

## Ozone layer in the stratosphere

CFCs were first introduced as a refrigerator compressor liquid.

When they were introduced it was in order to replace existing liquids that were toxic, such as ammonia or sulfur dioxide, with something safer.

Unfortunately CFCs were found to cause a huge environmental problem.

CFCs are particularly stable and do not break down until they get to the stratosphere.

In the stratosphere CFCs absorb ultraviolet light that causes a photo-dissociation of carbon-chlorine bonds, example:



These radicals catalyse the breakdown of ozone to oxygen.

In recent years the ozone layer has been thinned significantly over Antarctica, and to a lesser extent over Northern Europe.

Each year that passes produces a thinner layer of ozone.

The ozone layer provides us with an important sunscreen that prevents the harmful ultraviolet light from damaging our skin and causing skin cancers.

The incidence of skin cancers has increased since the use of CFCs.

The first step in addressing this problem was for chemists to understand how CFCs catalyse the breakdown of ozone.

As the carbon-chlorine bond is very reactive, it photodissociates in UV light.

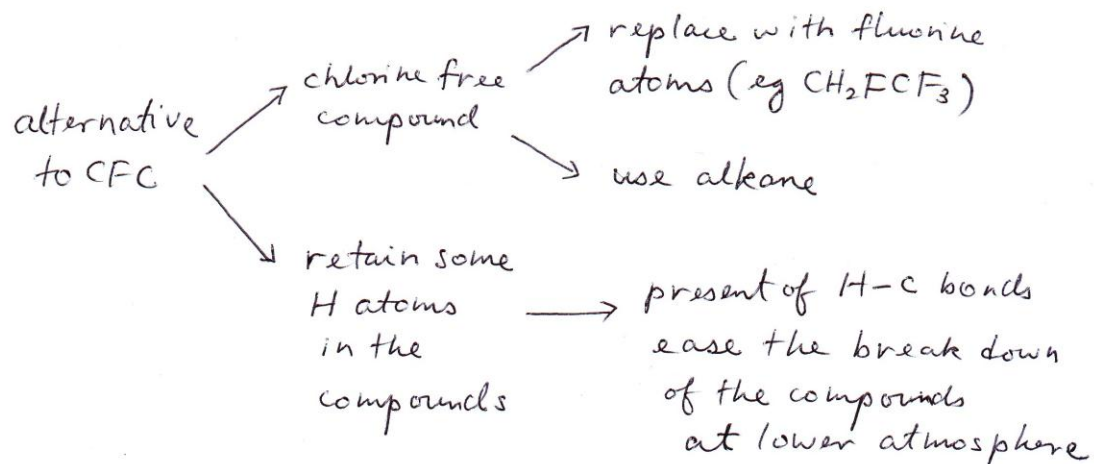
Chemists have now provided some alternatives to CFCs.

In general these are hydrofluorocarbons, for example  $\text{CH}_2\text{FCF}_3$ .

Alkanes may also be used.

The presence of the C-H bonds is important because this enables the compound to break down before it reaches the stratosphere.

And if it does reach the stratosphere, it can't produce the damaging chlorine free-radicals.



CFCs have a second adverse effect on the environment - they contribute to global warming. The new replacements for CFCs may be better in terms of the ozone layer but they are still greenhouse gases.

However, they are present in the atmosphere in much smaller quantities than other greenhouse gases such as carbon dioxide.

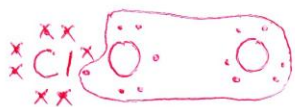
With the reduce of ~~the~~ CFCs usage and replacing with ozone friendlier compounds, there is some evidence that the hole has started to reduce in size.

### Exercise 1

'Cl• can also be generated by the reaction of the ClO• free radical with an oxygen atom formed when an O<sub>3</sub> molecule is broken down by absorbed UV light.'

Write an equation for this propagation step.

### Workings



## Exercise 2

In the stratosphere, the ultraviolet light from the sun breaks up CFC molecules and produces chlorine free radicals.

These chlorine free radicals then attack ozone molecules, in the propagation steps.



What is a termination step?

Write two termination steps for the sequence of propagation steps shown above.

### Workings

A termination step ends a series of propagation steps as two free radicals react to make a molecule.

Example of termination steps:

