# 32
# Atmosphere, Oxygen and Air Pollution

## 32.1 INTRODUCTION

Organisms have a close give and take relationship with their immediate environment. Oxygen from air is taken in during respiration and Carbon dioxide released into the atmosphere by majority of organisms. $CO_2$ is taken up by plants to manufacture food. But this harmonious relationship between organisms and nature has been disrupted by human activities. Intensive agriculture, industrialisation, urbanisation have degraded our physical resources and as a result soil, water and atmosphere have become highly polluted.

In this lesson we will define atmosphere and mention its constituents, discuss sources of air pollution and damage done to plant and animal life by atmospheric pollutants. We shall also outline measures that can stop further atmospheric pollution.

## 32.2 OBJECTIVES

After reading this lesson you will be able to :

- explain the composition of air.
- explain respiration, photosynthesis and decay cycle.
- cite examples of major air pollutants.
- recall sources of major air pollutants.
- identify relationship between carbon cycle and oxygen depletion by fossil fuel burning.
- define greenhouse effect.
- recognize factors causing greenhouse effect.

- explain global warming and its consequences.
- define ozone layer.
- explain depletion of ozone layer.
- explain acid deposition/acid rain.
- recognise ill effects of carbon monoxide on haemoglobin.
- list measures for reducing air pollution.

## 32.3 COMPOSITION OF AIR

The composition of clean, dry, unpolluted air remains constant. Natural atmospheric air is made up of gaseous and non gaseous constituents which are given below :

**(a) Gaseous :** Nitrogen and oxygen make up over 99% of volume of air. Other gases are $CO_2$, water vapour and inert gases such as argon, neon, krypton, helium.
xenon, ozone and radon are present in traces.

**(b) Non gaseous :** Smoke, Dust and Salt through evaporation from the sea are the non gaseous constituents of air.
Table 32.1 shows the proportion of various components of air

**Table 32.1 Components of air**

| GAS | CONCENTRATION |
|---|---|
| Nitrogen | 78 % |
| Oxygen | 21 % |
| Carbondioxide | 0.1 to 0.3 % |
| Inert gases (Argon and others) | 1 % |
| $SO_2$, $O_3$, Nitrogen-dioxide | Minute quantities |
| Water vapour | Varies from region to region. |

## 32.4 CARBON TRANSFER PATHWAYS–RESPIRATION, PHOTOSYNTHESIS AND DECAY CYCLE :

Carbon is actively cycled between inorganic carbon dioxide and various kinds of organic compounds of which organisms are made. It moves from inorganic to organic form through the activity of auto trophs (auto : self ; trophos : feed) the plants, which synthesize their own food through photosynthesis and form the "producers" in the food chain. The process which releases carbondioxide into the environment is respiration. It is a process indispensible for survival of almost all organisms. Another carbon transfer pathway is decay and decomposition of organic matter brought about by micro organisms.

### 32.4.1 Respiration

Respiration is a process of exchange of gases between organisms and atmosphere. Atmosphere is a reservoir of oxygen and organisms take in this oxygen for oxidation of food. Oxidation of food liberates energy. When oxygen reaches the cells of an organism, a series of enzyme catalysed reactions take place in which chemical bonds of glucose are broken, energy in the form of ATP is liberated and carbon-di-oxide is released. Carbon-di-oxide goes back into the atmosphere. (Fig. 32.1) Thus a considerable amount of Carbon-di-oxide is returned to the atmosphere through respiratory activity of organisms.

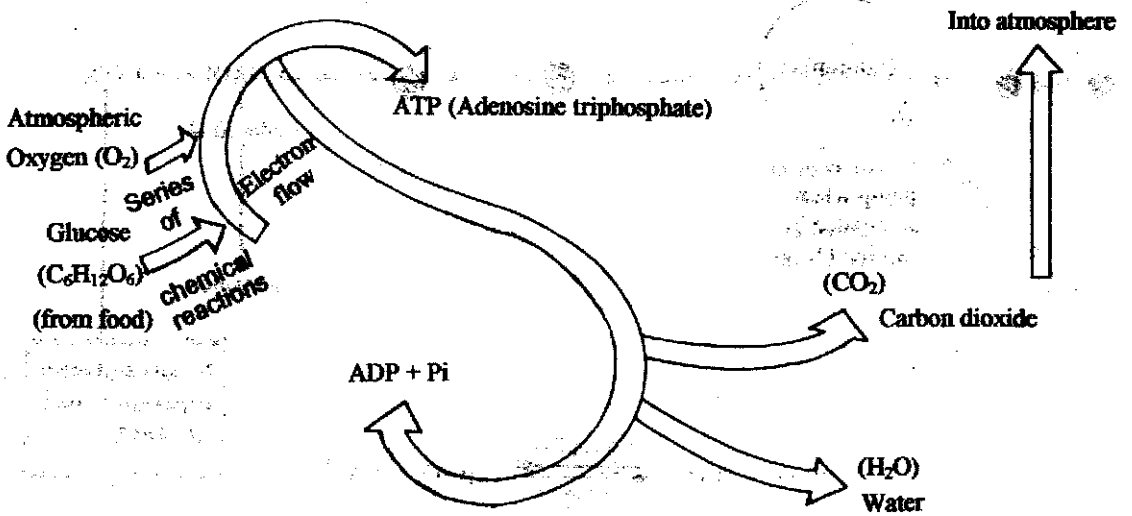


**Fig. 32.1 Cellular Respiration**

Fig. 32.1 shows cellular respiration in which oxygen oxidises glucose through a series of chemical reactions and an electron transport chain. Energy is released in the form of several molecules of ATP. $CO_2$ is given out and goes into the atmosphere. Some ATP molecules are also used up in the process and break up into ADP (adenosine diphosphate) and $P_i$ (inorganic phosphate).

### 32.4.2 Photosynthesis

Green plants pick up $CO_2$ from the atmosphere and water from soil. Leaves of green plants contain chlorophyll - the photosynthetic pigment. Leaves trap solar energy from sunlight. Light and the pigment interact. Then through a series of steps, starch is synthesized and Oxygen is liberated. Oxygen moves into the atmosphere (fig. 32.2). Infact for the first two billion years after living organisms evolved on earth, there was no oxygen. Oxygen of the atmosphere resulted from photosynthetic organisms.

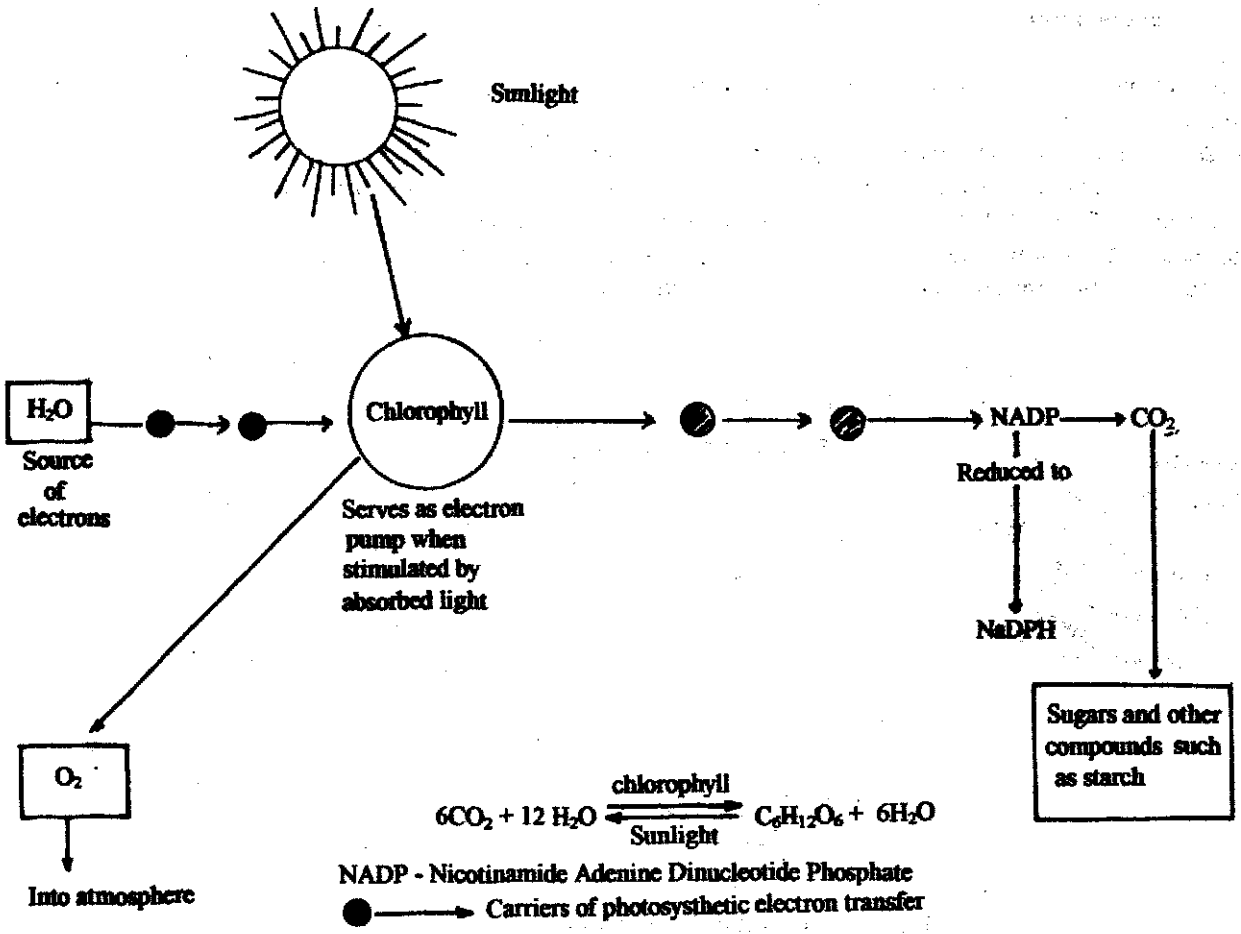


**Fig. 32.2 - Diagrammatic Representation of Photosynthesis in Plants.**

### 32.4.3 Decay

Micro organisms like bacteria and fungi bring about decay and decomposition of organic matter left after the death of organisms. As a result of microbial (by microorganisms) decomposition of partially digested organic matter and dead organisms, $CO_2$ is liberated and released into the atmosphere. Thus the decay cycle also adds $CO_2$ to the atmosphere.

In swamps, paddy (rice) fields and wet lands, anoxic (lack of oxygen) conditions prevail. Methanogenic bacteria convert low molecular weight fatty acids into methane in these areas. These bacteria can also convert $CO_2$ into $CH_4$ through a special anaerobic respiratory pathway. An anaerobic pathway is one in which respiration takes place and food is broken down in the absence of $O_2$. Since $CO_2$ is not available (as in case of aerobic respiration) to autotrophic

community of these areas, they are unable to carry out photosynthesis. Very few organisms, such as methanotrophs and nitrifers can oxidise methane and reintroduce carbon into the normal carbon cycle.

## 32.5 CARBON CYCLE IN NATURE

Carbon cycle is the most important biogeochemical gaseous cycle. Also, carbon is returned to the environment as fast as it is removed.

The richest source of carbon is the ocean where carbon exists as carbonate and bicarbonate ions. Carbon enters the atmosphere mainly as a product of aerobic respiration in the form of $CO_2$. Volcanic eruptions also release carbon from rocks deep in the earth's crust. $CO_2$ is taken in by plants for photosynthesis during which they use light energy for reducing $CO_2$. Plants are, therefore, termed photoautotrophs. (photo means light) There are other organisms such as some bacteria which use energy stored in chemical bonds for reducing carbons. They are termed **Chemoautotrophs**. Photosynthesis, however, is the most important process through which inorganic carbon is converted into organic form.

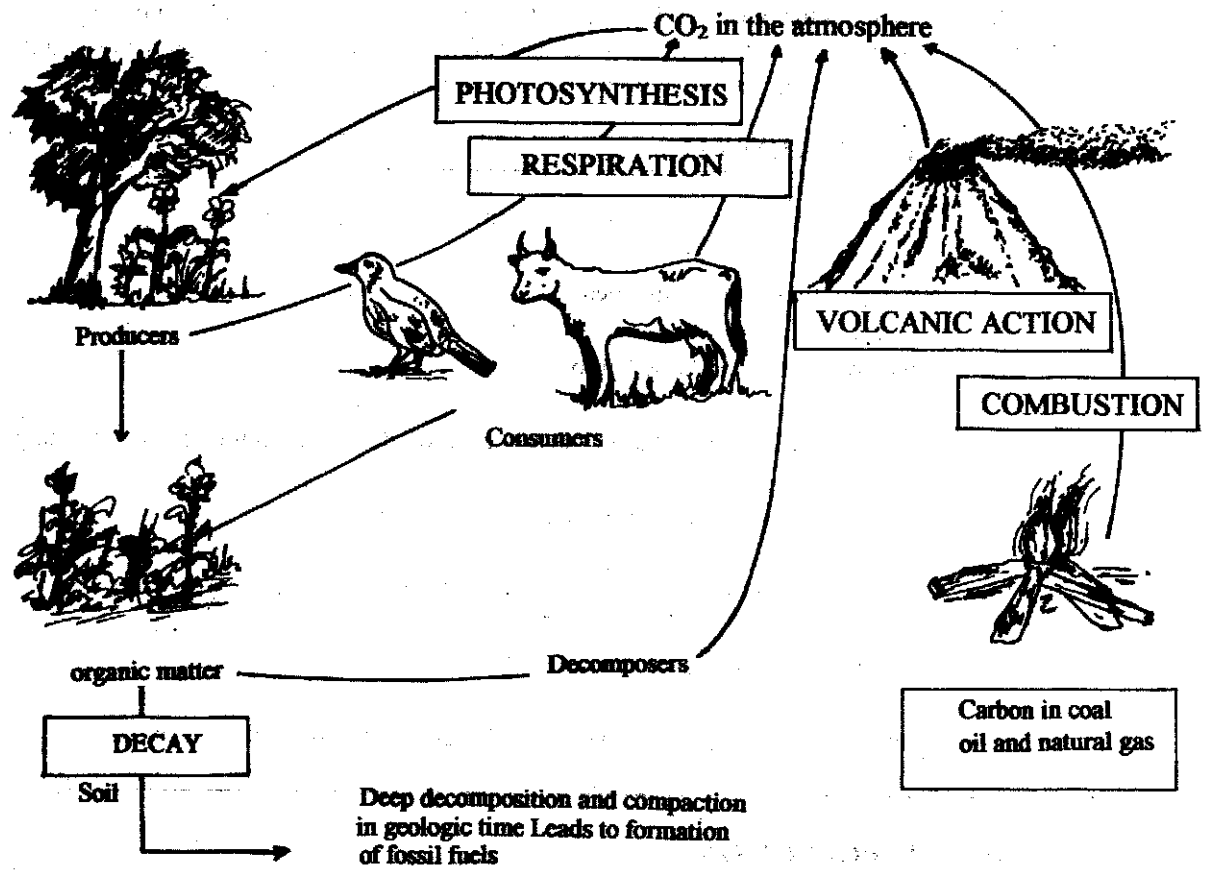


**Fig. 32.3 Carbon Cycle in Nature**

Carbon moves from atmospheric reservoir to the producers through photosynthesis for which $CO_2$ is taken up by them. Consumers eat producers. When producers and consumers die, decomposers reduce the organic matter of these dead organisms and carbon moves into the soil. Producers, consumers and decomposers add $CO_2$ to the atmosphere through respiration. Thus a balance in the proportions of $O_2$ and $CO_2$ is maintained in nature. (fig.32.3)

When trees die and fall, they get buried in the sediments and over a long geological time they become fossil fuels. Fossil fuels are buried deep in the soil. Carbon in this form remains unavailable till humans deliberately remove it.

## 32.6 OXYGEN DEPLETION AND INCREASE IN $CO_2$ LEVEL THROUGH FOSSIL FUEL BURNING

Human interference with the carbon cycle through fossil fuel burning, deforestation (cutting and felling trees), automobile and industrial emission and nuclear weapon testing have led to an increase in atmospheric $CO_2$. Fossil fuels such as coal and petroleum are dug out from natural coal mines and oil wells and burnt as fuel in industries and for domestic cooking etc. Deforestation, on the other hand, has depleted oxygen which is given off as a by product of photosynthesis. A rise in carbon dioxide has resulted in a rise in global temperature and a phenomenon called **greenhouse effect** about which you shall learn later in this chapter.

### INTEXT QUESTIONS 32.1

1. Which gas is present in the maximum amount in the atmosphere?

   .....

2. Name any two major constituents of air.

   .....

3. Which organisms are called autotrophs and why?

   .....

4. Name the food constituent which is broken down during respiration to liberate energy.

   .....

5. Which is the green photosynthetic pigment in plant?

   .....

6. How does carbon get into the environment from dead organic matter?

   .....

7. Are humans producers or consumers?

   .....

8. Name two physical phenomena by which carbon is fixed in the atmosphere.

   .....

## 32.7 AIR POLLUTION

You have just learnt how nature has its own means of using up and getting back its components

such as $CO_2$ and $O_2$. Now you know why environmentalists are deeply concerned about tree plantations and afforestation.

Undesirable changes have occured in the physical and chemical characteristics of air due to human activities. Undesirable changes in the atmosphere constitute air pollution. Pollutant gases such as $SO_2$ and $CO$, excessive amounts of $CO_2$ have been added to the atmosphere. Air pollutants may be classified as follows.

**Air Pollutants**

| Particulate pollutants | Liquid droplets | Gaseous pollutants |
|---|---|---|
| Soot | Hydrocarbons | $SO_2$ |
| Fly ash | | $H_2S$ |
| Flourides | | NO |
| Lead | | $NH_3$ |
| Dust from cement | | $CO_2$ and CO |
| and other factories | | Photo-chemical |
| Sodium chloride | | Oxidants($O_3$, PAN) |
| Agricultural chemicals | | Tobacco smoke |

### 32.7.1 Particulate Pollutants

Particulate pollutants such as soot and fly ash are released by various industries as by products of industrial processes. They are blown away by wind when they come out of the chimneys and other outlet of factories and mingle with air.

Suspended particulate matter is also emitted by exhaust of polluting diesel vehicles and ill-managed coal power plants. In nature, forest fires, wind erosion and volcanic eruptions add suspended particulate matter into air. Examples of particulate pollutants is soot, flyash from thermal power plants, cement dust, petrocoke from petroleum refineries. The particulate pollutants are discussed in detail below :

**Fluoride :** Aluminium, steel and electrochemical plants, blast furnaces, brick kilns, coal combustion, tile and glass etching factories add fluoride particles which settle on vegetation. They burn tips of leaves and when cattle eat the vegetation they suffer from fluorosis resulting in loss of teeth, weight and lameness. Humans also suffer from fluorosis. Volcanoes also release fluorides which form gaseous as well as particulate pollutant.

**Lead :** Lead particles come into air from automobile exhausts. Lead is used as an antiknock agent in automobile gasoline which contains tetraethyl lead. Paint, ceramic and pesticide factories also add lead particles to the atmosphere. Lead interferes with development of red blood corpuscles of blood and causes anemia (lack of haemoglobin -- the oxygen carrying pigment of blood). Pb is a cumulative poison and long exposure to lead may damage kidneys and liver.

**Dust :** Particulate matter less than 10 microns in size is dust. It reaches lungs, deposits along the respiratory tract and causes asthma or even lung cancer. Dust from stone crushers,

cement industries and lime kilns, asbestos dust, and coal dust cause diseases like silicosis and asbestosis which are respiratory problems due to deposition of silica and asbestos dust in the respiratory tract.

**Sodium chloride :** Sodium chloride is used to remove snow in winter and remains in the environment. Some sodium chloride is also added when waves of the sea spray it. Excess Sodium chloride has been found to cause defoliation (leaf falling), suppression of flowering and breaking of terminal shoots of apple.

**Agricultural chemicals :** Chemical insecticides, herbicides and other pesticides are known to have damaging effects on plants. They are toxic to animals and humans also. Residues of pesticides get suspended as particulate matter in air.

**32.7.2 Hydrocarbons :** Hydrocarbons which may be in the form of liquid droplets or gas pollute air. As liquid droplets they spill or are added through seepage of oil fields and natural gas leakage. Methane is emitted in the swamps and paddy fields by methanogenic bacteria. $CH_4$ is also generated in stomachs of ruminant animals. Incomplete combustion of fuels release 3-4 benzpyrene which causes lung cancer. Pesticides, paint solvents also release hydrocarbons. Methyl isocyanate gas accidentally leaked from pesticide factory in Bhopal in 1984 and killed many and caused serious problems to others. Hydrocarbons are a source of photochemical smog.

**32.7.3 Gaseous Pollutants :** $SO_2$, $CO_2$, nitrogen oxides are commonly added to the air by human activities. Excess of these have very serious damaging effects on the physical environment as well as on humans.

**$SO_2$ and $H_2S$** These are released into atmosphere through smelting of ores containing sulphur, manufacture of $H_2SO_4$, petroleum refining, combustion of fossil fuels, paper making, burning of sulphur containing refuse and in nature through volcanic eruptions. Plants exposed to $SO_2$ and $H_2S$ show defoliation (leaves falling off) and reduced growth.

In humans, $SO_2$ pollution causes headache, vomiting, irritation of eye and respiratory passages. $SO_2$ reacts with water to form $H_2SO_4$ which is washed down as acid rain about which you shall study later in the chapter.

**Nitrogen Oxides :** Anaerobic breakdown of nitrogenous compounds by bacteria is the natural source of nitrogen oxides. Burning fossil fuel also release them. Power generators, automobile exhausts, explosives and nitrogenous fertilizer industries form the other anthropogenic sources.

$NO_2$ causes early dropping off of leaves and fruits in plants. Nitrogen oxides are one source of photochemical smog, acid deposition and greenhouse effect.

**$CO_2$ and CO :** Combustion of oil, gas, coal and wood release $CO_2$ in the atmosphere. CO is released chiefly from gasoline engines and burning of coal in defective furnaces. Motor vehicles with internal combustion engines emit high levels of CO and hydrocarbon. Excess of $CO_2$ has caused global warming, CO causes photochemical smog and CO has a fatal effect when inhaled by humans.

**CO poisoning :** CO has a high affinity for haemoglobin. It combines with the blood pigment haemoglobin to form carboxyhaemoglobin. The normal function of haemoglobin is to carry $O_2$. But CO combines with Hb about two hundred times faster than $O_2$. Tissues do not get oxygen and die due to toxic effects of carboxyhaemoglobin which is dark red in colour. The victims of CO poisoning have dark red lips. Mild CO poisoning causes lung disorders like bronchitis and emphysema. CO from cigarette smoke makes haemoglobin non functional in smokers.

**Photochemical oxidants :** Primary pollutants such as nitrogen oxides and hydrocarbons mix in the atmoshpere and form secondary pollutants like peroxyacetyl nitrate (PAN) and Ozone, under the influence of UV radiation from the sun. Both PAN and $O_3$ form photochemical smog. PAN and $O_3$ are toxic to plants. In humans they cause irritation of eyes, coughing, headache, dry throat, respiratory problems and haemorrhage.

**Tobacco smoke :** Smoke from burning cigarettes or bidis contains nicotine and aromatic hydrocarbon like tar. These cause problems of blood pressure and heart, windpipe and lungs in the smoker as well as these around the smoker. Cigarette smoke is also carcinogenic. The various human activities which introduce air pollutants into the atmosphere are summarised in table 32.2.

**Table 32.2 Anthropogenic Sources of Air Pollution**

| ACTIVITY | POLLUTANTS |
|---|---|
| Burning of fossil fuels | $CO_2$, CO, $SO_2$, $NO_3$ hydrocarbons (including $CH_4$) particulate matter, flyash |
| Industrial activities | $SO_2$, particulate matter, photochemically reactive hydrocarbons, chlorofluoro carbons |
| Transportation practices | $CO_2$, CO, $NO_2$, smog forming hydrocarbons including $CH_4$ |
| Deforestation | Particulate matter CO, hydrocarbons |
| Burning vegetation and biomass | CO, $CO_2$, $NO_2$, particulate soot, polycyclic hydrocarbons. |
| Agricultural practices | $CH_4$ from digestive tracts of ruminants & rice cultivation in water logged soils, $N_2O$ by denitrification of nitrate fertilized soil by bacteria |

## INTEXT QUESTIONS 32.2

1. What is atmospheric pollution ?

   .....

2. Name two particulate pollutants.

   .....

3. Name two gaseous pollutants.

.....

4. Name one source of methane.

.....

5. Name two air pollutants which form photochemical smog.

.....

## 32.8 EFFECTS OF EXCESSIVE ATMOSPHERIC POLLUTANTS ON NATURE (OUTDOOR POLLUTION)

You are now familiar with the various atmospheric pollutants. Most of these are products of fuel combustion and have been released into atmosphere since human first started burning wood and coal. These pollutants have now accumulated in the atmosphere to a proportion whereby atmospheric composition has been significantly altered and physical phenomena such as photochemical smog, acid rain, ozone depletion greenhouse effect and global warming have appeared. These are damaging to plants, animals and humans.

The figure 32.4 (given on next page) shows the four major effects of atmospheric pollutants. In the diagram, arrows from the pollutant depicts its involvement in the physical phenomenon. The sources of the pollutants are depicted below the names of the pollutants. The four major phenomena are subsequently discussed one by one. They are photochemical smog, acid rain, greenhouse effect and ozone shield depletion.

## 32.9 TEMPERATURE INVERSION AND PHOTOCHEMICAL SMOG

Pollutants like sulphur dioxide which is released while burning sulphur containing fuel and particulate matter like soot present in stagnant air masses, get modified in sunlight and form a sheet called photochemical smog.

**Smog is a combination of fog, smoke and fumes released by mills and factories, homes and automobiles.**

When sunlight falls on stagnant air under low humid conditions in the presence of pollutants such as $SO_2$ soot, nitrogen oxide and hydrocarbons, photochemical smog is formed. (photochemical : chemical reactions in the presence of light) Smog stays close to the ground and reduces visibility.

Photochemical smog is also called *PAN smog* due to the production of peroxyacetyl nitrate or PAN and ozone which are formed from hydrocarbons and nitrogen oxides in the air in presence of solar radiation. PAN and Ozone are called photochemical oxidants. Both of these are toxic irritants of human lungs.

Smog formation is accompanied by *Temperature inversion or Thermal inversion*. Temperature inversion causes smog to settle and remain near the ground till wind sweeps it away. Normally, warm air rises up into atmosphere. When a layer of cool air at the ground level is held there by an overlying layer of warm stagnant air it is called **temperature or thermal inversion.** (Fig.32.5)

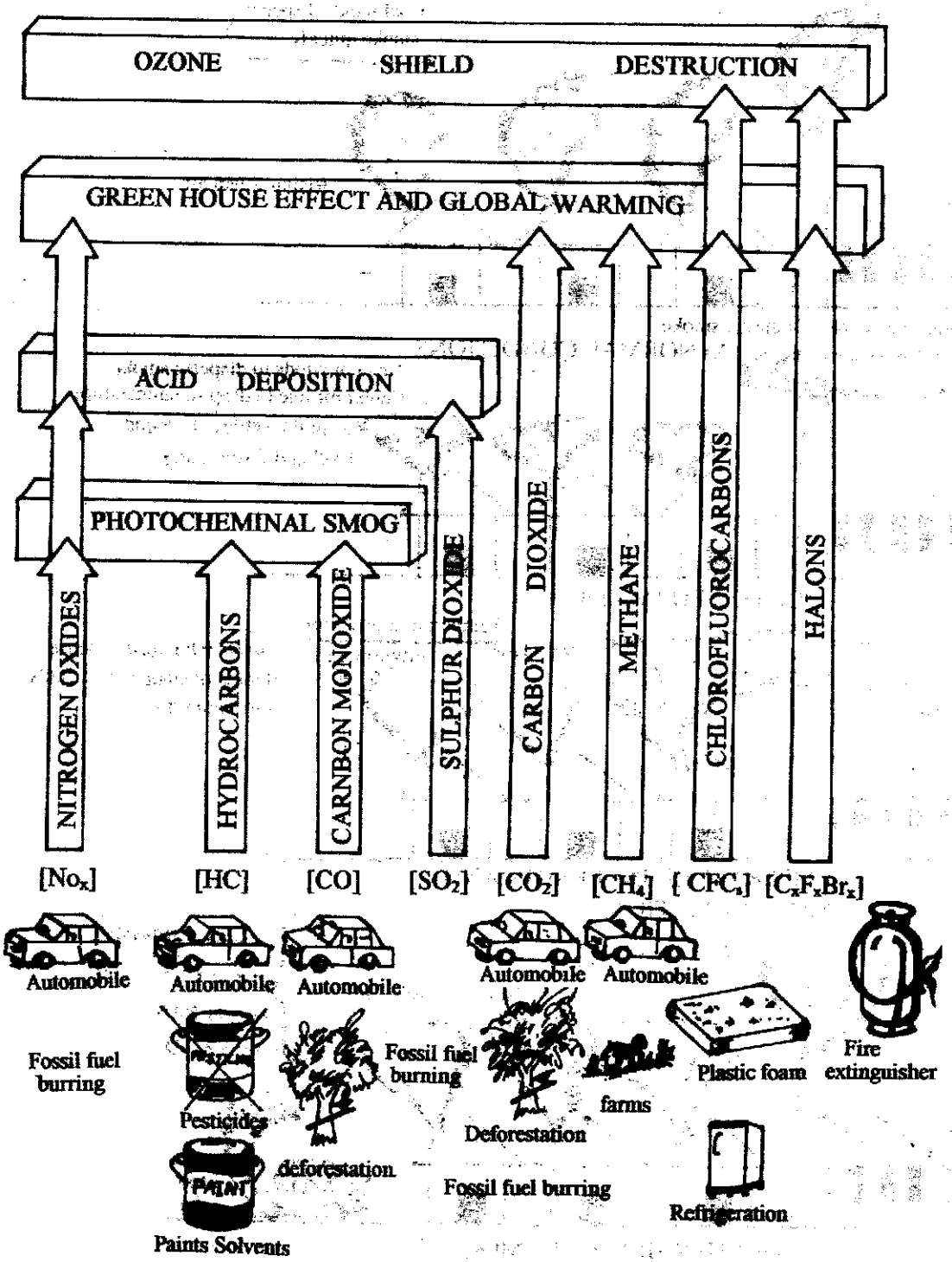


**Fig. 32.4 Four Major Effects of Atmospheric Pollutants**

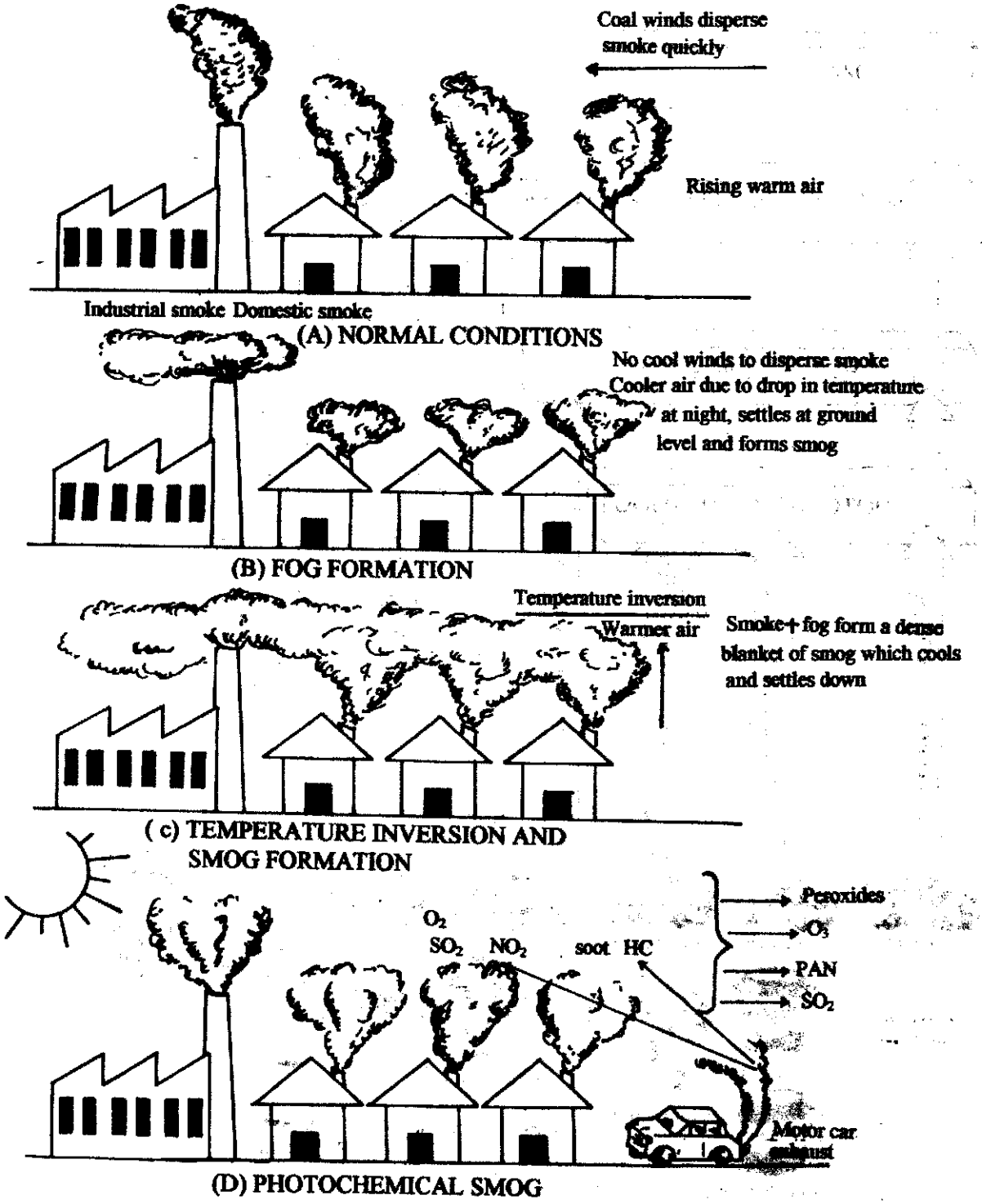


**Fig. 32.5 Formation of Photochemical Smog and Temperature Inversion**

**Exposure to smog causes respiratory problems, bronchitis, sore throat, cold, headache and irritation to eyes (red shot eyes). Smog also destroys crops and reduces crop yield.**

## 32.10 ACID RAIN

The coal and oil routinely burned by power plants release $SO_2$ into air. Automobile exhausts routinely add nitrogen oxides to the air. Both $SO_2$ and nitrogen oxides are converted into acids $HNO_3$ and $H_2SO_4$ when they combine with water vapour in the atmosphere. This reaction is promoted by $O_3$ in smog. The acids, so formed, return to earth as acid rain or acid snow or deposit as sulphate and nitrate salts.

Rain, even in its purest form is acidic with pH 5.6. But areas near coal and oil burning industries and where motor vehicles ply in large numbers, pH goes down to 2 and rain becomes strongly acidic. Mountain foot hills are the worst affected. There, as moisture laden air rises to higher altitudes it condenses to fall as rain or snow, dropping its load of pollutants. In spring, snow melts and adds pollutants to lakes and other water bodies.

When the dissolved pollutants drop as rain or snow, (**wet deposition**) it is termed **acid precipitation.** Deposition as dry gases and salts is **dry deposition.** Acid rain spreads over areas of several hundreds to several thousand kilometers.

### 32.10.1 Effects of Acid Rain

Some of the effects of acid rain are listed below :

(1) Excessive acid concentrations are phytotoxic. There have been widespread death of trees in forests due to acid rain.

(2) Sea waters are rich in minerals and have great buffering capacity. But buffering capacity of fresh water bodies is low and acid deposits have a toxic effect on the fresh water ecosystems.

(3) Mature (capable of reproduction) fish survive in acid rain fed water bodies but fail to reproduce. So there are no young fish in such waters.

(4) Exposed surfaces of buildings, statues get corroded. Limestone, $CaCO_3$ structures are specially damaged. (Fig. 32.6)

(5) Acidic sulphate when present in the atmosphere causes laziness. Acidic mist falling on the ground reduces visibility.

**Fig. 32.6 A Stone Statue Showing Corrosive effects of Acid Rain.**

## 32.11 GREEN HOUSE EFFECT AND GLOBAL WARMING

You must have seen delicate plants being grown in a glass chamber which is comparatively warmer inside than outside. Glass permits solar radiations to come in but restricts their outward movement. As a result, radiations get trapped inside the glass chamber.

Gases such as $CO_2$, $NO_2$, CFC, halons allow sun rays to pass through them but then absorb and reradiate the heat back towards the earth. These are, therefore, termed **greenhouse gases**.

### 32.10.1 Greenhouse Gases

The green house gases are listed below :

| | | | |
|---|---|---|---|
| (1) | $CO_2$ | - | from fossil fuel burning. |
| (2) | $NO_2$ | - | from fertilizer use and animal waste. |
| (3) | $CH_4$ | - | from bacterial decomposition, biogas flooded rice paddies. |
| (4) | CFC | - | from Freon, a refrigerant. |
| (5) | HALONS (halocarbons) | - | from fire extinguishers. |

### 32.11.2 How Does Earth's Atmosphere Trap Heat ?

Radiations from the sun penetrate the earth's atmosphere and reach earth. The surface of earth partially absorbs the radiation. The rest is re-radiated as infra radiation. In polluted air,

molecules of $CO_2$, $CH_4$, CFC, $N_2O$, $O_3$ and water vapour are present in excess. These gases can absorb infrared radiations. Energy of these trapped radiations raise the temperature of earth and its atmosphere. Thus if proportion of greenhouse gases increases in the atmosphere, heat trapped by them will raise the temperature of the earth and cause **global warming.** (Fig. 32.7)

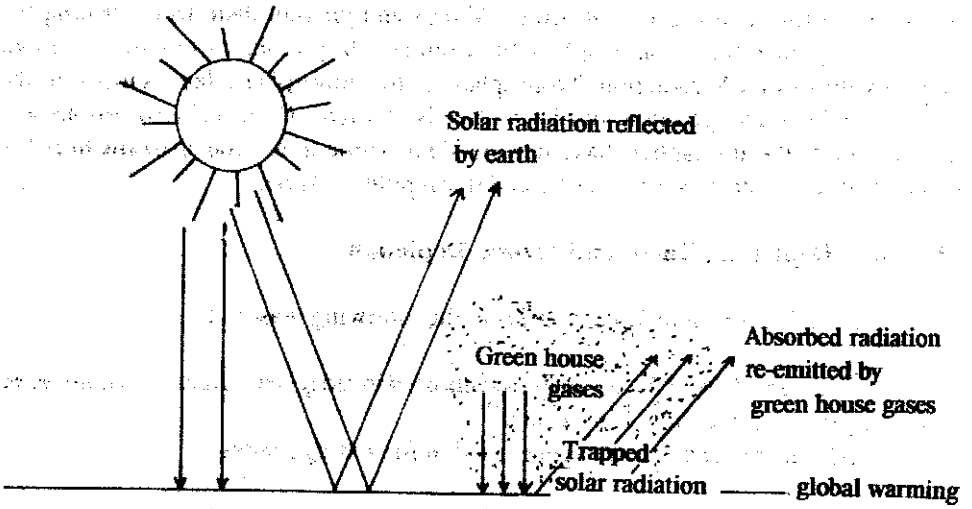


**Figure 32.7 Green House Effect**

### 32.11.3 Consequences of greenhouse effect

Greenhouse effect leading to global warming shall have severe effects on rainfall, sea level, plant growth and animals.

**(1) Rise in sea level :** It is estimated that by the turn of the century a rise of 5° C in global temperature will be due to effect of greenhouse gases if not checked now. Polar ice caps would melt because of rise in temperature and add more water to sea. In any case water expands when it heat up. This will lead to coastal flooding and loss of cities and coastal ecosystems such as marshes and swamps.

**(2) Drought :** A 3° C warming will result in 10% decrease in precipitation and this will decrease rain fall causing drought conditions.

**(3) Effect on plant growth :** Drought will cut down photosynthesis in plants and lead to reduced growth of plants.

**(4) Effect on animals :** Warmer conditions will encourage growth of pests.

**(5) Water shortage :** Increase in temperature will lead to increased evaporation leading to shortage of water for agricultural, municipal and industrial use.

Warmer conditions accelerate microbial degradation of organic matter and add more $CO_2$ and $CH_4$ to the atmosphere.

## 32.12 OZONE SHIELD DESTRUCTION

The atmosphere has two layers, the stratosphere and troposphere. Stratosphere lies 15 km-50 km above the surface of earth. The energy of the sun splits some molecular $O_2$ in this layer to give individual (O) atoms which combine with intact molecular oxygen to give $O_3$. The layer of $O_3$ forms a shield as it absorbs UV rays and prevent them from striking the earth. If UV rays penetrated our atmosphere life would not be possible as organisms cannot tolerate heavy doses of UV radiation. Troposphere is the atmospheric layer closest to the earth's surface whose composition you have already studied. Chloro fluorocarbons and halons released into the atmosphere have destroyed the ozone shield and an **ozone hole** has been detected at the south pole of Antartic and north pole of Arctic.

### 32.12.1 Ozone Depleting Gases and Ozone Depletion

Ozone shield depletion is primarily caused due to the following reasons :

(a) Chlorofluorocarbons (CFCs), heat transfer agents used in refrigerators and air conditioners, and foaming agents in foam cups and cartons.
(b) Halons or halocarbons are antifire agents used in fire extinguishers.

CFCs (Freons) have a life span of 150 years. It was believed that CFCs would drift upto stratosphere and be non reactive. But it is now clear that when temperature drops, they react chemically on frozen particle surfaces within the stratospheric clouds and release chlorine which reacts with $O_3$ of the ozone shield. Nuclear explosives and supersonic planes also cause accumulation of chlorine and $NO_2$ at altitudes. $NO_2$ reacts with the compounds formed by chlorine.

Once chlorine is released, a single atom destroys about 100,000 molecules of $O_3$ before settling on earths surface as chlorides. Halons similarly release bromine which reacts with Ozone.

### 32.12.2 Effects of Ozone Depletion

Ozone layer destruction will allow more UV rays to enter the troposphere and cause a series of harmful effects such as :

(1) Plants and animals living on the surface will start dying.
(2) UV radiation will fasten the formation of smog
(3) Temperature of the earth will increase leading to rise in sea level and flooding of low lying areas.
(4) UV rays will directly fall on the skin of humans causing skin cancer.
(5) Leaves of plants will show chlorosis (loss of Chlorophyll and yellowing).

## 32.13 EFFECTS OF AIR POLLUTION ON HUMANS

Air is mobile and impact of air pollution on ecosystems is reduced as wind blows away pollutants. But when winds are calm, air pollution becomes not only damaging but life threatening.

The damaging effects of atmospheric pollution have been described along with the account on pollutants. Long term exposure to moderate pollution causes more disease and death. Some adverse effects of air pollution on humans are summarised in table 32.3.

**Table 32.3 - Effects of air pollutants on humans**

| Disease / Discomfort | Cause |
|---|---|
| Emphysema, Bronchitis | CO, $SO_2$, PAN, $O_3$ |
| Eye irritation, headache | $SO_2$, PAN, $O_3$ |
| Silicosis, Asbestosis | Suspended particulate matter like silica, asbestos. |
| Coronary artery disease | Tobacco smoke |
| Anemia, Kidney, Liver damage | Pb |
| Fluorosis | Fluorides |
| Skin Cancer | Radiation due to ozone shield depletion. CFC and $O_3$ involved |
| Poisoning, death | CO |

## 32.14 CONTROL OF AIR POLLUTION

The alarming rate at which the atmosphere is being polluted, soon there will be more ailing human beings than healthy. The need of the hour is to put a quick check to atmospheric pollution.

Since most of air pollutants are emitted during combustion of fossil fuels, there are two practicable approaches for air pollution control which are discussed below :

(i) One approach is to control undesirable changes in the air we breathe by observing the following precautions :

(a) Limiting pollutants into air by using sulphur-free oil and coal, using catalytic converters in automobiles and avoiding burning of waste material

(b) Taking stringent measures against release of emissions from industries

(ii) The other approach is to use sources of energy other than fossil fuels such as wind, water, solar power etc. Use bicycles and battery powered cars rather than vehicles with internal combustion engines. Service vehicles should use lead free petrol.

Above all, it is necessary to educate the general public. Air pollution should become every human being's concern. Only then will the air become more congenial to healthy living.

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(3) Temperature of the earth will increase leading to rise in sea level and flooding of low lying areas.
(4) UV rays will directly fall on the skin of humans causing skin cancer.
(5) Leaves of plants will show chlorosis (loss of Chlorophyll and yellowing).

## 32.13 EFFECTS OF AIR POLLUTION ON HUMANS

Air is mobile and impact of air pollution on ecosystems is reduced as wind blows away pollutants. But when winds are calm, air pollution becomes not only damaging but life threatening.

The damaging effects of atmospheric pollution have been described along with the account on pollutants. Long term exposure to moderate pollution causes more disease and death. Some adverse effects of air pollution on humans are summarised in table 32.3.

**Table 32.3 - Effects of air pollutants on humans**

| Disease / Discomfort | Cause |
|---|---|
| Emphysema, Bronchitis | CO, $SO_2$, PAN, $O_3$ |
| Eye irritation, headache | $SO_2$, PAN, $O_3$ |
| Silicosis, Asbestosis | Suspended particulate matter like silica, asbestos. |
| Coronary artery disease | Tobacco smoke |
| Anemia, Kidney, Liver damage | Pb |
| Fluorosis | Fluorides |
| Skin Cancer | Radiation due to ozone shield depletion. CFC and $O_3$ involved |
| Poisoning, death | CO |

## 32.14 CONTROL OF AIR POLLUTION

The alarming rate at which the atmosphere is being polluted, soon there will be more ailing human beings than healthy. The need of the hour is to put a quick check to atmospheric pollution.

Since most of air pollutants are emitted during combustion of fossil fuels, there are two practicable approaches for air pollution control which are discussed below :

(i) One approach is to control undesirable changes in the air we breathe by observing the following precautions :

(a) Limiting pollutants into air by using sulphur-free oil and coal, using catalytic converters in automobiles and avoiding burning of waste material

(b) Taking stringent measures against release of emissions from industries

(ii) The other approach is to use sources of energy other than fossil fuels such as wind, water, solar power etc. Use bicycles and battery powered cars rather than vehicles with internal combustion engines. Service vehicles should use lead free petrol.

Above all, it is necessary to educate the general public. Air pollution should become every human being's concern. Only then will the air become more congenial to healthy living.

## INTEXT QUESTIONS 32.3

(1) What is smog ?

.....

(2) Name two photochemical oxidants.

.....

(3) Name two gases which form acid rain.

.....

(4) Mention any four greenhouse gases.

.....

(5) What are the sources of Freons and Halons in air ?

.....

(6) What effect does acid rain have on statues ?

.....

(7) Mention one measure to control air pollution.

.....

## 32.15 WHAT YOU HAVE LEARNT

- Nature's balance has been upset by human activities related to urbanisation, industrialisation and intensive agriculture.
- Atmosphere is made up of gases of which nitrogen - 78%, oxygen - 21%, carbondioxide - 0.1 to 0.3%, inert gases 1%
- Carbon is actively cycled between its inorganic form to organic form through respiratoin and photosynthesis. Decay cycle converts organic carbon to inorganic carbon.
- During respiration food is oxidised through a series of enzyme controlled steps in which chemical bonds of glucose are broken down to release energy and $CO_2$ is liberated.
- In photosynthesis green plants trap solar energy and synthesize starch from $CO_2$ and $H_2O$. Oxygen is released into air.
- After death, organisms are degraded by microorganisms. As a result, carbon moves back into environment.
- Methanogenic bacteria convert $CO_2$ to $CH_4$ and $CH_4$ may be oxidised to give carbon.
- Carbon cycle is the most important biogeochemical cycle. $CO_2$ of the atmosphere is obtained from volcanic action, combustion and respiration of organisms. $CO_2$ is taken up by plants for photosynthesis. Deep burial and compaction over long period of time turn carbon into coal and petroleum (fossil fuels). Human activities disrupt the carbon cycle.
- Air pollution is due to
  (i) particulate matter (F, Pb, soot, dust)
  (ii) aerosols composed of hydrocarbons
  (iii) gases like $SO_2$, $NO_2$
  They are mostly released by burning fossil fuels.
- $NO_2$ and hydrocarbons are modified by sunlight to form photochemical smog. Smog is a combination of smoke and fog. Automobile exhausts give out $NO_2$ and hydrocarbons. They form PAN (Peroxyacetyl nitrate) which along with Ozone and $SO_2$ forms photochemical smog.

- Smog cools and settles down near the earth and forms a blanket, while warmer air covers it. Thus there is a 'temperature inversion' with warm air above and cool air below unlike in the normal conditions.
- $SO_2$ and $NO_2$ form acids which drop as $H_2SO_4$ and $HNO_3$ on statues and spoil them. This is called acid precipitation. They may drop as salts (sulphates and nitrates). Acid rain kills trees, prevents reproduction in fish and causes poor visibility.
- Greenhouse gases are $CO_2$, $NO_2$, $CH_4$, chlorofluorocarbons and halons. They trap solar radiation and cause global warming.
- Global warming due to greenhouse effect leads to drought, rise in sea level, lack of rain and water shortage.
- Chlorofluorocarbons which are used in refrigerators and foam cups as aerosols and halons used in fire extinguishers. When released into the air cause depletion of ozone shield which protects us from harmful effects of solar radiations. It is feared that ozone depletion will have damaging effects on humans such as skin cancer.
- Air pollution causes respiratory diseases such as emphysema and bronchitis, eye irritation, fluorosis, cancer and may even be fatal.
- Control measures include use of sulphur free oil and coal, use of other sources of energy such as wind and solar power, use bicycle and battery powered vehicles, stop burning waste indiscriminately, have stringent measures for release of emissions from industries and above all educate general public and caution them against releasing air pollutants

## 32.16 TERMINAL EXERCISE

(1) How are fossil fuels formed ?

.....

(2) What are the damaging effects of $SO_2$ and $NO_2$ on plants and animals ?

.....

(3) Write a note on carbon monoxide poisoning.

.....

(4) What is thermal inversion and how is it caused ?

.....

(5) Enumerate the various effects of acid rain.

.....

(6) What is ozone hole ? What are the effects of ozone depletion.

.....

(7) Why does sea level rise due to global warming ?

.....

(8) How do greenhouse gases cause global warming.

.....

(9) Mention five diseases/discomforts in humans caused by air pollution. Mention the pollutants causing each.

.....

(10) Enumerate the various measures of control of air pollution.

.....

## CHECK YOUR ANSWERS

### INTEXT QUESTIONS 32.1

1. Nitrogen
2. Nitrogen/Oxygen/Carbondioxide
3. Plants ; because they synthesize their own food
4. Glucose
5. Chlorophyll
6. through decay and decomposition due to microorganisms
7. consumers
8. (i) volcanic eruption and (ii) combustion

### INTEXT QUESTIONS 32.2

1. undesirable changes in the atmosphere
2. Soot, Fluoride, Pb, Dust, NaCl (Any two)
3. $SO_2$, $CO_2$, CO, $NH_3$, $H_2S$ (Any two)
4. Methanogenic bacteria, ruminant stomach, fermentation in water logged paddy fields
5. PAN and $O_3$

### INTEXT QUESTIONS 32.3

1. fog and smoke
2. $O_3$ and PAN
3. $SO_2$, NO
4. $CO_2$, $NO_2$, $CH_4$, CFC, Halons
5. Refrigerants, fire extinguishers
6. Corrode them
7. See section 32.13

### TERMINAL EXERCISE

1. See Section 32.5
2. See Section 32.6
3. See Section 32.6
4. See Section 32.9
5. See Section 32.10
6. See Section 32.12
7. See Section 32.11
8. See Section 32.11
9. See Section 32.13
10. See Section 32.14