Atmospheric Pollution

- **Pollutant:** A pollutant is defined as undesirable matter present in excess in the environment.
- **Environmental pollution:** It is defined as the effect of undesirable changes occurring in our surroundings which has harmful effects on plants, animals and human beings.
- **Air pollution:** It is defined as the presence of a contaminant in the atmosphere in a concentration large enough to injure human, plant and animal life.
- **Smog:** A pollutant which is a combination of oxides of sulphur and nitrogen, partially oxidised hydrocarbons and their derivatives produced by industries and automobiles from a dark, thick dust and soot laden fog is known as smog.
- **Photochemical smog:** Smog formed by the photochemical reaction in the atmosphere is known as photochemical smog.

Types of Pollutants Present in the Atmosphere

Pollutants	Natural sources	Man-made sources
1. Oxides of carbon CO, CO_2	Respiration Volcanic eruptions	Combustion of fossil fuels Automobile exhausts Incomplete combustion of petrol and diesel
2. Oxides of sulphur SO_2 (major source) SO_3	Decay of vegetable matter and animals Volcanic eruptions	Burning of fossil fuels Exhausts from industrial plants such as sulphuric acid plants and smelting plants
3. Oxides of nitrogen NO, NO_2 (major source), N_2O	Certain microbes Lightening discharge	Fertiliser industry, nitric acid plants, automobile exhausts
4. Hydrogen sulphide H_2S	Volcanic eruptions	By-product in industrial processes
5. Particulates Dust, fumes, smoke, mist	Disintegration of soil and rocks	Various industrial smoke, insecticide, tobacco smoke, metallurgical plants, chemical processes

Factories in big cities release nitrogen dioxide and sulphur dioxide as their wastes. These gases dissolve in rainwater during rains and form nitrous acid and sulphurous acid. As the rain falls, these acids come down to the ground as acid rain.

- Acid rain refers to rain which has a pH less than 5.6. It is mainly caused by atmospheric pollutants.
- **Natural sources:** Bacterial decomposition, forest fires and volcanic eruptions.
- **Man-made sources:** Industries, smelting plants, power plants and automobile exhausts.

Formation of Acid rain

Oxides of nitrogen and sulphur interact with water vapour in the presence of sunlight in the atmosphere to form a mist of nitric acid and sulphuric acid, respectively. This mist remains as vapours at high temperature and condenses at low temperatures. These acids mix with rain (snow or fog) and fall down to the Earth resulting in acid rain.

Formation of nitric acid and nitrous acid

- Nitrogen and oxygen combine in the presence of thunder and lightning to form nitrogen oxide.
- Nitrogen oxide then gets oxidised in the atmosphere to form nitrogen dioxide. Nitrogen dioxide combines with water to form a mixture of nitrous acid and nitric acid.

$N_2 + O_2 \rightarrow 2NO$
(Nitrogen oxide)
$2NO + O_2 \rightarrow 2NO_2$
(Nitrogen dioxide)
$2NO_2 + H_2O \rightarrow HNO_2 + HNO_3$
(Nitrous acid) (Nitric acid)

Formation of sulphuric acid and sulphurous acid

1. Impurities in coal: Coal used in power plants contains up to 4% sulphur. On combustion, it forms pollutant sulphur dioxide (i.e. oxides of sulphur).

$S + O_2 \rightarrow SO_2$
(Sulphur dioxide)

2. Sulphur dioxide reacts with water vapour to form sulphurous acid.

$SO_2 + H_2O \rightarrow H_2SO_3$
(Sulphurous acid)

3. Sulphur dioxide can also be oxidised to sulphur trioxide.

$2SO_2 + O_2 \rightarrow 2SO_3$
(Sulphur trioxide)

4. Sulphur trioxide reacts with water vapour to form sulphuric acid.

$SO_3 + H_2O \rightarrow H_2SO_4$
(Sulphuric acid)

Impact of Acid Rain

1. **Changes the acidity of soil**
   The acids present in acid rain such as nitric acid, nitrous acid, sulphuric acid and sulphurous acid increase the acidity of soil.

2. **Affects water bodies and marine organisms**
   The water of lakes and rivers becomes acidic and may no longer support aquatic life.

3. **Material damage**
   It increases corrosion of metals, disintegrates paper and leather and weakens building materials such as marble, limestone, slate, mortar, statues and sculptures.

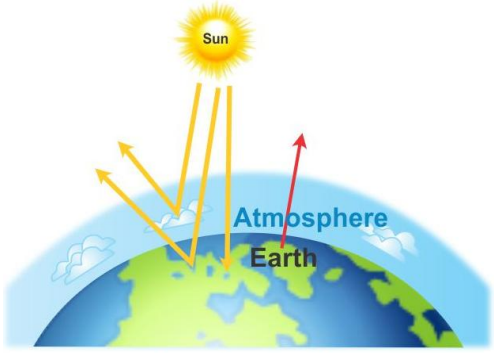
4. **Impact on living things**
   Acid rain damages forests. It gets absorbed by plants and animals directly or indirectly and thus enters the food chain, affecting humans. It can affect a person's breathing at sufficiently high concentrations.

Global Warming

Global warming is excess accumulation of greenhouse gases such as carbon dioxide, methane, nitrous oxide, ozone and chlorofluorocarbon (CFC) which causes warming of the Earth.

Greenhouse Effect

- The greenhouse effect is the process of heating up of the Earth's atmosphere due to trapping of the Sun's infrared radiations reflected from the Earth's surface by gases such as carbon dioxide, water vapour, nitrous oxide, ozone and methane, which are called greenhouse gases.
- These gases act as a thermal blanket and do not allow the heat energy to escape, thus causing the heating up of the atmosphere.
- Because of the greenhouse gases like carbon dioxide, the planet is ideally warm for the survival of life. However, excess accumulation of greenhouse gases is causing further warming of the Earth which results in **global warming**.



Greenhouse Effect

Ozone

Ozone is a light bluish gas found in the upper layer of the atmosphere called stratosphere. It is a poisonous gas with a chlorine-like smell.
It is formed by the action of ultraviolet rays of the Sun on oxygen.

$$\underset{\text{(Oxygen)}}{3O_2} \rightarrow \underset{\text{(Ozone)}}{2O_3}$$

- The ozone layer acts as a blanket in the atmosphere at a height of 16 km above the Earth's surface.
- It absorbs harmful ultraviolet rays (UV radiations) coming from the Sun and prevents them from reaching the surface of the Earth.

Depletion of the Ozone Layer

The decrease in the quantity of ozone in the upper layer of the atmosphere is called depletion of ozone. This is also known as ozone hole. Due to this hole, ultraviolet rays of the Sun can reach the Earth and cause diseases such as skin cancer.
Pollutants such as oxides of nitrogen and chlorine free radicals are produced in the atmosphere. Molecules of ozone react with these pollutants and are destroyed. This causes **depletion of the ozone layer.**

Harmful Effects of the Ozone Layer

1. Ozone is a poisonous gas. It causes respiratory problems.
2. It damages vegetation (plants and trees).
3. It causes damage to automobile tyres and asphalt.
4. In the stratosphere, the reactive species of chlorine get locked up and are unable to stop depletion of the ozone layer. Locking of chlorine monoxide and chlorine free radicals is called scavenging. In the atmosphere, nitrogen dioxide scavenges chlorine monoxide and methane scavenges chlorine atoms. These scavengers react with chlorine monoxide and chlorine free radicals [Cl].

$$ClO(g) + NO_2 \rightarrow ClONO_2(g)$$

$$Cl(g) + CH_4(g) \rightarrow CH_3(g) + HCl(g)$$