbon dioxide (CO_2) – Carbon dioxide is a colourless gas that contains one carbon atom and two oxygen atoms bound together (therefore it is written CO_2) It is present in the atmosphere and plants take it from the air for their own growth. We also release carbon dioxide while breathing out.

Cataract – A cataract is a disease of the eye and, according to the World Health Organization, is the leading cause of blindness in the World. Between 12 and 15 million people become blind from eye cataracts. A cataract causes a partial or total opacity of the lens of the eye. The lens is the transparent part of the eye that regulates the amount of light we need to see clearly. Exposure to UV radiation increases the risk of eye cataracts.

Chlorofluorocarbons (CFC) – Chlorofluorocarbons are chemicals that contain carbon, chlorine and fluorine. The abbreviation for chlorofluorocarbons is CFCs. CFCs are used inside freezers, refrigerators, spray cans and air conditioners. When released into the atmosphere, these chemicals cause ozone layer depletion.

Climate change / global warming – The climate of the Earth is not static, and has changed many times in response to a variety of natural causes. Scientists believe that human activity is the primary driver of recently observed changes in global climate patterns.

Climatologist – A person who studies long-term trends in the climate.

Chlorine monoxide (ClO) – Chlorine monoxide contains one chlorine atom and one oxygen atom.

Compost – Decomposed organic material or new soil, that can be used for plants.

Dobson Unit (DU)	A measure used in ozone research. 1 Dobson Unit (DU) is defined to be 0.01 mm thickness of ozone at 0 degrees centigrade and 1 atmosphere pressure at the surface of the Earth. So if 100 DU of ozone were brought to the Earth's surface, it would form a layer 1 mm thick. The unit is named after G.M.B. Dobson, one of the first scientists to investigate atmospheric ozone.
Energy saving light bulb or compact fluorescent lamp (CFL)	A type of fluorescent lamp. Compared to incandescent lamps, CFLs use less energy and have a longer rated life. The purchase price is higher than that of an incandescent lamp, but the money is gained back in energy savings and replacement costs over the bulb's lifetime. CFLs contain a toxic product called mercury, which means that the lamp has to be recycled after its use.
Environmental Investigation Agency (EIA)	An international campaigning organisation committed to investigating and exposing environmental crime. See www.eia-international.org/
Foam blowing agents	Chemicals (typically ODS), which are used as propellants with liquid plastic resin in the manufacture of foams. These foams are used in a variety of applications including insulation in refrigerators, buildings, automobiles, in furniture and packaging etc. In the case of insulation materials the blowing agent also functions as an insulating component of the foam.
Global warming	The observed increase in the average temperature of the Earth's near-surface air and oceans.
Greenhouse effect	The greenhouse effect is a natural phenomenon. The Earth's atmosphere acts a little like the glass of a greenhouse, allowing the heat of the Sun to enter and heat surfaces on the planet. These surfaces emit long wave radiation that is trapped near the surface of the planet by greenhouse gases. The greater their quantity, the more the atmosphere and surface heat up.
Greenhouse gases (GHGs)	Gases that warm the Earth by trapping heat in the atmosphere, which leads to global warming. Some greenhouse gases can occur naturally in the atmosphere, while others result from human activities. Greenhouse gases include carbon dioxide, methane, CFCs and others.
Halon	Halons are chemicals that contain bromide, fluorine and carbon. Halons are used for fire extinguishers. As CFCs, halons are responsible for the depletion of the ozone layer. When released into the atmosphere, they become dangerous to ozone molecules.

Hydrochlorofluorocarbon (HCFC)	A molecule containing hydrogen, chlorine, fluorine and carbon atoms. HCFCs are used to replace CFCs because they are not as dangerous to the ozone layer. HCFC is a greenhouse gas.
Infrared Radiation	Infrared radiation (IR) or infrared, refers to energy in the region of the electromagnetic radiation spectrum at wavelengths longer than those of visible light, but shorter than those of radio waves. Far infrared waves are thermal: the heat we feel from sunlight, a fire, a radiator or a warm road is infrared. Near infrared waves are not thermal: these shorter wavelengths are used, for example, by remote controls for electrical equipment.
Intergovernmental Panel on Climate Change (IPCC)	A scientific intergovernmental body set up by WMO and UNEP to provide the decision-makers and others interested in climate change with an objective source of information about climate change.
Kyoto Protocol	The international United Nations (UN) treaty that is helping to fight against global warming and climate change. The Kyoto Protocol, among other things, sets binding targets for the reduction of greenhouse-gas emissions by industrialized countries.
Melanin	Melanin is a black, dark-brown or reddish pigment present in the hair, skin and eyes. When exposed to the sun, our skin naturally produces melanin to protect itself from UV radiation. Everybody's skin contains melanin, but not the same amount: dark skin contains more melanin than light skin. However, melanin does not protect efficiently against UV rays and everybody, regardless of skin types, needs additional protection.
Methyl bromide (CH_3Br)	Methyl bromide is a gas and a widely used chemical pesticide in agricultural production. It is mainly used to kill parasites and insects. This gas is destroying the ozone layer 50 times faster than CFCs and is also very toxic to humans and animals.
Molecule	Invisible to the eyes, molecules are the simplest units of any substance that can exist. A molecule consists of two or more atoms bound together. Everything is made of molecules.

Montreal Protocol

The Montreal Protocol on Substances That Deplete the Ozone Layer is an international treaty designed to protect the ozone layer. The Protocol has been ratified by 191 countries. In so doing, these countries that have agreed to eliminate their production and use of ozone depleting substances according to the timetable set out in the Protocol If all countries continue to meet their obligations under the Montreal Protocol, the ozone layer will recover to pre-1980 levels by around the middle of the 21st century.

Nitrogen dioxide (NO_2)

Nitrogen dioxide contains a nitrogen atom and two oxygen atoms. It is a reddish-brown gas (in room temperature it is liquid) with a biting and irritating odour. NO_2 is one of the most prominent air pollutants and toxic by inhalation. NO_2 also plays a major role in atmospheric reactions that produce ground-level ozone, a major component of smog.

Nitrogen oxides (NO_x)

Nitrogen oxides refers to any binary compound of oxygen and nitrogen, or to a mixture of such compounds. All combustion in air produces NO_x. Natural sources of NO_x are small compared to emissions caused by human activity. In the cities with a lot of motor vehicles the NO_x are normally present in large quantities.

Nitrous oxide (N_2O)

Agriculture (cultivating soil, the use of nitrogen fertilizers and animal waste handling) is the main source of human-produced nitrous oxide. Unlike other nitrogen oxides, nitrous oxide is a major greenhouse gas. It is also an ODS.

Oxygen

Oxygen is a colourless and odourless gas found in the air. Oxygen is the gas we breathe and it is essential to all forms of life on Earth.

Ozone molecule (O_3)

An ozone molecule has three oxygen atoms. Ozone is a pale-blue gas with a sharp, irritating odour and it is toxic in the lower atmosphere. In the upper atmosphere it is vital for all the life on Earth as it blocks the sun's ultraviolet rays. The majority of ozone is in the stratosphere where it plays a crucial role in preventing harmful ultraviolet rays from reaching the Earth.

Ozone depleting substances (ODS)

Ozone depleting substances (ODS) are chemicals responsible for ozone layer depletion: these ozone depleting substances are mainly chlorofluorocarbons (CFCs), halons and methyl bromide.

Ozone layer

The ozone layer is a thin invisible shield made of ozone gas. It protects us from the dangerous UV rays of the sun. The ozone layer stands in the stratosphere (upper atmosphere), at an altitude of 15 to 50 kilometres (10 to 30 miles) above the Earth.

Ozone layer depletion

A number of human activities release in the air some chemicals (ODS) that destroy ozone molecules in the upper atmosphere; while ozone molecules are destroyed in the upper atmosphere, the ozone layer gets thinner and thinner. This is ozone layer depletion. The consequence for us is an increased amount of damaging UV rays reaching the surface of the Earth.

Pesticide

Chemical products that eliminate or reduce the number of harmful pests.

Pests

Insects that damage stored foods, and some soil-dwelling organisms that damage crop roots.

Phase out

Phase out of the ODS means their gradual elimination.

Photochemical reaction

Any chemical reaction caused by absorption of light including visible, ultraviolet and infrared light. Photosynthesis is a common example of a photochemical reaction.

Photosynthesis

Photosynthesis is the chemical process by which plants use the energy from sunlight to turn carbon dioxide (from the air) and hydrogen (from water) into their own nutrients.

Refrigerant or coolant

Refrigerants like CFCs and HCFCs are used to cool air. They are mainly used in refrigerators and air-conditioners.

Renewable energy

Natural resources such as sunlight, wind, rain, wood, tides and geothermal heat are naturally replenished and can be transformed into energy. Solar power, wind power and biomass (wood burning) are probably the most common renewable energies used worldwide. Burning wood contributes to global warming because it releases CO_2 into the atmosphere, therefore it is not the most recommended form of renewable energy.

Skin cancer

Skin cancer is a very serious skin disease that must be treated at an early stage. It starts when the skin cells, confused, behave abnormally and begin growing and multiplying. Overexposure to the sun increases the risk of skin cancer. Skin cancer must be prevented by avoiding sun exposure.

Solvent

A liquid that dissolves a solid, liquid, or gaseous solute resulting in a solution. The most common solvent is water. CFC has been used as cleaning solvent in a liquid form.

Stratosphere

The upper layer of the atmosphere, situated from 15 km to about 50 km (10 to 30 miles) above the Earth.

Sun burn	Sunburn is an inflammation of the skin caused by overexposure to the sun.
Sun tan	Suntan is a brownish colouring of the skin caused by the production of melanin within the skin on exposure to the sun.
Troposphere	The lower layer of the atmosphere. Practically all the human activities take place in the troposphere and all the water vapour is found there. Most of the clouds are in the troposphere layer.
Ultraviolet (UV)	Ultraviolet radiation is a harmful component of sunlight that we cannot see or feel. Ultraviolet radiation is dangerous for us because it damages our health by penetrating deep into our skin and eyes, and by weakening our immune system. There are three categories of UV rays: UV-A, UV-B and UV-C. UV-B are the most dangerous.
UV Index (UVI)	The UV Index is a tool to describe the level of solar UV radiation at the Earth's surface. It is aimed at alerting people about the need to adopt protective measures against the sun. The UV Index uses a range of values from zero upward. The higher the value, the greater the amount of dangerous UV rays and the potential for damage to our health.
Vitamin D	Vitamin D is an essential substance that helps our body use calcium, needed for bones and teeth to be strong.
Volatile organic compounds	Any organic (i.e. carbon-containing) compound that evaporates readily to the atmosphere at room temperature.

www.unep.org
United Nations Environment Programme
P.O. Box 30552 Nairobi, Kenya
Tel.: ++254-(0)20-62 1234
Fax: ++254-(0)20-62 3927
E-mail: cpiinfo@unep.org

UNEP
United Nations Environment Programme

DTI/1061/PA