



Notes

ENVIRONMENTAL CHEMISTRY

The earth has just the right kind of conditions of temperature range, air, water, soil for supporting life and is protected from harmful rays from the outer space by the ozone layer. With progressive increase in human population and human activities, the quality of air, water, soil and other natural sources get degraded and become unfit for use by organisms. Increasing population, urbanisation and industrialisation has led to the decreased availability of water. The quality of water used is also being deteriorated as it is getting more and more polluted. You may be aware of at least some health hazards and harmful effects of water pollution. The main components of soil are 90–95% Inorganic matter and 5–10% organic matter besides soil contains water and air, the composition of the soil varies considerably place to place.

Soil has become dumping ground of most of the waste products There will be a great loss of earth crust. The dumping of nuclear waste is a world side problem, cause of soil pollution. In this lesson a detailed account of various types, sources and effects of water pollutants is given. Some methods of water pollution control and legislatures involved have also been discussed.

It causes unwanted effects. In this lesson you shall learn about the sources of pollutants and their effects on environment. Thus the pollution in many ways threaten the existence of many organisms including human being on the earth. Therefore, any threat of degradation or damage to the environment should be a matter of concern the green chemistry is environment friendly living on design of chemical products with their impacts on human health and on environment. it reduces the use of hazardous substances.



OBJECTIVES

After reading this lesson you will be able to :

- define environment and biosphere;

- differentiate the various environmental segments;
- explain nature of threats to environment;
- define pollutants and its types;
- list sources of pollutants and
- explain the effects of pollutants on environment, organisms and humans in particular.
- list earth's water resources;
- define water pollution and its different parameters;
- list the major types of water pollutants, their sources and effects;
- distinguish between natural and man-made pollutants;
- use the concept of biological oxygen demand (BOD) and account for the changes in a water body;
- state methods for the prevention of water pollution;
- compare primary, secondary and tertiary treatment of sewage;
- identify the sources of soil pollution;
- how to control of soil pollution,
- explain the principles of green chemistry;
- the achievements of green chemistry; and
- explain strategies to control environmental pollution.



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32.1 COMPONENTS OF ENVIRONMENT

Different organisms live in different types of surroundings such as air, water and soil. Different kinds of living organisms share these surroundings. The surroundings are the “environment” of an organism.

Environment has two components

- (i) physical or abiotic (non-living) components and
- (ii) living or biotic components.

Abiotic components of environment are air, water, soil, energy radiation, etc.

Biotic components of environment are microbes (such as bacteria, algae and fungi), plants, animals, etc.

Environment is the sum total of living and non living components surrounding an organism.

Environment consists of four segments such as

- (i) Biosphere
- (ii) Atmosphere
- (iii) Hydrosphere, and
- (iv) Lithosphere

Biosphere : All the parts of the earth are not suitable for survival of organisms. Some parts are too hot or very cold to support life.

The part of earth on which organisms can survive and reproduce is called biosphere.

Survival of organisms depend upon a delicate balance between themselves and with the various components of the environment. Any disturbance, damage or adverse change in the quality of environment poses a threat to the survival and well being of organisms. Therefore, any threat of degradation or damage to environment should be a cause of concern to all of us.

Atmosphere : Atmosphere is the only place where free oxygen and water vapour exist.

Atmosphere is a thin layer of air (mixture of gases) around the earth which is a great source to all living organisms.

Hydrosphere : Water plays an important role in the biosphere, without it life is impossible.

Hydrosphere is the part of earth on which all types of water resources exists, viz., oceans, seas, rivers, lakes, glaciers, ice caps, ground water, etc.

Lithosphere : Soil is a part of lithosphere which supports life.

Lithosphere is the part of the earth where all types of minerals, metals, organic matters, rocks, soils, etc. exist

Global Environmental Damages

Some example of global damages are discuss below.

- (i) Chloroflouro carbons (CFCs), used as refrigerants, and various kinds of sprays or sols (eg. perfumes, air freshner, etc.). CFCs cause ozone holes in the ozone layer. Ozone hole refer to depletion of ozone molecules in the ozone layer due to the reacton of CFCs. The holes in the ozone layer appear elsewhere and not where these chemicals are used.
- (ii) More ultraviolet radiations reach the earth through the ozone holes and the reflected radiations from the earth are absorbed by CO_2 water vapour, etc. The traped radiations release more and more heat resulting in the phenomenon of **Global Warming**. This effect is also known as **Green House Effect**.

Global environment damage affects quality of environment over a much larger area and is not localised to the area where the damage is initiated. Global warming will cause ill effects and are not confined to the area causing the damage. It causes wide range of effects like melting of glaciers, polar caps, rise in water level of sea and flooding of costal plains, etc.



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INTEXT QUESTIONS 32.1

1. Define environment.
2. What are the two components of environment?
3. List three biotic components?
4. How do CFCs affect the ozone layer?
5. What are the different segments of environment?

32.2 POLLUTION

In ancient times human settlements began and flourished along river banks as rivers provided them basic facilities. Growth of population forced people to move to other places. They started utilising natural resources such as trees and soil (mud) to build shelters. More waste material started collecting at places they inhabited. Humans themselves created conditions for disposal of waste (sanitation). Humans then started industries to manufacture goods for their own comforts. Pesticides and chemical fertilisers were manufactured to grow more food for the growing demand by population. Industries also generated wastes, which ultimately finds its way to water sources. Pesticides and chemicals were washed into natural water bodies such as sea, river, lakes and ponds and affected the aquatic organisms. Supply of potable (safe for drinking) water diminished. All this badly affects life of organism including humans. All such waste generated through human activities and spoiling the natural environment is termed as **pollutants**. Damaging the natural environment by pollutants is termed as **pollution**.

Pollution refers to deterioration or unclean objectionable conditions in the quality of natural resources such as air, water and soil because of the action or presence of unwanted substances beyond a certain limit.

32.3 POLLUTANTS

Pollutants are the substances or effect introduced into the environment in significant amounts in solid, semi solid, liquid gas or sub molecular particle form which has a detrimental (bad) effect on the environment.

The pollutants may be classified in the following ways (Fig.32.1).

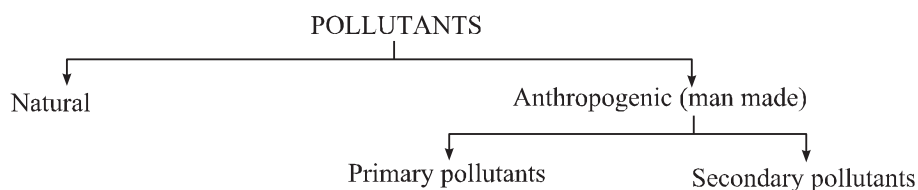


Fig. 32.1 : Classification of pollutants



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32.3.1 Natural Pollutants

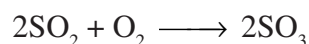
There can be several natural sources which are the cause of pollution. Some of them are listed below :

- (i) Fires in forests may be caused when lightening strikes the trees. Burning of tree produces a lot of CO_2 which is released to the atmosphere.
- (ii) Soil erosion increases suspended particulate matter and dust in air. These may even enter water bodies as they are washed down by rain or natural water falls.
- (iii) Volcanic eruptions also add pollutants like SO_2 and solid particles to the environment.
- (iv) Volatile organic compounds from leaves, trees and dead animals naturally enter the atmosphere.
- (v) Natural radioactivity and the other natural pollutants have been entering the environment since ages. (But the low level of pollution has rarely endangered lives of organisms).

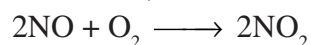
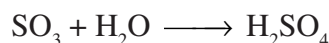
32.3.2 Anthropogenic Pollutants

Increased human activities releases a large amount of pollutants to the environment and poses a threat to the human life. Pollutants added to the environment through human activities are termed *anthropogenic pollutants*. These are of two kinds.

- (i) **Primary pollutants:** Primary pollutants are added directly in a harmful form to the atmosphere. eg CO_2 and CO from burning of fossil fuel; SO_2 and oxides of nitrogen from vehicular combustion, thermal power stations, etc.
- (ii) **Secondary Pollutants:** Secondary pollutants are the products of reaction between the primary pollutants and normal environmental constituents.



Thus, SO_2 a primary pollutant which reacts with oxygen of air to give SO_3 . Further, SO_3 reacts with water vapour present in the atmosphere and forms H_2SO_4 . Thus SO_3 and H_2SO_4 are secondary pollutants.



Nitric oxide (NO), a primary pollutant reacts with oxygen to give NO_2 which is a secondary pollutant.



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Depending on the sources, anthropogenic pollutants may be classified further into

- (i) Industrial Pollutants
 - (ii) Domestic Pollutants
- (i) **Industrial Pollutants:** Paper, textile industries, tanneries and distilleries dispose various effluents like oil, grease, plastic and metallic wastes into the environment.
- (ii) **Domestic Pollutants:** Detergents, fluoride toothpastes, edible colours, food flavouring agents, polythene bags and wrappers find their way into the environment as pollutants. Methane is produced in cattle stomach and in stagnant paddy fields is also a domestic pollutant.



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INTEXT QUESTIONS 32.2

1. Define a pollutant.
2. Name two sources of natural pollution.
3. Define a secondary pollutant.
4. What do you mean by environmental pollution?

32.4 SOURCES OF POLLUTANTS

Many of the pollutants in our environment have natural as well as human related origins. For example, the natural origin of pollutants includes the release of sulphur dioxide (SO_2) from volcanic eruptions, erosion of soil by wind and water, dissolved minerals carried on to rivers and ocean by surface run off, etc.

The sources of pollutants are also classified :

- (i) Stationary and
- (ii) Mobile sources

Stationary Sources : The pollutants released from a fixed location or a well defined area is known as stationary source. e.g. smokestacks of power plants, smelters, surface mines, etc.

Mobile Sources : The pollutants released from diffused sources or the sources that move from place to place is termed as a mobile source. e.g. automobiles, buses, aircrafts, ships, trains, etc.

The various pollutants of water, their sources and effects are given in Table 32.1

Table No. 32.1 : Major Air Pollutants their Sources and Effects

Major Pollutants of Air	Some of the Sources	Some of the Effects
SO ₂	Vehicular combustion, fossil fuel burning	Irritation to the eyes, acid rain premature falling of leaves
CO and CO ₂	Vehicular combustion and burning of fuels and hydrocarbons	Global warming, green house effect CO has great affinity for haemoglobin and forms the carboxy haemoglobin
Smoke, fly ash and soot	Thermal power stations	Respiratory diseases.
Lead and mercury	Auto exhaust from gasoline, paints, storage batteries. fossil fuel burning	Affects the nervous system and circulatory system causing nerve and brain damage.
CFCs	Refrigerants and aerosol	Kidney damage and ozone depletion.



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The various pollutants of water, their sources and effects are summarised in Table No. 32.2

Table 32.2 : Major Water Pollutants their Sources and Effects

Major Pollutants of Water	Some of the Sources	Some of the Effect
Pesticides and insecticides like DDT, BHC	Improper use in agriculture, mosquitos repellants	Toxic to fishes, predatory birds and mammals.
Plastics	Homes and industries	Kills fishes and animals like cows.
Chlorine compounds	Water disinfection with chlorine, paper and bleaching powder	Fatal for plankton (organisms floating on the surface of industries water) foul taste and odour, can cause cancer in humans.
Lead	Leaded gasoline, paints, etc.	Toxic to organisms
Mercury	Natural evaporation and dissolved industrial wastes, fungicides	Highly toxic to humans
Acids	Mine drainage, industrial wastes	Kills organisms
Sediments	Natural erosion, run off from fertilizer and other factories, mining and construction activities.	Reduces ability of water to assimilate oxygen.

The general effects of pollutants are produced due to interactions of pollutants among themselves.

Contamination

Contaminations refer to the mere presence of undesirable materials to a medium like air, water, soil, etc. making it unfit for a particular use. For example, contamination of air by hazardous exhaust from automobiles. It becomes a pollutant if its concentration exceeds the level which can cause harmful effect.

32.5 AIR POLLUTION

You have just learnt how nature has its own means of using up and getting back its components such as CO_2 , O_2 and N_2 . If the balance of CO_2 , O_2 or N_2 is disturbed by human activity then it will have adverse affect on life on the earth. Now you know why environmentalists are deeply concerned about environmental pollution, tree plantations and afforestation.

Undesirable changes have occurred in the physical and chemical constituents of air due to human activities. Undesirable change in the atmosphere is air pollution. Pollutant gases such as SO_2 oxides of nitrogen, CO and excessive amount of CO_2 have been added to the atmosphere. Air pollutant may be classified as particulate matter, liquid droplets and gaseous pollutants (Fig 32.2) :

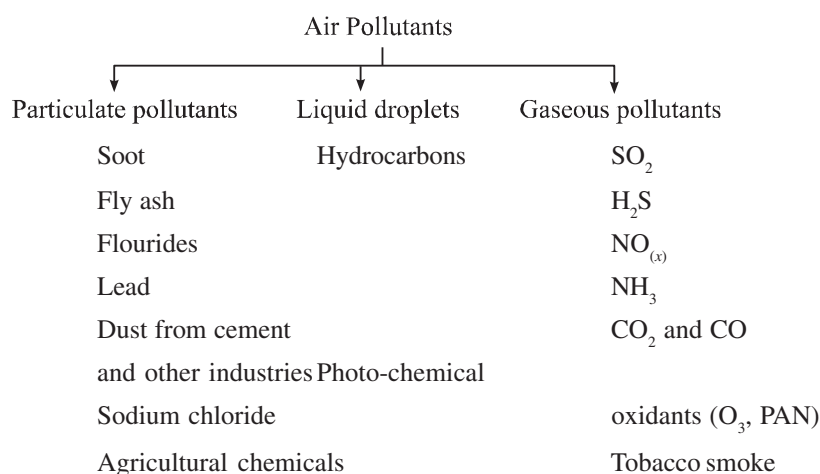


Fig. 32.2 : Classification and Example of Air pollutants

32.5.1 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 outlets of industries and mix with air.

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



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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 industries also add lead particles to the atmosphere. Manufacture of lead storage batteries and recycling of discarded batteries add to lead pollution. Lead interferes with development of red blood corpuscles and causes anaemia (lack of haemoglobin - the oxygen carrying pigment of blood). Lead is a cumulative poison and prolonged exposure even in low concentration 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 is another example of particulate pollutant.

Sodium chloride: Sodium chloride is used to remove snow in winter and remains in the environment. Some sodium chloride is also added to the environment 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.

32.5.2 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. Methane (CH_4) is also generated in stomachs of ruminant animals. Incomplete combustion of fuels release 3, 4 benzopyrene which causes lung cancer. Pesticides, paints and solvents also release hydrocarbons. Hydrocarbons are a source of photochemical smog.

32.5.3 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



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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 releases them. Power generators, automobile exhausts, explosives and nitrogenous fertilizer industries and the other anthropogenic sources produce nitrogen oxides.

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 releases 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 hydrocarbons. Excess of CO_2 can cause global warming, CO causes photochemical smog and 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 haemoglobin about two hundred times faster than O_2 . Tissues do not get oxygen and die due to lack of oxygen. Carboxy haemoglobin 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 atmosphere 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, aromatic hydrocarbons and tar. These cause problems of blood pressure and heart, windpipe and lungs in the smoker as well as those around the smoker. Cigarette smoke is also carcinogenic. The various human and natural activities which introduce air pollutants into the atmosphere are summarised in Table 32.2



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Table 32.3 : Common air pollutants, their sources and contribution of Natural and Anthropogenic pollution

Air Pollutants	Some Sources	Emission (% of total)	
		Natural	Anthropogenic
Sulphur oxide (SO _x)	Fossil fuel burning, industry biomass biomass burning, volcanoes, oceans.	50	50
Carbon monoxide (CO)	Incomplete combustion, methane oxidation, transportation, biomass burning, plant metabolism.	91	9
Nitrogen oxide (NO _x)	Fossil fuel burning, lightening, biomass burning, soil microbes.	40	60
Hydrocarbons (HC)	Fossil fuels, industrial processes, evaporation of organic solvents, agricultural burning, plant isoprenes and other biogenics.	84	16
Suspended Particulate Materials (SPM)	Biomass burning, dust, sea salt, biogenic aerosols, gas to particle conversion.	89	11



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**INTEXT QUESTIONS 32.3**

1. What is atmospheric pollution?
2. Name two particulate pollutants.
3. Name two gaseous pollutants?
4. Name one source which causes pollution due to methane.
5. Name two air pollutants which form photochemical smog.

32.6 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. These pollutants have been released into atmosphere ever since human first started burning wood and coal. Later on, pollutants are being released into air due to increased industrial activity. The nature has not been able to remove all these pollutants because much more pollutants are added than the nature can handle to maintain the balance. Therefore, pollutants have now accumulated in the atmosphere to a proportion whereby atmospheric composition of air has been significantly altered. It is the causes of physical phenomena such as photochemical smog, acid rain, ozone depletion, greenhouse effect and global warming. These are damaging to plants, animals and humans.

The figure Fig. 32.3 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 temperature inversion, photochemical smog, acid rain, greenhouse effect and ozone layer (shield) depletion.

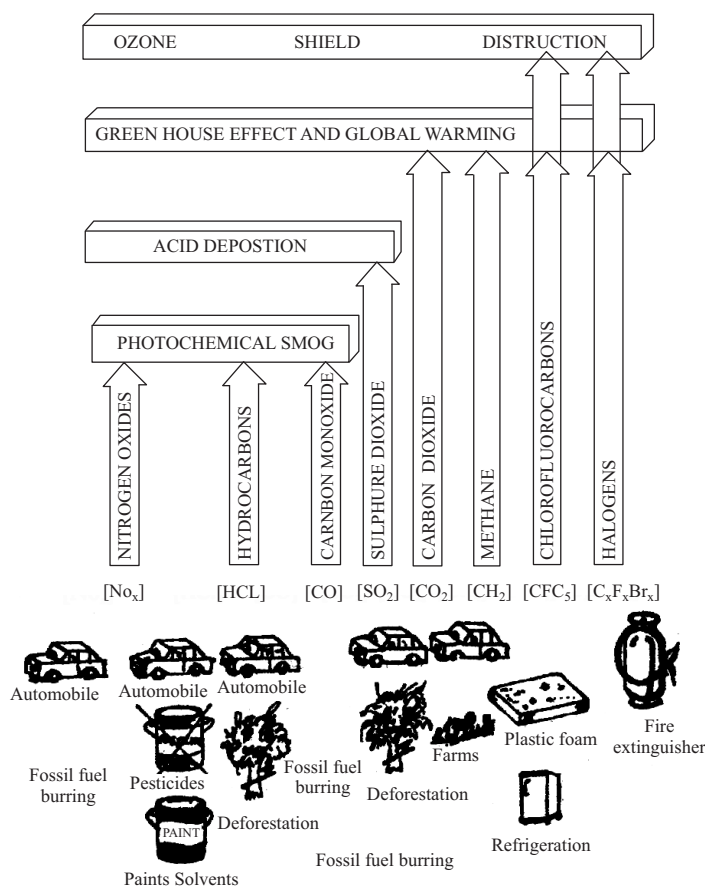


Fig. 32.3 : Four Major Effects of Atmospheric Pollutants

32.7 TEMPERATURE INVERSION AND PHOTOCHEMICAL SMOG

Pollutants like sulphur dioxide which is released while burning sulphur containing fuels (fossil fuels) 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 oxides and hydrocarbons, photochemical



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smog is formed (photochemical: chemical reactions in the presence of light). Smog stays close to the ground and reduces visibility and causes irritation.

Photochemical smog is also called *PAN smog* due to the formation of peroxyacetyl nitrate or PAN and ozone which are formed from hydrocarbons and nitrogen oxides in the presence of solar radiation. PAN and ozone are called photochemical oxidants. Both of these are toxic irritants to 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.32.4).

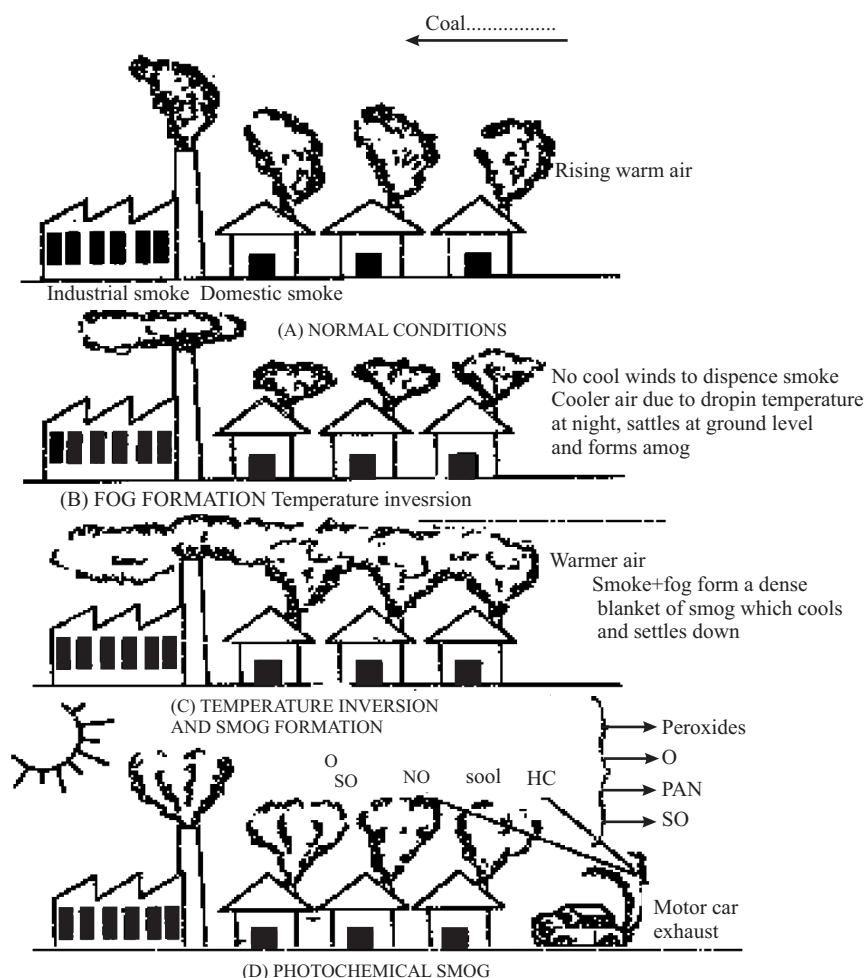


Fig. 32.4 : Formation of Photochemical Smog and Temperature Inversion

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



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32.8 ACID RAIN

Coal and oil burned by power plants and other industries release SO_2 into air because coal and oil contain small amount of sulphur. Automobile exhausts add SO_2 and 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 oxygen and water vapour in the atmosphere as per the following photo chemical reactions.



This reaction is promoted by O_3 in smog. The acids, so formed are washed down from air to earth during rain or snow fall. It is called acid rain or acid snow. The acids react with minerals present in soil to form sulphates and nitrates due to acid rain.

Rain water even in its purest form is slightly acidic with pH 5.6 due to dissolved CO_2 . 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 is 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.

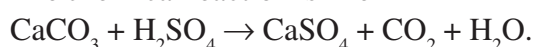
When the dissolved pollutants drop as rain or snow (wet deposition) it is termed acid precipitation. Deposition of dry gases and salts is dry deposition. Acid rain spreads over areas of several hundreds to several thousand kilometers.

32.8.1 Effects of Acid Rain

Some of the effects of acid rain are listed below:

- (1) Excessive acid concentrations are phytotoxic (toxic to plants). 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 survives in acid rain fed water bodies but fails to reproduce. So there are no young fish in such waters.
- (4) Exposed surfaces of buildings, statues get corroded. Limestone or marble (CaCO_3) structures are specially damaged (Fig. 32.5).

The chemical reaction is like



The sulphates are leached out by rain water.



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



Fig. 32.5 : A Stone statue showing corrosive effects of Acid Rain



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32.9 GREEN HOUSE EFFECT AND GLOBAL WARMING

The literal meaning and function of green house is to trap the heat. 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 the outward movement of heat. The radiations get trapped inside the glass chamber and raises the temperature.

Gases such as CO_2 , NO_2 , CFCs (chloro fluorocarbons) allow sun rays to pass through them but then absorb and reradiate the heat back towards the earth. These are therefore termed as **green house gases**.

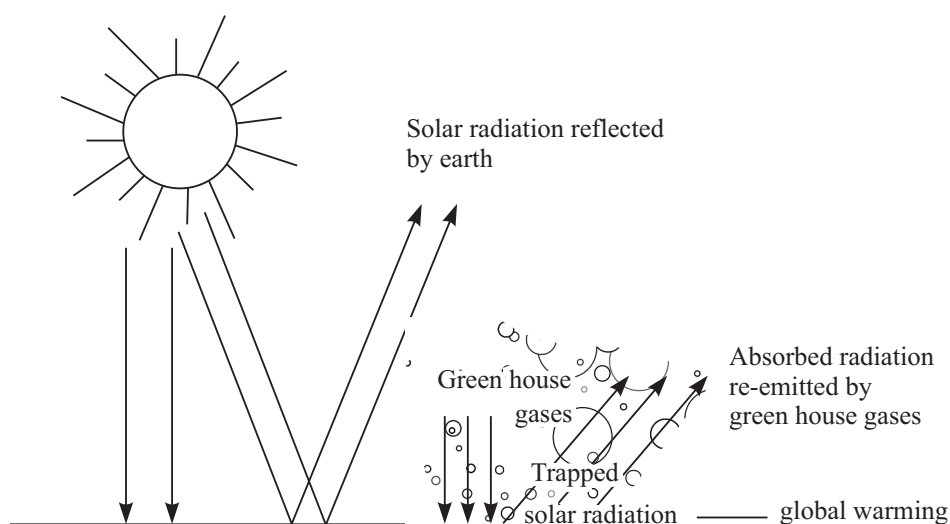


Fig. 32.6 : Green House Effect

32.9.1 Greenhouse Gases

The common green house gases and their sources of pollution are listed below:

- (1) CO_2 - from fossil fuel burning.
- (2) NO_2 - from fertilizer plants, automobile exhaust use and animal waste.
- (3) CH_4 - from bacterial decomposition, biogas, flooded rice fields.
- (4) CFCs - from freon, (a refrigerant), aerosol sprays.
- (5) HALONS (halocarbons) - from fire extinguishers.

32.9.2 How Does Earth's Atmosphere Trap Heat?

Radiations (ultra violet) from the sun penetrate the earth's atmosphere and reach earth. The surface of earth partially absorbs the radiations. The rest is re-radiated as infrared radiation from the earth's surface. In polluted air, molecules of CO_2 , CH_4 , CFCs, N_2O , O_3 and water vapours are present. These gases can absorb infrared radiations but cannot absorb the ultra violet radiations. Energy of these trapped radiations raise the temperature of earth and its atmosphere. Thus if proportion of green house gases increases in the atmosphere heat trapped by them will raise the temperature of the earth and will cause global warming.

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

Global warming is defined as the increase in the average global temperature of the atmosphere near earth's surface.

- (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. Moreover water expands when it heats up. This will lead to rise of sea level. It will flood the low lying coastal area and many cities will get submerged in water.
- (2) **Drought:** A 3°C warming will result in 10% decrease in precipitation (rain fall) and this will decrease rain fall causing drought conditions.
- (3) **Effect on plant growth:** Drought will reduce 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.
- (6) **Climatic changes :** It has great effect on climate changes. For example, spring now occurs about a week earlier than normal time.



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- (7) **Increase in CO₂**: Warmer conditions accelerate microbial degradation of organic matter and add more CO₂
- (8) **Day and Night temperature** : Night temperatures have increased more than day temperature as green house gases prevent heat from escaping at night.
- (9) **Formation of ozone hole** :

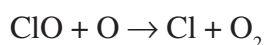
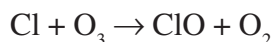
The atmosphere has two layers, the stratosphere and troposphere. Stratosphere lies 15 km to 50 km above the surface of earth. The energy of the sun splits some molecular O₂ in this layer to give individual (O) atoms which combine with intact molecular oxygen to give O₃. The layer of O₃ forms a shield as it absorbs UV rays and prevent them from striking the earth. If UV rays penetrate our atmosphere the 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 Antarctic and North Pole of Arctic.

32.10 DEPLETION OF OZONE LAYER

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

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

The ozone in the stratosphere is being depleted by the presence of mainly chlorofluorocarbons (CFCs) and halogen gas, particularly chlorine. The highly energetic ultra violet radiation splits up the CFCs, releasing chlorine. The released chlorine is responsible for conversion of the ozone into oxygen molecule consequently depletion of ozone layer occurs as per the following equations.



It is believed that one molecule of CFC is capable of destroying 1,00,000 ozone molecules in the stratosphere. The area where the ozone is completely destroyed is known as **ozone hole**. The first ozone hole was observed over Antarctic Ocean.

The important function of ozone layer in the stratosphere is to protect us from dangerous ultra violet (UV) radiations from the sun by absorbing it.

32.10.1 Effects of Ozone Depletion

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

- (1) Plants and animals living on the surface will start dying.



Notes

- (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) More 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),



Notes

32.11 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 32.4.

Table 32.4 : Effects of air pollutants on humans

Disease / Discomfort	Caused by
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, Skin Cancer	Fluorides
Poisoning death	CO

32.12 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 practical approaches for air pollution control which are discussed below:

- (i) One approach is control undesirable changes in the air we breathe by observing the following precaution :
 - (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.



Notes



INTEXT QUESTIONS 32.4

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 marble statues ?
7. Mention one measure to control air pollution.

32.13 WATER POLLUTION – PARAMETERS

A large amount of water is discharged back after domestic and industrial usage. This is contaminated with domestic waste and industrial effluents. When this contamination reaches beyond certain allowed concentrations, it is called **pollution** and the contaminants are called the **pollutants**. **Water pollution** may be defined as the contamination of streams, lakes, seas, underground water or oceans by substances, which are harmful for living beings. If the concentration of substances naturally present in water increases then also the water is said to be polluted.

Water pollution may be defined as the contamination of streams, lakes, seas, underground water or oceans by substances, which are harmful for living beings. Industrialisation and population explosion are two important factors for water pollution.

Water may be called polluted when the following parameters stated below reach beyond a specified concentration in water.

- (i) **Physical parameters.** Colour, odour, turbidity, taste, temperature and electrical conductivity constitute the physical parameters and are good indicators of contamination.

For instance, colour and turbidity are visible evidences of polluted water while an offensive odour or a bitter and difference than normal taste also makes water unfit for drinking.

- (ii) **Chemical parameters:** These include the amount of carbonates, sulphates, chlorides, fluorides, nitrates, and metal ions. These chemicals form the total dissolved solids, present in water.
- (iii) **Biological parameters:** The biological parameters include matter like algae, fungi, viruses, protozoa and bacteria. The life forms present in water are affected to a good extent by the presence of pollutants. The pollutants in water may cause a reduction in the population of both lower and higher plant and animal lives. Thus, the biological parameters give an indirect indication of the amount of pollution in water.



Notes

32.14 WATER POLLUTION – SOURCES

Water pollutants refer to the substances which are capable of making any physical, chemical or biological change in the water body. These have undesirable effect on living organisms. As mentioned earlier, the water used for domestic, agricultural and industrial purposes is discharged with some undesirable impurities in it. This contamination leads to the pollution of water, which is generally called the **fresh water pollution**. Fresh water pollution may be classified into two types: **surface water pollution** and **ground water pollution**.

32.14.1 Surface Water Pollution

When pollutants enter a stream, river or lake these gives rise to surface water pollution. The surface water pollution has a number of sources. These can be categorised as:

- Point and Non-point Sources
- Natural and Anthropogenic Sources

(i) Point and Non-point Sources

The well-defined sources that emits pollutants or effluents directly into different water bodies of fresh water are called **point sources**. Domestic and industrial waste are examples of this type. The point sources of pollution can be effectively checked. On the other hand, the **non-point sources** of water pollution are scattered or spread over large areas. This type of sources deliver pollutants indirectly through environmental changes and account for majority of the contaminants in streams and lakes. For example, the contaminated water that runs off from agriculture farms, construction sites, abandoned mines, enters streams and lakes. It is quite difficult to control non-point sources.

(ii) Natural and Anthropogenic Sources

As mentioned earlier, an increase in the concentration of naturally occurring substances is also termed pollution. The sources of such an increase are called **natural sources**. **Siltation** (which includes soil, sand and mineral particles) is one such natural source. It is a common natural phenomenon, which occurs in most water bodies. Indiscriminate deforestation makes soil loose and flood waters bring silt from mountains into streams, rivers and lakes.

On the other hand, the human activities that result into the pollution of water are called **anthropogenic** or man made sources of water pollution. For example, domestic (sewage and waste water), industrial and agricultural wastes that goes into the rivers, lakes, streams and seas are anthropogenic sources. Certain materials that are leached from the land by run-off water and enter the various water bodies also belong to this category. The anthropogenic sources of water pollution are shown in Fig. 32.7.

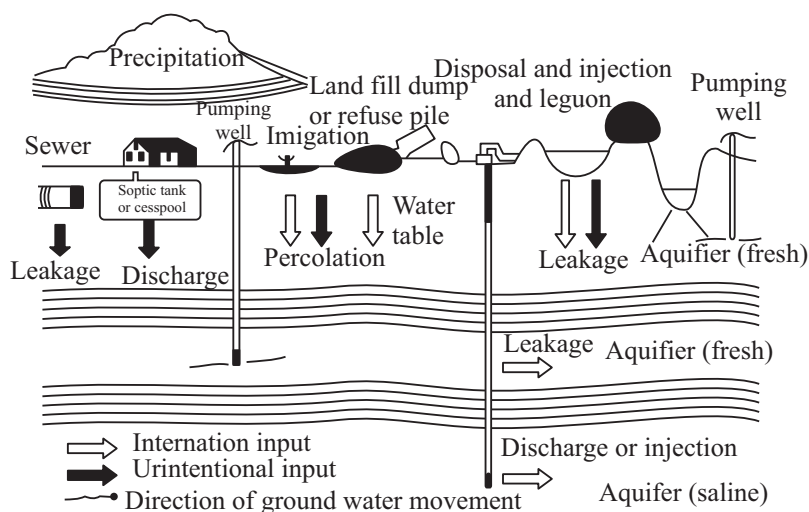


Fig. 32.7 : Anthropogenic Sources of water pollution

32.14.2 Ground Water Pollution

When the polluted water seeps into the ground and enters an aquifer it results into **ground water pollution**. The most of our villages and many townships, ground water is the only source of drinking water. Therefore, pollution of groundwater is a matter of serious concern. Groundwater gets polluted in a number of ways. The dumping of raw sewage on soil, seepage pits and septic tanks cause pollution of groundwater. Fig. 32.3. The porous layers of soil hold back solid particles while the liquid is allowed to pass through. The soluble pollutants are able to mix with the groundwater. In addition to these, the excessive use of nitrogenous fertilizers and unchecked release of toxic wastes and even carcinogenic substances by industrial units many result in slow trickling down



Notes

through the earth's surface and mixing with the groundwater. This problem is very serious especially in areas where water table is high (i.e., where water is available near surface of earth).

The ground water can move over large distances by virtue of the large empty space available below the earth's surface. This way if some impurities seep into the ground water at one point, they may be observed at a different point far removed from the point of source. In such a case it is difficult to estimate the source of water pollution. However, suspended impurities and bacterial contaminants are removed in the process of seepage by the soil acting as an absorbent and filter, and water acting as a solvent.

Since the movement of groundwater through the porous rock is very slow, pollutants which get mixed with the groundwater are not readily diluted. Furthermore, groundwater does not have access to air (in contrast to surface water) therefore, oxidation of pollutants into harmless products in groundwater does not occur.

32.15 WATER POLLUTANTS

You have read the various sources from where pollutants enter the water bodies. Let us now learn about the various types of pollutants arising out of these sources. These can be broadly put under the following types.

- (i) Sewage Pollutants (Domestic and Municipal Waste)
- (ii) Industrial Pollutants
- (iii) Agricultural Pollutants
- (iv) Radioactive and Thermal Pollutants

(i) Domestic and Municipal Pollutants : The sewage contains garbage, soaps, detergents, waste food and human excreta and is the single largest sources of water pollution. Pathogenic (disease causing) microorganisms (bacteria, fungi, protozoa, algae) enter the water system through sewage making it infected. Typhoid, cholera, gastroenteritis and dysentery are commonly caused by drinking infected water. Water polluted by sewage may carry certain other bacteria and viruses cannot grow by themselves, but reproduce in the cells of host organisms. They cause a number of diseases, such as, polio, viral hepatitis and may be cancer which are resistant to like the organic matter are oxygen demanding substances. They are responsible for deoxygenation of water-bodies which is harmful for aquatic life.

Other ingredients which enter the various water bodies are the plant nutrients, i.e., nitrates and phosphates. They support growth of algae, commonly called **algal bloom** (blue-green species). This process is called **eutrophication** and is discussed in details in the next section.



Notes

- (ii) **Industrial Pollutants** : Many industries are located near rivers or fresh water streams. These are responsible for discharging their untreated effluents into rivers like highly toxic heavy metals such as chromium, arsenic, lead, mercury, etc. along with hazardous organic and inorganic wastes (e.g., acids, alkalis, cyanides, chlorides, etc.). River Ganges receives wastes from textile, sugar, paper and pulp mills, tanneries, rubber and pesticide industries. Most of these pollutants are resistant to breakdown by microorganisms (called nonbiodegradable), therefore damage the growth of crops and the polluted water is unsafe for drinking purposes.

Factories manufacturing plastic, caustic soda and some fungicides and pesticides release mercury (a heavy metal) along with other effluents in nearby water body. Mercury enters the food chain through bacteria, algae, fish and finally into the human body. The toxicity of mercury became evident by the Minamata Bay tragedy in Japan during the period 1953-60. Fish died due to mercury consumption and those who ate fish were affected by mercury poisoning and quite a few died. The milder symptoms of mercury poisoning are depression and irritability but acute toxic effects can cause paralysis, blindness, insanity, birth defects and even death. The high concentration of mercury in water and in fish tissues results from formation of soluble monomethylmercury ion, $(\text{CH}_3, \text{Hg}^+)$ and volatile dimethylmercury $[(\text{CH}_3)_2 \text{Hg}]$ by anaerobic bacteria in sediments.

- (iii) **Agricultural Waste**: Manure, fertilizers, pesticides, wastes from farms, slaughterhouse, poultry farms, salts and silt are drained as run-off from agricultural lands. The water body receiving large quantities of fertilizers (phosphates and nitrates or manures becomes rich in nutrients which leads to eutrophication and consequent depletion of dissolved oxygen. Consumption of water rich in nitrates is bad for human health especially for small children.

Pesticides (DDT, dieldrin, aldrin, malathion, carbaryl etc.) are used to kill insect and rodent pests. Toxic pesticide residues enter the human body through drinking water or through food chain (biomagnification). These compounds have low solubility in water but are highly soluble in fats. For example, the concentration of DDT in river water may be very low but some fish over a period of time accumulate so much of DDT that they become unfit for human consumption. The use of pesticides in our country is increasing very rapidly.

Some of these chemicals which are highly toxic become metabolised by animals that graze on fields. Therefore, these poisonous chemicals have been often observed in the human food chain. The presence of these chemicals in humans even in minute amounts can cause hormonal imbalance and may lead to cancer.



Notes

(iv) **Physical Pollutants:** Physical pollutants can be of different types. Some of them are discussed below :

- (a) **Radioactive Wastes :** Radionuclides found in water are radium and potassium-40. These isotopes originate from natural sources due to leaching from minerals. Water bodies are also polluted by accidental leakage of waste material from uranium and thorium mines, nuclear power plants and industries, research laboratories and hospitals which use radioisotopes. Radioactive materials enter human body through water and food, and may be accumulated in blood and certain vital organs. They cause tumours and cancer.
- (b) **Thermal Sources:** Various industries, nuclear power plants and thermal plants require water for cooling and the resultant hot water is often discharged into rivers or lakes. This results in thermal pollution and leads to the imbalance in the ecology of the water body. Higher temperature lowers the dissolved oxygen level (which is very essential for marine life) by decreasing the solubility of oxygen in water. Fish and other aquatic organism can get affected by a sudden change in water temperatures.
- (c) **Sediments :** Soil particles carried to streams, lakes or oceans form the sediments. The sediment become polluting due to their large amount. Soil erosion defined as the soil carried by flood water from crop land, is responsible for sedimentation. The sediments may damage the water body by introducing a large amount of nutrient matter.
- (v) **Petroleum Products:** Petroleum products are widely used for fuel, lubrication, plastics manufacturing, etc. and happen to be poisonous in nature. Crude oil and other related products generally get into water by accidental spillage from ships, tankers, pipelines etc. Besides these accidental spills, oil refineries, oil exploration sites and automobile service centres pollute different water bodies. Oil slick which floats on the water surface causes death of marine life and severely affects the ecosystem of the ocean.

A list of various types of water pollutants, their sources and effects have been summarised in Table 32.1.

Table 32.1: Types of water pollutants, their sources and effects

	Pollutant	Sources of Pollutants	Effects and Significance
1	Pathogens	Sewage, human and animal wastes, natural and urban runoff from land, industrial waste	Depletion of dissolved oxygen in water (foul odour) health effects (outbreaks of water borne diseases)



Notes

2	Organic pollutants <ul style="list-style-type: none"> ● Oil and grease ● Pesticides and weedicides ● Plastics ● Detergents 	Automobile and machine waste, tanker spills, offshore oil leakage Chemicals used for better yield from agriculture Industrial and household waste Industrial and household waste	Disruption of marine life, aesthetic damage Toxic effects (harmful for aquatic life), possible genetic defects and cancer; kills fish Eutrophication, aesthetics
3	Inorganic pollutants Fertilizers (phosphates and nitrates) Acids and alkalis	Agricultural runoff Mine drainage, industrial wastes, natural and urban runoff	Algal bloom and eutrophication, nitrates cause methemoglobinemia Kill fresh water organisms, unfit for drinking, irrigation and industrial use.
4	Radioactive materials	Natural sources, uranium mining and processing, hospitals and research laboratories using radioisotopes	Cancer and genetic defects
5	Heat	Cooling water for industrial, nuclear and thermal plants	Decreases solubility of oxygen in water, disrupts aquatic ecosystems
6	Sediments	Natural erosion, runoff from agricultural land and construction sites	Affects water quality, reduces fish population



Notes



INTEXT QUESTIONS 32.5

1. Define water pollution.
2. List any three anthropogenic sources of water pollution.
3. List the parameters indicating water pollution.

32.16 WATER POLLUTION AND SOME BIOLOGICAL EFFECTS

The natural source of water in the form of precipitation or rain is the purest form available in nature. However after reaching the surface and then underground it gets contaminated by a number of pollutants. There are some biological factors also mentioned earlier responsible for spoiling the quality of water. These include the lower plants like algae and bacteria which are the causes of nutrient accumulation in aquatic systems. This nutrient accumulation gives rise to a condition called eutrophication explained below.

32.16.1 Eutrophication

Eutrophication is a process by which a water body slowly becomes rich in plant nutrients such as nitrates and phosphates due to soil erosion and run off from the

surrounding land. Let us try to understand this phenomenon. A water system like a lake or any reservoir may get a large inflow of organic matter from domestic wastes and run off from the surrounding land. Increasing human population, intensive agriculture and rapid industrial growth have led to an increasing release of domestic waste, agricultural residues, industrial wastes and land run-off into various water bodies. Nutrients are released from organic waste by aerobic (oxygen requiring) bacteria which start decomposing it. Dissolved oxygen is consumed in this process. As more and more organic matter enters a water body, more is the deoxygenation of the water body and larger is the production of nutrients. These nutrients fertilize an abnormal growth of algae and other large water plants such as duckweed. As more plants grow, some of them die also due to larger oxygen demand and therefore oxygen deficiency in the water body (i.e., deoxygenation of the water body). Such a water body is said to be **eutrophied** and the process is called **eutrophication**. The word eutrophication is derived from the Greek word which means well nourished as (eu:true, trophos:feeding)

Eutrophication of a water body results due to the release of large amount of nutrients by the action of aerobic bacteria on organic wastes entering a water body naturally or by human activity.

The above discussion leads us to a concept called biological oxygen demand (BOD). Let us try to understand by the description given below.

32.16.2 Biological Oxygen Demand (BOD)

The quantity of oxygen used up by microorganisms at 27°C and in darkness during 3 days in breaking down organic wastes in a water body is called its **biological oxygen demand (BOD)**.

It can be explained in the following manner.

You know that there are many organic compounds or waste present in a water body. The microorganisms present in the system act upon this waste for their own consumption and growth. In the process the metabolic activity requires oxygen which is met by the dissolved oxygen present in water. It is this amount of oxygen which is defined as **biological oxygen demand (BOD)**. The BOD value of an aquatic system depends upon:

- the type and amount of organic waste
- the organisms acting on it
- temperature and pH

The greater the amount of organic waste in the water body, the greater is the amount of oxygen required to break it down biologically and therefore higher is the BOD value of water. This value is a good measure in evaluating the degree of pollution in a water body. The less polluted water shows comparatively low value of BOD. Its value is used as a criterion for managing water pollution of a water



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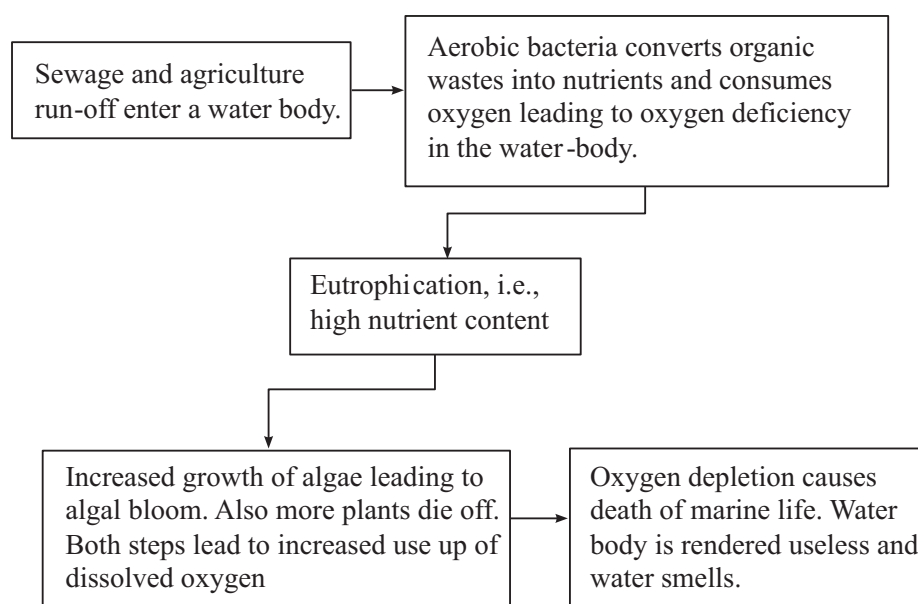
body. An evaluation is made by determining oxygen concentration in water before and after incubation at 20°C in dark for 5 days.

32.16.3 Biomagnification

A variety of toxic chemicals move through food chains. Toxic pesticides may be sprayed for controlling insect pests, fungi, herbs, but they concentrate in the food chain and harm to other (non target) organisms. For example, DDT was sprayed in the U.S. to control mosquitoes at a concentration expected to be harmless to non target organisms like fish and birds. DDT accumulated in the marshes and planktons. Planktons were eaten by fish and the fish had a higher concentration of DDT in its body. Further, when birds ate the fish, they accumulated still higher concentration. This increase in concentration of accumulated toxic chemicals as one goes higher in the food chain is termed **biomagnification**. Biomagnification has at times threatened the reproduction and survival of carnivores (secondary consumers) who occupy the highest level of the food chain.



Notes



32.17 WATER POLLUTION – SOME CONTROL MEASURES

Waste water generated by household activity, industries or garbage landfills is called **sewage** which is classified as the municipal water pollution. Sewage contains solid matters in the form of suspended colloidal and dissolved organic matter, detergent, mineral matter, nutrients and gases. Sewage is one of the major causes of water borne diseases and therefore the treatment of sewage is one of the important tasks. For a long time treatment of municipal waste in the form of sewage involved mainly of the removal of suspended solids, oxygen demanding materials and harmful bacteria. Now the disposal of the solid residue from sewage has been improved by applying municipal treatment processes.

The treatment of this waste water is carried out in the following three stages:

- (i) Primary treatment
- (ii) Secondary treatment, and
- (iii) Tertiary treatment

Primary Treatment: When the waste water is to be dumped off into a river or flowing stream, the treatment is carried out by sedimentation, coagulation and filtration. This is known as primary treatment. If the water is required for drinking purposes, it has to undergo further treatment called secondary and tertiary treatments. The following steps are performed to do primary treatment of water:

- (i) **Sedimentation:** This step is carried out in large tanks specially built for this purpose in sewage treatment plant. The polluted water is allowed to settle so that silt, clay and other matter settle to the bottom and water is slowly allowed to move out. Fine particles do not settle and are thus required to be removed in the next step.
- (ii) **Coagulation:** Fine particles and colloidal suspension are combined into large particles by a process called coagulation. This step is carried out by the addition of special chemicals called coagulants (flocculants) such as potash alum. The large particles either settle to the bottom or are moved in the next step.
- (iii) **Filtration:** Suspended particles, flocculants, bacteria and other organisms are filtered by passing the water through a bed of sand or finely divided coal or through some fibrous materials. The total impurities collected in these steps are called **sludge**. It is used as a valuable fertilizer. On composting (i.e. the action of anaerobic bacteria), it releases sludge gas. It consists mainly of methane gas which is used for cooking purposes.

Secondary or Biological Treatment: The water after primary treatment is not fit for drinking purposes and has to undergo further treatment. This is done through secondary or biological treatment. A commonly used method is to allow polluted water to spread over a large bed of stones and gravel so that the growth of different microorganisms needing nutrients and oxygen is encouraged. Over a period of time a fast moving food chain is set up. For example, bacteria consume organic matter from the polluted water; protozoa live on bacteria. Every form of life including algae and fungi help in the cleaning up process. This is called secondary treatment of water. It involves the following processes

- (i) **Softening :** By this treatment undesirable cations of calcium and magnesium are removed from hard waters. Either water is treated with lime and soda ash to precipitate Ca^{2+} ions as carbonates or it is passed through cation exchangers. This makes water soft.



Notes

(ii) **Aeration:** In this process, soft water is exposed to air by forcing air through it to add oxygen to water. This encourages bacterial decomposition of organic matter into harmless products such as carbon dioxide and water. The addition of oxygen reduces carbon dioxide, sulphide etc.. The water is as yet not fit for drinking purposes. The pathogenic and other microorganisms need to be killed. This is done in the next treatment.

Tertiary Treatment : The tertiary treatment is actually disinfecting water. Chlorine is the most commonly used disinfectant used for killing bacteria. However, chlorine also reacts with traces of organic matter present in water and forms undesirable chlorinated hydrocarbons (toxic and potentially carcinogenic). It is therefore desirable to reduce the organic matter in water before passing chlorine gas. Other methods of disinfection such as ultraviolet radiation, ozone gas treatment or reverse osmosis are preferred over chlorine treatment. But these methods are more expensive. Fig. 32.8 gives a clear picture of the process of sewage treatment in total.

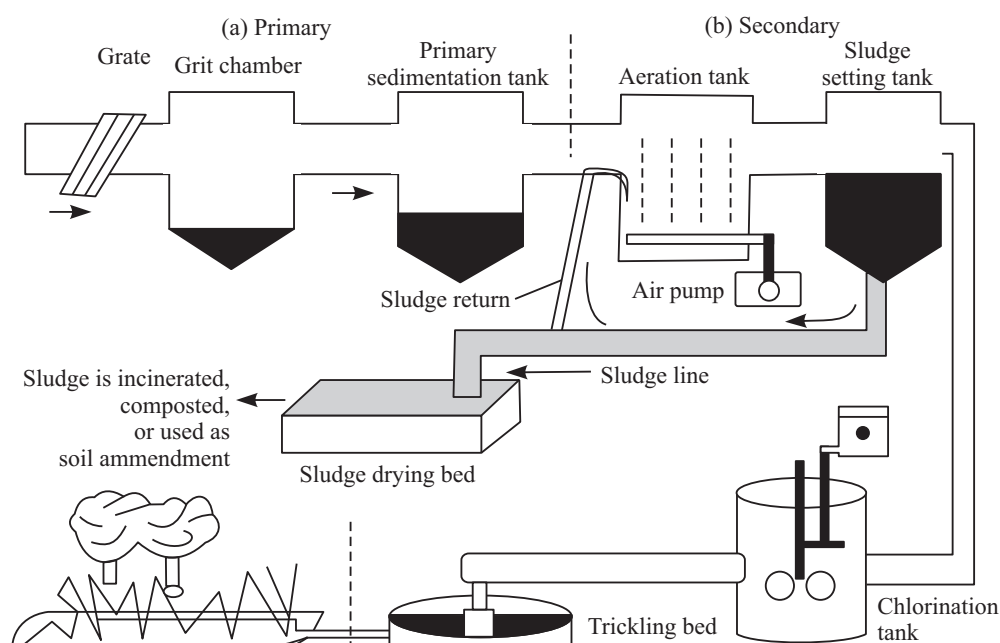


Fig. 32.8 : Treatment process of sewage

In a treatment plant, the waste is passed through a series of screens, chambers and chemical processes to reduce its bulk and toxicity. During primary treatment a large percentage of suspended solids and inorganic material is removed from sewage. The secondary stage reduces organic material by accelerating natural biological processes. Tertiary treatment is done when water is to be reused. Here 99% of solids are removed and various chemical processes are used to ensure that water is free from infecting materials.



Notes

**INTEXT QUESTIONS 32.6**

1. Define eutrophication.
2. Why does aquatic life get killed in an eutrophied pond?
3. What is the significance of BOD?
4. What is biomagnification?

32.18 SOIL POLLUTION

The adulteration of soil (land) by the addition of unwanted substances is known as soil pollution.

Sources of pollution

1. **Industrial waste:** The industrial wastes are the major cause of soil pollution because the wastes are toxic due to presence of cyanides, chromates, acids, alkalis, metal like nickel, cadmium, mercury and lead. Some industries like paper industries Sugar mills, textile mills and distilleries, chemical industries & cement industries are also responsible for soil pollution. The wastes of these industries are not bio-degradable.
2. **Urban and domestic waste:** The urban and domestic wastes referred as soil refuse, containing garbage, and rubbish, paper pieces, glass, plastics polythene bags, cans detergents and cakes. These substances emit gases, toxic hydrocarbons and pathogenic microbes cause to disease.
3. **Agricultural chemicals:** The fertilizers, pesticides, herbicides insecticides and fungicides are commonly used to save and increase the yield of crops but they have polluted the soil. Some time the entry of these chemicals in food chain has cause to adverse effects on health of consumers.
4. **Fertilizers:** The fertilizers increase the yield crop it has no doubt but the excessive use has adverse effects. It disturb the pH of soil, ionic balance and the presence of certain elements. So they have a number of health hazards. The nitrites cause to cancer in human body.
5. **Pesticides:** The chemicals are used to kill or to stop the growth of unwanted organisms and entry of these chemicals into food and water cause cause effect on the health of animals and human beings.
6. **Insecticides:** Some chemicals like DDT, BHC, aldrin, dieldrin are used to kill the insects, the use of DDT is banned by the Government because It is not biodegradable. It also effects the next crop in the field due to observed by the soil. Some bio degradable organ phosphates, carbonates may be used in place of insecticides.



Notes

7. **Herbicides:** The compounds used to control the growth of weeds, some inorganic compounds like sodium chlorate and sodium arsenite (Na_3AsO_3) were commonly used as herbicides. These are toxic in nature. So nowadays organic herbicide Triazines are preferred.
8. **Fungicides:** Fungicides are used to check the growth of fungi. Fungi is one of those plants in which chlorophyll is not present i.e. they can not make their food by the process photosynthesis. They live on dead organic matters as saprophytes. Organic compounds of mercury have been used as fungicides. Many people in Iraq resulted to death due to eating breads made from grains that been treated with methyl mercury fungicide. Its use has many disastrous consequences because these compounds breakdown in soil.

Control of soil Pollutions: The following steps have been suggested to control the soil pollutions:

- (i) The use of chemical fertilizers can be reduced by applying bio-fertilizers and manures.
- (ii) Re cycling and recovery of materials appears to be a reasonable solution for reducing soil pollutions. Materials like papers, glass and some kinds of plastics can be recycled.
- (iii) Control of land loss can be attempted through restoring forests and grass cover to check soil erosion and flood.
- (iv) Proper methods should be adopted for the disposal of solid wastes.



INTEXT QUESTIONS 32.7

1. What is refuse?
2. Write the name of one insecticide?
3. What is soil erosion?

32.19 GREEN CHEMISTRY AS AN ALTERNATIVE TOOL FOR REDUCING POLLUTION

We have discussed about hazards of environmental pollution in these units. The main reasons of this pollution is due to rapid industrialization, production and use of toxic chemicals. An important initiative to protect the environment from chemical effluents and wastes is known as Green chemistry.

“Green chemistry is the design of chemical products and processes that reduce or eliminate the use and generation of hazardous substances.”

Green chemistry is environment friendly, linking the design of chemical products and processes with their impacts on human health and the environment.



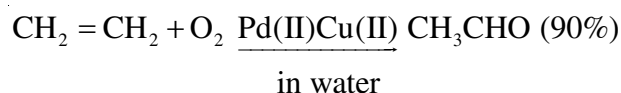
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Principles of Green Chemistry

- (i) The use of starting materials, reagents and solvents which are less hazardous to man and his environment.
- (ii) More efficient use of raw materials.
- (iii) Utilisation of chemical reactions which completely incorporate the starting materials into final products and least amount of by product.
- (iv) Search new alternatives which are environmental friendly.
- (v) It is better to prevent the waste than to treat or cleanup the waste after it has been created.

Achievements of Green chemistry

- (i) Development of dense phase CO₂. Dense phase CO₂ has been recently developed chemical product with amazing characteristics. It has ability to clean everything. It can be used as recyclable solvent and finds number of applications in food industries.
- (ii) Development of fuel cells of cellular phones which can last for the full life time of the phone.
- (iii) Development of process involving use of CO₂ as a blowing agent for manufacture of poly styrene foam. This technology discard the use of chloro fluoro carbon.
- (iv) H₂O₂ hydrogen peroxide gives better results and not harmful for bleaching of clothes in the laundry instead of tetrachloro ethene (Cl₂C=CCl₂). This compound is suspected to be carcinogenic and contaminated the ground water.
- (v) Hydrogen peroxide (H₂O₂) is used with catalyst for bleaching papers, instead of toxic chlorine gas.
- (vi) Ethanal (CH₃CHO) is now a days being prepared on a commercial scale by one step oxidation of ethane in presence of ionic catalyst in aqueous solution

**32.20 STRATEGIES TO CONTROL ENVIRONMENTAL POLLUTIONS**

Environmental pollutions affects the plants, animals and human beings as well as materials. The production and improper disposal of waste are causes for the great deal of environmental pollution. In addition to the have hold waste



Notes

these sewage and municipal garbage, many toxic industrial wastes from manufacturing processes require treatment and safe disposal. The biodegradable and non-biodegradable waste like polythene bags plastics, metal scrap should be put in separate boxes. The biodegradable waste is deposited in the landfills.

Industrial wastes are also sorted as biodegradable and non-biodegradable, should be put in separate boxes. Fly ash, furnace slag mud and sludges and gypsum like non-biodegradable wastes have produced great problems. Some chemical industries producing inflammable wastes and hazardous chemicals as by-products.

Some methods are usually employed one given below

1. Recycling: When materials are recycled, there are several benefits, apart from savings on the cost of raw materials, waste disposal costs are reduced.
 - (i) the collection and recycling of glass.
 - (ii) Iron scrap can be used in manufacturing steel.
 - (iii) Polythene bags and plastics can also be recycled.
 - (iv) The newspapers, used copies, and magazines can be used for making papers.

Sewage treatment

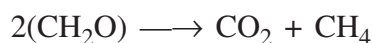
Sewage is the liquid waste which includes household wastes, industrial wastes, ground wastes, etc. which contains 99.9% water with inorganic, organic matters in dissolved, suspension and colloidal states. It involves the following stages.

- (i) The removal of large solid particles. It can be done by screening and sedimentation. The solid wastes are deposited in landfills.
- (ii) It is allowed to stand in tanks. Many solids settle down by the use of chemicals like alums and ferrous sulphate while oil, grease, float on the surface which can be skimmed off.
- (iii) Next stage involves the biological oxidation of organic content of waste materials by microorganisms followed by filtration.
- (iv) Finally some physical and chemical processes are applied to remove some chemicals like phosphates and adding chlorine to improve the quality of waste water.
 - (i) **Incineration:** It converts the organic and biological wastes to carbon dioxide and water at higher temperature 1273 K and excessive supply of oxygen. Exhaust gases must be filtered. The incomplete oxidation of polychlorinated biphenyls (PCBs) may convert to toxic polychlorodibenzodioxins (PCDDs). Main problem of this process is air pollution due to incomplete oxidations.



Notes

- (ii) **Digestion:** In digestion, sludge is kept in a closed tank in the absence of air for a prolonged period whereby it goes anaerobic respirations, yields gases like carbon dioxide methane and ammonium sulphide. The methane gas can be used as fuel.



- (iii) **Dumping:** Dumping of the sewage sludge into sea has been very common. However dumping of the sludge into land is increasing now-a-days. Because it has nitrogen and phosphorus which act as fertilizers for the soil.



Notes



INTEXT QUESTIONS 328

1. Write the names of those wastes which can be recycled
2. Name the chemicals which are used in sedimentation of solid waste.
3. How the incineration cause to air pollutions?



WHAT YOU HAVE LEARNT

- Surroundings in which we live is our environment.
- There are two components of environment : physical or abiotic and living organisms or biotic
- Pollutants may be defined as substances added to natural surroundings.
- There are two major sources of pollutants - stationary and mobile.
- Pollutants have adverse effects on environment and living organisms.
- SO_2 , CO_2 , CO, smoke, Pb, Hg, CFC, etc. pollute air. Their sources and effects are varied.
- Pollution in simple words is the unhealthy and harmful condition for living organisms and non-living things.
- Pesticides, plastic, detergents, chlorine, mercury, etc. pollute water and endanger life of aquatic organisms.
- Unwanted sounds are termed as noise. Sound is measured in decibels. Beyond 70 decibels noise has harmful effects on humans.
- The Government of India has set up various environmental laws and judiciary system to punish the polluters.
- 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%, carbon dioxide - 0.1 to 0.3%, inert gases 1 %
- Increase of temperature with altitude is known as positive lapse rate where as decrease in temperature with increase of altitude is negative lapse rate of temperature.
- Air pollution is due to
 - (i) particulate matter (soot, dust)
 - (ii) aerosols composed of hydrocarbons
 - (iii) gases like SO_2 , NO_2 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. 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.
- There is a layer of ozone in stratosphere, which protects us from UV radiation by absorbing it.
- 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 causing skin cancer.
- Complete destruction of ozone layer over an area is termed as ozone hole.
- Air pollution causes respiratory diseases such as emphysema and bronchitis, eye irritation, fluoroisis, cancer and may even be fatal.
- Control measures include use of sulphur free oil and coal, use of alternative sources of energy such as wind and solar power, use bicycle and battery powered vehicles, stop burining waste indiscriminately, have stringent measures for release of emissions from industries and above all educate general public and caution them against releasing air pollutants.



Notes

- Water pollution refers to any physical, chemical or biological change that has an undesirable affect on living organisms.
- Sewage, industrial, agricultural pollution and physical pollutants are the various sources of water pollution. These sources may be limited to a point sources or spread over large areas (non-point sources).
- Sewage, fertilizers, detergents, toxic wasters released by industries are some of the sources of groundwater pollution.
- Phosphatic, and nitrogenous fertilizers cause algal bloom and severe oxygen depletion in water body. The water body is said to be eutrophied.
- The quantity of oxygen needed by micro-organisms in degrading organic wastes in a water body is defined in terms of its biological oxygen demand (BOD).
- Biological magnification of toxic materials released into water bodies poses a serious threat to aquatic life and eventually to human life.
- Polluted water may be made useful for human consumption by subjecting it to various treatments.
- Legislative measures have been enacted in our country to restrict the pollution of various water bodies.



Notes

**TERMINAL EXERCISE**

1. What is environment?
2. Explain the term anthropogenic pollutants.
3. Write four major pollutants of water, their sources and effects.
4. Differentiate between the Primary and Secondary Pollutants.
5. What are the damaging effects of SO_2 and NO_2 on plants and animals?
6. Write a note on carbon monoxide poisoning.
7. What is thermal inversion and how is it caused?
8. Enumerate the various effects of acid rain.
9. What is ozone hole? What are the effects of ozone depletion?
10. Why does sea level rise due to global warming?
11. How do greenhouse gases cause global warming.
12. Mention five disease/discomforts in humans caused by different air pollutants.
13. Enumerate the various measures of control of air pollution.
14. How the industrial wastes and domestic wastes are helpful in soil pollution?

15. What one fungicides.
16. How to control soil pollution?
17. Explain main effects of water pollutions.
18. What are the various types of water pollutants? State their consequences.
19. What are the effects of detergents on fresh water bodies?
20. What are the various sources of groundwater pollution?
21. How is the disease 'methaemoglobinaemia' caused?
22. How can domestic waste be used as manure?
23. What will be the problem arise due to abundance of phyto plankton?
24. Write in brief about sewage treatment.



Notes



ANSWERS TO INTEXT QUESTIONS

32.1

1. The air, water, earth and living beings in a joint form is called environment.
2. There are two components of environment namely biotic and abiotic.
3. Living organisms such as plants, animals, microbes, etc.
4. Causes holes in the ozone layer.
5. Atmosphere, biosphere, hydrosphere and lithosphere.

32.2

1. Any substance which is present in its excess concentration such as CO_2 , CO , SO_2 .
2. Volcanic eruptions and run-off from surface mines.
3. Secondary pollutants are the products of reaction between the primary pollutant and the normal environmental constituents.
4. Environmental pollution is the deterioration or unclean objectionable conditions in the quality of natural resources such as air water and soil because of the action or presence of unwanted substances in undesirable concentration.

32.3

1. undesirable level of undesirable and harmful substances in the atmosphere
2. soot, fluoride, Pb dust, NaCl (any two)
3. SO_2 , CO_2 , CO , NH_3 , H_2S (any two)

- methanogenic bacteria, ruminant stomach, fermentation in water logged paddy fields (any one).
- PAN and O_3

32.4

- fog and smoke
- O_3 and PAN
- SO_2 and NO
- CO_2 , NO_2 , CH_4 , CFC, Halons
- refrigerants, fire extinguishers
- corrode them
- reducing use of fuel which releases air pollutants and use clean renewable fuels. Educate everyone about dangers of pollution.

32.5

- Refer to section 32.2
- Refer to section 32.3.1. (ii)
- Refer to section 32.1

32.6

- Refer to section 32.5.1
- Refer to section 32.5.1
- Refer to section 32.5.2
- Refer to section 32.5.3

32.7

- The urban and domestic wastes referred as soil refuse containing.
- DDT or BHC,
- The loss of fertile layer (dipper layer) of soil is called soil erosion.

32.8

- Glass, polythene, iron, paper etc.
- Potash Alumns and ferrous sulphate.
- The conversion of biological wastes to CO_2 and water at 1273 K. The incomplete oxidation PCBs are also causes to air pollutions.



Notes

