

Maintaining Air Quality

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What You Will Learn

- ▶ What is air made of?
- ▶ What are air pollutants?
- ▶ What is ozone layer?
- ▶ What is carbon cycle?
- ▶ What are the global warming and climate change?

What Is Air Made Up Of?

- ▶ Air is a **mixture** of gases.
- ▶ Air's composition by volume is approximately **78% nitrogen** and **21% oxygen**. Water vapour, noble gases and carbon dioxide make up the approximately 1% that remains. Argon is the most common noble gas in clean air.
- ▶ These gases can be separated by **fractinal distillation** as they each have a unique boiling point.

What Are Air Pollutants?

- ▶ Air pollution is the introduction of *unwanted and harmful chemicals* into the atmosphere.
- ▶ Air pollution can come from natural causes, such as lightning strikes, wildfires and volcanic eruptions. It can also come from human activities, such as industrial emissions, combustion engine emissions and man-made fires.
- ▶ Common air pollutants are
 - ▶ Sulfur dioxide SO_2
 - ▶ Nitrogen oxides NO and NO_2
 - ▶ Carbon monoxide CO
 - ▶ Methane CH_4
 - ▶ Unburnt hydrocarbon C_xH_y
 - ▶ Ozone O_3

Some air pollutants and their harmful effects

Air pollutants	Sources	Harmful effects
Sulfur dioxide (SO ₂)	<ul style="list-style-type: none">• Combustion of fossil fuels• Volcanic eruptions• $S + O_2 \ggg SO_2$	Sulfur dioxide and nitrogen oxides react with oxygen in the air to form acidic oxides which dissolve in rain water, forming solution of strong acids. This is called acid rain which kills plants and aquatic life, also corrodes limestone building and metal objects. $SO_2 + O_2 + H_2O \ggg H_2SO_4$ $NO_2 + O_2 + H_2O \ggg HNO_3$
Nitrogen oxides (NO & NO ₂)	<ul style="list-style-type: none">• Vehicles combustion engines• Lightning• $N_2 + O_2 \ggg 2NO$• $2NO + O_2 \ggg 2NO_2$	
Carbon oxide (CO)	Incomplete combustion of carbon-based fuels	Carbon monoxide binds irreversibly with the haemoglobin in our red blood cells. This lowers the ability of the haemoglobin to transport oxygen to the rest of our body resulting in loss of consciousness and even death .
Methane (CH ₄)	<ul style="list-style-type: none">• Anaerobic bacterial decay of organic substances• Waste gases from cattle	A major greenhouse gas that leads to <i>global warming</i>

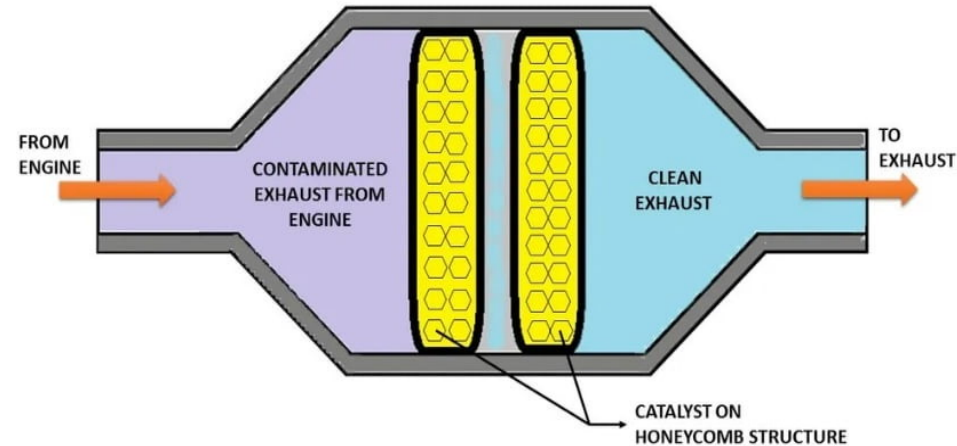
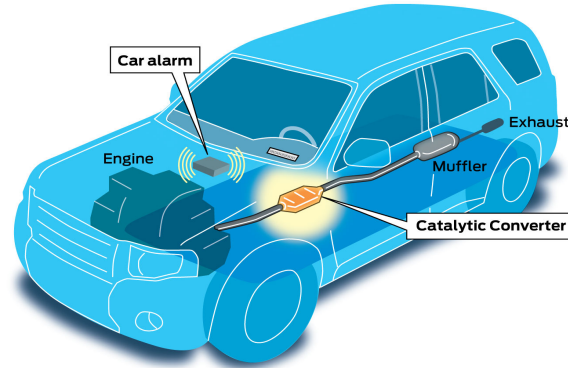
Some air pollutants and their harmful effects

Air pollutants	Sources	Harmful effects
Unburnt hydrocarbons (C_xH_y)	Vehicle combustion engines	<ul style="list-style-type: none">• Cause eye and respiratory tract irritation• Unburnt hydrocarbons react with nitrogen oxides in the presence of sunlight to form photochemical smog which appears as a brown haze.
Ozone (O_3)	<ul style="list-style-type: none">• Lightning• Reactions between oxygen molecules and sunlight in the upper atmosphere• Reactions between unburnt hydrocarbons and nitrogen oxides in the presence of sunlight in the lower atmosphere	<ul style="list-style-type: none">• Ozone can cause eye and respiratory tract irritation, leading to breathing difficulties.• When inhaled, it also causes chest pains and headaches.• Slow down photosynthesis in plants, which can damage crops.

Acid Rain

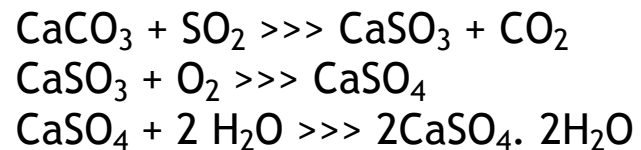
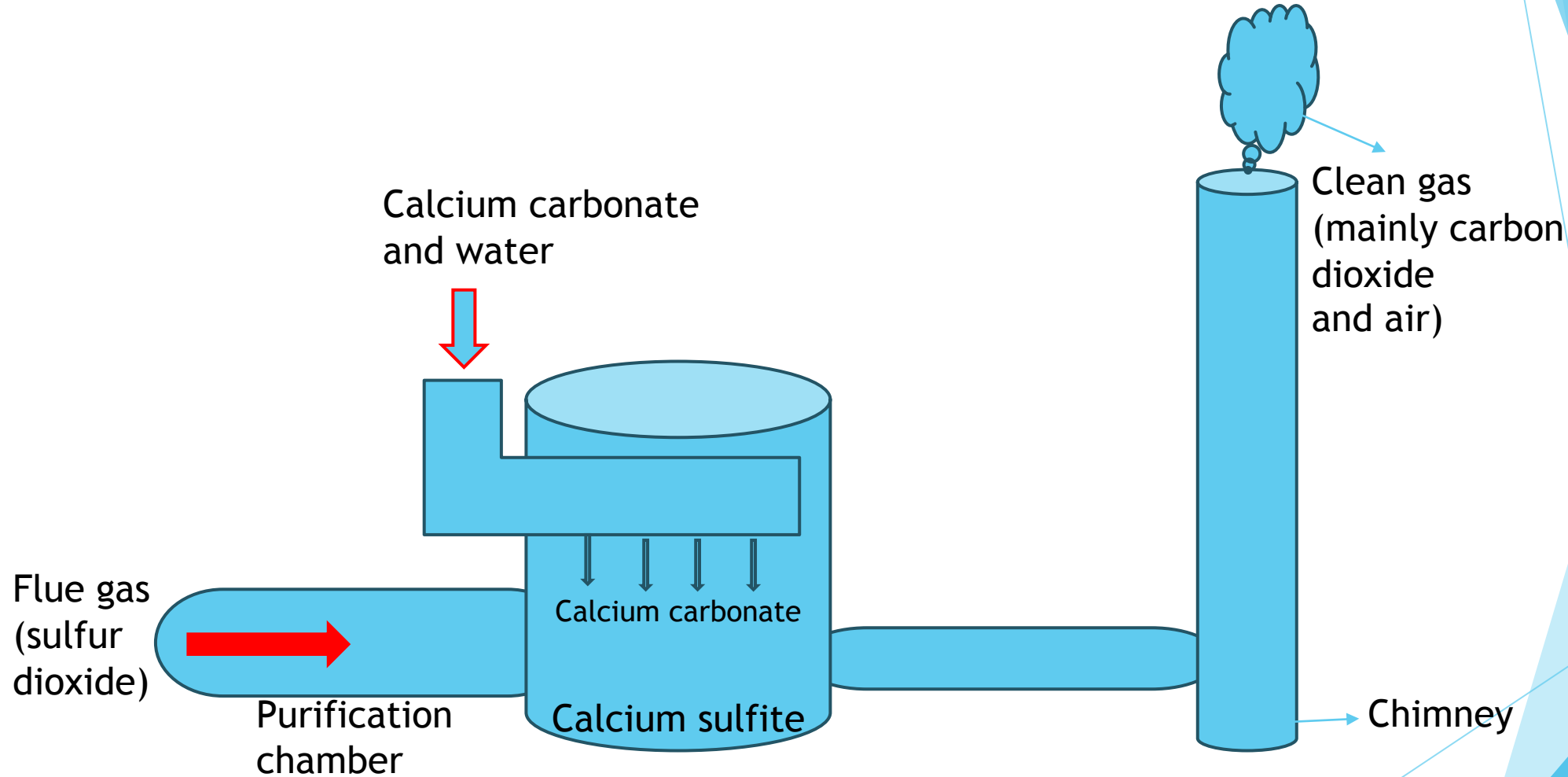
- ▶ Rainwater typically has a pH between 5.0 to 5.5 due to naturally occurring oxides dissolving in raindrops as they fall.
- ▶ However, when rain combines with excessive amounts of sulfur dioxide and nitrogen dioxide produced by human activity, it can have a pH of around 4.0.
- ▶ Frequent exposure to acid rain can have devastating effects on forests and water bodies, **killing plants and aquatic life.**
- ▶ Acid rain also **corrodes limestone buildings and metal objects.**

Control of Air Pollution---Catalytic Converters

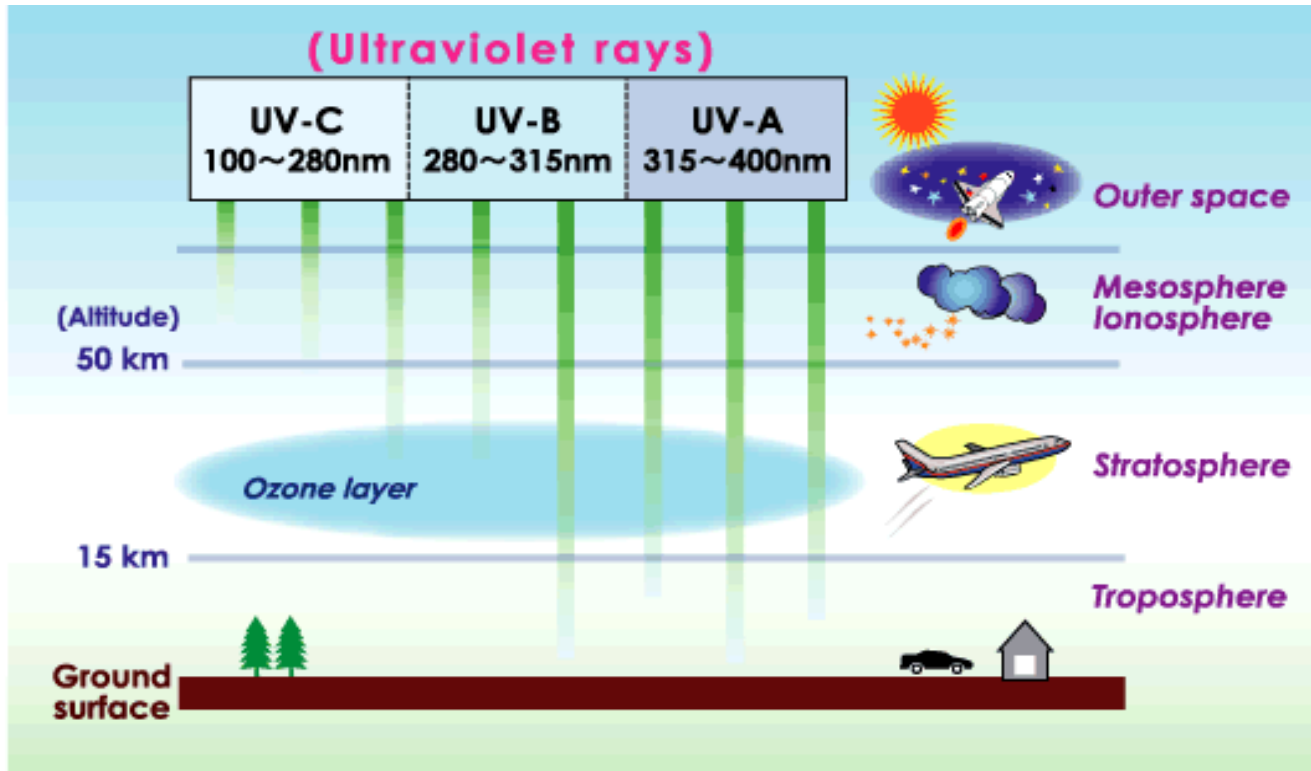


- Catalytic converters are located midway in the exhaust system of a vehicle
- It contains a coating a catalysts made up of platinum, palladium and rhodium that the speed up the *conversion of harmful substances in the vehicle exhaust into less harmful substances.*
 - $2\text{CO} + 2\text{NO} \ggg 2\text{CO}_2 + \text{N}_2$
 - $2\text{CO} + \text{O}_2 \ggg 2\text{CO}_2$
 - $2\text{NO}_2 \ggg \text{N}_2 + 2\text{O}_2$
 - $2\text{C}_8\text{H}_{18} + 25\text{O}_2 \ggg 16\text{CO}_2 + 18\text{H}_2\text{O}$

Control of Air Pollution---Flue Gas Desulfurisation

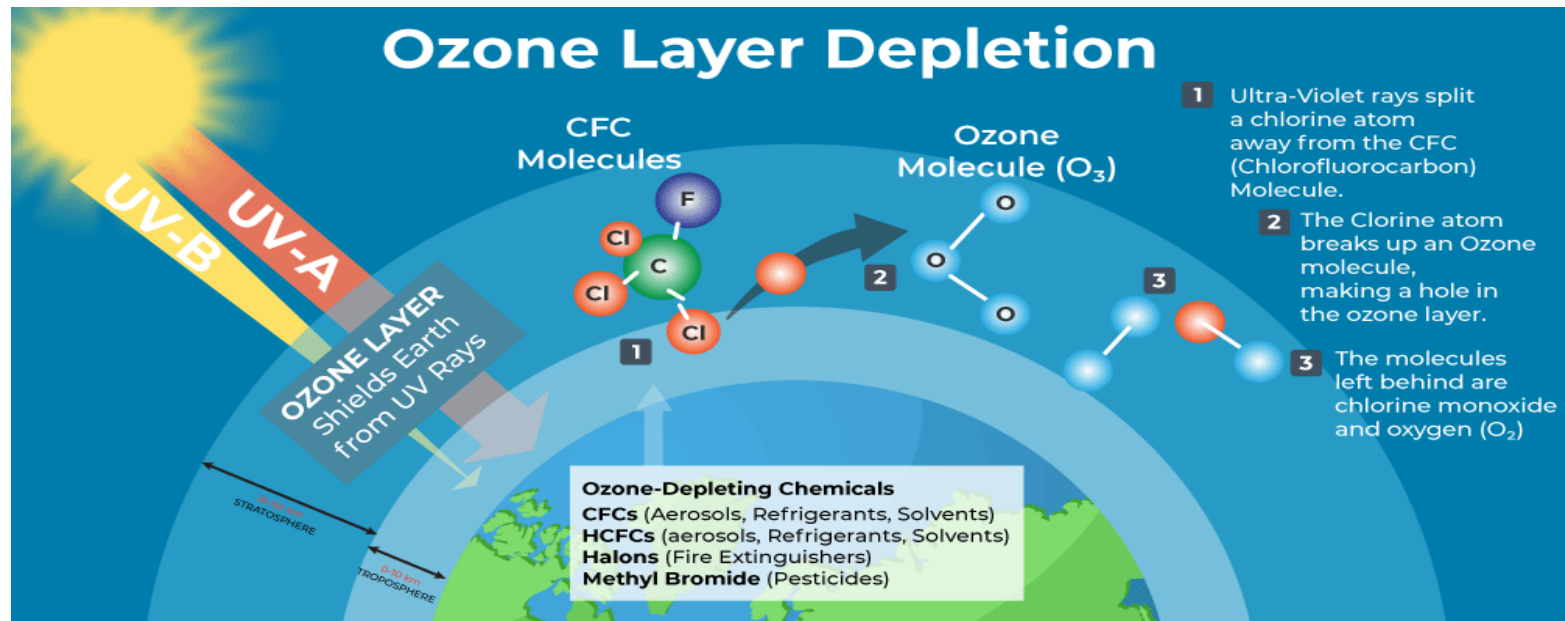


What Is the Ozone Layer?



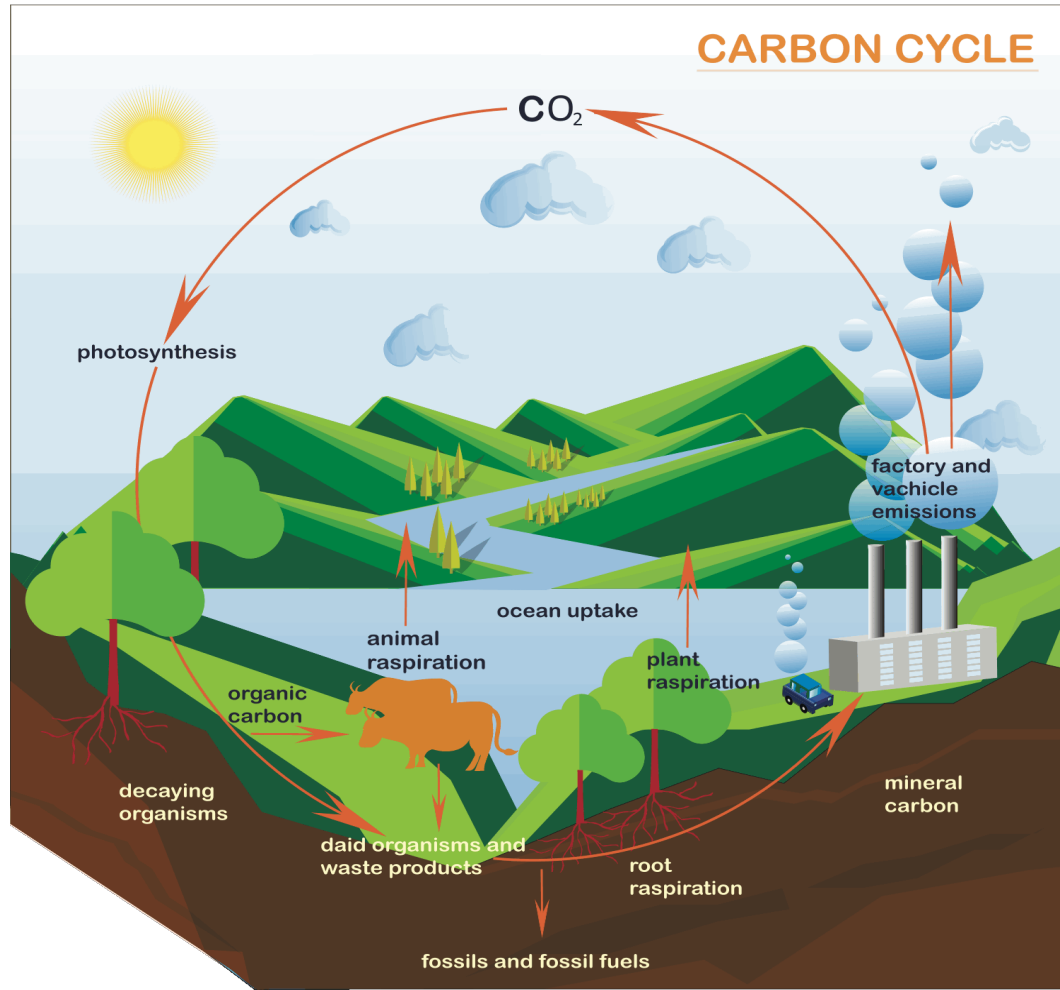
- The layer of ozone can absorb ultraviolet radiation, thus reducing the amount of UV radiation that reaches the earth's surface.
- Ozone molecules form when oxygen molecules interact with UV radiation from the sun.

Depletion of the Ozone Layer



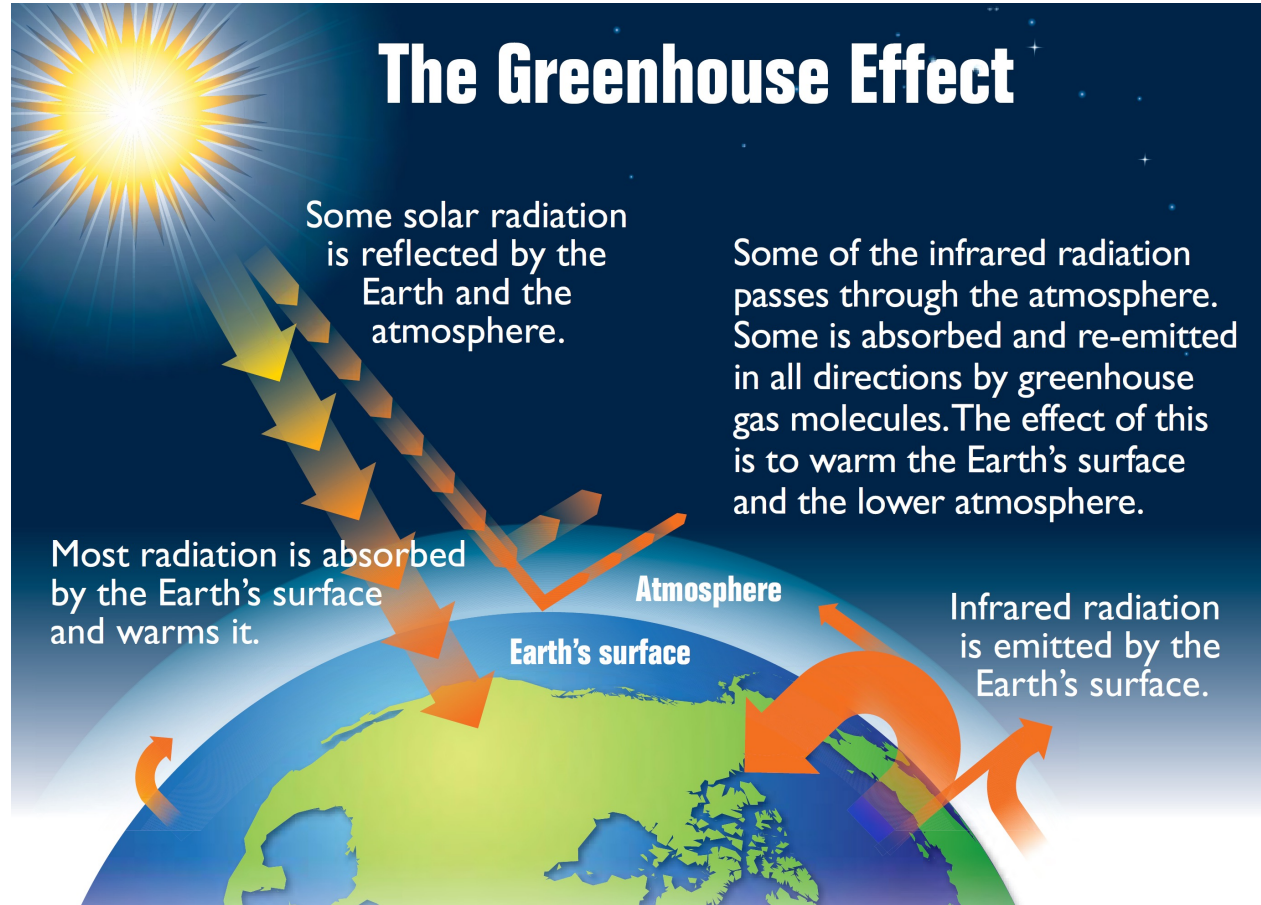
1. UV radiation from the sun breaks up the CFC molecules in the stratosphere into chlorine atoms
2. Within the layer, the chlorine atoms from the CFCs react with ozone to form oxygen and chloride oxide. Chlorine oxide continues to break up another ozone molecule. The chlorine atom is released and continues to attack Another ozone molecule in a chain reaction.
3. Holes in the ozone layer start to form. The holes allow harmful UV radiation to reach the Earth's surface and contributed to increases in skin cancer.

What Is the Carbon Cycle?



- The **carbon cycle** describes a set of processes that regulates the amount of carbon dioxide in the atmosphere.
- **Combustion:** fossil fuels burn to generate energy and produce carbon Dioxide.
- **Photosynthesis:** plants take in carbon dioxide and water to make glucose and oxygen in the presence of sunlight.
- **Respiration:** living organisms gain the energy for life processes by breaking down glucose back into CO_2 and water, which are released into the atmosphere.
- **Ocean uptake:** oceans and other large bodies of water absorb carbon dioxide.
- **Decomposition:** Dead organisms are broken down into simpler compounds by decomposers. Aerobic decomposition occurring in the presence of oxygen releases carbon dioxide into the atmosphere.

What Are Global Warming and Climate Change?



Global warming is the increase in the average temperature of the earth's surface due to increasing amounts of greenhouse gases in the atmosphere.

Major sources of greenhouse gases:

1. CO₂ carbon dioxide:
 - combustion of fossil fuels in power plants, industries and vehicles
 - Deforestation
2. CH₄ methane:
 - Waste gases from cattle
 - Leakage from methane reservoirs under the arctic tundra and from oceanic methane ice

Climate Change and Other Consequences

- ▶ **Change in Rainfall Patterns:** desertification or the destructive conversion of fertile land into deserts, the amount of food that can be produced globally would decrease.
- ▶ **Heat Waves:** high temperature can be fatal, especially for the elderly.
- ▶ **Tropical Storms:** extreme weather (typhoons and tornadoes), property is destroyed and lives may be lost.
- ▶ **Ocean Warming and Acidification:** fish population would be depleted.
- ▶ **Glacial Retreat and the Melting of Polar Ice Caps:** sea levels would rise and permanently flood coastal areas.

Concept Map

