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# **OZONE DEPLETION**

## **Fact Sheet Series for Key Stages 2 & 3**

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Glossary

# 1. What is Ozone?

## Oxygen and Ozone

**Ozone** is a form of **oxygen**. The oxygen that we breathe is made up of 2 oxygen **atoms** ( $O_2$ ), but ozone is made of 3 oxygen atoms ( $O_3$ ).



Without ozone, life on Earth would never have evolved. All life began with single-celled organisms. These need an oxygen-free environment to develop. This type of environment existed on Earth over 3000 million years ago. As the early plant life multiplied and evolved they began to release tiny amounts of oxygen through **photosynthesis**.

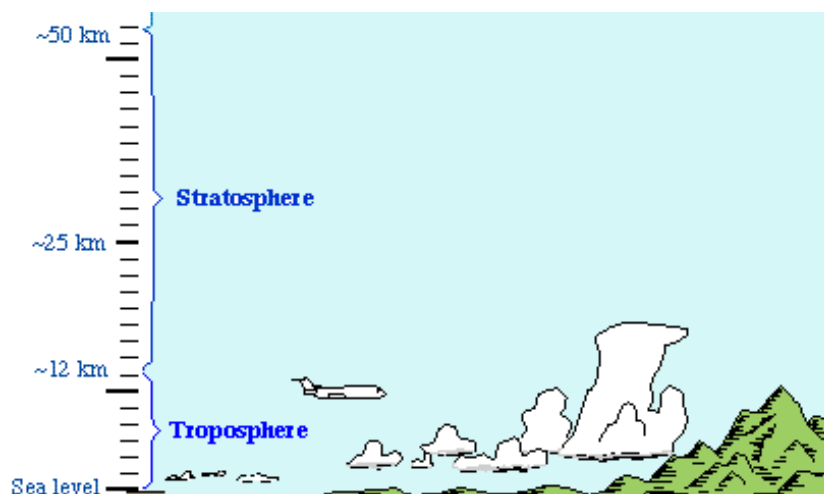
## The Ozone Layer

This natural build up of oxygen in the **atmosphere** gradually led to the formation of the **ozone layer**. This layer is found between 19 and 30 **kilometres** (km) above

the ground. The ozone layer filters out incoming **radiation** from the Sun that is harmful to life on Earth. The development of the ozone layer allowed more advanced life-forms to evolve.

## ***The Production of Ozone***

Most ozone is produced naturally in the **stratosphere**, a layer of atmosphere between 10 and 50km above the Earth's surface, but it can be found throughout the whole of the atmosphere.



Ozone occurs in very small amounts in the **troposphere** (or lower atmosphere), where it is produced at ground level by a reaction between **pollution** and sunlight. Ground level ozone is found in **photochemical smog** and is harmful to the environment.

## 2. What is Ultraviolet Radiation?

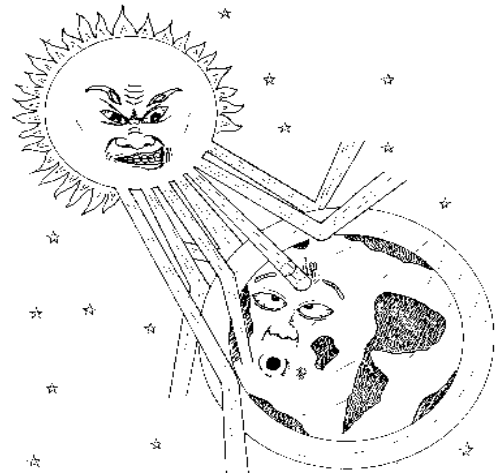
**Ultraviolet (UV) radiation** is a form of energy that comes from the Sun. UV radiation is split into 3 different categories:

UV-A (least energetic)

UV-B

UV-C (most energetic)

The more energetic radiation is more damaging if it reaches the Earth.



UV-A radiation is the least damaging and it reaches the Earth in large amounts. Most UV-A rays pass right through the ozone layer in the stratosphere.

UV-B radiation can be very harmful. Luckily, most UV-B radiation is filtered out by the ozone layer.

UV-C radiation is the most harmful, but fortunately it is all filtered out by ozone and oxygen in the stratosphere.

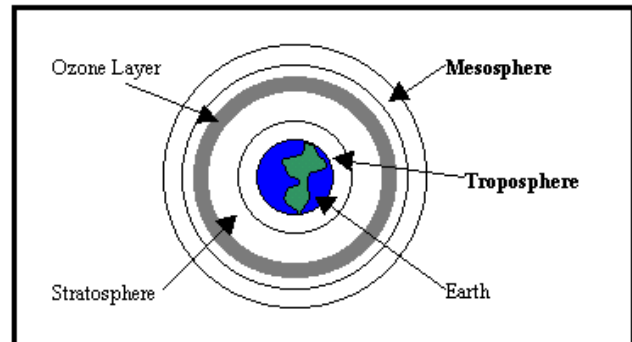
(upper atmosphere), and so never reaches the Earth's surface.

The ozone layer is very important and life on Earth would find it difficult to exist without it.

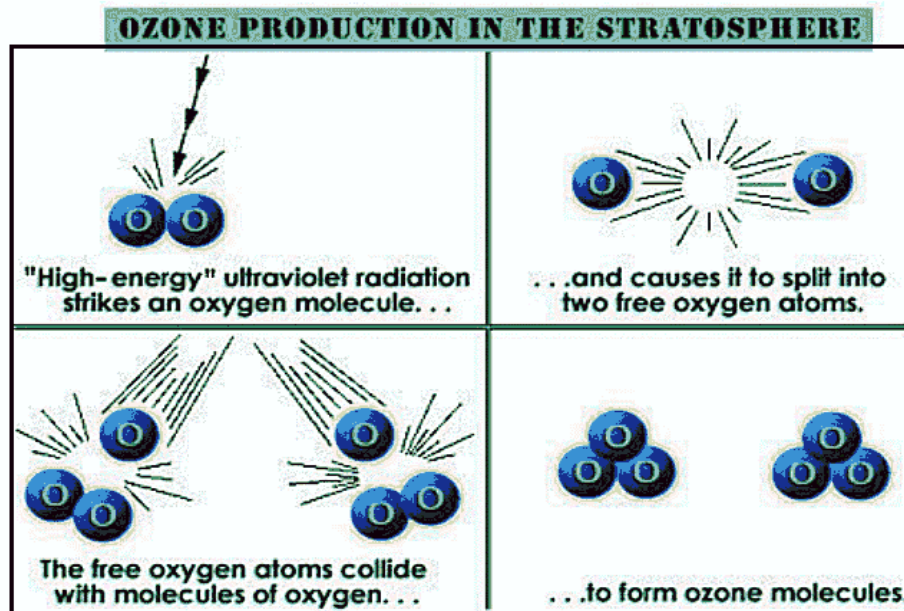
## 3. What is the Ozone Layer?

### Where is the Ozone Layer?

The ozone layer is found in the stratosphere, between 19 and 30 kilometres (km) above the ground. Stratospheric ozone is



made when energy from the Sun causes oxygen atoms to split apart.



Most of the ozone in the atmosphere is formed over the equator, where sunshine amounts are greatest. It is then transported by moving air towards the North and South Poles. Hence, highest amounts of ozone in the upper atmosphere usually occur at high *latitudes*.

### ***What Can Destroy the Ozone Layer?***

In the 1970s, scientists discovered that *chlorofluorocarbons* (CFCs) could destroy ozone in the stratosphere. CFCs had been used in refrigeration, coolants and aerosols since the 1930s, so this posed a major problem.

## 4. What are CFCs?

Chlorofluorocarbons, or CFCs, were developed in the 1930s. Man-made CFCs are the main cause of ozone depletion in the stratosphere. CFCs have a lifetime of about 20-100 years and can therefore continue to destroy ozone for a long period. One CFC *molecule* can result in the loss of 100,000 ozone molecules.

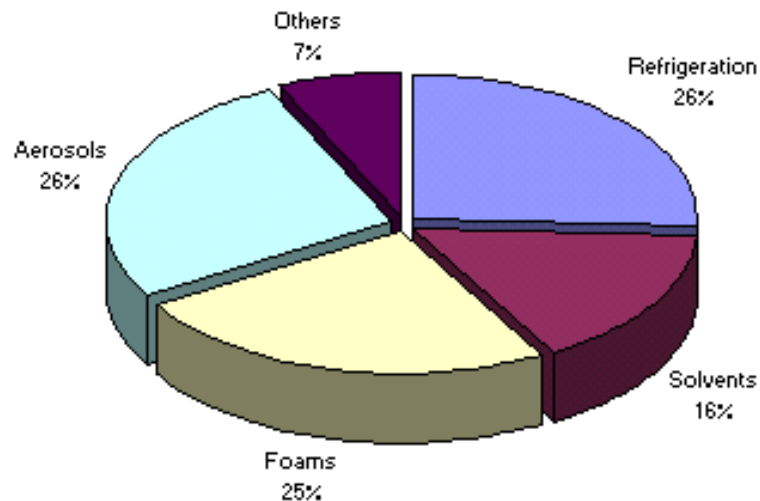
CFCs are made up of *carbon*, *chlorine* and *fluorine* atoms and there are a number of different types.

CFCs have been widely used as:

- solvents in cleaners;
- coolants in refrigeration and air conditioning;
- blowing agents in the production of foam (e.g. fire extinguisher);
- propellants in aerosols.



The pie chart below shows the uses of CFCs in various products before countries agreed in 1987 to ban them because of the dangers they posed to the ozone layer.



No new CFCs have been produced since 1995 in countries like the UK, America and Japan. Total usage of CFCs has also fallen dramatically, particularly by aerosols. The only aerosols using CFCs in these countries are asthma inhalers and these too are being phased out. Aerosols now use only 5% of all the most common CFCs still used in the world today.

Nevertheless, because man-made CFCs were used so widely before, they have accounted for roughly 80% of the total ozone depletion.

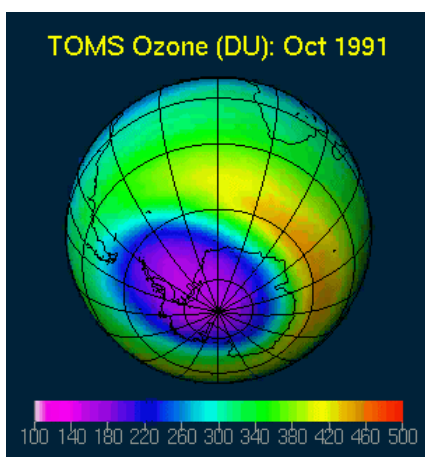
## 5. What is the Ozone Hole?

### *Where Does Ozone Depletion Occur?*

Ozone depletion occurs when there is more ozone being destroyed (by CFCs and other ozone-depleting chemicals) than there is being created.

Scientists believe that ozone levels were quite stable until the late 1970s. Ozone depletion over **Antarctica** has been occurring since 1979, and a general decrease in global ozone levels has been observed since the early 1980s.

### *The Ozone Hole over the Antarctic*



Every winter and spring since the late 1970s an ozone hole has formed in the stratosphere above the Antarctic continent. In recent years this hole has become larger and deeper as more ozone has been destroyed.

The depth of the hole is measured in **Dobson Units** (DU). The ozone depletion is described as a hole when levels of ozone fall below 200 DU.

The hole forms because the air above Antarctica is cut off from the rest of the world by a natural circulation of wind called the **Polar Vortex**. This prevents mixing in the atmosphere and so any ozone depletion is concentrated here.

### ***The Ozone Hole over the Arctic***

Although ozone depletion occurs over the **Arctic**, weather conditions are very different and appear to have prevented large ozone holes from forming so far.

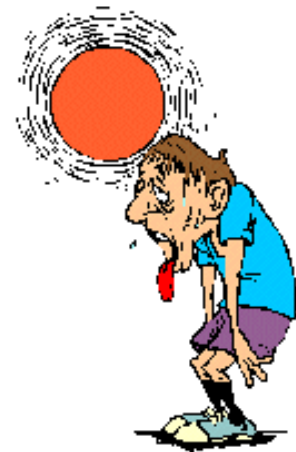
## ***6. The Effects of the Ozone Depletion on Human Health***

### ***Introduction***

The ozone layer acts as our planet's sunscreen, providing a filter to help protect all life forms from the Sun's damaging ultraviolet (UV) rays. Any significant decrease in the amount of ozone in the stratosphere would result in an increase in the amount of UV radiation reaching the Earth's surface. This in turn would lead to an increase in health problems for humans.

### ***Skin Cancer***

The most widely known effect of UV radiation is the reddening of the skin in sunshine, called sunburn. Exposure to strong sunlight over many years can lead to skin cancer. According to some estimates a 10% loss in global ozone levels may lead to a 26% increase in skin cancer among fair skinned people.



## *Eye Disorders*

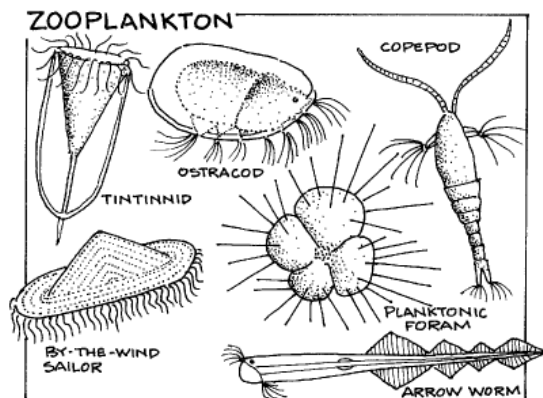
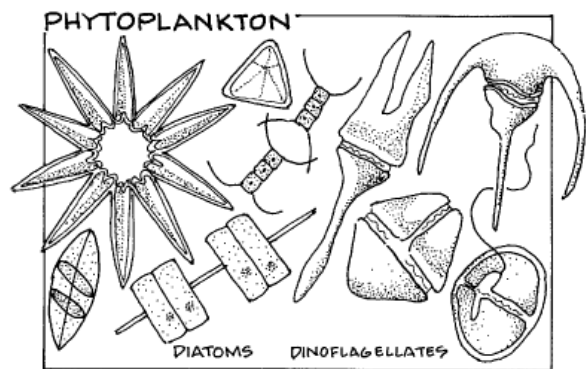


Ultraviolet radiation can also be damaging to our eyes, and hence an increase in the amount of UV radiation reaching the Earth would lead to an increase in eye disorders. Cataracts and blindness are the most common eye diseases associated with ozone loss. The eyes are much more sensitive than the skin, and a 1% decrease in ozone may result in 100,000 to 150,000 additional cases of blindness due to eye cataracts worldwide.

## 7. The Effects of Ozone Depletion on Plants & Animals

### Water Life

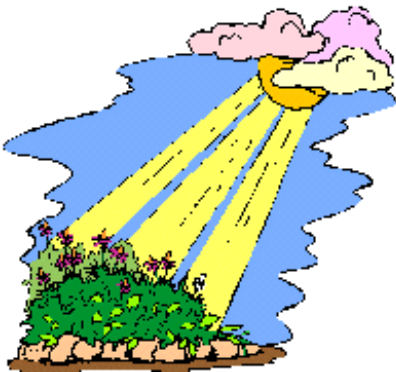
Ultraviolet (UV) light can travel through water. Too much UV light may kill **plankton**. Phytoplankton and zooplankton are the names of 2 organisms that are so small they can only be seen under a microscope. They are found in the sea and are very sensitive to ultraviolet (UV) radiation.



UV radiation is only absorbed by a few layers of cells, and so large animals are not as sensitive to UV rays. UV radiation, however, is extremely harmful to small animals and plants like plankton. Zooplankton and phytoplankton form the base of the food chain. These plankton are an

important source of food for many other creatures like fish and whales.

## ***Land Plants***



Large amounts of ultraviolet radiation are damaging to the growth processes of almost all green plants. There is concern that ozone depletion may lead to a loss of plant *species* and reduce the global food supply. Plants form the basis of the land food web, prevent soil erosion and water loss and are the producers of oxygen. Scientists have shown that over 100 species of plants may be sensitive to ozone depletion.

## ***8. Saving the Ozone Layer & Protecting Our Health***

### ***Introduction***

Agreements made between countries to stop the destruction of the ozone layer are very important. Protecting the ozone layer in the future, however, also requires the help of every individual. Everyone needs to work together to prevent products being used which destroy ozone. We can also protect our health from damage caused by increasing ultraviolet radiation.

### ***Protecting Our Health***

Sunglasses that protect your eyes from dangerous UV rays will help to reduce the risk of ***cataracts*** and other eye damage. Check the label when buying sunglasses.

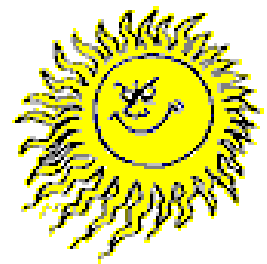




Hats with wide brims will protect your eyes and the skin on your head and neck from the Sun's rays that can lead to skin cancers.

Clothes provide protection against the risk of skin cancers.

Sunscreen with a high Sun protection factor (*SPF*) of at least 15 blocks out most harmful radiation.



Limit your time in the Sun and try to avoid it between 10am and 4pm when the rays are strongest.

Sunlamps/ sunbeds damage skin and unprotected eyes.

### ***Protecting the Ozone Layer***

We have all helped to thin the ozone layer as we didn't know for a long time that the chemicals in some of our household products were destroying the ozone layer. Now that we have this knowledge, we can be part of the solution to protect the Earth's fragile shield.



Due to the *Montreal Protocol*, most chemicals that destroy ozone have, or are being, phased out of use in most products. These include aerosols, refrigeration and air conditioning (e.g. in cars).

However, household products bought before the international agreements were made may still be in use, such as fridges. These are expensive to replace and so should be cared for properly, to make sure that the CFCs they contain are never released into the air. Remember, a single CFC molecule can destroy 100,000 ozone molecules.



In addition, try to avoid buying any equipment that contains chemicals that damage the environment in other ways. Alternatives to CFCs include HCFCs, which are greenhouse gases.

## ***9. What is the Government Doing?***

### ***Introduction***

In 1985 an agreement was made between many countries of the world to investigate and monitor chemicals that destroy ozone. This was called the Vienna Convention, and in the same year the hole in the ozone layer above the Antarctic was discovered.

Two years later, in 1987, an agreement was signed between 24 countries. This was called the Montreal Protocol on Substances that Deplete the Ozone Layer. The Protocol required all the countries that signed it to reduce their use of CFCs and other ozone-destroying substances.

### ***The Protocol***

The Montreal Protocol was the first international agreement where countries were legally required to reduce and eventually phase out ozone-destroying

chemicals. Stiff penalties were given to countries that didn't keep to the agreement.

In most cases it has been quite easy to develop and use other substances to replace CFCs. The use of CFCs in aerosols and foam has already been stopped in most countries.

However, the replacement of CFCs in fridges and other cooling equipment and insulating materials has not been so easy.

**Developing countries** were given 10 years to reduce their uses of CFCs, as they have less money to develop alternatives. China and India however, are still increasing their use of **air conditioning** and cooling equipment. It is much cheaper to use CFCs rather than the alternative chemicals that don't harm ozone.

A fund has been set up between the richer countries of the world to help these countries to use more environmentally-friendly technologies.

The destruction of the ozone layer is a world-wide problem, and is not confined to the area of the ozone layer above those countries that produce ozone-

depleting chemicals. It is necessary for all countries to co-operate with each other to overcome the problem.

### ***Can Ozone Destruction Be Reversed?***

The hole in the ozone layer can be repaired if the levels of all ozone-destroying chemicals are reduced. The natural balance of ozone creation and destruction would then be restored. The Montreal Protocol has gone a long way to achieving this. However, it is thought despite the reduction in the use of CFCs, the ozone hole will not fully repair itself until the middle of the 21<sup>st</sup> Century.

# Glossary

**Air Conditioning:**

A system that controls the temperature of the air.

**Antarctica:**

A large continent of the Earth centred over the South Pole.

**Arctic:**

The part of the world around the North Pole mostly made up of sea ice.

**Atmosphere:**

The layer of gases that surrounds the Earth.

**Atoms:**

The most basic units that make up any substance.

**Carbon:**

A non-metal element found in all living things.

**Cataracts:**

A disease where a growth forms over the eye, and has to be removed by an operation.

**Chlorine:**

An element that is poisonous in large amounts, and usually found as a greenish yellow gas.

**Chlorofluorocarbons:**

Also known as CFCs, this artificial chemical contains carbon, fluorine and chlorine.

**Developing Countries:**

Poor countries that are trying to develop their resources by becoming industrialised.

**Dobson Unit:**

A measurement of ozone amounts in the atmosphere.

**Fluorine:**

A gaseous element that can be poisonous.

**Kilometre:**

One thousand metres.

**Latitude:**

A geographical measure of how far north or south a place is from the equator.

**Molecule:**

Groups of atoms.

**Montreal Protocol:**

A legally binding agreement between countries to stop emissions of chemicals that destroy the ozone layer.

**Nanometre (nm):**

One thousand millionths of a metre.

**Oxygen:**

A gas that has no colour or smell. It is very abundant in the atmosphere and essential for life on Earth.

**Ozone:**

Ozone consists of three atoms of oxygen bonded together. In the stratosphere, ozone absorbs radiation and protects life on Earth.

**Ozone Layer:**

The region in the stratosphere containing the bulk of atmospheric ozone.

**Photochemical Smog:**

The hazy conditions that occur when pollutants react with sunlight at ground level.

**Photosynthesis:**

The process by which plants use carbon dioxide, light and water to grow.

**Plankton:**

Tiny microscopic creatures living in the sea. Some are animals - zooplankton, whilst others are plants - phytoplankton.

**Pollution:**

Harmful substances in the environment

**Radiation:**

Another word for energy, e.g. energy from the Sun.

**Species:**

A particular group of plant or animal that can only reproduce with others of the same kind.

**SPF:**

This stands for Sun Protection Factor, and indicates the amount of protection from the Sun that a sun cream offers.

**Stratosphere:**

The upper layers of the gases surrounding the Earth.

**Troposphere:**

The lower layers of the gases surrounding the Earth.

**Ultraviolet Radiation:**

A type of radiation produced by the Sun that is harmful to plants and animals.

**Wavelength:**

A method of measuring types and strengths of energy.