

ENVIRONMENTAL CHEMISTRY

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JEE(Main) Syllabus

Environmental pollution - Atmospheric, water and soil.

Atmospheric pollution - Tropospheric and stratospheric

Tropospheric pollutants - Gaseous pollutants: Oxides of carbon, nitrogen and sulphur, hydrocarbons; their sources, harmful effects and prevention; Green house effect and Global warming; Acid rain;

Particulate pollutants: Smoke, dust, smog, fumes, mist; their sources, harmful effects and prevention.

Stratospheric pollution- Formation and breakdown of ozone, depletion of ozone layer - its mechanism and effects.

Water Pollution - Major pollutants such as pathogens, organic wastes and chemical pollutants; their harmful effects and prevention.

Soil pollution - Major pollutants such as Pesticides (insecticides, herbicides and fungicides), their harmful effects and prevention. Strategies to control environmental pollution.



Environmental Chemistry

Introduction

The environmental pollution may be defined as direct or indirect undesirable changes in our surrounding as a result of human activities that have harmful effects on plants, animals and human beings.

A substance, which causes pollution, is known as pollutant. Pollutants may be solid, liquid or gaseous substance present in greater concentration than in natural abundance and are produced due to human activities or due to natural happenings.

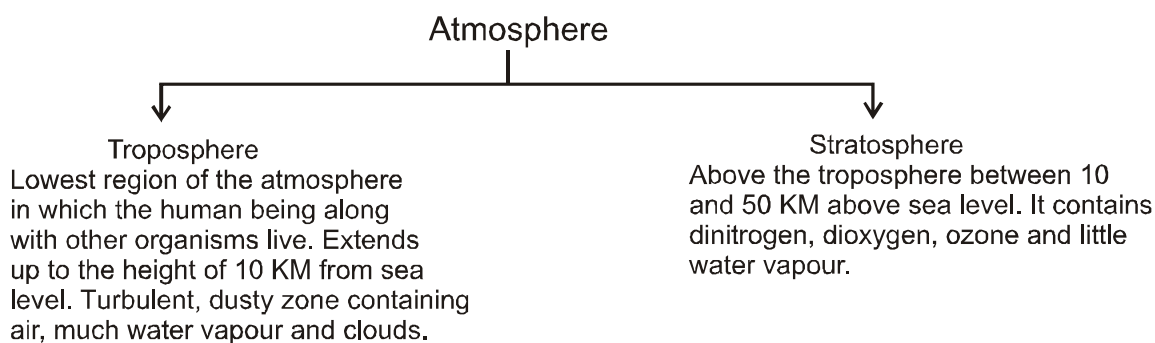
- (a) Pollutants can be fast degradable i.e. which rapidly break down by natural processes. For example, discarded vegetable.
- (b) Pollutants can be non-degradable. These remain in the environment in an unchanged form for many decades. For example dichloro diphenyltrichloroethane (DDT), plastic materials, heavy metals, nuclear wastes etc, if once released into environment are difficult to remove.

The process of environmental pollution involves :

- (i) The origin of pollutant from different source
- (ii) Transportation by air or water or dumping into soil by human being.

Atmosphere

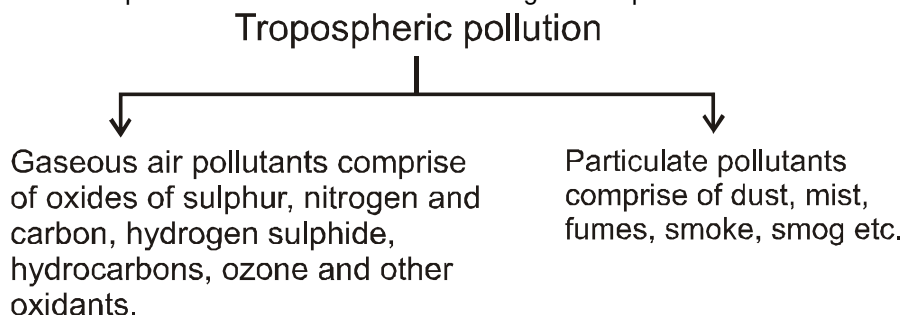
It is a protective blanket of gases surrounding the earth. The atmosphere is held to the earth by the force of gravity. The total mass of atmosphere is about 5×10^{15} metric tones. The constituents which make up the atmosphere are gases, water vapours and aerosols.



Section (A) : Gaseous air pollutants

1. Tropospheric pollution :

It occurs due to the presence of undesirable solids or gaseous particles in the air.



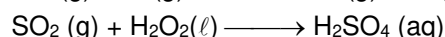
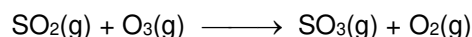
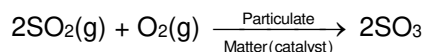


1.1 Oxides of sulphur

Sulphur (from fossil fuel) $\xrightarrow{\text{Burn}}$ Oxides of sulphur (SO_2, SO_3)

Toxic effect : SO_2 is poisonous to both animals and plants.

- (i) A low concentration of SO_2 causes respiratory diseases e.g. asthma, bronchitis, emphysema in human being.
- (ii) It causes irritation to the eyes resulting in tears and redness.
- (iii) High concentration of SO_2 is responsible for the **stiffness of flower buds** which eventually fall off from plants.

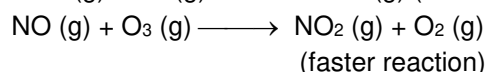
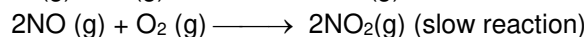
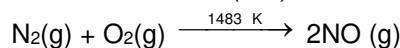


The SO_2 present in the atmosphere is generally contaminated with SO_3 . The SO_3 so formed gets converted into H_2SO_4 in the presence of moisture. This acid comes down from the atmosphere in form of sulphuric acid rain.

1.2 Oxides of nitrogen

N_2 and O_2 at high altitudes combine to form oxides of nitrogen when lightning strikes. NO_2 is then oxidised to NO_3^- which is washed into soil, where it serves as a fertilizer.

In an automobile engine when fossil fuel (i.e. hydrocarbons) is burnt, N_2 and O_2 combine to give significant quantities of nitric oxide (NO) and NO_2 .



Toxic effect :

- (i) The irritant **red haze** in the traffic and congested places is due to oxides of nitrogen.
- (ii) Higher concentration of NO_2 damages the leaves of plants and retard the rate of photosynthesis.
- (iii) It is toxic to living tissues.
- (iv) NO_2 is also harmful to various textile fibres and metals.

1.3 Hydrocarbons

They are formed by incomplete combustion of fuel used in automobiles.

Toxic effect :

- (i) They are carcinogenic, i.e. they cause cancer.
- (ii) In plants, they cause ageing, break down of tissues and shedding of leaves, flowers and twigs.

1.4 Oxides of carbon

(1) Carbon monoxide

Sources of carbon monoxide

- (i) Incomplete combustion of carbon, coal, fire wood, petrol etc.
- (ii) Automobile exhaust

***Toxic effect :**

- (i) Carbon monoxide is poisonous. It binds to haemoglobin to form carboxy haemoglobin which is about 300 times more stable than the oxygen-haemoglobin. This stable complex (when concentration reaches about 3 to 4%) reduces the oxygen carrying capacity of blood to greater extent. This oxygen deficiency causes headache, weak eyesight, nervousness and cardiovascular disorder.
- (ii) In pregnant women increased CO level induces premature birth, spontaneous abortions and deformed babies.



(2) Carbon dioxide [CO₂]

Sources of carbondioxide

- (i) Respiration (exhaled air contains CO₂)
- (ii) Burning of fossil fuels for energy.
- (iii) Decomposition of lime stone during the manufacture of cement.
- (iv) Volcanic eruptions.

It is found 0.03 percent by volume of the atmosphere and is confined to troposphere only.

Green plants require CO₂ for photosynthesis and they, in turn, release oxygen, thus maintaining the delicate balance. But deforestation and burning of fossil fuel increases the CO₂ level and disturbs the balance in the atmosphere. This increased amount of CO₂ in the air is mainly responsible for global warming.

1.5 Global warming and green house effect

*It has been found that about 75% of solar energy reaching the earth is absorbed by the earth's surface and, in turn, this increases the temperature of the earth. The remaining of the heat radiates back to the atmosphere. Some of the heat is trapped by gases such as carbondioxide, methane, ozone, chlorofluorocarbon compounds (CFCs) and water vapour in the atmosphere. Thus, they increases the temperature of the atmosphere. This causes, global warming.

*Just as the glass in a green house holds the sun's warmth inside, atmosphere traps the heat from the sun near the earth's surface and keeps it warm. This is called natural green house effect because it maintains the temperature and makes the earth perfect for life.

*In a green house, visible light passes through the transparent glass and heats up the soil and the plants. The warm soil and plants emit infrared radiations. Since glass is opaque to infrared radiations (heat), it partly reflects and partly absorbs these radiations. This process keeps the energy of the sun trapped in the green house.

Similarly, CO₂ molecules also trap heat as they are transparent to sun-light but not to the heat radiation. If the amount of carbon dioxide crosses the delicate proportion of 0.03%, the natural green house balance may get disturbed.

CO₂ is the major contributor to global warming. In addition to CO₂, other green house gases are methane, water vapour, nitrous oxide, CFCs and ozone.

Sources :

(a) Methane (CH₄) :

- (i) CH₄ is liberated naturally when vegetation is burnt, digested or rotted in absence of oxygen.
- (ii) Methane is released in paddy fields, coal mines, from rotting garbage dumps and by fossil fuels.

(b) CFCs : CFCs are man-made industrial chemicals used in air conditioning etc.

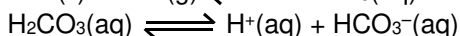
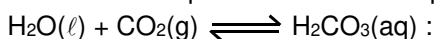
Note : CFCs are responsible for depletion of the ozone layer.

(c) N₂O : Nitrous oxide occurs naturally in the environment but in recent years it's quantities have increased significantly due to the use of chemical fertilizers and the burning of the fossil fuels.

Increase in the global temperature increases the incidence of infectious diseases like dengue, malaria, yellow fever, sleeping sickness etc.

1.6 Acid Rain

The pH of rain water is 5.6 due to the presence of H⁺ ions formed by the reaction of rain water with carbon dioxide present in the atmosphere as per following reactions :



When the natural rain falls through polluted air, it comes in contact with chemicals such as gaseous oxides of sulphur (SO_x), oxides of nitrogen (NO₂), mist of hydrochloric acid and phosphoric acid. These substances dissolves in falling rain making it more acidic than normal pH ranging between 5.6 and 3.5.

When the pH of rain water drops below 5.6, it is called acid rain. Nowadays, the term acid rain is used to describe the way in which acid from the atmosphere is deposited on the earth's surface. Oxides of nitrogen and sulphur which are acidic in nature can be blown by wind along with solid particles in the atmosphere and finally settle down either on the ground as dry deposition or in water, fog and snow as wet deposition.

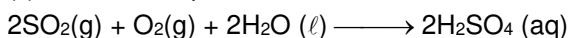


Chemistry of acid rain :

SO₂ and NO₂ after oxidation and reaction with water are major contributors to acid rain, because polluted air usually contains particulate matter that catalyses the oxidation. Following are the major sources of the oxides of sulphur and nitrogen.

(i) Burning of fossil fuels (which contain sulphur and nitrogeneous matter) such as coal and oil in power station and furnaces or petrol and diesel in motor engines.

(ii) Volcanic eruptions, forest fires and bacterial decomposition of organic matter.



Beside these ammonium salts are also formed and can be observed as an atmospheric haze (Aerosol of fine particles).

Aerosol particles of oxides or ammonium salts in rain drops settle down as wet deposition. SO₂ is also absorbed directly on both solid and liquid ground surfaces and is thus deposited as dry-deposition.

Harmful effect of acid rain

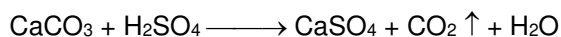
(i) Acid rain is harmful for agriculture, plants and trees because it dissolves and washes away nutrients needed for their growth.

(ii) Acid rain affects plants and animal life in aquatic ecosystem.

(iii) It causes respiratory ailments in human beings and animals.

(iv) It corrodes water pipes resulting in the dissolution of heavy metals such as iron, lead and copper into the drinking water.

(v) Building materials such as stone, marble, dolomite, mortar, slate or metal are corroded and weakened on reaction with acid rain because of the formation of soluble compounds.



1.7 Particulate pollutants

Particulate refers to minute solid particles or liquid droplets in air. These are found in vehicle emissions, smoke particles from fires, dust particles and ash from industries. Particulates in the atmosphere may be viable or non-viable.

Viable Particulates : The viable particulates are minute living organisms that are dispersed in the atmosphere. Some examples are bacteria, fungi, molds, algae etc. They cause plant diseases and also produce allergic reactions to human beings.

Non-viable Particulates : Non-viable particulates may be classified according to their nature and size as given below.

(a) Smoke particulates : They consist of solid or mixture of solid and liquid particles formed during combustion of organic matter. Examples are cigarette smoke, smoke from burning of fossil fuel, garbage and dry leaves, oil smoke etc.

(b) Dust : It consists of fine solid particles over 1µm in diameter produced during crushing, grinding and attribution of solid materials.

Examples are sand from sand blasting, saw dust from wood works, pulverized coal, cement and fly ash from factories, dust storms etc.

(c) Mists : They are produced by particles of spray liquids and by condensation of vapours in air. Examples are H₂SO₄ mist, herbicides and insecticides that miss their target and travel through air and form mists.

(d) Fumes : They are generally produced by the condensation of vapours during sublimation, distillation, boiling and several chemical reactions. Organic solvents, metals and metallic oxides form fume particles.

Air borne particles such as dust, fumes, mists etc are dangerous for human health.

**Toxic effect :**

- (i) Particulate pollutants bigger than 5 microns are supposed to lodge in the nasal passage.
- (ii) Particulate pollutants of about 1.0 micron enter into lungs easily.
- (iii) Leaded petrol is the primary source of air-borne lead emission. Lead interferes with the development and maturation of red blood cells.

1.8 Smog

Word smog is obtained from the combination of the words smoke and fog. It is the one of the most common examples of air pollution that occurs in many cities through out the world. There are two types of smog as explained below.

Classical Smog

It is also known as **sulphurous smog** or **London smog** (as first occurred in London). It occurs in cool and humid climate. It is a mixture of smoke, fog and sulphur dioxide. Because of the presence of SO₂ and carbon particles (soot), it is a reducing mixture and therefore it is also called as **reducing smog**.

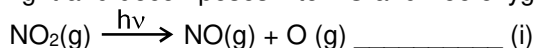
Photochemical Smog

It is also known as **Los Angeles smog** (as first occurred in Los Angeles). It occurs in warm, dry and sunny climate. The main components of this smog result from the action of sunlight on unsaturated hydrocarbons and nitrogen oxides produced by automobiles and factories. Photo chemical smog has high concentration of oxidising agents like NO₂ therefore called **oxidising smog**.

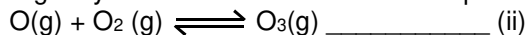
Mechanism of photochemical smog :

*Burning of fossil fuels yields variety of pollutants into the earth's troposphere. Most important pollutants are hydrocarbons (unburned fuels) and nitric oxide (NO).

*When the concentration of these pollutants increases to sufficiently high levels, a chain reaction occurs from their interaction with sunlight in which NO is converted into NO₂. This NO₂ in turn absorbs energy from sunlight and decomposes into NO and free oxygen atom.



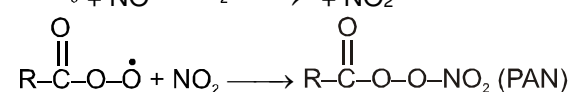
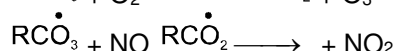
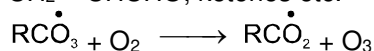
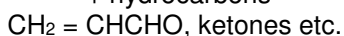
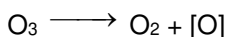
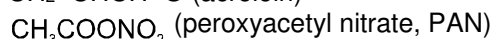
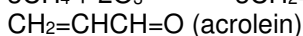
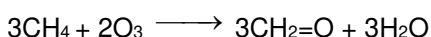
Oxygen atom being very reactive combines with atmospheric oxygen forming ozone.



The ozone formed in the above reaction reacts rapidly with the NO(g) formed in the reaction (i) to regenerate NO₂. NO₂ is a reddish brown/brown gas and at sufficiently high level can contribute to haze.



*Like NO₂, O₃ is a toxic gas and both NO₂ and O₃ are strong oxidising agents : They can react with the unburnt hydrocarbons in the polluted air to produce compounds like formaldehyde, acrolein and peroxyacetyl nitrate (PAN).





Harmful/toxic effects of photochemical smog

- (i) Components of photochemical smog, NO and O₃, irritate the nose and throat and their high concentration causes headache, chest pain, dryness of the throat, cough and difficulty in breathing.
- (ii) Both ozone and PAN act as powerful eye irritants.
- (iii) Photochemical smog leads to cracking of rubber and extensive damage to plant life. PAN inhibits photo system, inhibits formation of chlorophyll and also spoils enzymes.
- (iv) Photochemical smog also causes corrosion of metals, stones, building materials, rubber and painted surfaces.

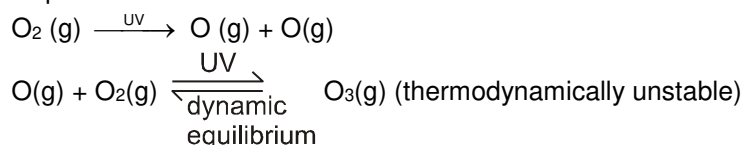
Control of photochemical smog

- (i) Certain chemical compounds are sprayed into atmosphere, which generate free radicals. These free radicals combine with those free radicals which are responsible for the formation of the component of photo chemical smog.
- (ii) Using catalytic converters in the automobiles, which prevent the release of NO and hydrocarbons to the atmosphere.
- (iii) By plantation of certain plants like pinus, juniparus, quercus, pyrus ant vitis which metabolise NO and thus help in the control of the formation of photochemical smog.

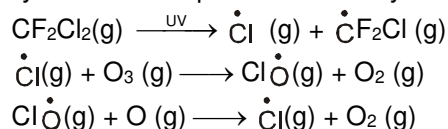
2. Stratospheric Pollution

Formation and break down of ozone

- * The upper part of stratosphere consists of considerable amount of ozone (O₃). The ozone layer protects us from the harmful ultra violet (UV) radiations ($\lambda = 255 \text{ nm}$) coming from the sun.
- * These radiations cause skin cancer (melanoma) in human beings and, therefore, it is important to maintain and protect the ozone shield/layer.
- * Ozone is produced as a result of the action of ultraviolet radiations on dioxygen as given below.



- * The main reason of ozone layer depletion is believed to be the release of chlorofluorocarbon compounds (CFCs) which are also known as freons.
- * The CFCs are non reactive, nonflammable, non-toxic organic molecules and, therefore, used in refrigerations, airconditioners, in the production of plastic foam and by the electronic industry for cleaning computer parts. Released CFCs come in contact with the normal atmospheric gases and eventually reach stratosphere where they cause depletion in ozone layer as described below.



In this the chlorine radicals are continuously regenerated and cause the decomposition of ozone. Hence, CFCs act as transporting agents for continuously generating chlorine radicals into the stratosphere and damaging the ozone layer.

Ozone Hole

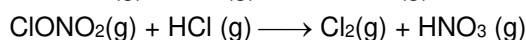
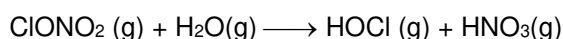
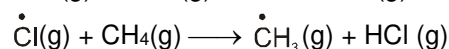
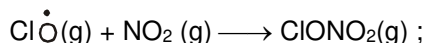
In Antarctica, scientists reported about the depletion of ozone layer commonly known as ozone hole over the south pole. They reported that a unique set of conditions was responsible for the ozone hole.

Polar stratospheric clouds

- (i) In summer season, nitrogen dioxide and methane react with chlorine monoxide and chlorine atom forming chlorine sinks and, thereby, preventing much ozone depletion.



In winter, special type of clouds called polar stratospheric clouds are formed over antarctica. These polar stratospheric clouds provide surface on which chlorine nitrate formed gets hydrolysed to form hypochlorous acid. It also reacts with HCl produced to give molecular chlorine.



(ii) In spring, when sunlight returns to the Antarctica, the sun's warmth, break up the clouds and HOCl and Cl_2 are photolysed by sun light according to the following reactions.



The chlorine radicals thus formed, initiate the chain reaction for ozone depletion.

Harmful effects of depletion of ozone layer :

- (i) UV radiation lead to ageing of skin, cataract, sunburn, skin cancer, killing of many phytoplanktons, damage to fish productivity etc.
- (ii) UV radiations affect the plant protein which eventually leads to the harmful mutation of cells.
- (iii) UV radiations increase the evaporation of surface water through the stomata of the leaves and thus decreases the moisture content of the soil.
- (iv) Increase in UV radiations damage paints and fibres, causing them to fade faster.

Ex-1. Explain tropospheric pollution in 100 words

Sol. Tropospheric pollution occurs due to the presence of undesirable gases and the solid particles in the air. The major gaseous and the particulate pollutants present in the troposphere are as follows :

- Gaseous air pollutants. These include mainly oxides of sulphur (SO_2 , SO_3), oxides of nitrogen (NO , NO_2) and oxides of carbon (CO , CO_2) in addition to hydrogen sulphide (H_2S), hydrocarbons, ozone and other oxidants.
- Particulate pollutants. These include dust, mist, fumes, smoke, smog, etc.

Ex-2. What is the composition of photochemical smog ?

Sol. Mixture of NO_2 , O_3 , peroxyacyl nitrates (PAN), aldehydes, ketones, hydrocarbons and CO .

Section (B) : Water pollution, soil pollution and waste management

3. Water pollution

Pollution of water originates from human activities :

(i) Point source pollution

Easily identified source of pollution is called as point source. Examples are municipal and industrial discharge pipes where pollutants enter the water source.

(ii) Non point source pollution

Non point sources of pollution are those where a source of pollution can not be identified. Examples are agriculture run off (from farm, animals and crop-lands), acid-rain storm water, drainage (from streets, parking lots and lawns) etc.



Water pollutants and their sources.

Pollutant	Source
(i) Micro-organisms	Domestic sewage
(ii) Organic wastes	Domestic sewage, animal excreta and waste, decaying animals and plants, discharge from food processing factories
(iii) Plant nutrients	Chemical fertilizers
(iv) Toxic heavy metals	Industries and chemical factories
(v) Sediments	Erosion of soil by agriculture and strip mining
(vi) Pesticides	Chemical used for killing insects, fungi and weeds
(vii) Radioactive substances	Mining of uranium containing minerals
(viii) Heat	Water used for cooling in industries.

3.1 Causes of water pollution :

(a) Pathogens :

Water pollutants which are the disease causing agents are called pathogens. Pathogens include bacteria and other organisms that enter water from domestic sewage and animal excreta.

Human excreta contains bacterias such as *Escherichia coli* and *Streptococcus faecalis* which cause gastrointestinal diseases.

(b) Organic waste :

Organic matter such as leaves, grass, trash etc. are major water pollutants. They pollute the water as a consequence of decay i.e. run off. Excessive phytoplankton growth within water is also a cause of water pollution. These wastes are biodegradable.

Biodegradable waste :

These are domestic wastes which can be rapidly decomposed under natural processes by micro-organism.

Non-Biodegradable waste :

These are poisonous wastes which do not degrade or degrade very slowly in the ecosystem naturally. These are not recycled in the natural environment.

3.2 Dissolved Oxygen (DO) :

Bacteria present in large population causes the decomposition of organic matter present in water. They consume oxygen dissolved in water. The dissolved oxygen (DO) is limited in water. In winter i.e. in cold water, dissolved oxygen can reach a concentration up to 10 ppm. That is why even a moderate amount of organic matter when decompose in water can deplete the amount of dissolved oxygen in water.

If the concentration of dissolved oxygen in water is below 6 ppm, the growth of fish gets inhibited. Oxygen reaches to water (i) through atmosphere and (ii) from the process of photosynthesis carried out by many aquatic green plants during day light.

However during night, photosynthesis stops but the plants continue to respire, resulting in the reduction of dissolved oxygen. The dissolved oxygen is also used by the microorganism to oxidise organic matter. If too much of organic matter is added to water, all the available oxygen is consumed. This leads to the death of oxygen dependent aquatic life.

The concentration of dissolved oxygen in water is very important for aquatic life. Thus **anaerobic bacteria** (which do not require oxygen) begin to break down the organic matter/waste and produce chemicals that have foul smell and are harmful to human health. Aerobic (oxygen requiring) bacteria degrade these organic waste and keep the water depleted in dissolved oxygen.



3.3 Biochemical oxygen demand (BOD)

The amount of oxygen required by bacteria to break down the organic waste present in a certain volume of a sample of water is called biochemical oxygen demand (BOD).

Biochemical oxygen demand (BOD) is a measure of the amount of dissolved oxygen that would be needed by the microorganism to oxidise the organic compounds. 'Clean water' would have a BOD value of **less than 5 ppm** where as highly polluted water (river, lake, ponds etc.) could have a BOD value of **17 ppm or more**.

3.4 Chemical pollutants

Chemical pollutants include water soluble such as cadmium, mercury, nickel etc. All these metals are dangerous to human because our body can not excrete them. Over the time, the concentration of these metals crosses the tolerance limit and thus, these metals then can damage kidneys, central nervous system, liver, etc.

Acids (like H_2SO_4) from mine drainage and salts like sodium and calcium chloride which are used to melt snow and ice in the colder climates are water soluble chemical pollutants.

Organic pollutants include petroleum products (e.g. major oil spills in oceans), pesticides, various industrial chemicals (e.g. poly chlorinated biphenyls used as cleansing solvent), detergent and fertilizers PCBs (Polychlorinated biphenyl) are suspected to be carcinogenic. Detergents are biodegradable. However their use can create problem. The addition of fertilizer increases the amount of soluble phosphates in the water and this enhances the growth of algae. Such profuse growth of algae, covers the water surface and reduces the oxygen concentration in water. This leads to anaerobic conditions, commonly, with accumulation of abnoxious decay and death. Thus, bloom-infested water inhibits the growth of other living organism in the water body.

3.5 Eutrophication

The process in which nutrient enriched water bodies support a dense plant population, which kills animal life by depriving it of oxygen and results in subsequent loss of biodiversity is known as Eutrophication.

3.6 International standards for drinking water

(a) Fluoride : Drinking water should contain fluoride ions concentration up to **1 ppm** or 1 mg dm^{-3} . Its deficiency in drinking water causes diseases such as tooth decay etc. The F^- ions make the enamel on teeth much harder by converting hydroxyapatite, $[\text{3Ca}_3(\text{PO}_4)_2 \cdot \text{Ca}(\text{OH})_2]$, the enamel on the surface of the teeth, into much harder fluorapatite, $[\text{3 Ca}_3(\text{PO}_4)_2 \cdot \text{CaF}_2]$.

However, F^- ion concentration above 2 ppm causes brown mottling of teeth. Similar excess fluoride (over 10 ppm) causes harmful effect to bones and teeth.

(b) Lead : The upper standard limit of lead concentration is about **50 ppb**. It can damage kidney, liver, reproductive system etc.

(c) Sulphate : Excessive concentration of sulphate ($>500 \text{ ppm}$) causes laxative effect.

(d) Nitrate : The maximum of nitrate is **50 ppm** and excess nitrate in water can cause diseases such as methemoglobinemia ('blue baby' syndrome).

(e) Other metals :

Metal	Maximum of concentration (ppm or mg dm^{-3})
Fe	0.2
Mn	0.05
Al	0.2
Cu	3.0
Zn	5.0
Cd	0.005



4. Soil pollution

Insecticides, pesticides and herbicides cause soil pollution.

(a) Pesticides :

Pesticides are synthetic toxic chemicals with ecological repercussions.

The repeated use of the same or similar pesticide give rise to pests that are resistant to that group of pesticides thus making the pesticide ineffective. Therefore, other organic toxins such as aldrin and dieldrin were introduced, as insect resistance of DDT increased.

Most of them are water insoluble and non-biodegradable. These high persistent toxins are, therefore, transferred from lower trophic level to higher trophic level through food chain.

Over the time, concentration of the toxins in higher animals reach a level which causes serious metabolic and physiological disorders.

(b) Herbicides :

Herbicides such as sodium chlorate (NaClO_3), sodium arsenite (Na_3AsO_3) and many other are now a days used to kill weeds. However because of their toxic effect to mammals their use have been restricted, some herbicides cause birth effect.

These days, organic compounds such as **triazines** are widely used as herbicides.

(c) Insecticides : These are used to control insects and thus help to curb diseases and protect crops. They include chlorinated hydrocarbons, DDT, BHC and malathion etc. However, due to adverse effects, use of DDT has been banned in india.

5. Industrial waste

(i) Biodegradable waste

Generated by cotton mills, food processing units, paper mills and textile factories.

(ii) Nondegradable waste

Generated by thermal power plants (fly ash); integrated iron and steel plants (blast furnace slag and steel melting slag); aluminium, zinc and copper manufacture (mud and tailings); Fertilizer industries (gypsum)

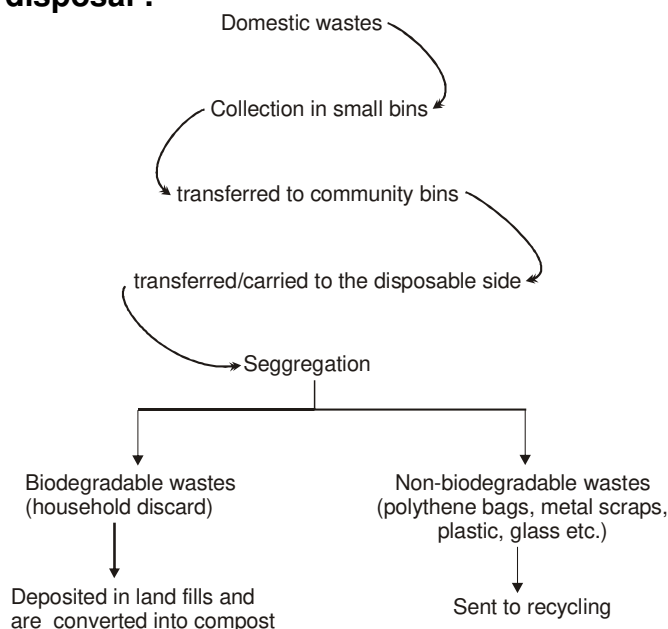
Disposal : Fly ash and slag from the steel industries are used in the cement industries.

Large quantities of toxic wastes are usually destroyed by controlled incineration, while small quantities are burnt along with factory garbage in open bins.

5.1 Waste Management

In addition to the improper disposal of the house hold wastes, disposal of medical, agriculture, industrial and mining wastes is one of the major causes of environmental degradation. Therefore, management of wastes is of utmost importance.

5.2 Collection and disposal :





- Note :** (i) Non-biodegradable waste like polythene bag, metal scraps, etc choke the sewers and if polythene bags are swallowed by cattle, it can cost their lives also. The poor waste management causes health problems leading to epidemics due to contamination of ground water.
- (ii) The persons who are directly involved in the collection and disposal of waste should make the use of protective device such as gloves or water proof boots and gas masks.

6. Green chemistry

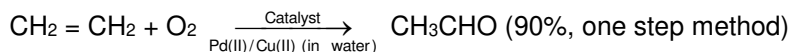
- (i) Green chemistry is a way of thinking and is about utilising the existing knowledge and principles of chemistry and other services to reduce the adverse impact on environment.
- (ii) Green chemistry is a continuous process that would bring about minimum pollution or deterioration to the environment.
- (iii) The generation of by-products during a process if not used gainfully are not only environmental unfriendly but also cost-ineffective. In a chemical reaction, if reactants are fully converted by optimising reaction conditions into useful environment friendly medium then there would be no chemical pollutants introduced in the environment. It will be worth while to carry out the synthetic reactions in aqueous medium in place of organic solvents since water has high specific heat and low volatility. Water is cost effective, noninflammable and devoid of any carcinogenic effects.

Green chemistry in day-to-day life :

(i) **Dry cleaning of clothes** : Tetra chloroethene used for dry cleaning was found to contaminate the ground water and is also a suspected carcinogen. This compound has now been replaced by **liquefied carbondioxide** with a suitable detergent. This will result in less harm to ground water.

(ii) **Bleaching of paper** : Use of H_2O_2 with suitable catalyst has replaced the use of chlorine gas for bleaching paper.

(iii) Synthesis of chemicals :



Important : Green chemistry leads to reduction in

- (i) material (ii) energy consumption and (iii) waste generation.



MISCELLANEOUS SOLVED PROBLEMS

1. What would have happened if the greenhouse gases were totally missing in the earth's atmosphere ? Discuss.
Sol. The solar energy radiated back from the earth surface is absorbed by the greenhouse gases (i.e. CO₂, CH₄, O₃, CFC's and water vapour) present near the earth's surface. They heat up the atmosphere near the earth's surface and keep it warm. As a result, they keep the temperature of the earth constant and help in the growth of plants and existence of life on the earth. If there were no greenhouse gases, there would have been no vegetation and life on the earth.

2. A large number of fish are suddenly found floating dead on a lake. There is no evidence of toxic dumping but you find an abundance of phytoplankton. Suggest a reason for the fish kill.
Sol. Excessive phytoplankton (organic pollutants such as leaves, grass, trash, etc.) present in water is biodegradable. A large population of bacteria decomposes this organic matter in water. During this process they consume the oxygen dissolved in water. Water has already limited dissolved oxygen (= 10 ppm) which is further depleted. When the level of dissolved oxygen falls below 6 ppm, the fish cannot survive. Hence, they die and float dead in water.

3. How can domestic waste be used as manure ?
Sol. Domestic waste comprises of two types of materials, biodegradable such as leaves, rotten food, etc., and non-biodegradable such as plastics, glass metal, scrap, etc. The non-biodegradable waste is sent to industry for recycling and the biodegradable waste should be deposited in the land fills. With the passage of time, it is converted into compost manure.

4. For your agricultural field or garden, you have developed a compost producing pit. Discuss the process in the light of bad odour, flies and recycling of wastes for a good produce.
Sol. The compost producing pit should be set up at a suitable place or in a tin to protect ourselves from bad odour and flies. It should be kept covered so that flies cannot make entry into it and the bad odour is minimized. The recyclable material like plastics, glass, newspapers, etc. should be sold to the vendor who further sells it to the dealer. The dealer further supplies it to the industry involved in recycling process.

5. Answer the following subparts
 (i) What is loam soil ?
 (ii) What are asbestosis and silicosis ?
 (iii) What are particulates and what is their approximate size ?
 (iv) Name three natural sources of air pollution
 (v) How are flue gases from industries feed from oxides of nitrogen and sulphur ?
Sol. (i) Soil containing 34% air, 66% water along with humus is called loam soil. It is best for crops.
 (ii) Asbestosis and silicosis are lung diseases caused by particulates.
 (iii) Particulates are finely divided solid or liquid particles suspended in air. Their size varies from $2 \times 10^{-4} \mu$ to 500μ .
 (iv) Volcanic eruptions, forest fires and pollen grains of flowers.
 (v) The flue gases are subjected to scrubbing with conc. H₂SO₄ or with alkaline solutions such as Ca(OH)₂ or Mg(OH)₂ etc.



6. (i) Name two important sinks of CO_2 .

(ii) What is marine pollution

(iii) What is humification ?

(iv) What are viable and non-viable particulates ?

Sol. (i) Oceans (which dissolve it) and plants (which use it for photosynthesis)

(ii) Pollution of sea water due to discharge of wastes into it is called marine pollution.

(iii) The decomposition of organic material (leaves, root etc.) in the soil by microorganism to produce humus is called humification.

(iv) Viable particulates are small size living organisms such as bacteria, fungi, moulds, algae, etc. Non-viable particulates are formed by disintegration of large size materials or condensation of small size particles or droplets e.g. mist, smoke, fume and dust.

7. (i) What is the composition of photochemical smog and classical smog ? How do the two differ in their behaviour ?

(ii) What should be the tolerable limit of fluoride ions in drinking water ? What happens if it is higher than 10 ppm ?

Sol. (i) Photochemical smog is mixture of a number of irritation causing compounds like NO_2 , O_3 aldehydes, peroxyacyl nitrates, ketones, hydrocarbons and CO. It is formed in summer months after sunrise.

Classical smog is a mixture of oxides of sulphur and carbons (soot). It is formed in early hours of winter months. Photochemical smog is oxidising in nature whereas classical smog is reducing in nature.

(ii) 1 ppm or 1 mg dm^{-3} . Higher concentration is harmful to bones and teeth.

8. What do you understand by greenhouse effect ? What are the major gases ?

Sol. The warming of the earth or global warming due to re-emission of sun's energy absorbed by the earth followed by its absorption by CO_2 molecules and H_2O vapour present near the earth's surface and then its radiation back to the earth is called greenhouse effect.

Though CO_2 is the main gas in the greenhouse effect, there are some other greenhouse gases like methane, chlorofluorocarbons, ozone, nitrous oxide and water vapours.

9. (i) Why does rain water normally have a pH of about 5.6? When does it become acid rain ?

(ii) Why is acid rain considered as a threat to Taj mahal ?

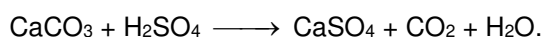
(iii) Explain by giving reason " The presence of CO reduces the amount of haemoglobin available in the blood for carrying oxygen to the body cells."

(iv) State briefly the reactions causing ozone layer depletion in the stratosphere.

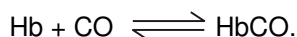
Sol. (i) Normally rain has a pH of about 5.6 due to dissolution of CO_2 into the atmosphere

$(\text{CO}_2 + \text{H}_2\text{O} \longrightarrow \text{H}_2\text{CO}_3 \rightleftharpoons 2\text{H}^+ + \text{CO}_3^{2-})$. When the pH of rain falls below 5.6, it becomes acid rain.

(ii) Taj mahal is made of marble. The acid rain contains H_2SO_4 which attacks the marble (CaCO_3) thereby pitting it, discolouring it and making it lustreless.



(iii) CO combines with haemoglobin of the red blood cells (RBCs) about 300 times more easily than oxygen to form carboxyhaemoglobin reversibly as follows.



Thus it is not able to combine with oxygen to form oxyhaemoglobin and transport of oxygen to different body cells cannot take place.



Exercise-1

PART - I : OBJECTIVE QUESTIONS

Section (A) : Gaseous air pollutants

- A-1.** Burning of fossil fuels is the main source of, which of the following pollutants ?
 (1) Nitrogen oxide (2) Nitric oxide (3) Nitrous oxide (4) Sulphur dioxide
- A-2.** SO_2 and NO_2 produce pollution by increasing :
 (1) alkalinity (2) acidity (3) neutrality (4) buffer action
- A-3.** Air pollutants that produce photochemical oxidants include :
 (1) CO_2 , CO and SO_2 (2) N_2O , NO and HNO_3
 (3) O_2 , Cl_2 and HNO_3 (4) O_3 , Cl_2 and SO_2
- A-4.** Carbon monoxide is pollutant as it :
 (1) inactivates nerves (2) inhibits glycolysis
 (3) combines with oxygen (4) combines with haemoglobin
- A-5.** Acid rains are produced by :
 (1) excess NO_2 and SO_2 from burning fossil fuels
 (2) excess production of NH_3 by industry and coal gas
 (3) excess release of carbon monoxide by incomplete combustion
 (4) excess formation of CO_2 by combustion and animal respiration.
- A-6.** Spraying of DDT produces pollution of the type:
 (1) air (2) air and water (3) air and soil (4) air, water and soil
- A-7.** Chlorofluorocarbon releases which of the following chemical harmful to ozone :
 (1) fluorine (2) chlorine (3) nitrogen peroxide (4) sulphur dioxide
- A-8.** Most hazardous metal pollutant of automobile exhausts is :
 (1) mercury (2) cadmium (3) lead (4) copper
- A-9.** Classical smog occurs in places of :
 (1) excess CO_2 (2) cool and humid
 (3) warm, dry and sunny (4) excess NH_3
- A-10.** The aromatic compounds present as particulates is/are :
 (1) benzene (2) toluene (3) nitrobenzene (4) polycyclic hydrocarbons
- A-11.** Which of the following statements is true about photochemical smog ?
 (1) It is reducing in nature.
 (2) it is formed in winter.
 (3) It is a sulphurous smog.
 (4) Components of the smog, NO and O_3 , irritate the nose and throat and their high concentration causes headache, chest pain, dryness of the throat, cough and difficulty in breathing.
- A-12.** Besides CO_2 , the other green house gas is :
 (1) CH_4 (2) N_2 (3) Ar (4) O_2
- A-13.** Which of the following is not a part of green chemistry ?
 (1) Photochemistry (2) Sonochemistry (3) Nuclear chemistry (4) Biochemistry
- A-14.** Ultraviolet radiation from sun causes a reaction that produces :
 (1) fluorides (2) carbon monoxide (3) sulphur dioxide (4) ozone
- A-15.** Ozone depletion in stratosphere shall result in :
 (1) forest fires
 (2) increased incidence of skin burns and skin cancer
 (3) increase in biological oxygen demand
 (4) global warming



- A-16.** Which of the following statements is true ?
 (1) London smog is oxidising in nature.
 (2) London smog contains H_2SO_4 droplets.
 (3) London smog is mixture of smoke, fog and SO_2 .
 (4) London smog causes bronchitis.
- A-17.** Which of the following processes does not increase the amount of CO_2 in atmosphere ?
 (1) Decay of animals (2) Breathing (3) Photosynthesis (4) Burning of petrol
- A-18.** Consider the following statements and select the correct option :
S₁ : Dust is a non-viable particle.
S₂ : Particulates acquire negative charge and are attracted by the positive electrode.
S₃ : O_2 is a green house gas.
S₄ : Algae is a viable particulate.
 (1) S_1 and S_2 only (2) S_1 , S_2 and S_3 only (3) S_1 , S_2 and S_4 only (4) S_2 , S_3 and S_4
- A-19.** Which of the following statements is true about ozone layer ?
 (1) It is harmful because ozone is dangerous to living organism.
 (2) It is beneficial because oxidation reaction can proceed faster in the presence of ozone.
 (3) It is beneficial because ozone cuts off the ultra violet radiation of the sun.
 (4) It is harmful because ozone cuts out the important radiation of the sun which are vital for photosynthesis.
- A-20.** Incomplete combustion of petrol or diesel oil in automobile engines can be best detected by testing the fuel gases for the presence of ?
 (1) CO and water vapour (2) CO
 (3) NO_2 (4) SO_2
- A-21.** The basic component of smog is :
 (1) PAN (2) PBN (3) NO_2 (4) All of these
- A-22.** In Antarctica, ozone depletion is due to the formation of the following compound :
 (1) Acrolein (2) peroxy acetyl nitrate
 (3) SO_2 and SO_3 (4) chlorine nitrate
- A-23.** Pick up the correct statement :
 (1) CO which is a major pollutant resulting from the combustion of fuels in automobiles plays a major role in photochemical smog.
 (2) Classical smog has an oxidizing character while the photochemical smog is reducing in character.
 (3) The photochemical smog occurs in day time whereas the classical smog occurs in the morning hours.
 (4) During formation of smog the level of ozone in the atmosphere goes down.
- A-24.** High concentration of fluoride is poisonous and harmful to bones and teeth at levels over
 (1) 1 ppm (2) 3 ppm (3) 5 ppm (4) 10 ppm
- A-25.** Which of the following is not a green house gas ?
 (1) CO_2 (2) CH_4 (3) O_3 (4) CCl_2F_2
- A-26.** An object is located at a height of 5 km from the surface of the earth. The object is located in which part of the atmosphere.
 (1) Thermosphere (2) Mesosphere (3) Stratosphere (4) Troposphere
- A-27.** Which of the following is secondary pollutant ?
 (1) CO_2 (2) N_2O (3) PAN (4) SO_2
- A-28.** Which of the following compounds helps in achieving equilibrium between O_2 and CO_2 in atmosphere ?
 (1) Chlorophyll (2) Vitamin-12 (3) Porphyrin (4) Ethyl salicylic acid

Section (B) : Water pollution , soil pollution and waste management

- B-1.** Which causes water pollution ?
 (1) Pathogens (2) Automobile exhausts
 (3) PCBs (4) (1) and (3)



- B-2.** Most abundant water pollutant is :
 (1) detergents (2) pesticides
 (3) industrial wastes (4) ammonia
- B-3.** Drained sewage has biological oxygen demand (BOD) :
 (1) more than that of water (2) less than that of water
 (3) equal to that of water (4) none of the above
- B-4.** Eutrophication causes reduction in :
 (1) dissolved hydrogen (2) dissolved oxygen (3) dissolved salts (4) all the above
- B-5.** Which of the following will increase the BOD of water supply ?
 (1) CO₂ (2) O₃ (3) H₂O (4) C₂H₅OH
- B-6.** Sewage water is purified by :
 (1) microorganism (2) light (3) fishes (4) aquatic plants
- B-7.** Which of the following is not a herbicide ?
 (1) Sodium chlorate (2) Sodium arsenate (3) Phosphate (4) Triazines
- B-8.** Domestic waste mostly constitutes :
 (1) non-biodegradable pollutants (2) biodegradable pollutants
 (3) effluents (4) air pollution
- B-9.** Measurement of the rate of oxygen utilisation by a unit volume of water over a period of time is to measure :
 (1) fermentation (2) biogas generation
 (3) biosynthetic pathway (4) biological oxygen demand.
- B-10.** Fishes die in water bodies polluted by sewage due to :
 (1) pathogens (2) clogging of gills by silt
 (3) reduction in oxygen (4) foul smell
- B-11.** Which of the following statements is false ?
 (1) The industrial and domestic sewage discharge is the main reason for river water pollution.
 (2) Surface water contains a lot of organic matter and mineral nutrients.
 (3) Oil spill in sea water causes heavy damage to fishery.
 (4) Oil slick in sea water increases dissolved oxygen.
- B-12.** Which of the following statements is false ?
 (1) The lower the concentration of dissolved oxygen, the more polluted is the water sample.
 (2) The tolerable limit of lead in drinking water is 50 ppb.
 (3) Water is considered pure if it has BOD less than 5 ppm.
 (4) The safe limit of copper in drinking water is 10 ppm.
- B-13.** Phosphate pollution is caused by :
 (1) weathering of phosphate rock only
 (2) agriculture fertilizers only
 (3) phosphate rocks and sewage
 (4) sewage and agricultural fertilizers.
- B-14.** Modes of controlling pollution in large cities includes :
 (1) cleanliness and less use of insecticides
 (2) proper disposal of organic wastes, sewage and industrial effluents.
 (3) use of liquefied carbondioxide with a suitable detergent in place of tetrachloroethene for dry cleaning.
 (4) all the above
- B-15.** Green chemistry means such reactions which
 (1) produce colour during reactions.
 (2) reduce the use and production of hazardous chemicals.
 (3) are related to the depletion of ozone layer.
 (4) study the reactions in plants.



B-16. The process of 'eutrophication' is due to :

- (1) increase in concentration of insecticide in water.
- (2) increase in concentration of fluoride ion in water.
- (3) the reduction in concentration of the dissolved oxygen in water due to phosphate pollution.
- (4) attack of younger leaves of a plant by peroxyacetyl nitrate.

PART - II : ASSERTION / REASONING

Assertion / Reason

This section contains reasoning type questions. Each question has 4 choices (1), (2), (3) and (4), out of which **ONLY ONE** is correct.

- (1) If both assertion and reason are true and reason is a correct explanation of assertion.
- (2) If both assertion and reason are true but reason is not a correct explanation of assertion.
- (3) If assertion is true but reason is false.
- (4) If assertion and reason both are false.

1. **Assertion :** The pH of rain water is 5.6
Reason : H^+ ions are formed by the reaction of rain water with carbondioxide present in the atmosphere
2. **Assertion :** Bacteria, fungi, molds and algae are viable particulates.
Reason : Smoke particulates consist of solid or mixture of solid and liquid particles formed during combustion of organic matter.
3. **Assertion :** Photochemical smog results from the action of sunlight on unsaturated hydrocarbons and nitrogen oxides liberated by automobiles and factories.
Reason : Classical smog is a mixture of smoke, fog and sulphurdioxide.
4. **Assertion :** In the stratosphere, ozone is produced by the action of UV radiations on dioxygen.
Reason : UV radiations split the molecular oxygen into free oxygen (O) atoms which combine with molecular oxygen to form ozone.
5. **Assertion :** The deficiency of fluoride in drinking water causes diseases such as tooth decay etc.
Reason : The F^- ions make the enamel on teeth much harder by converting hydroxyapatite, the enamel on the surface of the teeth, into much harder fluorapatite.
6. **Assertion :** Green plants maintain an appropriate level of CO_2 in the atmosphere.
Reason : Green plants require CO_2 for photosynthesis and they, in turn, releases oxygen.

Exercise-2

PART - I : OBJECTIVE QUESTIONS

Single choice type

1. Which of the following statement is correct ?
 (1) Lower stratosphere consists of considerable amount of ozone.
 (2) Ozone layer protects humans living on earth from the harmful effect of ultraviolet radiations coming from sun.
 (3) Ozone is thermodynamically stable.
 (4) Smoke clouds play significant role in creating ozone over antarctica.
2. Which of the following compound belong to the class of freons ?
 (1) CCl_4 (2) $COCl_2$ (3) C_3O_2 (4) CF_2Cl_2
3. The extensive use of CFC'S as refrigerant fluids and in aerosol is because of :
 (1) its high chemical stability (2) good absorber of UV radiation
 (3) its polar nature (4) high toxicity
4. In stratosphere, which of the following radical retards the formation of O_3 ?
 (1) $\dot{C}H_3$ (2) $\dot{C}I$ (3) \dot{F} (4) Cl_2





5. Which of the following helps in creating ozone over antractia ?
 (1) Radioactive clouds (2) Polar stratospheric clouds
 (3) Spring clouds (4) Smoke clouds
6. Which are natural sinks for $\dot{\text{C}}\text{IO}$ radicals in other parts of stratosphere ?
 (1) SO_2 and NO_2 (2) NO and NO_2 (3) CH_4 and NO_2 (4) Cl_2 and F_2
7. Eutrophication is a source of water pollution. It occurs when water :
 (1) is low in nutrients (2) is high in nutrients
 (3) has high temperature (4) has excess amount of organic matter
8. Which of the following statements is false ?
 (1) Absorption of the terrestrially radiated heat by the carbondioxide is the main cause of global warming.
 (2) The global warming will increases the rate of melting of **polar ice caps** increasing the sea level.
 (3) The global warming of the earth surface is mainly due to reforestation.
 (4) CO_2 , NO , CH_4 , O_3 , CCl_4 and water vapour are green house gases.
9. Which of the following is the primary precursor of photochemical smog ?
 (1) Hydrocarbon (2) Ozone (3) PAN (4) Water vapour
10. Photochemical smog can be reduced by :
 (1) using catalytic converter in the automobiles
 (2) plantation of certain plants like pinus, juniperus, vitis etc.
 (3) both (1) and (2)
 (4) None
11. In stratosphere CFCs gets broken down by the action of powerful UV radiation releasing :
 (1) $\dot{\text{C}}\text{H}_3$ (2) $\dot{\text{C}}\text{IO}$ (3) $\dot{\text{C}}\text{I}$ (4) $\dot{\text{C}}\text{FCl}_2$
12. Which of the following statements is false ?
 (1) Over antarctica, the depletion of ozone layer is due to the formation of chlorine nitrate.
 (2) Both O_3 and NO_2 reacts with unburnt hydrocarbons in the polluted air to give PAN.
 (3) Classical smog consists of a mixture of smog, fog and sulphurdioxide.
 (4) Gaseous pollutants consist of oxide of carbon, sulphur and nitrogen along with dust, fumes smoke, smog etc.
13. Which of the following does not contribute to water pollution ?
 (1) Pathogens (2) Organic wastes
 (3) chemical pollutants (4) none
14. Which of the following is false.
 (1) Green house gases are carbondioxide, methane, water vapours, nitrous oxide, CFCs and ozone.
 (2) CO is highly poisonous to living beings because of its ability to block the delivery of oxygen to the organs and tissues.
 (3*) The troposphere contains dinitrogen, dioxygen, ozone and little water.
 (4) The primary source of air borne lead emission is leaded-petrol
15. Which of the following is false.
 (1) Photochemical smog has high concentration of reducing agents and is, therefore, called as reducing smog.
 (2) Non-viable particulates consist of smoke, dust, mist, fumes etc.
 (3) Classical smog occurs in cool humid climate and it is mixture of smoke, fog and sulphurdioxide.
 (4) Ozone reacts with unburnt hydrocarbons in polluted air to produce peroxyacetyl nitrate (PAN).
16. Which of the following is incorrect about the size of particulates ?
 (1) Soot particles have diameter of about 5 nm.
 (2) H_2SO_4 fog particles have size of 500–1000 nm.
 (3) Fly ash particles have diameter of 5×10^5 nm.
 (4) All particulates have same size.



PART - II : COMPREHENSION

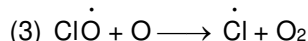
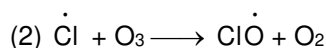
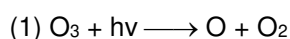
Read the following comprehension carefully and answer the questions :

Comprehension # 1

Ozone is an unstable, dark blue diamagnetic gas. It strongly absorbs the UV radiation, thus protecting the people on the earth from the harmful UV radiation from the sun. The use of chlorofluorocarbon (CFC) in aerosols and refrigerators, and their subsequent escape into the atmosphere, is blamed for making holes in the ozone layer over the Antarctic and Arctic.

Ozone acts as a strong oxidising agent in acidic and alkaline medium. For this property ozone is used as a germicide and disinfectant for sterilising water and improving the atmosphere of crowded places.

1. CFCs damage ozone layer by reactions :



(4) all of the above

2. Identify the incorrect statement with respect to ozone ?

(1) Ozone is formed in the upper atmosphere by a photochemical reaction involving dioxygen.

(2) Ozone protects the earth's inhabitants by absorbing UV radiations.

(3) Ozone can also be made by heating O_2 over 2500°C and quenching

(4) Chlorine gas is preferred over ozone for the purification of drinking water and for water treatment in swimming pools.

3. Which of the following statement is correct ?

(1) The dark blue colour of ozone is due to intense absorption of green light.

(2) Oxides of nitrogen and the halogen cannot damage the O_3 layer.

(3) Ozone oxidises dry iodine to I_2O_5 .

(4) Ozone forms orange coloured compound KO_3 with potassium hydroxide.

Comprehension # 2

Pesticides are synthetic toxic chemicals which are used in agriculture to control the damages caused by insects, rodents, weeds and various crop diseases. Their repeated use gives rise to pests that are resistant to that group of pesticides. As a result, these pesticides become ineffective for those pests. Examples are DDT, aldrin, dieldrin etc.

Herbicides are the chemicals used to control weeds, earlier inorganic compounds such as sodium chlorate, and sodium arsenite were used but arsenic compounds being toxic to mammals, are no longer preferred instead organic compounds such as triazines, are now considered as better herbicides, especially for the corn-fields.

4. Which of the following is a biodegradable pesticide ?

(1) DDT

(2) Aldrin

(3) Dieldrin

(4) None of these

5. Which of the following compounds belongs to herbicides (Weedisides) ?

(1) Sodium arsenite

(2) Sodium chlorate

(3) Triazines

(4) All of these

6. Which of the following statements is false ?

(1) The fly ash and slag of steel industry is being used by the cement industries

(2) Industrial wastes, agricultural pollutants and radioactive pollutants are the sources of soil pollutants.

(3) The recycling of material such as paper, glass and some kinds of plastics would help in the conservation of natural sources.

(4) BHC, malathion and chlorinated hydrocarbon are herbicides.



PART - III : MATCH THE COLUMN

1. Match the entries of **column-I** with appropriate entries of **column-II**. Each entry in **column-I** may have one or more than one correct option(s) from **column-II**.

Column-I

- (1) Acid rain
- (2) Green house effect
- (3) Ozone hole
- (4) Eutrophication

Column-II

- (p) Oxides of nitrogen
- (q) Oxides of sulphur
- (r) Carbon dioxide
- (s) Phosphate fertilizer i.e. plant nutrient (excess).
- (t) Chlorofluorocarbon (CFCs)

2. Match the entries of **column-I** with appropriate entries of **column-II**. Each entry in **column-I** may have one or more than one correct option(s) from **column-II**.

Column-I

- (1) Classical smog
- (2) Photochemical smog
- (3) Particulate Pollutants
- (4) Gaseous pollutants

Column-II

- (p) SO₂
- (q) NO₂
- (r) bacteria
- (s) smoke
- (t) Fe₃O₄

Exercise-3

JEE (MAIN) / AIEEE PROBLEMS (PREVIOUS YEARS)

JEE(MAIN) OFFLINE PROBLEMS

1. The smog is essentially caused by the presence of : [AIEEE 2004, 3/225]
 - (1) O₂ and O₃
 - (2) O₂ and N₂
 - (3) Oxides of sulphur and nitrogen
 - (4) O₃ and N₂
2. Identify the wrong statement in the following : [AIEEE 2008, 3/105]
 - (1) Ozone layer does not permit infrared radiation from the sun to reach the earth.
 - (2) Acid rain is mostly because of oxides of nitrogen and sulphur.
 - (3) Chlorofluorocarbons are responsible for ozone layer depletion.
 - (4) Green house effect is responsible for global warming.
3. Identify the incorrect statement from the following [AIEEE 2011, 4/120]
 - (1) Ozone absorb the intense ultraviolet radiation of the sun.
 - (2) Depletion of ozone layer is because of its chemical reaction with chlorofluoro carbon.
 - (3) Ozone absorbs infrared radiation
 - (4) Oxides of nitrogen in the atmosphere can cause the depletion of ozone layer
4. The concentration of fluoride, lead, nitrate and iron in a water sample from an underground lake was found to be 1000 ppb, 40 ppb, 100 ppm and 0.2 ppm, respectively. This water is unsuitable for drinking due to high concentration of : [JEE(Main) 2016, 4/120]
 - (1) Lead
 - (2) Nitrate
 - (3) Iron
 - (4) Fluoride
5. A water sample has ppm level concentration of following anions [JEE(Main) 2017, 4/120]
 $F^- = 10$; $SO_4^{2-} = 100$; $NO_3^- = 50$
 The anion/anions that make/makes the water sample unsuitable for drinking is/are:
 - (1) both SO_4^{2-} and NO_3^-
 - (2) only F^-
 - (3) only SO_4^{2-}
 - (4) only NO_3^-
6. The recommended concentration of fluoride ion in drinking water is up to 1 ppm as fluoride ion is required to made teeth enamel harder by converting $[3Ca_3(PO_4)_2 \cdot Ca(OH)_2]$ to: [JEE(Main)2018, 4/120]
 - (1) $[3Ca_3(PO_4)_2 \cdot CaF_2]$
 - (2) $[3\{Ca(OH)_2\} \cdot CaF_2]$
 - (3) $[CaF_2]$
 - (4) $[3(CaF_2) \cdot Ca(OH)_2]$



JEE(MAIN) ONLINE PROBLEMS

- Which of the following statements about the deletion of ozone layer is correct ?
[JEE(Main) 2014 Online (11-04-14), 4/120]
 (1) The problem of ozone depletion is less serious at poles because NO_2 solidifies and is not available for consuming ClO^\bullet radius.
 (2) The problem of ozone depletion is more serious at poles because ice crystalline in the clouds over poles act as catalyst for photochemical reactions involving the decomposition of ozone by Cl^\bullet and ClO^\bullet radicals.
 (3) Freons, chlorofluorocarbons, are inert chemically, they do not react with ozone in stratosphere.
 (4) Oxides of nitrogen also do not react with ozone in stratosphere.
- Global warming is due to increase of :
[JEE(Main) 2014 Online (12-04-14), 4/120]
 (1) methane and nitrous oxide in atmosphere (2) methane and CO_2 in atmosphere
 (3) methane and O_3 in atmosphere (4) methane and CO in atmosphere
- Addition of phosphate fertilisers to water bodies causes : [JEE(Main) 2015 Online (11-04-15), 4/120]
 (1) increase in amount of dissolved oxygen in water
 (2) deposition of calcium phosphate
 (3) increase in fish population
 (4) enhanced growth of algae
- Which one of the following substances used in dry cleaning is a better strategy to control environmental pollution?
[JEE(Main) 2016 Online (10-04-16), 4/120]
 (1) Nitrogen dioxide (2) Sulphur dioxide
 (3) Tetrachloroethylene (4) Carbon dioxide.
- Identify the pollutant gases largely responsible for the discoloured and lustreless nature of marble of the Taj Mahal.
[JEE(Main) 2017 Online (08-04-17), 4/120]
 (1) SO_2 and NO_2 (2) SO_2 and O_3 (3) O_3 and CO_2 (4) CO_2 and NO_2
- Which of the following is a set of green house gases? [JEE(Main) 2017 Online (09-04-17), 4/120]
 (1) CO_2 , CH_4 , N_2O , O_3 (2) O_3 , NO_2 , SO_2 , Cl_2
 (3) CH_4 , O_3 , N_2 , SO_2 (4) O_3 , N_2 , CO_2 , NO_2
- The correct match between items of List-I and List-II is : [JEE(Main) 2018 Online (15-04-18), 4/120]

List-I	List-II
(A) Coloured impurity	(P) Steam distillation
(B) Mixture of o-nitrophenol and p-nitrophenol	(Q) Fractional distillation
(C) Crude Naphtha	(R) Charcoal treatment
(D) Mixture of glycerol and sugars	(S) Distillation under reduced pressure
(1) (A)-(R), (B)-(S), (C)-(P), (D)-(Q)	(2) (A)-(P), (B)-(S), (C)-(R), (D)-(Q)
(3) (A)-(R), (B)-(P), (C)-(Q), (D)-(S)	(4) (A)-(R), (B)-(P), (C)-(S), (D)-(Q)
- Biochemical oxygen Demand (BOD) value can be a measure of water pollution caused by the organic matter. Which of the following statements is correct ? [JEE(Main) 2018 Online (15-04-18), 4/120]
 (1) Aerobic bacteria decrease the BOD value
 (2) Anaerobic bacteria increase the BOD value
 (3) Clean water has BOD value higher than 10 ppm.
 (4) Polluted water has BOD value higher than 10 ppm
- A water sample has ppm level concentration of the following metals :
[JEE(Main) 2019 Online (09-01-19) S1, 4/120]
 $\text{Fe} = 0.2$; $\text{Mn} = 5.0$; $\text{Cu} = 3.0$; $\text{Zn} = 5.0$. The metal that makes the water sample unsuitable for drinking is :
 (1) Fe (2) Zn (3) Cu (4) Mn
- Which of the following conditions in drinking water causes methemoglobinemia?
[JEE(Main) 2019 Online (09-01-19) S2, 4/120]
 (1) > 100 ppm of sulphate (2) > 50 ppm of lead
 (3) > 50 ppm of nitrate (4) > 50 ppm of chloride



11. The pH of rain water, is approximately : [JEE(Main) 2019 Online (09-01-19) S2, 4/120]
 (1) 7.0 (2) 6.5 (3) 7.5 (4) 5.6
12. Water filled in two glasses A and B have BOD values of 10 and 20, respectively. The correct statement regarding them, is : [JEE(Main) 2019 Online (10-01-19) S1, 4/120]
 (1) A is more polluted than B. (2) Both A and B are suitable for drinking.
 (3) A is suitable for drinking, whereas B is not. (4) B is more polluted than A
13. The reaction that is **NOT** involved in the ozone layer depletion mechanism in the stratosphere is: [JEE(Main) 2019 Online (10-01-19) S2, 4/120]
 (1) $\text{HOCl(g)} \xrightarrow{h\nu} \dot{\text{O}}\text{H(g)} + \dot{\text{Cl}}\text{(g)}$ (2) $\text{CF}_2\text{Cl}_2\text{(g)} \xrightarrow{h\nu} \dot{\text{Cl}}\text{(g)} + \dot{\text{CF}}_2\text{Cl(g)}$
 (3) $\dot{\text{ClO}}\text{(g)} + \text{O(g)} \longrightarrow \dot{\text{Cl}}\text{(g)} + \text{O}_2\text{(g)}$ (4) $\text{CH}_4 + 2\text{O}_3 \longrightarrow 3\text{CH}_2=\text{O} + 3\text{H}_2\text{O}$
14. Peroxyacetyl nitrate (PAN), an eye irritant is produced by: [JEE(Main) 2019 Online (11-01-19) S1, 4/120]
 (1) Classical smog (2) Organic waste
 (3) Photochemical smog (4) Acid rain
15. The concentration of dissolved oxygen (DO) in cold water can go upto: [JEE(Main) 2019 Online (11-01-19) S1, 4/120]
 (1) 8 ppm (2) 16 ppm (3) 14 ppm (4) 10 ppm
16. The higher concentration of which gas in air can cause stiffness of flower buds? [JEE(Main) 2019 Online (11-01-19) S2, 4/120]
 (1) NO_2 (2) CO (3) SO_2 (4) CO_2
17. Taj Mahal is being slowly disfigured and discoloured. This is primarily due to : [JEE(Main) 2019 Online (11-01-19) S2, 4/120]
 (1) water pollution (2) acid rain (3) soil pollution (4) global warming
18. Water samples with values of 4 ppm and 18 ppm, respectively, are : [JEE(Main) 2019 Online (12-01-19) S1, 4/120]
 (1) Highly polluted and Clean (2) Clean and Clean
 (3) Highly polluted and Highly polluted (4) Clean and Highly polluted
19. The molecule that has minimum/no role in the formation of photochemical smog is : [JEE(Main) 2019 Online (12-01-19) S1, 4/120]
 (1) $\text{CH}_2 = \text{O}$ (2) NO (3) N_2 (4) O_3
20. The compound that is NOT a common component of photochemical smog is: [JEE(Main) 2019 Online (12-01-19) S2, 4/120]
 (1) $\text{H}_3\text{C}-\overset{\text{O}}{\underset{\text{O}}{\parallel}}\text{C}-\text{OONO}_2$ (2) O_3 (3) CF_2Cl_2 (4) $\text{CH}_2=\text{CHCHO}$
21. The upper stratosphere consisting of the ozone layer protects us from the sun's radiation that falls in the wavelength region of : [JEE(Main) 2019 Online (12-01-19) S2, 4/120]
 (1) 0.8 – 1.5 nm (2) 400 – 550 nm (3) 200 – 315 nm (4) 600 – 750 nm



Answers

EXERCISE - 1

PART - I

A-1. (4)	A-2. (2)	A-3. (2)	A-4. (4)	A-5. (1)
A-6. (4)	A-7. (2)	A-8. (3)	A-9. (2)	A-10. (4)
A-11. (4)	A-12. (1)	A-13. (3)	A-14. (4)	A-15. (2)
A-16. (3)	A-17. (3)	A-18. (3)	A-19. (3)	A-20. (2)
A-21. (1)	A-22. (4)	A-23. (1)	A-24. (3)	A-25. (4)
A-26. (4)	A-27. (3)	A-28. (1)	B-1. (4)	B-2. (1)
B-3. (1)	B-4. (2)	B-5. (1)	B-6. (1)	B-7. (3)
B-8. (2)	B-9. (4)	B-10. (3)	B-11. (4)	B-12. (4)
B-13. (4)	B-14. (4)	B-15. (2)	B-16. (3)	

PART - II

1. (3)	2. (2)	3. (2)	4. (1)	5. (1)
6. (1)				

EXERCISE - 2

PART - I

1. (2)	2. (4)	3. (1)	4. (2)	5. (2)
6. (3)	7. (2)	8. (3)	9. (1)	10. (3)
11. (3)	12. (4)	13. (4)	14. (3)	15. (1)
16. (4)				

PART - II

1. (4)	2. (4)	3. (4)	4. (4)	5. (4)
6. (4)				

PART - III

1. (1 – p,q); (2 – r); (3 – p,t); (4 – s)	2. (1 – p); (2 – q); (3 – r,s,t); (4 – p,q)
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EXERCISE - 3

JEE(MAIN) OFFLINE PROBLEMS

1. (3)	2. (1)	3. (3)	4. (2)	5. (2)
6. (1)				

JEE(MAIN) ONLINE PROBLEMS

1. (2)	2. (2)	3. (4)	4. (4)	5. (1)
6. (1)	7. (3)	8. (4)	9. (4)	10. (3)
11. (4)	12. (4)	13. (4)	14. (3)	15. (4)
16. (3)	17. (2)	18. (4)	19. (3)	20. (3)
21. (3)				