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8 ATMOSPHERIC POLLUTION

SYLLABUS

Acid rain – composition, cause and its impact.
Sulphur in fossil fuels giving oxides of sulphur when burnt. High temperatures in furnaces and internal combustion engines produce oxides of nitrogen. (Equations to be included). Acid rain affects soil chemistry and water bodies.
Global warming
Greenhouse gases – their sources and ways of reducing their presence in the atmosphere.
(Water vapour, carbon dioxide, methane and oxides of nitrogen).
Ozone depletion
Formation of ozone – relevant equations
Function in the atmosphere.
Destruction of the ozone layer – chemicals responsible for this to be named but reactions not required.

8.1 INTRODUCTION

The environment comprises the physical and biological world in which we live, that is, air, water and land. It changes from region to region, since it results from a combination of different factors.

Industrial activities and faster modern modes of transport add harmful substances to the environment. These substances are harmful and potentially toxic. They are considered to be the principle cause of pollution.

Environmental pollution is the effect of undesirable changes in our surroundings that have a harmful effect on plants, animals and human beings.

The word 'pollution' is derived from the Latin word 'pollutes', which means "made dirty". Pollution is created by harmful substances generally produced by human beings. At times, nature also pollute the environment. The substances (pollutants) that contaminate and degrade earth's environment have an adverse impact not only on human life but also on plants and animals. Nature certainly has the capacity to accommodate some of these pollutants by way of recycling or storage in harmless form. However, when these pollutants are added to the environment at a rate much faster than nature, it leads to the deterioration of environment.

Toxic and otherwise harmful substances that have an undesirable impact on different components of the environment and life forms, are known as **pollutants**.

On the basis of their origin (sources), pollutants are of two types : natural and man-made.

Natural sources of air pollutants

- **Volcanoes.** Volcanoes release large amounts of air pollutants such as carbon monoxide, sulphur dioxide, hydrogen sulphide, chlorine, hydrogen chloride, hydrocarbons and particulates.
- **Decaying vegetation.** Microbial action on organic matter in soil releases pollutant *i.e.*, nitrous oxide.
- Forest fires release poisonous gas carbon monoxide.
- Winds and dust storms carry particulate matter like sand and dust.

Man-made sources of air pollutants

- **Automobiles** use diesel or petrol as fuel. Incomplete combustion of these fuels releases carbon monoxide, sulphur dioxide, hydrocarbons, nitrogen oxides and particulates like lead.
- **Factories** release carbon dioxide, sulphur dioxide, nitrogen monoxide and particulates.
- **Industrial processes** release different types of air pollutants, depending upon the type of process involved.

  Examples : Coal power plants release carbon monoxide, sulphur dioxide, ash and smoke. Fertilizer industries release nitrogen oxides and ammonia.

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- Decay of crop residue in rural areas is the main source of carbon monoxide and methane.

8.2 AIR POLLUTION

Air pollution means degradation of air quality due to concentration of harmful contaminants that affects human, plant and animal lives.

Table 8.1 : Gaseous components of 'ordinary' dry air (non-polluted)

Pure air components	(by volume) percent proportion	Concentration ppm (parts per million)
Nitrogen	78·08	780,900
Oxygen	20·94	209,400
Inert gases		
Argon	0·93	9300
Neon		18
Helium		5
Krypton		1
Xenon		1
Carbon dioxide	0·03	315
Methane		1
Hydrogen		0·5
Natural pollutants		
Oxides of nitrogen		0·52
Ozone		0·02

If composition of air is altered, it affects not only human life but also animal and plant life, and the atmosphere is then said to be polluted.

Air pollution is caused due to the presence of gaseous pollutants like oxides of sulphur, nitrogen, carbon, hydrocarbons, and particulate pollutants like dust, smoke, mist, spray and fume.

8.2.1 Gaseous pollutants and their effects

Sulphur dioxide affects yield of crops and causes damage to lungs.

Hydrogen sulphide gas reduces growth of crops and causes irritation to human eyes.

Fluorides cause destruction of vegetation and affects teeth and bones.

Nitrogen oxides cause death of many plants and are suspected to cause cancer.

Carbon monoxide prevents haemoglobin from carrying oxygen to different parts of the body.

Tobacco smoke causes lung cancer.

Lead, which enters air from motor vehicles using tetraethyl lead, impairs the body's metabolic activities.

Cotton dust produces lung fibrosis and **smoke particles** cause asthma and other lung diseases.

A pollutant, which is a combination of oxides of nitrogen and sulphur and of partially-oxidized hydrocarbons and their derivatives produced by industries and automobiles forms a dark, thick, dust and soot laden fog and is known as **smog**.

Smog is noxious and irritating. It reduces visibility, induces respiratory troubles, and can cause death by suffocation.

The other main pollutants together contribute to more than 90% of global air pollution, and they are as follows :

- Nitrogen oxides (N_2O, NO and NO_2)
- Hydrocarbons (mainly methane, CH_4)
- Sulphur oxides (SO_2 and SO_3)
- Hydrogen sulphide (H_2S)
- Carbon monoxide (CO)
- Particulates (small solid particles and liquid droplets)

Oxides of nitrogen as air pollutants

Nitric oxide (NO) and nitrogen dioxide (NO_2) enter the atmosphere in the following ways :

- On burning of fuels in **furnaces**, temperature increases. At high temperature, nitrogen and oxygen present in air combine to form oxides of nitrogen.
- When fuel burns in an **internal combustion engine**, oxides of nitrogen are produced, and they enter the atmosphere as exhaust gases from automobile engines.
- Nitric acid is formed by the reaction between atmospheric nitrogen and oxygen in the presence of electric discharge, which happens during thunder storms, when there is lightning.

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- Nitric oxide further reacts with atmospheric oxygen (O_2) and ozone (O_3) to form nitrogen dioxide.

$$2NO + O_2(g) \rightarrow 2NO_2(g)$$

$$NO(g) + O_3(g) \rightarrow NO_2(g) + O_2(g)$$

Harmful effects of the oxide of nitrogen

Nitrogen dioxide (NO_2) is very harmful to plants and animals.

1. It causes irritation in mucous membrane.
2. Large concentrations of NO_2 may cause serious lung diseases.
3. Nitrogen dioxide causes serious injury to vegetation; it damages plant leaves.
4. In sunlight, nitrogen dioxide oxidizes hydrocarbons to form photochemical smog. *Photochemical smog causes eye irritation, asthma attacks and nasal and throat infections.*

Compounds of sulphur as pollutants

Compounds of sulphur like sulphur dioxide (SO_2), sulphur trioxide (SO_3) and hydrogen sulphide (H_2S) are pollutants.

1. **Hydrogen sulphide (H_2S)** is produced by decaying organic matter, such as rotten vegetables, by sewage and certain industrial operations.

Harmful effects of hydrogen sulphide

It causes nausea and irritates the eye and the throat. Being acidic in nature, H_2S destroys vegetable matter.

2. **Sulphur dioxide (SO_2) and sulphur trioxide (SO_3)** are produced by combustion of sulphur containing fuels like coal and oil. It is also produced by metallurgical processes involving sulphide ores.

Harmful effects of oxides of sulphur

- It causes headache, vomiting and even death due to respiratory failure.
- It destroys vegetation and weakens building materials/constructions.
- It mixes with smoke and fog to form smog, which is very harmful.
- It is oxidized by atmospheric oxygen into **sulphur trioxide (SO_3)**, which combines with water to form sulphuric acid (H_2SO_4). Sulphuric acid is the cause of acid rain.

$$2SO_2(g) + O_2(g) \rightarrow 2SO_3(g)$$

$$SO_3(g) + H_2O(l) \rightarrow H_2SO_4(aq)$$

Carbon monoxide (CO) as air pollutant

Carbon monoxide is formed by incomplete combustion of fuels in homes, factories and automobiles. Carbon monoxide is a highly poisonous gas.

If inhaled, it passes through the lungs directly into the blood stream. There it combines with haemoglobin, the substance that carries oxygen to body tissues. Because haemoglobin binds with carbon monoxide more than 200 times more strongly than does oxygen, even low concentrations of carbon monoxide in air have magnified effects on the body. *It reduces the oxygen-carrying capacity of blood by an amount equivalent to the amount of haemoglobin converted into carboxy haemoglobin.*

Haemoglobin + CO $\rightarrow$ Carboxy haemoglobin

Since heart and brain are the two tissues most sensitive to oxygen depletion, they show the most serious effects of carbon monoxide exposure. In high concentration, carbon monoxide may thus kill by paralyzing normal brain action.

Control of carbon monoxide pollution

Carbon monoxide pollution can be controlled in the following ways :

(a) By switching over from internal combustion engines to electrically powered cars.

Although the latter would transfer source of pollution to power companies, it is easy to control the pollution created by power companies.

(b) Many pollution control devices are now installed in cars. Most of these devices help reduce pollution by burning gasoline completely. Complete combustion of gasoline produces only carbon dioxide and water vapour.

$$2\underset{\text{octane}}{C_8H_{18}} + 25O_2 \rightarrow 16CO_2 + 18H_2O$$

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(c) By using substitute fuels for gasoline : Natural gas in both compressed (CNG) and liquefied forms (LNG) is now increasingly being used as fuel. Alcohols are other feasible substitutes.

(d) By using **catalytic convertors**

- Nitrogen oxide is reduced to nitrogen and oxygen in the presence of finely divided platinum or palladium as catalyst.

$$2NO \xrightarrow{Pt} N_2 + O_2$$

$$2NO_2 \xrightarrow{Pt} N_2 + 2O_2$$

- Carbon monoxide changes into carbon dioxide in the presence of finely divided platinum as catalyst.

$$CO \xrightarrow[[O]]{Pt} CO_2 + H_2O$$

Fig. 8.1

EXCERCISE 8 (A)

1. Define the following terms :
   (i) pollution (ii) pollutant
   (iii) air pollution.
2. Name any *four* gaseous pollutants.
3. Name the compounds of sulphur that cause air pollution. Also state the harmful effects of sulphur compounds.
4. State :
   (i) natural sources of air pollution
   (ii) man-made sources of air pollution
5. (a) How do oxides of nitrogen enter the atmosphere ?
   (b) What are their harmful effects ?
6. State the origin and health impact of smog.
7. What are the harmful effects of oxides of sulphur?
8. State the main sources and effects of carbon monoxide.
9. Give the mechanism of the action of carbon monoxide.
10. How can we control carbon monoxide poisoning?

8.3 ACID RAIN

The term 'acid rain' is used to describe all precipitations — rain, snow, fog, dew — that are more acidic than normal water. Normal rain is only slightly acidic, having pH about 5·6; this is because carbon dioxide reacts with it to form weak carbonic acid.

$$CO_2 + H_2O \rightarrow H_2CO_3$$

pH of acid rain usually ranges between 5·6 and 3·5; at times it can be as low as 2.

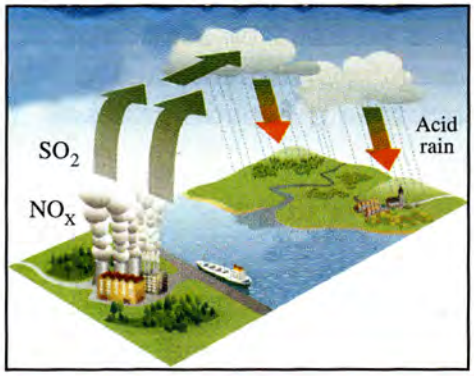
8.3.1 Composition of Acid Rain

Acid rain results from acids like nitric acid and sulphuric acid present in polluted air. These acids are formed when oxides of nitrogen and sulphur come into contact with rain water.

8.3.2 Causes of Acid Rain

Fossil fuels contain compounds of nitrogen and sulphur in addition to carbon. Due to combustion of these fuels, large amount of sulphur dioxide, oxides of nitrogen and carbon dioxide get discharged into the atmosphere. These oxides dissolve in rain water forming mineral acids.

The main cause of acid rain is the formation of mineral acids like carbonic acid, nitric acid and sulphuric acid, during rains.



Sulphur dioxide (SO_2)
Nitrogen oxides (NO_X) + Water vapour (clouds) → Acid rain

Fig. 8.2 Acid rain

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Formation of Nitric acid

Nitric acid is formed by the combination of nitrogen and oxygen, *i.e.* oxides of nitrogen. Nitrogen and oxygen combine in the presence of thunder and lightning. Oxides of nitrogen are also produced by **internal combustion engines** (automobile engines).

$$N_2 + O_2 \xrightarrow{\text{high temperature}} 2NO$$

Nitrogen oxide then gets oxidized in the atmosphere to nitrogen dioxide.

$$2NO + O_2 \rightarrow 2NO_2$$

Nitrogen dioxide combines with water to form a mixture of nitrous acid and nitric acid.

$$2NO_2 + H_2O \rightarrow HNO_2 + HNO_3$$

Formation of Sulphuric acid

Coal used in power plants contains up to 4% sulphur. Combustion of coal forms sulphur dioxide. Petroleum products also release sulphur dioxide on combustion.

Some sources of oxides of sulphur are chemical plants, metal-processing plants and copper, lead and zinc smelting industries. Sulphur is a non-metallic element found in coal (fossil fuels) and fuel oil. When these fuels are burned, sulphur combines with oxygen in air to form its gaseous oxides, sulphur dioxide (SO_2) and sulphur trioxide (SO_3).

$$S + O_2 \rightarrow SO_2$$
$$2SO_2 + O_2 \rightarrow 2SO_3$$

Sulphur dioxide and sulphur trioxide react with water to form H_2SO_4, which is the main cause of acid rain.

$$2SO_2 + O_2 + 2H_2O \rightarrow 2H_2SO_4$$
$$SO_3 + H_2O \rightarrow H_2SO_4$$

8.3.3 Impact of Acid Rain

(i) Acid rain affects **soil chemistry.** It removes calcium and potassium, both the **basic ingredients of soil,** thus making it lose its fertility, which ultimately damages forests. Acid rain causes loss of nutrients from plants, thus damaging their leaves.

(ii) Acid rain has serious ecological impacts, as it affects **water bodies** too. The water of lakes and rivers is gradually becoming acidic due to acid rain, which is affecting aquatic life.

(iii) Acid rain causes extensive damage to building and sculptural materials like marble, limestone, slate, mortar, etc. These materials become pitted and thus weaken mechanically.

$$CaCO_3 + H_2SO_4 \rightarrow CaSO_4 + CO_2 + H_2O$$
$$CaCO_3 + 2HNO_3 \rightarrow Ca(NO_3)_2 + CO_2 + H_2O$$

The **Taj Mahal** is facing this serious problem.

(iv) Acid rain increases corrosion of metals. *For example*, formation of rust on structures like iron gates and iron frames increases due to acid rain.

(v) Acid rain impacts humans too. In sufficiently high concentrations it can affect a person's breathing. Sulphur dioxide irritates the upper respiratory tract, the part of our body that serves to expel soot particles and dust from inhaled air. In lower concentrations, it injures lung tissues.

Reducing the impact of Acid Rain :

The impact of acid rain can be reduced by checking the root cause of acid rain, *i.e.* by reducing the emission of oxides of sulphur and nitrogen. This can be done by using coal or oil with low sulphur content.

We can also reduce such emissions by using a scrubber, a device that absorbs gaseous pollutants. A scrubber used for removing sulphur dioxide from a smoke stack usually consists of a fine spray of water and gas rising from the stack, which is passed through the scrubber, where water absorbs sulphur dioxide. Thus the formation of this constituent of acid rain is reduced.

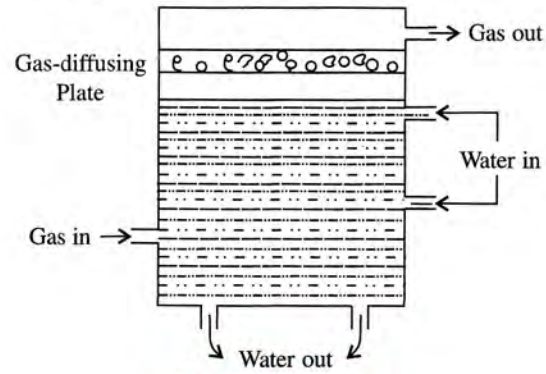

Fig. 83 A scrubber

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EXCERCISE 8 (B)

1. Why does rain water have pH less than 7 ?
2. pH of acid rain is sometimes as low as 2. Explain.
3. Explain the formation of acid rain due to :
   (i) oxides of sulphur (ii) oxides of nitrogen
4. What are the causes of acid rain ?
5. Give the impact of acid rain :
   (i) on plants (ii) on soil
   (iii) on water bodies.
6. How does a scrubber help in reducing the formation of acid rain ?

8.4 GLOBAL WARMING

About three-fourth of the sun's energy reaching the earth is absorbed by the earth's surface, which causes an increase in the temperature of the earth's surface. Some heat is also trapped by green house gases, *i.e.* carbon dioxide, methane, nitrous oxide, ozone, chloro-fluoro-carbon compounds (CFC) and water vapour present in the atmosphere. This causes GLOBAL WARMING.

8.4.1 Green house effect

Heating of the earth and its environment due to solar radiation trapped by carbon dioxide and water vapour in the atmosphere is called **greenhouse effect**.

The name green house comes from glass structures called green houses that are used to grow green plants in the colder regions of the earth. The glass structure allows sunlight to enter it but does not allow the radiated heat to escape, thus heating up the green house.

8.4.2 Greenhouse gases :

Gases that contribute to greenhouse effect are carbon dioxide, water vapour, oxides of nitrogen, methane, ozone, chloro-fluro-carbons, etc., and are thus called **green house gases**. The relative contributions of these gases towards green house effect is given in the following table :

Gases	CO_2	CH_4	CFC	O_3	N_2O	H_2O
% contribution	50	19	17	8	4	2

Sources of greenhouse gases : The major sources of greenhouse gases are :

Carbon dioxide

- Burning of fossil fuels like coal, natural gas and petroleum.
- Industrial processes like manufacture of lime and those seen in fermentation units.
- Biological decay of plants.
- Respiration by animals, human beings and plants.

Water vapours

The main source of water vapour is burning of hydrocarbons. This produces carbon dioxide and water vapour.

Hydrocarbon + Oxygen → Carbondioxide + Water vapour

Oxides of Nitrogen

Combustion of fossil fuels like coal, oil, natural gas, gasoline, etc. in automobiles and power plants produce high temperatures, whereupon nitrogen and oxygen combines to form nitric oxide and nitrogen dioxide. Some chemical industries also produce oxides of nitrogen as by-products.

Methane

It is emitted in large quantities during anaerobic decomposition of organic matter in soil, water and sediments. Incomplete combustion of fossil fuels also produces methane and other hydrocarbons.

Mechanism of Green House effect

Sunlight reaching the earth consists of three types of radiations, namely, ultraviolet (UV) radiation, visible radiation and infra-red (IR) radiation. As sunlight passes through the atmosphere, most of the UV radiation is absorbed by ozone; 30% of IR radiation reaches the earth's surface, heating up the surface. As the earth becomes hot, it starts emitting radiations with less energy than the incoming radiations and thus with longer wavelength. Some emitted infrared radiations escape from the earth's surface and some are absorbed by CO_2, thus remaining on the earth.

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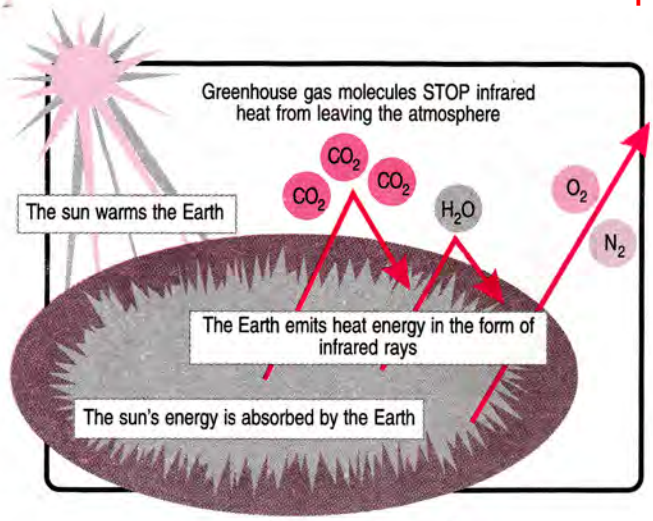

Fig. 8.4 Green House effect

Trapped radiation warms both the earth's surface and the lower parts of the atmosphere.

Advantages of Green House effect

- Green House effect has played an important role in the evolution of life on earth. Without the Green House gases, all the heat coming from the sun would have escaped from the earth, which would then become as cold and barren as the moon.
- It is necessary for evaporation of water and formation of clouds, leading to rain.

Although green house gases are important for survival of life on earth, there is an optimum level for them. If the proportion of Green House gases increases, earth's surface temperature will also rise. Rise in average temperature of the earth's surface is called **Global Warming.** A slight increase in the world's temperature, say, of 1°C to 3°C, can have far-reaching consequences for the earth's environment.

Effects of Global Warming

- **Rise in sea level :** Due to global warming, glaciers and polar ice caps have started to melt, and gradually this may lead to an increase in sea level. This will in turn flood several coastal areas in countries like India, Bangladesh, Netherlands and Maldives.
- Global warming will cause more water to evaporate from water bodies, thus forming more water vapour. Since water vapour also contributes to green house effect, global warming will further increase.
- Global warming can lead to changes in rain pattern and thus shift in crop zones. For example, the wheat producing zones will shift from Russia and Canada to the less fertile polar regions.
- Change in rain pattern due to global warming will also affect trees and plants in forests that are natural habitats of wild life. With destruction of forests many species of wild life will also begin to die out.

Note : If the level of CO_2 continues to rise at the present rate, the earth will become warmer by 1°C to 3°C by 2050 A.D.

Ways of Reducing Global Warming

(i) Minimize use of automobiles : depending on the situation, one can use bicycle or the public transport system and car pools.

(ii) Plant more trees to increase the green cover.

(iii) Avoid burning of dry leaves, wood, etc.

(iv) Avoid smoking. It is illegal to smoke in public places and work places, because smoke is harmful not only for the one who is smoking but also to others sitting nearby.

(v) Help the people in understanding global warming; most people are unaware of it.

EXCERCISE 8 (C)

1. What do you understand by Green House effect?
2. What are green house gases. How are they responsible for global warming ?
3. State the sources and effects of the following gases:
   (i) Carbon dioxide (ii) Methane
   (iii) Water vapour
4. State the ways of reducing the presence of green house gases.
5. State the effects of green house gases on the atmosphere.
6. State the role of a green house in growing plants.
7. Our atmosphere acts as a green house. Explain.
8. How can we reduce global warming ?

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8.5 OZONE

Ozone is a light bluish gas found in the upper layer of atmosphere (stratosphere). Ozone is formed by the action of ultraviolet rays of the sun on oxygen.

$$3O_2(g) \rightarrow 2O_3(g)$$

8.5.1 Function of ozone in the atmosphere

The ozone layer acts as a blanket in the atmosphere above 16 km from the earth's surface. Ozone absorbs the harmful ultra-violet rays coming from the sun and thus prevents them from reaching the earth. Thus it protects the life on earth from harmful effects of ultra-violet rays that can :

(i) cause skin cancer

(ii) destroy many organisms necessary for life in general.

High energy ultra-violet radiation, also known as far **UV,** helps in breaking oxygen molecules into oxygen atoms.

$$O_2 + UV \rightarrow O + O$$

Oxygen atom then reacts with oxygen molecule to form ozone.

$$O + O_2 \rightarrow O_3$$

Net reaction : $3O_2 + UV \rightarrow 2O_3$

The ozone produced absorbs UV radiations of comparatively longer wave lengths forming oxygen molecule and oxygen atom.

$$O_3 \rightarrow O_2 + O$$

8.5.2 Destruction of ozone layer

Decrease in quantity of ozone in the upper layer of atmosphere is called DEPLETION OF OZONE, which leads to the formation of an OZONE HOLE. Due to the ozone hole, ultraviolet rays of the sun reach the earth and cause diseases like skin cancer. In 1980, scientists detected an ozone hole above Antarctica.

An equilibrium is set up between generation and destruction of ozone such that, under normal conditions, ozone concentration remains constant. Pollutants like oxides of nitrogen, free chlorine radicals, etc. are produced in the atmosphere. Molecules of ozone react with these pollutants and

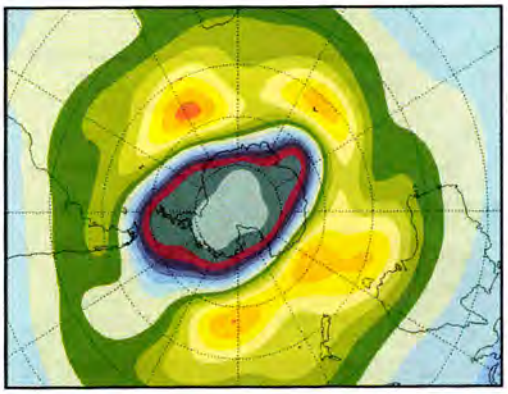

Fig. 10.5 Ozone hole — depletion

get destroyed. This causes DEPLETION OF OZONE LAYER.

8.5.3 Chemicals responsible for destruction of ozone layer

(1) Excessive use of chlorofluoro carbons : Chloro-fluoro-carbons (freons) enter the atmosphere because of their excessive use in solvents, aerosol sprays, propellants, refrigerants and blowing agents for plastic foams.

Chloro-fluoro-carbons are decomposed by ultra-violet rays to highly reactive chlorine, which is produced in its atomic form.

$$CF_2Cl_2(g) \xrightarrow{\text{Ultraviolet rays}} CF_2Cl(g) + Cl(g)$$

(free radical)

This free radical [Cl] reacts with ozone, and chlorine monoxide is formed.

$$Cl(g) + O_3(g) \rightarrow ClO(g) + O_2(g)$$

This causes depletion of ozone, and chlorine monoxide further reacts with atomic oxygen to produce more free radicals of chlorine.

$$ClO(g) + O(g) \rightarrow Cl(g) + O_2(g)$$

Again this free radical [Cl] destroys ozone, and the process continues, giving rise to large-scale ozone depletion.

(2) Fuel of planes : When the fuel of planes burn, a large quantity of nitric oxide and other gases are emitted in the atmosphere. Nitric oxide reacts with ozone to form nitrogen dioxide and nitrogen trioxide.

$$NO(g) + O_3(g) \rightarrow NO_2(g) + O_2(g)$$

$$NO_2(g) + O_3(g) \rightarrow NO_3(g) + O_2(g)$$

This also causes depletion of ozone.

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Harmful effects of ozone

Ozone is a poisonous gas with a chlorine like smell.

(i) It causes respiratory problems.

(ii) It damages plants and trees.

(iii) It causes damage to automobile tyres and asphalt.

In the stratosphere, the reactive species of chlorine gets locked up and is thus unable to stop depletion of ozone.

Locking of chlorine monoxide and free radicals of chlorine is called SCAVENGING. In the atmosphere, nitrogen dioxide scavanges chlorine monoxide and methane scavanges chlorine atoms. These scavangers react with chlorine monoxide and free radicals of chlorine (Cl).

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

Table 8.2 : List of major air pollutants : Their origin and health impact

Pollutants	Origin	Health impact
Carbon monoxide	Produced due to incomplete burning of petrol, diesel, wood and tobacco.	Reduces oxygen in blood causing retardation and dizziness.
Carbon dioxide (CO_2)	Produced by burning of coal, oil and natural gases.	Reduces oxygen levels.
Chloro-fluoro carbons (CFC)	Released by refrigerators and air-conditioning systems.	Reduces ozone layer that protects us from the harmful ultraviolet rays of the sun.
Lead	Present in petrol, diesel, paints and batteries.	Damages the nervous and digestive systems and can cause cancer.
Ozone	Emissions from vehicles and industries.	Burning, itching, watery eyes and lowered resistance to respiratory diseases.
Oxides of nitrogen	Produced during burning of petrol, diesel and coal.	Smog (combination of fog and smoke) produces acid rain that makes children more susceptible to respiratory diseases.
Sulphur dioxide (SO_2)	Produced from burning of coal, petrol and diesel.	Smog and acid rain containing sulphuric acid make children more susceptible to respiratory diseases.
Suspended particulate matter (SPM)	Solids suspended in smoke, dust and vapour.	Small particles get lodged in the lungs and gradually damage the functioning of lungs.

CHAPTER AT GLANCE

- Environmental pollution is the effect of undesirable changes in our surroundings that have harmful effects on plants, animals and human beings.
- Pollution may be defined as contamination of air, water or soil by undesirable amounts of materials or heat and is caused by the concentration of substances that have harmful effects.
- Air pollution is caused due to the presence of (i) gaseous pollutants, like oxides of sulphur, nitrogen and carbon, (ii) by hydrocarbons, and (iii) by particulate pollutants like dust, smoke, mist and fume.
- Acid rain is a result of acids like nitric acid and sulphuric acid. These acids are formed when oxides of nitrogen and sulphur present in air come in contact with rain water.

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- Nitrogen and oxygen combine in the presence of thunder and lightining or inside internal combustion engines to produce nitrogen oxides, which get converted into nitrogen dioxide, which then reacts with rain water to form nitric acid.
- Sulphur present in fossil fuels forms oxides on burning; these oxides react with rain water to produce sulphuric acid.
- Acid rain causes damage to buildings and forests, corrodes metals, and even damages plants.
- Heating of the earth and its environment due to radiations of the Sun trapped by carbon dioxide and water vapour in the atmosphere is called **greenhouse effect**.

  The name green house has been adopted from a glass structure called a green house, which is used to grow green plants in the colder regions of the earth. The glass structure allows sunlight to reach inside it but does not allow reflected radiations to escape, thus heating up the green house.
- Rise in average temperature of earth's surface is caused by the radiations trapped in the earth's atmosphere.
- Due to global warming, glaciers melt, more water evaproates, and pattern of rain fall changes.

EXERCISE 8

1. What is a pollutant ?
2. What is the effect of the following pollutants on living beings (one in each case).
   (a) Fluorides (b) Smoke particles
   (c) Lead (d) Mercury compounds
   (e) Smog (d) Nitrogen oxide
3. What is air pollution? How does this pollution take place?
4. What are the components of clean, dry air ?
5. Name some particulate pollutants.
6. Why is cigarette-smoking harmful ?
7. What is smog ? State its damaging effects.
8. What do you understand by ppm ?
9. Describe the major air pollutants. How does carbon monoxide pollute our environment?
10. How do you propose to control :
    (a) carbon monoxide emission ?
    (b) SO_x emission?
11. Give the composition, causes and affects of acid rain.
12. Explain the effect of sulphur dioxide on the atmosphere.
13. Explain the formation of ozone in the atmosphere.
14. What is the function of ozone in the atmosphere ?
15. State the chemicals responsible for ozone layer destruction.
16. Name any two :
    (a) natural sources of atmospheric pollution.
    (b) gases which are responsible for the formation of acid rain.
17. Explain the term 'global warming'. State two ways by which global warming can be reduced.
18. State two effects of ozone depletion.
19. What is the cause of acid rain? Give any two impacts of acid rain.
20. Explain the methods of preventing acid rain.
21. State an advantage of CNG (Compressed Natural Gas).
22. State how CFC break ozone layer.
23. Describe the methods of saving ozone layer.
24. Fill in the blanks :
    (a) The pollutants such as NO_2, SO_2 and SO_3 dissolved in the moisture of air are the cause of .....
    (b) Excessive release of carbon dioxide in the atmosphere is the cause of ..... effect which produces global warming.
    (c) Ozone layer prevents the harmful ..... radiation of the sun to reach the earth.
    (d) Decrese of the concentreation of ozone in the stratosphere is the cause of formation of ..... holes.
    (e) Ozone depletion is mainly caused by the active ..... atoms generated from CFC in the presence of UV radiation.
25. Select the correct answer :
    (a) Excessive release of carbon dioxide in the atmosphere is the cause of
        (i) Depletion of ozone

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(ii) formation of polar vartex

(iii) global warming

(iv) formation of smog

(b) Inhalation of air polluted with carbon monoxide is dangerous because :

(i) CO combines with O_2 dissolved in blood.

(ii) CO combines with haemoglous of blood.

(iii) CO removes water from the body and causes dehydration.

(iv) CO causes coagilatin of preteins in the body

(c) Decrease of amount of ozone in stratosphere is called depletion of ozone and it is cused by

(i) UV radiations of sun

(ii) Use of CFC compounds

(iii) excessive use of detergents

(iv) Use of polychlorinated biphenys

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