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Behind marketing yard,  
Near Lalpari lake, Between  
Amargadh-Bhichri,  
Rajkot- 360 002.  
Ph.No. 90990 63150

## M. Sc. Chemistry

### Semester II (CBCS)

#### C 204 Analytical chemistry

### Air pollution

(Introduction, causes, effects)

Prepared By,  
**Rahul Talaviya**



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## Q- Explain environmental segments

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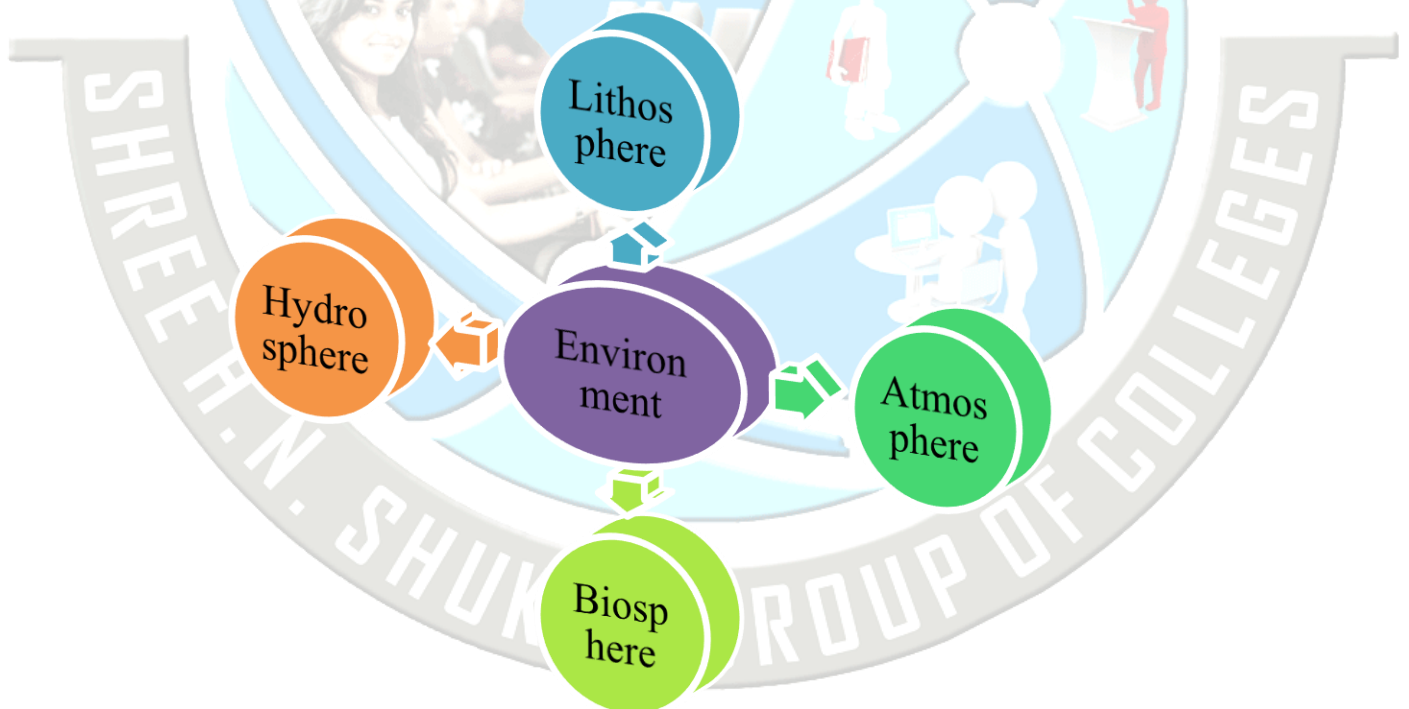
*In this topic, we study about the types of environmental segments*

*In short LABH (Lithosphere, Atmosphere, Biosphere and Hydrosphere).*

*For simplicity, the Earth environment is divided into four parts. All these four parts are depend on each other and all necessary for sustain of life over the Earth.*

*For more knowledge visit on <https://www.youtube.com/watch?v=tV3B8CAaXTA>*

Generally there are four parts of environmental segments;





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## Lithosphere:

- It means the **mantle** of rocks constituting the earth's crust.
- The solid component of the earth is called Lithosphere, which includes soil, earth, rocks and mountains etc.
- The lithosphere mainly contains three layers –

### (a) Inner and Outer Core:

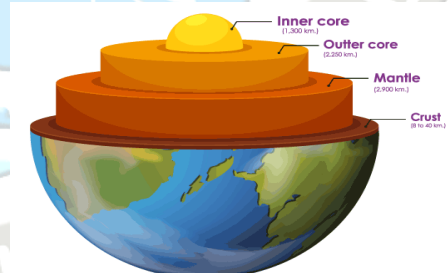
- It is the centre and the hottest layer of the Earth. The inner core is solid and made up of **iron and nickel** with temperature up to **5,500 °C**. Due to its immense heat energy, the inner core is more like the engine room of the Earth.
- It includes Central fluid or vaporised sphere of diameter of about **2500 km** from the centre of the earth.
- The outer core of the Earth is similar to a very hot ball of metals. It is so hot that the metals inside are all in the liquid state.

### (b) Mantle:

- Mantle is the widest section of the Earth. Its thickness is approximately 2,900 km. The mantle is mainly made up of semi-molten rock known as magma. The rock is hard in the upper part of the mantle, but lower down the rock is softer and begins to melt

### (c) Crust:

- Outermost solid zone about 8-40 km above mantle.



## Hydrosphere:



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- It covers more than 75% of the earth surface either as oceans or as fresh water.
- A hydrosphere is the total amount of water on a planet.
- The hydrosphere includes water that is on the surface of the planet, underground, and in the air.
- A planet's hydrosphere can be liquid, vapor, or ice. On Earth, liquid water exists on the surface in the form of oceans, lakes and rivers.
- Hydrosphere includes sea, rivers, oceans, lakes, ponds, streams etc.

## Atmosphere:

- The air envelope surrounding the earth is known as **Atmosphere**.
- This protective envelop surrounding earth sustain life on earth and protect us from **unfriendly environment** of outer space.
- It extends to the height of about **1600 km** from the earth surface.
- It consists of life saving gases like  $O_2$  for human beings and animals and  $CO_2$  for plants.
- In atmosphere, the maximum concentration of nitrogen is also obtained.

## Biosphere:

- Generally defined, the portion of the universe where all life is found is called the biosphere.
- Since scientists have not found organisms beyond planet Earth, the biosphere is defined as the parts of Earth where life exists.
- The biosphere is made of three parts, called the lithosphere, atmosphere and hydrosphere.
- This segment of environment consists of atmosphere (air contain various gases likes  $O_2$ ,  $N_2$ ,  $CO_2$  etc).
- Lithosphere (land- minerals, salts, food, nutrients) and hydrosphere (water- dissolved oxygen, Salts) which influences and support the entire **biotic and abiotic life systems**.



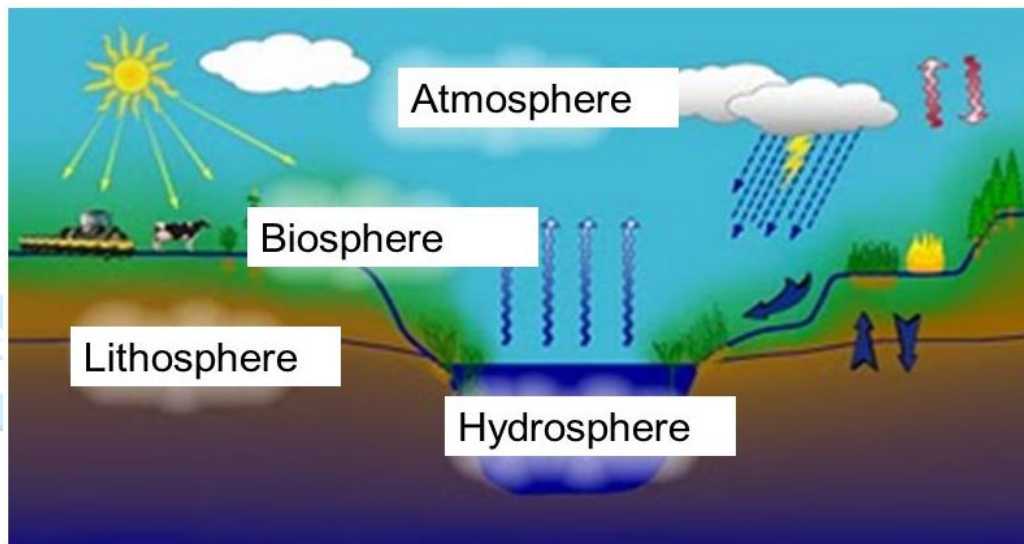
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## Short Question Answer for Competitive exam

Sr No.	Question	Answer
1	How many segments of environment have?	<b>four</b>
2	Iron, Nickel metals present in which sphere?	<b>Inner core of lithosphere</b>
3	Hydrosphere covers how many percentage of earth?	<b>75 %</b>
4	Which sphere protects us from harmful radiation of the sun?	<b>Atmosphere</b>
5	Which sphere is consist combination of all the rest spheres?	<b>Biosphere</b>

## Q- What is pollution/ define pollution?

**Pollution** is the introduction of contaminants into the natural environment that causes adverse change.

Or

**Pollution** is an undesirable change in physical, chemical or biological characteristics of air, water or soil and become harmful for human, animal and rest of the environment is known as pollution causes compounds known as **pollutants**.



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Or

Pollution is an accumulation of foreign material like organic, inorganic, biological or radiological in nature which may affect the living organisms directly or indirectly, immediately or affect a long time.

## Q- What is pollutant? Explain its types?

The compounds or foreign materials like **organic, inorganic, biological** or **radiological** in nature which may affect the living organisms directly or indirectly are generally known as **pollutant**.

### JUST FOR INFORMATION ONLY

*Now days, pollution is biggest question for the world. Day by day, there are increases in pollution.*

*Pollution is nothing but the accumulation of compounds or microorganisms which is harmful for the living and non living on the Earth.*

*In this topic, we study about pollutants as well as its types, e.g., degradable and non degradable. Examples also given of types.*

*Further, these compounds which are causes pollution may be radical, ion or particle depends on the origins.*

According to origin or availability, the pollutants are classified according to given as below;

- 1) Non degradable pollutant
- 2) Degradable pollutant

### **Non degradable pollutant:**

- These are not broken down the natural processes like action of microbes (bacteria, fungus etc).



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- Most of these type compounds get accumulated in the environment and also get biologically magnified as these move along the food chains in an under composed state.
- Sometimes these may also react with other compounds in the environment to produce toxic compounds.
- **These can be further subdivided into two more classes:**
  - (i) **Waste:**  
E.g. glass, plastic, phenolic, aluminium cans etc.
  - (ii) **Poisons:**  
E.g. radio-active substances, pesticides, smog gases, heavy metals like mercury, lead and their salts

## Degradable pollutant:

- These are natural organic substances which can be decomposed, removed or consumed by **microorganisms** in nature.
- Hence, the amount of such pollutant is reduced to acceptable levels either by natural processes like biological or microbial action or by some engineered systems, like **sewage treatment plants**.
- The degradable pollutants can be further sub-divided into two categories:
  - (i) **Rapidly degradable or non-persistent pollutant:**
    - The **degradation** of these pollutants is very faster process.
    - For example, the decomposition of sewage and wastes of animals and plants is a faster process.
    - The **domestic sewage** can be rapidly decomposed by natural processes.
    - However, the problems become complicated when the input into environment get exceeded of the decomposition or dispersal capacity.
  - (ii) **Slowly degradable or persistent pollutant:**
    - The degradation of these pollutants is a very slower process.
    - It seems as if the amount of pollutant remains unchanged with time.



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- For example, degradation of synthetic compounds and radio-active elements like **Iodine 137, Strontium 90 or Plutonium 239** takes a longer period of time.

## Some question and answer for competitive exam

Sr No.	Question	Answer
1	The compounds or foreign materials in nature which may affect the living organisms directly or indirectly are generally known as?	<b>pollutant</b>
2	In case of degradable pollutants, pollutants decomposed by natural organic substances which are known as?	<b>microorganism</b>
3	Examples of Slowly degradable or persistent pollutant?	<b>Iodine 137, Strontium 90 or Plutonium 239</b>

## Q- What are particles, ions and radicals? How are they formed in the atmosphere?

- Particles are mainly present in the troposphere.
- They vary in number from several hundred per cubic centimetre in pure air to more than  $10^5$  per cubic centimetre in polluted air.
- The particles also vary in size **(0.1-10) $\mu$** .
- Their **mass** ranges from **10 $\mu\text{g}/\text{m}^3$**  in clean air to **60-2000  $\mu\text{g}/\text{m}^3$**  in polluted air.
- In case of particles, their size is more important than their total count.
- Particles in the size **0.1-1 $\mu$**  are responsible for the **electrical phenomena** in the atmosphere.
- They are also responsible for cloud and fog formation.



## Organic particulate matter

- Such particles are in 1  $\mu$  size range and are potential health hazards for human.





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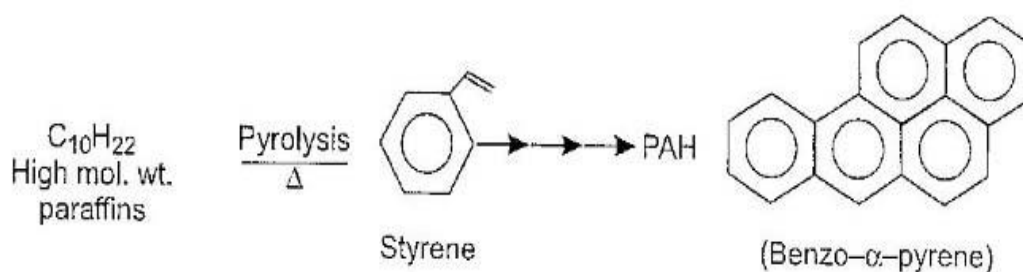
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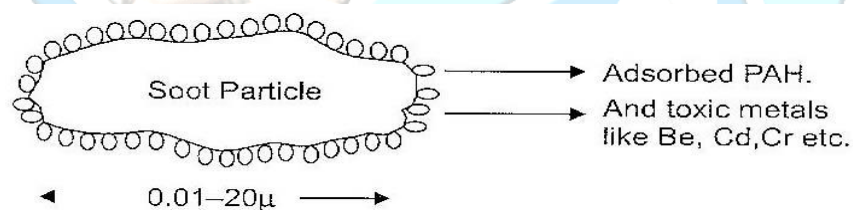
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- For example, **polycyclic (polynuclear) aromatic hydrocarbons (PAH)** in organic particulate matter have carcinogenic effect. One such compound responsible for carcinogenic effect is beno ( $\alpha$ -) pyrene.
- Such compounds generally occur in urban atmospheres at about  $20\mu\text{g}/\text{m}^3$  level and originated from the **pyrolysis of paraffin's** present in fuels and plant material.



- The PAH formed remain adsorbed on soot particles, which are formed as a residue on combustion of fuels in automobiles and electricity generating power plants, which use coal as the raw material.
- Generally speaking, the soot particles, which we come across, contain adsorbed **PAH** and toxic metals. A typical soot particle is represented is shown in below figure.



- The atmospheric particles (**soot particles**) enter human body through respiration. These get lodged in the lungs causing health hazards.
- The removal of particulate matter from the gases is important for controlling air pollution.

## Ions and Radicals:



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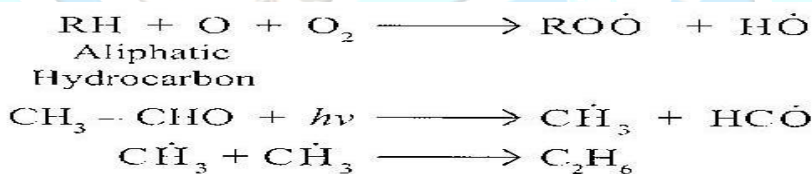
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- Ions are atoms that have either lost one or more electrons, making it positively charged (or cations) or gained one or more electrons making it negatively charged (anions).
- Ions are normally present in the ionosphere region of the mesosphere.
- In this region, positive ions like  $O^{2+}$ ,  $O^+$ ,  $NO^+$  etc. and electrons exist at **significant levels**.
- These species are formed due to solar radiations. During the night, the UV radiations are not available and so these ions recombine with free electrons to give neutral species from which they originated.
- **The ions are influenced by the earth's magnetic field. This results in the formation of two belts of ionizing particles encircling the earth. These are known as van Allen belts.**

## Radicals:

- Radicals are a group of atoms, either in a compound or existing alone.
- Free Radicals are atoms or group of atoms with an unpaired valence electron.
- Free radicals can be produced by photolysis or pyrolysis in which a bond is broken without forming ions. Because of their unpaired valence electrons, most free radicals are extremely reactive.
- Besides ions, the atmosphere also contains free radicals, which take part in chain reactions in which one of product is a free radical. The chain can be terminated by combination of two free radicals.



## Some question and answer for competitive exam

Sr No.	Question	Answer
1	Particle size present in air as pollutant?	(0.1-10) $\mu$
2	Full form of PAH?	polycyclic (polynuclear) aromatic hydrocarbons



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3	The ions are influenced by the earth's magnetic field. This results in the formation of two belts of ionizing particles encircling the earth. These are known as?	van Allen belts
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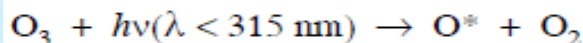
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## Q- Explain Hydroxyl and Hydroperoxyl Radicals in the Atmosphere

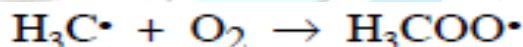
- The hydroxyl radical,  $\bullet\text{OH}$ , is the neutral form of the hydroxide ion ( $\text{OH}^-$ ).
- Hydroxyl radicals are highly reactive (easily becoming hydroxyl groups) and consequently short-lived.
- Most notably hydroxyl radicals are produced from the decomposition of hydro-peroxides ( $\text{ROOH}$ ) or, in atmospheric chemistry, by the reaction of excited atomic oxygen with water.
- It is formed by several mechanisms. At higher altitudes, it is produced by photolysis of water:



- Hydroxyl radicals are also produced during UV-light dissociation of  $\text{H}_2\text{O}$ .



- In the presence of organic matter, hydroxyl radical is produced in abundant quantities as an intermediate in the formation of photochemical smog.
- The highly reactive methyl radical,  $\text{H}_3\text{C}\bullet$ , reacts with  $\text{O}_2$ , to form **methylperoxyl radical**,  $\text{H}_3\text{COO}\bullet$ .



### Some question and answer for competitive exam

Sr No.	Question	Answer
1	Give structure of hydroxyl radical	$\bullet\text{OH}$
2	Ozone break into _____ and _____ in the presence of UV light.	Nation oxygen and oxygen
3	The highly reactive methyl radical, $\text{H}_3\text{C}\bullet$ , reacts with $\text{O}_2$ , to form	<b>methylperoxyl radical</b> , $\text{H}_3\text{COO}\bullet$ .



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## AIR POLLUTION

- **Air pollution** occurs when harmful substances including particulates and biological molecules are introduced into Earth's atmosphere.
- It also occurs when any harmful gases, dust, smoke enters into the atmosphere and makes it difficult for plants, animals and humans to survive as the air becomes dirty.



- It may cause diseases, allergies or death of humans; it may also cause harm to other living organisms such as animals and food crops, and may damage the natural or built environment. Human activity and natural processes can both generate air pollution.
- There are many reasons which may causes air pollution in whole the world.
- Out of them some are natural and other reasons are due to mankind activities.



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## Q- Explain types of air pollutant

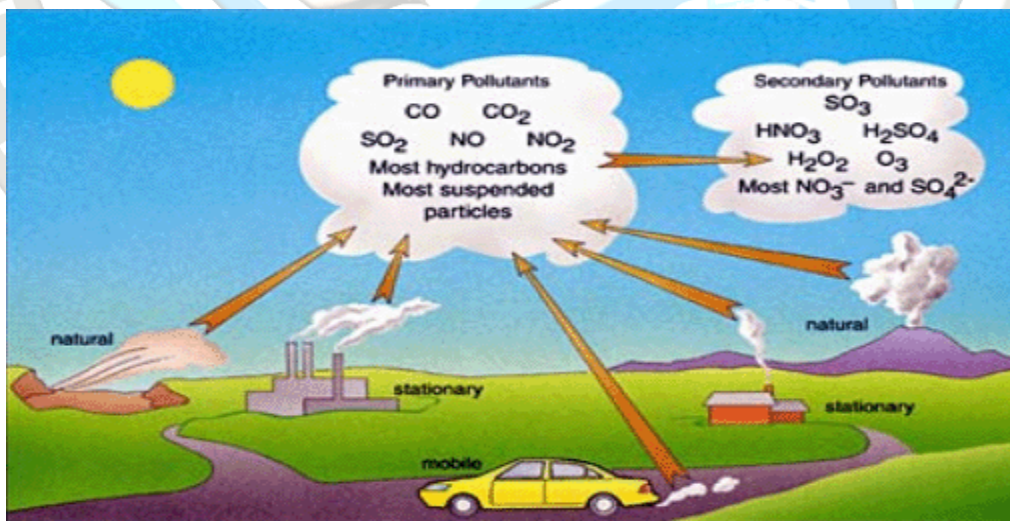
In order to understand the causes of Air pollution, several divisions can be made.

### Primarily air pollutants

- It can be caused by primary sources or secondary sources.
- The primary pollutants are “directly” emitted from the processes such as **fossil fuel consumption, volcanic eruption and factories.**
- The major primary pollutants are Oxides of Sulphur, Oxides of Nitrogen, Oxides of Carbon, Particulate Matter, Methane, Ammonia, Chlorofluorocarbons, toxic metals etc

### Secondary air pollutants

- The secondary pollutants are not emitted directly.
- The secondary pollutants form when the primary pollutants react with themselves or other components of the atmosphere.
- Most important secondary level Air Pollutants are Ground Level Ozone, **Smog** and **POPs** ([Persistent Organic Pollutants](#)).
- **Smog** created by the interactions of several primary pollutants is known to be as secondary pollutant.





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## Q-Explain Factors responsible for air Pollution

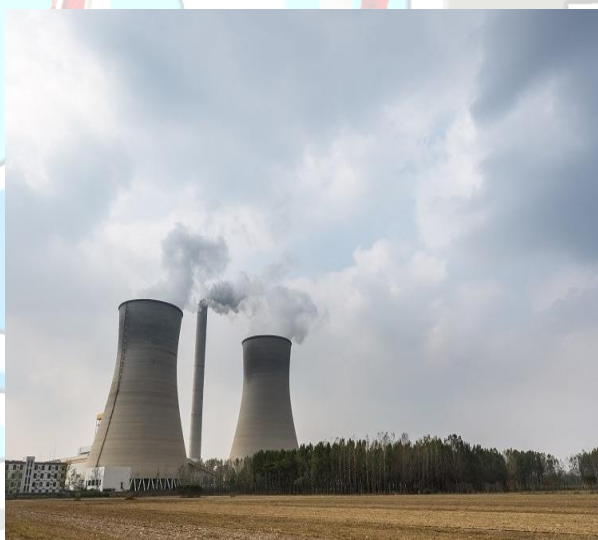
There are many factors which causes air pollution. Some of them are given as below;

- ❖ **Power Plants**
- ❖ Vehicle Emissions
- ❖ Deforestation
- ❖ **Industries**
- ❖ Wood Fire
- ❖ Smoking
- ❖ **Indoor air pollution**
- ❖ **Natural Process**

### Power Plants/Burning of fossil fuel

- Now a days, fossil fuel especially coal one of the major source of energy used in power plant to generate electricity.
- But during burning of coal, many gases including carbon dioxide, methane, nitrous oxide, sulphur oxide and fluorinated gases are emitted.
- Sulfur dioxide emitted from the combustion of fossil fuels like coal, petroleum and other factory combustibles is one the major cause of air pollution.

- Hence, ultimately concentration of air pollutants increases in atmosphere.





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## Vehicle Emissions

- Cars, trucks, and buses powered by fossil fuels are major contributors to air pollution—transportation emits more than half of nitrogen oxides in our air, and is a major source of global warming emission.
- Carbon Monoxide (CO) caused by improper or incomplete combustion and generally emitted from vehicles.
- Private transportation accounts for about 10 percent of your carbon footprint, or the amount of carbon dioxide your lifestyle and activities contribute to the atmosphere.

## Industries

- Industry is a major contributor to air pollution.
- Industrial processes release pollutants such as nitrous oxide, sulphur oxides, hydrofluorocarbons etc., into the air.
- Further, mining industries are responsible for the emission of particulate matter into air.
- Hence, the overall effect is an increase in the global warming potential.

## Wood Fires

- Wood fires cause air pollution by releasing particulate matter along with large number of carbon dioxide gas into the air.
- These particles can become lodged in your respiratory system, causing irritation to tissues.
- The particles can also aggravate existing health conditions such as asthma.
- Further, during fire oxygen gas used hence concentration of O<sub>2</sub> gas decreases.

## Deforestation

- Deforestation affects the atmosphere in several ways.
- Trees store carbon dioxide in their plant tissue as they take in this gas to undergo food-making. In effect, this action removes carbon dioxide from the air.
- When forests are burned and destroyed, this storage area for carbon dioxide is removed, increasing the concentrations of atmospheric carbon dioxide.





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## Smoking

- You are still at risk of the dangers of smoking even if you are a non-smoker.
- The University of Minnesota estimates that up to 90 percent of the American population is routinely exposed to second hand smoke.
- Tobacco smoke contains 40 carcinogens, making it an especially lethal form of air pollution.

## Indoor air pollution

- Household cleaning products, painting supplies emit toxic chemicals in the air and cause air pollution.
- Have you ever noticed that once you paint walls of your house, it creates some sort of smell which makes it literally impossible for you to breathe.
- Suspended particulate matter popular by its acronym SPM, is another cause of pollution. Referring to the particles afloat in the air, SPM is usually caused by dust, combustion etc.

## Natural Processes

- Natural processes can contribute to the effects of air pollution.
- Natural events such as volcanoes and tornadoes can stir up debris and cause widespread air pollution.
- Natural erosion of rock and soils also releases toxic compounds such as dust, fine particles into the air.

## Some question and answer for competitive exam

Sr No.	Question	Answer
1	In power plant, which fossil used as fuel	coal
2	From the coal generally which oxides emitted major	Sulphur oxide
3	Wood fire causes air pollution how?	Due to emit particulate matter
4	The particles can also aggravate existing health conditions such as	Asthma
5	Full form of SPM in case of air pollution	Suspended particulate matter



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## Effects of Air pollution

There are many effect of air pollutant is observed over living and non living organisms. Some of them are listed as below:

- Respiratory and heart problems**
- Global warming**
- Acid Rain**
- Effect on Wildlife**
- Depletion of Ozone layer**

### Respiratory and heart problems

- The Air pollution creates several **respiratory and heart** conditions along with Cancer, among other threats to the body.
- Several millions are known to have died due to direct or indirect effects of Air pollution. Children in areas exposed to air pollutants are said to commonly suffer from pneumonia and asthma.
- Sometimes it becomes difficult in taking breath due to presence of air pollutant.

### Global warming

- The most effect of carbon dioxide as air pollutant is observed over temperature of earth.
- Due to increases in concentration of carbon dioxide gas, the temperature increases rapidly.
- The increases in temperatures worldwide cause melting of ice from colder regions and icebergs and due to this increase in sea levels.
- The increases in sea level are causes risk for **costal area**.



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## Acid Rain

- Harmful gases like **nitrogen oxides and sulfur oxides** are released into the atmosphere during the burning of **fossil fuels**.
- When it rains, the water droplets combines with these air pollutants, becomes acidic and then falls on the ground in the form of acid rain.
- Acid rain can cause great damage to human, animals and crops.
- Due to acid rain, the pH of land decreases suddenly and due to these essential minerals present in land is washed away with water.

## Effect on Wildlife

- Just like humans, animals also face some devastating effects of air pollution.
- Toxic chemicals present in the air can force wildlife species to move to new place and change their habitat.
- The toxic pollutants deposit over the surface of the water and can also affect sea animals.

## Depletion of Ozone layer

- Ozone exists in earth's stratosphere and is responsible for protecting humans from harmful ultraviolet (UV) rays.
- Earth's ozone layer is depleting due to the presence of chlorofluorocarbons, hydro chlorofluorocarbons in the atmosphere.
- As ozone layer will go thin, it will emit harmful rays back on earth and can cause skin and eye related problems.
- UV rays also have the capability to affect crops and animals.



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## Q- How to reduced air pollution

Or

## Explain solution of air pollution

There are many ways to reduced air pollutants in the air. However the best ways are that to emit fewer amounts of air pollutants. e.g.,

### Use public mode of transportation:

- Encourage people to use more and more public modes of transportation to reduce pollution.
- Also, try to make use of car pooling.
- Less uses of vehicles
- Used vehicle based on electricity

### Conserve energy

- Switch off fans and lights when you are going out.
- Large amount of fossil fuels are burnt to produce electricity.
- You can save the environment from degradation by reducing the amount of fossil fuels to be burned.

### Understand the concept of Reduce, Reuse and Recycle

- Do not throw away items that are of no use to you.
- In-fact reuses them for some other purpose. For e.g. you can use old jars to store cereals or pulses.

### Emphasis on clean energy resources:

- Clean energy technologies like solar, wind and geothermal are on high these days.
- Governments of various countries have been providing grants to consumers who are interested in installing solar panels for their home. This will go a long way to curb air pollution.



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## Use energy efficient devices

- CFL lights consume less electricity as against their counterparts.
- They live longer, consume less electricity, lower electricity bills and also help you to reduce pollution by consuming less energy.

## One word question answer

Sr No.	Question	Answer
1	Ozone is responsible for protecting humans from harmful	UV radiation
2	Harmful gases like ___ and _____ are responsible for acid rain	nitrogen oxides and sulfur oxides
3	Global warming is due to _____ gas present in the air	carbon dioxide



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# ACID RAIN

- Acid rain, or acid deposition, is a broad term that includes any form of precipitation with acidic components, such as sulphuric acid or nitric acid that fall to the ground from the atmosphere in wet or dry forms. This can include rain, snow, fog, hail or even dust that is acidic.
- **Acid rain**, also called **acid precipitation** or **acid deposition**.

**Q- What causes of acid rain?**

**Or**

**Responsible factors for acid rain?**

- Acid rain results when sulfur oxide ( $\text{SO}_2$ ,  $\text{SO}_3$ ) and nitrogen oxides ( $\text{NO}_2$ ) are emitted into the atmosphere and transported by wind and air currents.
- The  $\text{SO}_2$ ,  $\text{SO}_3$  and  $\text{NO}_2$  react with water, oxygen and other chemicals to form sulphuric acid and nitric acids.
- This then mix with water and other materials and falls to the ground.
- A small portion of the  $\text{SO}_2$ ,  $\text{SO}_3$  and  $\text{NO}_2$  that cause acid rain is from natural sources such as volcanoes, most of it comes from the burning of fossil fuels.
- The major sources of  $\text{SO}_2$ ,  $\text{SO}_3$  and  $\text{NO}_2$  in the atmosphere are:

**Burning of fossil fuels are responsible for generate electricity. Two thirds of  $\text{SO}_2$  and one fourth of  $\text{NO}_2$  in the atmosphere come from electric power generators.**



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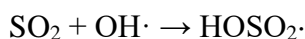
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**Vehicles and heavy equipment.**

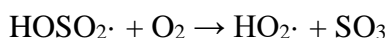
**Manufacturing, oil refineries and other industries.**

## Reaction occur in atmosphere to form acids

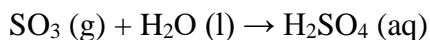
In the gas phase sulfur dioxide is oxidized by reaction with the [hydroxyl](#) radical via an intermolecular reaction:



This is followed by:



In the presence of water, [sulfur trioxide](#) ( $\text{SO}_3$ ) is converted rapidly to [sulfuric acid](#):



Nitrogen dioxide reacts with OH to form nitric acid:

This shows the process of the air pollution being released into the atmosphere and the areas that will be affected.



## One word question answer

Sr No.	Question	Answer
1	term used that includes any form of precipitation with acidic components, such as sulphuric acid or nitric acid that fall to the ground from the atmosphere in wet or dry forms.	Acid rain
2	Acid fall over the ground along with water is known as	Wet acid rain



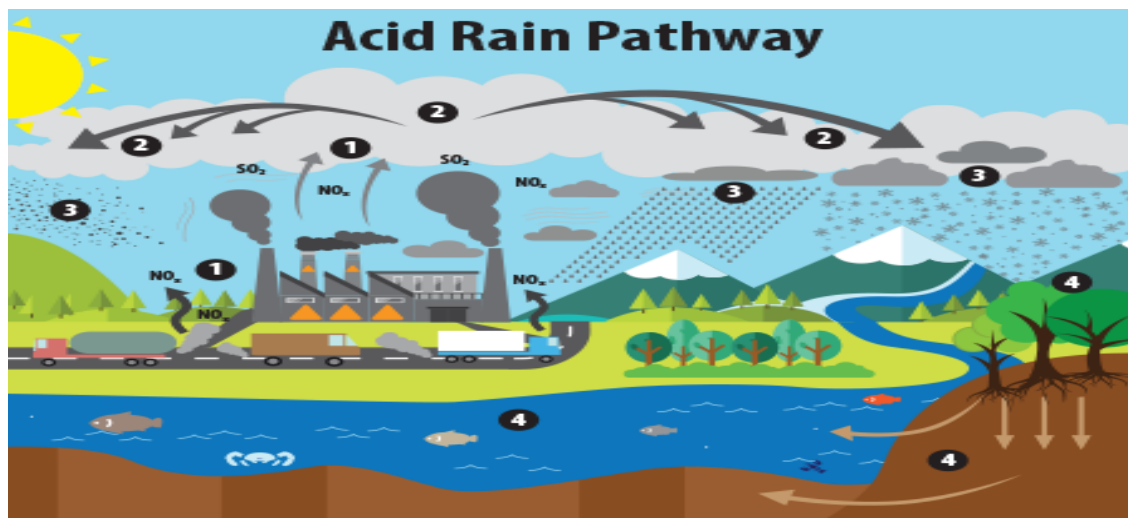
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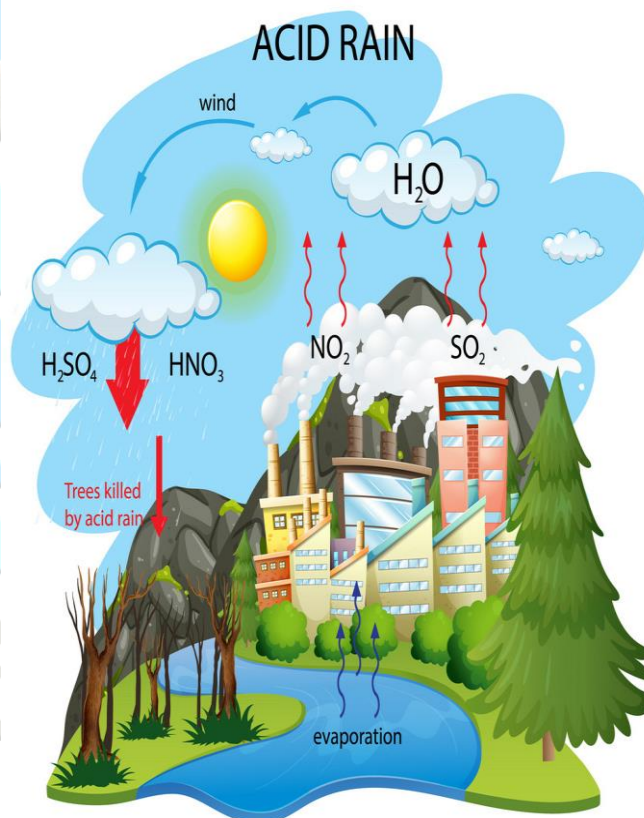
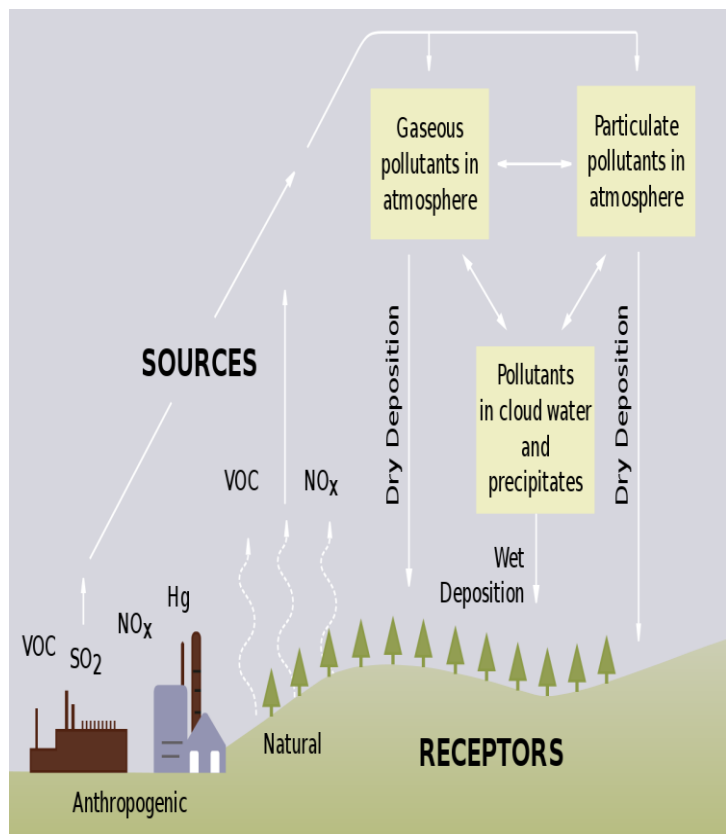
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This image illustrates the pathway for acid rain in our environment: (1) Emissions of SO<sub>2</sub> and NO<sub>x</sub> are released into the air, where (2) the pollutants are transformed into acid particles that may be transported long distances. (3) These acid particles then fall to the earth as wet and dry deposition (dust, rain, snow, etc.) and (4) may cause harmful effects on soil, forests, streams and lakes.







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## Q- Explain form of acid deposition

Or

### Give types of acid rain

There are two form of acid deposition according to acid falls to the ground.

- 1) Wet deposition
- 2) Dry deposition

### Wet Deposition

- Wet deposition is what we most commonly think of as **acid rain**.
- The sulphuric acid and nitric acids formed in the atmosphere fall to the ground mixed with rain, snow, fog, or hail.
- Due to falls of acids in combine with water molecules, known as wet acid deposition or wet acid rain.
- Generally wet acid rain observed in such area where moisture content in atmosphere is higher.

### Dry Deposition

- The sulphuric acid and nitric acids formed in the atmosphere fall to the ground mixed with particles and gases.
- Hence such fallen of Acidic particles and gases from the atmosphere in the absence of moisture known as **dry deposition**.
- The amount of acidity in the atmosphere that deposits to earth through dry deposition depends on the amount of rainfall an area receives.
- For example, in desert areas the ratio of dry to wet deposition is higher than an area that receives several inches of rain each year.

### Effect

- The acidic particles and gases may deposit to surfaces quickly or may react during atmospheric transport to form larger particles that can be harmful to human health.
- When the accumulated acids are washed off a surface by the next rain, this acidic water flows over and through the ground, and can harm plants and wildlife, such as insects and fish.



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## The Effects of Acid Rain on Ecosystems

- Effects of Acid Rain on Fish and Wildlife
- Effects of Acid Rain on Plants and Trees
- Buffering Capacity
- Episodic Acidification
- Nitrogen Pollution
- Effects of Acid Rain on Materials
- Visibility and Human Health



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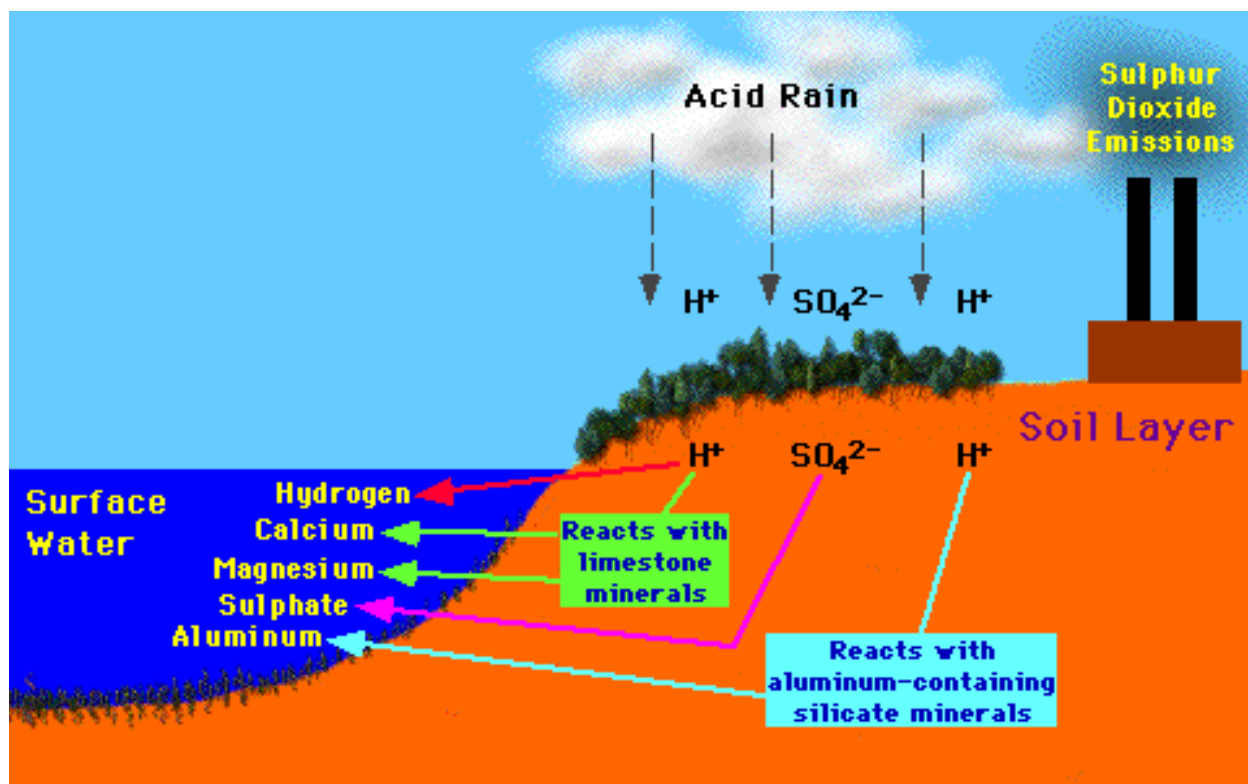
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## Effects of Acid Rain on Fish and Wildlife

- The ecological effects of acid rain are most clearly seen in aquatic environments, such as streams, lakes, and marshes
- Most adverse effect of acid rain is observed over fish and other wildlife.
- As it flows through the soil, acidic rain water can leach aluminium from soil clay particles and then flow into streams and lakes.
- The more acid that is introduced to the ecosystem, the more aluminium is released.
- Higher concentration of **aluminium affects the marine life**.
- Some types of plants and animals are able to tolerate acidic waters and moderate amounts of aluminium.
- Others, however, are acid-sensitive and will be lost as the pH declines. Some acidic lakes have no fish.
- Even if a species of fish or animal can tolerate moderately acidic water, the animals or plants it eats might not. For example, frogs have a critical **pH around 4**, but the mayflies they eat are more sensitive and may **not survive pH below 5.5**.





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## Effects of Acid Rain on Plants and Trees

- Dead or dying trees are a common sight in areas affected by acid rain.
- Acid rain leaches aluminum from the soil. That **aluminum may be harmful to plants as well as animals.**
- Acid rain also removes minerals and nutrients from the soil that trees need to grow.
- At high elevations, acidic fog and clouds might strip nutrients from **trees' foliage**, leaving them with brown or dead leaves and needles.
- The trees are then less able to absorb sunlight, which makes them weak and less able to withstand freezing temperatures.

## Buffering Capacity

- **Many forests, streams, and lakes that experience acid rain don't suffer effects because the soil in those areas can buffer the acid rain by neutralizing the acidity in the rainwater flowing through it.**
- This capacity depends on the thickness and composition of the soil and the type of bedrock underneath it. In areas such as mountainous parts of the Northeast United States, the soil is thin and lacks the ability to adequately neutralize the acid in the rain water.
- As a result, these areas are particularly vulnerable and the acid and aluminum can accumulate in the soil, streams, or lakes.

## Episodic acidification

- **A short period of time when streams, lakes, and the ground have a much higher pH level than they normally do. This often happens in the spring, when the snow that contains acidic pollutants begins to melt.**
- Lakes that do not normally have a high level of acidity may temporarily experience effects of acid rain.
- However, when the melting snow or downpour brings greater amounts of water into the river which is helped to balanced pH of water.



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- This short duration of higher acidity (i.e., lower pH) can result in a short-term stress on the ecosystem where a variety of organisms or species may be injured or killed.

## Nitrogen Pollution

- Acid rain also contains nitrogen, and this can have an impact on some ecosystems. The acid rain causes leaching of nitrogen in land and accumulates at particular area or water.
- For example, **nitrogen pollution** in our coastal waters is partially responsible for declining fish and shellfish populations in some areas.
- In addition to agriculture and wastewater, much of the nitrogen produced by human activity that reaches coastal waters comes from the atmosphere.

## Effects of Acid Rain on Materials

- When acid rain and dry acidic particles fall to earth, the nitric acid and sulphuric acid that make the particles acidic can land on statues, buildings, and other manmade structures, are damage by their surfaces.
- The acidic particles corrode metal especially iron and cause paint and stone to deteriorate more quickly.
- They also dirty the surfaces of buildings and other structures such as monuments.
  1. damaged materials that need to be repaired or replaced,
  2. increased maintenance costs, and
  3. Loss of detail on stone and metal statues, monuments and tombstones.

## Visibility

- In the atmosphere,  $\text{SO}_2$  and  $\text{NO}_x$  gases can be transformed into sulfate and nitrate particles, while some  $\text{NO}_3$  can also react with other pollutants to form ozone.
- These particles and ozone make the air hazy and difficult to see through.
- Such type air shows a series effect on health because it contain high concentration of pollutants.
- This affects our enjoyment of national parks that we visit for the scenic view such as Shenandoah and the Great Smoky Mountain.



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## Human Health

- Walking in acid rain, or even swimming in a lake affected by acid rain, is no more dangerous to humans.
- Very strong acids will burn if they touch your skin and can even destroy metals. Acid rain is much, much weaker than this, never acidic enough to burn your skin.
- It is linked to several indirect health effects.
- $\text{SO}_2$  and  $\text{NO}_x$  react in the atmosphere to form fine sulfate and nitrate particles that people can inhale into their lungs which causes adverse effect on health.
- Specifically, sulfur dioxide particles in the air can encourage chronic lung problems, like asthma and bronchitis.
- Many scientific studies have shown a relationship between these particles and effects on heart function, such as heart attacks resulting in death for people with increased heart disease risk, and effects on lung function, such as breathing difficulties for people with asthma.

## One word question answer

Sr No.	Question	Answer
1	Acid fall over the ground along with solid particle is known as	Dry acid rain
2	The _____ elements harmful for marine life.	Aluminium
3	A short period of time when streams, lakes, and the ground have a much higher pH level than they normally do. This often happens in the spring, when the snow that contains acidic pollutants begins to melt, which is known as	Episodic acidification



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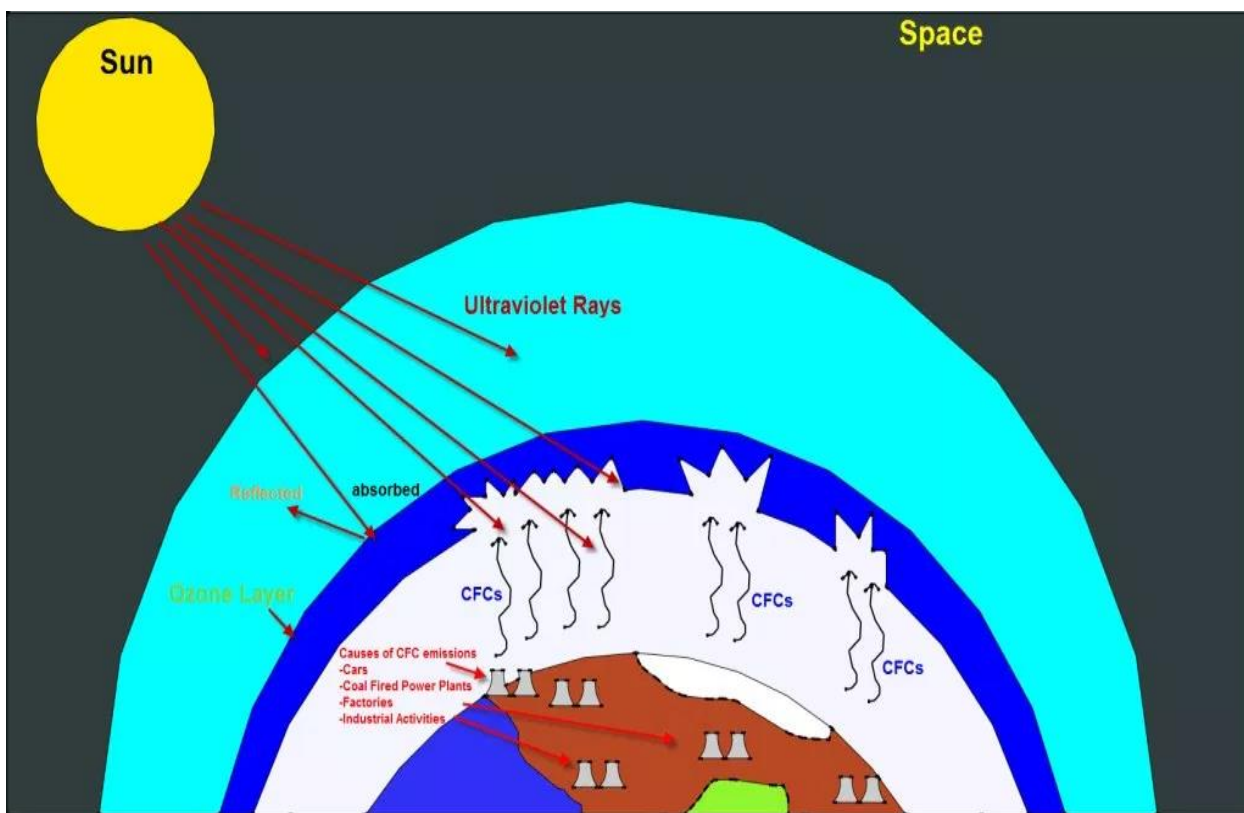
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# The Greenhouse Effect and Global Warming





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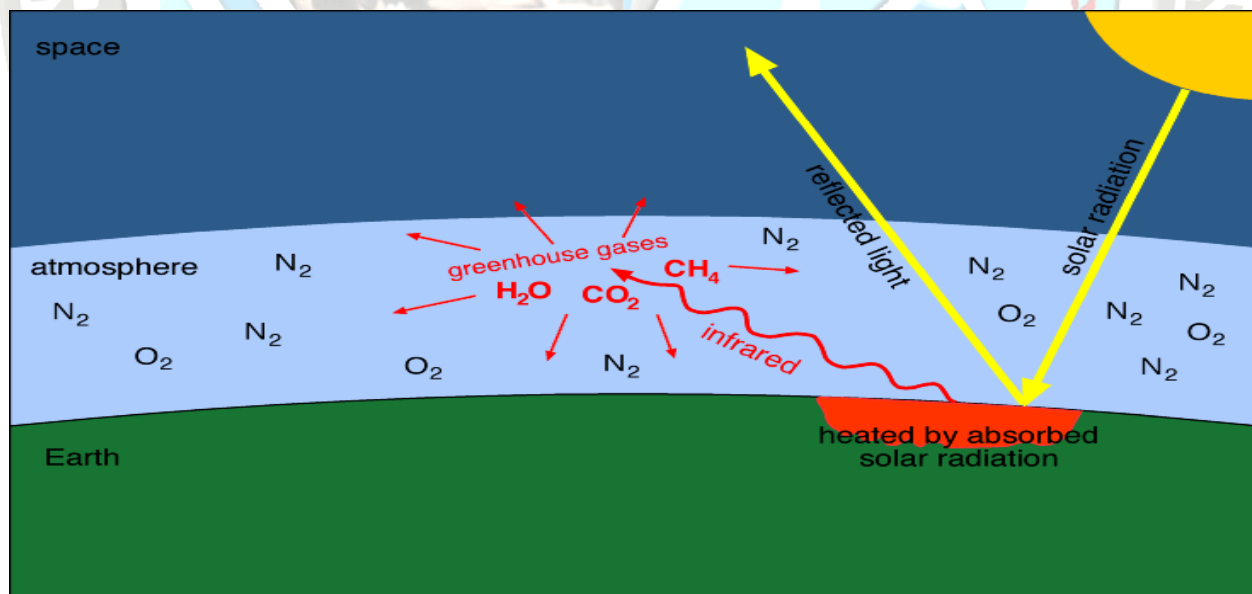
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## Q- What is green house effect? Explain it causes?

- The greenhouse effect increases the temperature of the Earth by trapping heat in our atmosphere.
- This keeps the temperature of the Earth higher than it would be if direct heating by the Sun was the only source of warming.
- **Simply, the green house effect is the process by which radiation from a planet's atmosphere warms the planet's surface to a temperature above what it would be without its atmosphere.**
- Earth receives energy from the Sun in the form of ultraviolet, visible, and near-infrared radiation.
- About 26% of the incoming solar energy is reflected to space by the atmosphere and clouds, and 19% is absorbed by the atmosphere and clouds.
- Most of the remaining energy is absorbed at the surface of Earth. Because the Earth's surface is colder than the Sun, it radiates at wavelengths that are much longer than the wavelengths that were absorbed.



- Most of this thermal radiation is absorbed by the atmosphere and warms it.





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- The atmosphere radiates energy both upwards and downwards; the part radiated downwards is absorbed by the surface of Earth.
- This leads to a higher equilibrium temperature than if the atmosphere were absent.

## Q-Explain green houses gases?

Or

## Explain gases which are responsible for green house effect?

- There are many gases present in atmosphere which are capable of absorbing effective heat waves and infrared rays while transparent to radiation of lower wave length.
- Homogeneous gas molecules  $N_2$  and  $O_2$  have vibrational energy level but are symmetrically stretched or compressed. Thus involve no change in dipole moment and do not interact with infrared radiation.
- So  $N_2$  and  $O_2$  are transparent to the infrared radiation.
- But other gases such like  $CO_2$ ,  $H_2O$ ,  $CH_4$ , CFCs,  $NO_x$ , etc change their dipole moment hence they absorbed Infrared radiation and so they increase the temperature of atmosphere.
- By their percentage contribution to the greenhouse effect on Earth the four major gases are:

Water vapor	3 %	chlorofluorocarbon	12 %
Carbon dioxide	50 %	$N_2O$	5 %
Methane	20 %	remaining	2 %
ozone	8 %		

- All the above components are IR active means they absorbed radiation lies in infra red region. Due to absorbance of radiation, molecule got vibrates and increases entropy.
- These excited molecules are reemits energy of lower wave length. This radiation is then absorbed by surface of earth and hence temperature of earth surface is increases.

## Q- Explain Causes of the Greenhouse Effect



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There are many factors which are responsible for increases green house gases in atmosphere.

- Burning of Fossil Fuels**
- Deforestation**
- Increase in Population**
- Industrial Waste and Landfills**

## Burning of Fossil Fuels

- Fossil fuels like coal, oil and natural gas have become an integral part of our life.
- They are used on large basis to produce electricity and for transportation.
- When they are burnt, the carbon stored inside them is released which combines with oxygen in the air to create carbon dioxide.
- When these vehicles run, they release carbon dioxide, which is one the main gas responsible for increase in greenhouse effect.
- Apart from that, electricity-related emissions are high because we are still dependent on coal for electricity generation which releases large amount of CO<sub>2</sub> into the atmosphere and is still the primary source of fuel for generating electricity.
- Although, renewable sources are catching up, but it may take a while before we can reduce our dependence on coal for electricity generation.

## Deforestation

- Forests hold a major green area on the planet Earth.
- Plants and trees intake carbon dioxide and release oxygen, through the process of photosynthesis, which is required by humans and animals to survive.
- Large scale development has resulted in cutting down of trees and forests which has forced people to look for alternate places for living.
- When the wood is burnt, the stored carbon is converted back into carbon dioxide.



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## Increase in Population

- Over the last few decades, there have huge increase in the population.
- Now, this has resulted in increased demand for food, cloth and shelter.
- New manufacturing hubs have come up cities and towns that release some harmful gases into the atmosphere which increases the greenhouse effect.
- Also, more people mean more usage of fossil fuels which in turn has aggravated the problem.

## Industrial Waste and Landfills:

- Industries which are involved in cement production, fertilizers, coal mining activities, oil extraction produce harmful greenhouse gases.
- Also, landfills filled with garbage produce carbon dioxide and methane gas contributing significantly to greenhouse effect.

## Q- Explain effect of Greenhouse gases

- Increased greenhouse gases directly increase the heat on the planet's surface and lower atmosphere. This has a rippling effect as it can thin and even create holes in the ozone layer. This means that other radiation like ultra violet (UV) rays can seep in from the Sun.
- Melting glaciers, early snowmelt, and severe droughts will cause more dramatic water shortages and increase the risk of wildfires in the American West.
- Rising sea levels will lead to coastal flooding on the Eastern Seaboard, especially in Florida, and in other areas such as the Gulf of Mexico.
- Forests, farms, and cities will face troublesome new pests, heat waves, heavy downpours, and increased flooding. All those factors will damage or destroy agriculture and fisheries.



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- Allergies, asthma, and infectious disease outbreaks will become more common due to increased growth of pollen-producing ragweed, higher levels of air pollution, and the spread of conditions favorable to pathogens and mosquitoes.

## OZONE LAYER



- The **ozone layer** or **ozone shield** is a region of Earth's stratosphere that absorbs most of the Sun's ultraviolet (UV) radiation.
- The ozone layer contains less than 10 parts per million of ozone, while the average ozone concentration in Earth's atmosphere as a whole is about 0.3 parts per million.
- The ozone layer is mainly found in the lower portion of the stratosphere, from approximately 20 to 30 kilometres (12 to 19 miles) above Earth, although its thickness varies seasonally and geographically.



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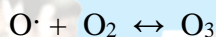
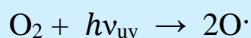
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## Q- Explain creation of ozone in atmosphere

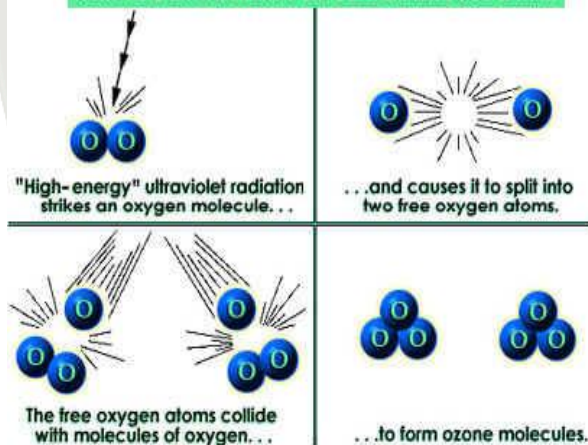
Or

### Explain ozone oxygen cycle

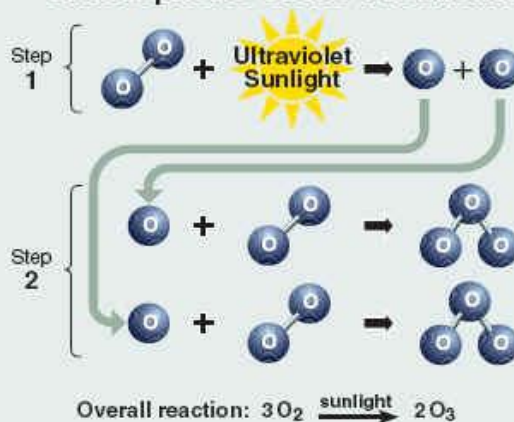
- Ozone in the Earth's stratosphere is created by ultraviolet light striking ordinary oxygen molecules containing two oxygen atoms ( $O_2$ ), splitting them into individual oxygen atoms (atomic oxygen); the atomic oxygen then combines with unbroken  $O_2$  to create ozone,  $O_3$ .
- The ozone molecule is unstable (although, in the stratosphere, long-lived) and when ultraviolet light hits ozone it splits into a molecule of  $O_2$  and an individual atom of oxygen, a continuing process called the ozone-oxygen cycle.
- Chemically, this can be described as:



#### OZONE PRODUCTION IN THE STRATOSPHERE



#### Stratospheric Ozone Production



- About 90 percent of the ozone in the atmosphere is contained in the stratosphere. Ozone concentrations are greatest between about 20 and 40 kilometers (66,000 and 131,000 ft), where they range from about 2 to 8 parts per million.



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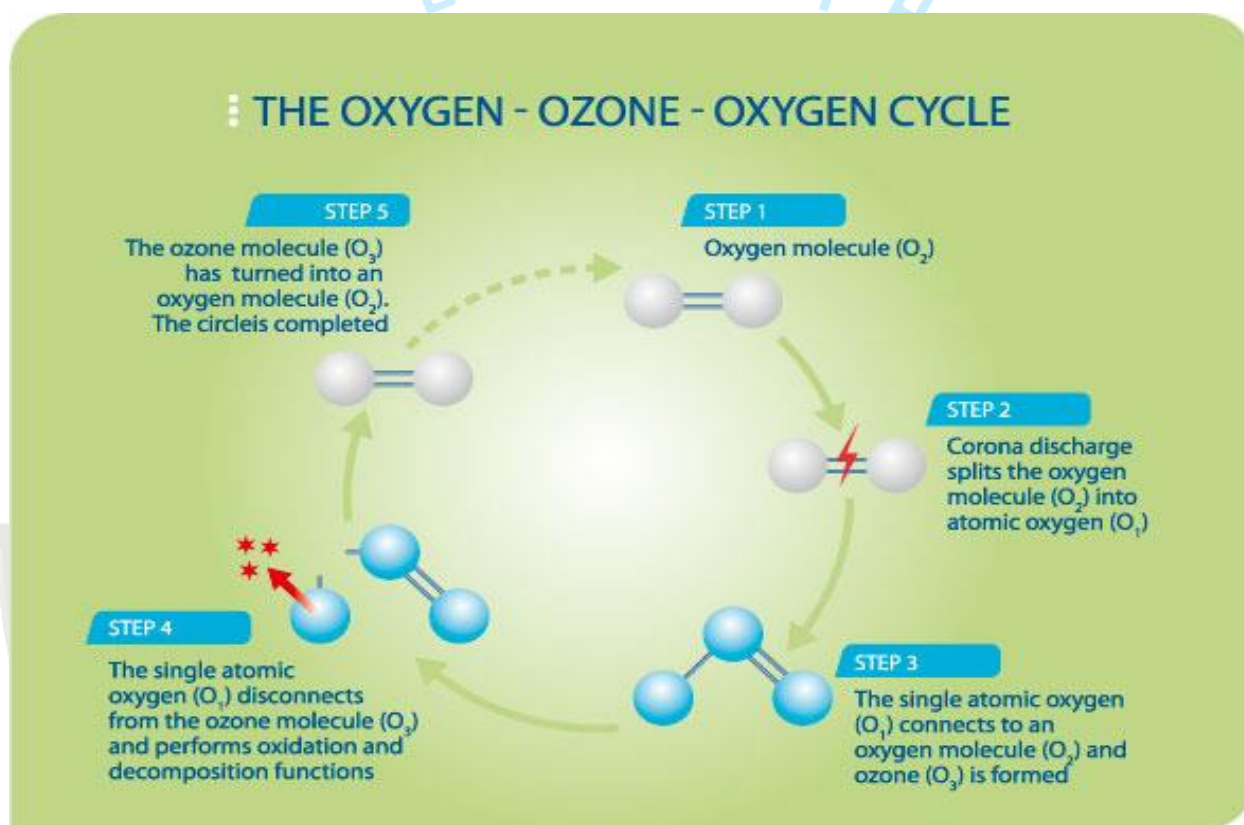
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- If all of the ozone were compressed to the pressure of the air at sea level, it would be only 3 millimetres ( $\frac{1}{8}$  inch) thick.

## OZONE-OXYGEN CYCLE





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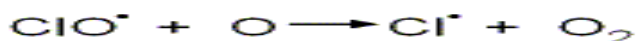
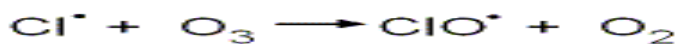
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## Q- Explain Importance of ozone layer

# DEPLETION OF OZONE LAYER

- Ozone's unique physical properties which providing an invisible filter to help protect all life forms from the Sun's damaging ultraviolet (UV) rays.
- Most incoming UV radiation is absorbed by ozone and prevented from reaching the Earth's surface.
- Ultraviolet radiation affects a plant's ability to grow and can cause skin cancer and cataracts in humans.
- Without the protective effect of ozone, life on Earth would not have evolved in the way it has.
- The ozone layer can be depleted by free radical present in atmosphere.
- For example nitric oxide (NO), nitrous oxide (N<sub>2</sub>O), hydroxyl (OH), atomic chlorine (Cl), atomic bromine (Br) etc., are mainly responsible for the depletion of ozone layer.
- These highly stable compounds are capable of surviving the rise to the stratosphere, where Cl and Br radicals are liberated by the action of ultraviolet light.
- Each radical is then free to initiate and catalyze a chain reaction capable of breaking down over 100,000 ozone molecules.

Simply above reaction also write as





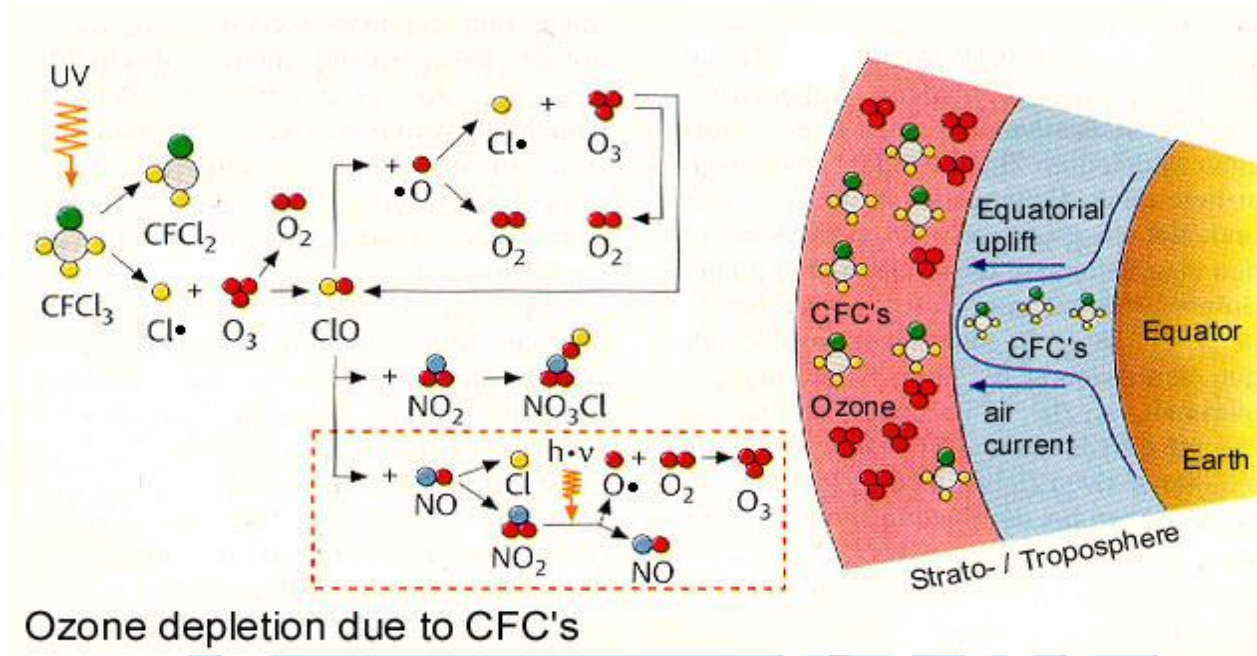
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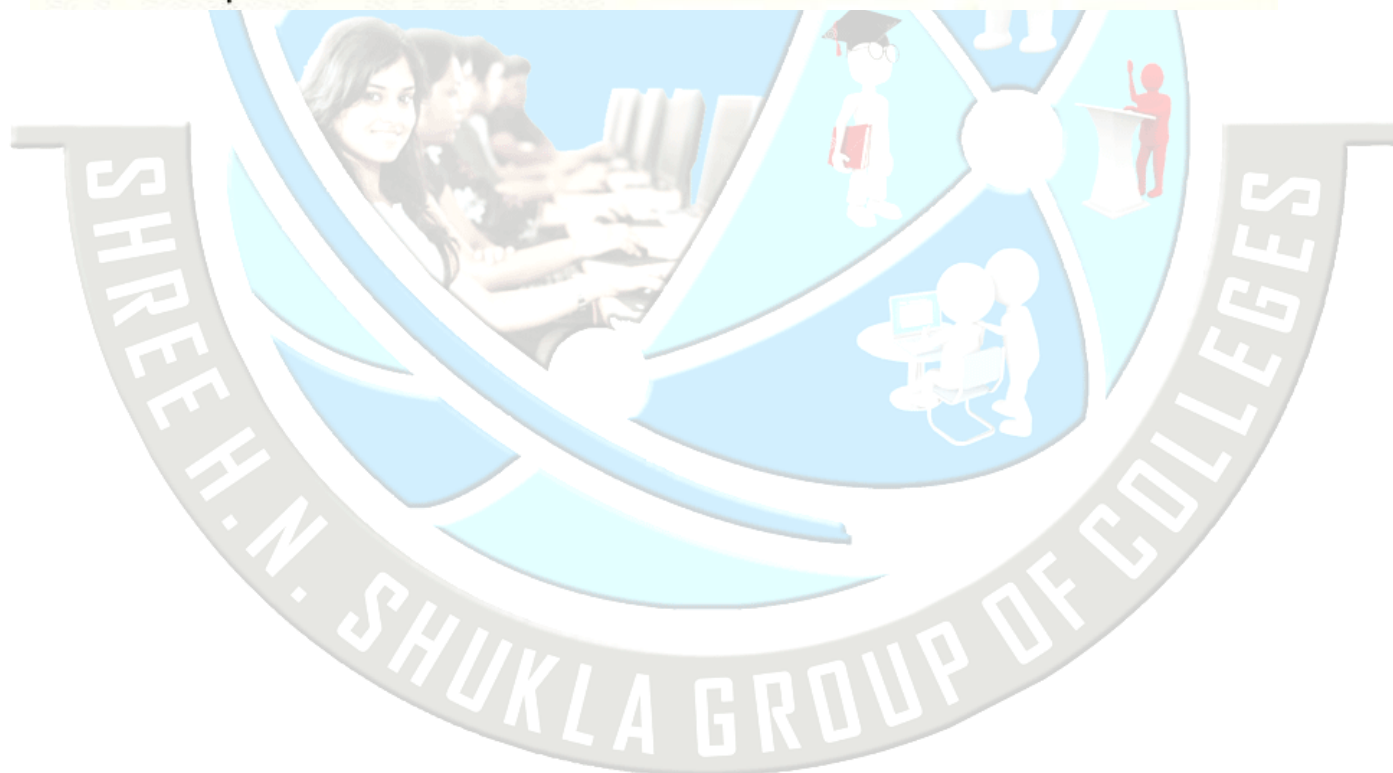
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Ozone depletion due to CFC's







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## EFFECTS OF DEPLETION OF OZONE LAYER

The depletion of ozone layer allows entering of UV rays from sun into the earth's atmosphere which is associated with a number of health related and environmental issues. Let us see its major impacts on human beings.

### Harm to human health

- More skin cancers, sunburns and premature of the skin.
- More cataracts, blindness and other eye diseases: UV radiation can damage several parts of the eye, including the lens, cornea, retina and conjunctiva.
- Weakening of the human immune system (immune suppression). Early findings suggest that too much UV radiation can suppress the human immune system, which may play a role in the development of skin cancer.

### Damage to marine life

- In particular, plankton (tiny organisms in the surface layer of oceans) is threatened by increased UV radiation. Plankton is the first vital step in aquatic food chains.
- Decreases in plankton could disrupt the fresh and saltwater food chains, and lead to a species shift in Canadian waters.
- Loss of biodiversity in our oceans, rivers and lakes could reduce fish yields for commercial and sport fisheries.



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## Animals

- In domestic animals, UV overexposure may cause eye and skin cancers.
- Species of marine animals in their developmental stage (e.g. young fish, shrimp larvae and crab larvae) have been threatened in recent years by the increased UV radiation under the Antarctic ozone hole.

## Materials

- Wood, plastic, rubber, fabrics and many construction materials are degraded by UV radiation.
- The economic impact of replacing and/or protecting materials could be significant.

## Adverse impacts on agriculture, forestry and natural ecosystems

- Several of the world's major crop species are particularly vulnerable to increased UV, resulting in reduced growth, photosynthesis and flowering.
- These species include wheat, rice, barley, oats, corn, soybeans, peas, tomatoes, cucumbers, cauliflower, broccoli and carrots.
- The effect of ozone depletion on the Canadian agricultural sector could be significant.
- Experiments results suggest that plant growth, especially in seedlings, is harmed by more intense UV radiation.