Chapter

14

Environmental Chemistry

ENVIRONMENTAL POLLUTION

The addition of any undesirable material to air, water and soil by a natural source (or due to human activity) which affects the quality of environment is called an environmental pollution.

A substance which causes pollution is called pollutant. They can be solid, liquid or gaseous substances present in greater concentration than in natural abundance and are produced due to human activities or due to natural happenings.

Types of Pollutants :

(i) Primary and Secondary Pollutants:

(a) Primary pollutants: Those which enter the environment after their formation and remain as such.

Ex. : NO, NO_2, SO_2

(b) Secondary pollutants : The harmful materials which are formed by chemical reaction between primary pollutants in the atmosphere.

Ex. Hydrocarbon + Oxide of nitrogen $\xrightarrow{h\nu}$ compound

(ii) Bio-degradable and Non Bio-degradable Pollutants :

(a) Bio degradable pollutants : They are thus not harmful, but if present in excess in environment, they do not undergo degradation completely and thus become pollutant.

(b) Non bio degradable pollutants : The materials (such as Hg, Al, DDT) which do not undergo degradation (or degrade very slowly) but their presence even in very small amount in the environment is very harmful.

ATMOSPHERIC POLLUTION

Atmosphere consists of concentric layers of air and each layer has a different density. The lowest region in which the human beings along with other organisms live is called troposphere. It extends upto a height of ~ 10 km from sea level. Above the troposphere, between 10-50 km above sea level, lies stratosphere. Atmospheric pollution is studied as tropospheric and stratospheric pollution.

Tropospheric Pollution.

It occurs due to presence of undesirable solid or gaseous particles in air. The major pollutants are:

(I) Gaseous air pollutants

(i) Oxides of sulphur:

Produced when S containing fossil fuel (coal, petroleum etc.) is burnt in automobiles, industries, refineries, metallurgical operations etc. SO_2 is the more common. It causes respiratory diseases, eg. asthma, bronchitis. It causes irritation to eyes. SO_2 get oxidised to SO_3 by following reactions:

$$2SO_2(g) + O_2(g) \xrightarrow[\text{matter}]{\text{particulate}} 2SO_3(g)$$

$$SO_2(g) + O_3(g) \longrightarrow SO_3(g) + O_2(g)$$

In presence of moisture SO_3 is converted into highly corrosive sulphuric acid.

$$SO_3 + (\text{moisture}) \longrightarrow H_2SO_4$$

(ii) Oxides of nitrogen:

Source - combustion of coal, gasoline, natural gas, petroleum refining, chemical plants, manufacturing explosives and fertilizers, tobacco smoke.

$$N_2(g) + O_2(g) \xrightarrow{1483\ K} 2NO(g)$$

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

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

High conc. of NO_2 damage the leaves of plants and retard the rate of photosynthesis. It can lead to acute respiratory disease in children and is toxic to living tissues.

NO_2 reacts with moisture to form acids.

$$2\,NO_2 + H_2O \longrightarrow HNO_2 + HNO_3,$$

$$3\,HNO_2 \longrightarrow 2\,NO + HNO_3 + H_2O$$

(iii) Hydrocarbons

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

They harm plants by causing ageing, breakdown of tissues, shedding of leaves, flowers and twigs.

(iv)

Oxides of carbon

CO	CO_2
(a) It is formed as a result of incomplete combustion of hydrocarbons.	(a) CO_2 is discharged in to atmosphere by respiration, burning of fossil fuels, decomposition of limestone, during volcanic eruptions.
(b) Mainly released from automobile exhaust.	(b) The increased amount of CO_2 in air is responsible for global warming.
(c) It is poisonous because it binds with Hb in blood forming carboxyhaemoglobin, $Hb + CO \longrightarrow HbCO$ (Carboxy haemoglobin) $Hb + O_2 \longrightarrow HbO_2$ (oxyhaemoglobin) Thus as a result O_2 carrying capacity of blood is reduced. This oxygen deficiency results in headache, weak eyesight, nervousness and cardiovascular disorder.	

Global Warming and Green House Effect

The atmosphere traps the sun's heat near the earth's surface and keeps it warm. This is called natural greenhouse effect as it maintains the temperature and makes the earth perfect for life. Some of the gases present in earth's atmosphere like CO_2, CH_4, O_3, CFC's, water vapours etc. which are capable of trapping solar energy are called green house gases. However, if the conc. of these gases increase beyond sustainable limit, the average global temperature will increase thereby causing global warming

Consequences of global warming :

(i) Global warming would result in rise in sea level due to increased rate of melting of glaciers and floods.

(ii) Increase in infectious diseases like malaria, dengue, etc.

Acid Rain

Normal pH of rain water is 5.6 if pH of rain water drops below 5.6, it is called acid rain. H_2SO_4, HNO_3 (and small amount of HCl) which are formed from the oxide of S and N_2 present in the air is causes acid rain. These oxides are discharged into atmosphere as a by products of various human activities

$$NO(g) + O_3(g) \longrightarrow NO_2(g) + O_2(g)$$
$$NO_2(g) + O(g) \longrightarrow NO(g) + O_2(g)$$

SO_2 and NO_2 then undergo oxidation and react with water to form H_2SO_4 and HNO_3 which are major contributors of acid rain.

$$2SO_2(g) + O_2(g) + 2H_2O(\ell) \longrightarrow 2H_2SO_4(aq)$$

$$4NO_2(g) + O_2(g) + 2H_2O(\ell) \longrightarrow 4HNO_3(aq)$$

Ammonium salts are also formed and can be seen as an atmospheric haze. Aerosol particles of oxides or ammonium salts in rain drops result in wet deposition.

Harmful effects of acid-rain:

(i) It damages buildings and statues which contain marble, lime stone, mortar etc.

$$CaCO_3 + H_2SO_4 \longrightarrow CaSO_4 + H_2O + CO_2$$

(ii) It damage irons and steel structure.

(iii) It corrodes water pipes. As a result, heavy metals (like Fe,Pb, Cu) are mixed with water which have toxic effect.

(iv) Acid rain increases the acidity of the lake, which is harmful to fishes.

(v) It damages trees, plants and retards the growth of the plants.

(II) Particulate pollutants

Particulates are the minute solid particles or liquid droplets in air. These particles are usually individually invisible to the naked eye. Collectively, however, small particles often form a haze that restricts visibility. The viable particulates are the minute living organisms that are dispersed in atmosphere. These include bacteria, fungi, moulds, algae etc. Non-viable particulates are formed either by the breakdown of larger materials or by the condensation of minute particles and droplets. There are four types of non-viable particulates in the atmosphere : mists, smoke, fumes and dust.

(i) Mist is produced by particles of spray liquids and the condensation of vapours in air.

(ii) Smoke denotes very small soot particles produced by burning and combustion of organic matter.

(iii) Fumes are condensed vapours Fumes of metals are well-known particulates of this type.

(iv) Dust consists of the particles produced during crushing, grinding and attribution of solid materials.

Particulates are present in vehicle emissions, smoke particles, dust and ash.

SOME EFFECTS OF AIR POLLUTION

Smog

It is a mixture of smoke and fog in suspended droplet form. It is of two types:

(i) Classical smog: It occurs in cool, humid climate. It consists of a mixture of smoke fog and SO_2 . Classical smog is of reducing nature and have high concentrations of SO_2

(ii) Photochemical Smog : It occurs in warm, dry, sunny climate. It is formed as a result of action of sunlight on unsaturated hydrocarbons and nitrogen-oxide

Photochemical smog is of oxidising nature and have high concentration of oxidising agents.

Formation of photochemical smog

The chemistry of formation of photochemical smog centres around NO, which is emitted into air with the exhaust gases. This NO oxidises in air to NO_2 which in turn absorbs energy from sunlight and breaks up into nitric oxide and free oxygen atom. (Photochemical decomposition)

$$NO_2(g) \xrightarrow{hv} NO(g) + O_2(g)$$
$$O(g) + O_2(g) \longrightarrow O_3(g)$$
$$NO(g) + O_3(g) \longrightarrow NO_2(g) + O_2(g)$$

Both NO and O_3 are strong oxidising agents and can react with the unburnt hydrocarbons in the polluted air to produce chemicals such as formaldehyde, acrolein and peroxyacetyl nitrate (PAN) that cause the eyes to water and burn and are harmful to the respiratory system.

$$3CH_4 + 2O_3 \longrightarrow 3HCHO + 3H_2O$$

Acrolein and peroxyacetyl nitrate (PAN) are particularly noxious.

$CH_2 = CHCH = O$
Acrolein

CH_3COONO_2 (‖ O)
Peroxyacetyl nitrate (PAN)

Control of photochemical smog :

Catalytic converters are used in automobiles which prevent the release of NO and hydrocarbons to atmosphere.

Stratospheric Pollution

Formation of ozone layer

O_3 in stratosphere (11 -50 km) is a product of UV radiations acting on O_2 molecules.

$$O_2(g) \xrightarrow{UV} O(g) + O(g)$$

$$O(g) + O_2(g) \underset{}{\overset{UV}{\rightleftharpoons}} O_3(g)$$

$$O_3(g) \xrightarrow{Uv} O_2(g) + O(g) + x \text{ kcal}$$

Depletion of ozone layer

The presence of chemicals like CFC's and NO in stratosphere result in depletion of ozone layer. This is shown below:

$$CF_2Cl_2(g) \xrightarrow{UV} \dot{Cl}(g) + \dot{C}F_2Cl(g)$$

$$CFCl_3(g) \xrightarrow{Uv} \dot{Cl}(g) + \dot{C}FCl_2(g)$$

$$\dot{Cl}(g) + O_3(g) \longrightarrow Cl\dot{O}(g) + O_2(g)$$

$$Cl\dot{O}(g) + O(g) \longrightarrow \dot{Cl}(g) + O_2(g)$$

The $\dot{Cl}$ radicals are continuously regenerated and cause the breakdown of ozone. Thus, CFC's are transporting agents for continuously generating $\dot{Cl}$ radicals into stratosphere and damaging the ozone layer.

Ozone hole

In summers, NO_2 and CH_4 react with $Cl\dot{O}$ and $\dot{Cl}$ forming chlorine sinks preventing ozone depletion.

$$Cl\dot{O}(g) + NO_2(g) \longrightarrow ClONO_2(g)$$

$$\dot{Cl}(g) + CH_4(g) \longrightarrow \dot{C}H_3(g) + HCl(g)$$

In winters, polar stratospheric clouds are formed which provide surface on which chlorine nitrate formed gets hydrolysed to form hypochlorous acid. It also reacts with the HCl produced to give Cl_2.

$$ClONO_2(g) + H_2O(g) \longrightarrow HOCl(g) + HNO_3(g)$$

$$ClONO_2(g) + HCl(g) \longrightarrow Cl_2(g) + HNO_3(g)$$

When sunlight returns in spring, sun's warmth breaks up the clouds and HOCl and Cl_2 are photolysed by sunlight as:

$$HOCl(g) \xrightarrow{hv} \dot{O}H(g) + \dot{Cl}(g)$$

$$Cl_2(g) \xrightarrow{hv} 2\dot{Cl}(g)$$

These $\dot{Cl}$ radicals thus formed initiate the chain reaction for O_3 depletion as discussed above.

Effects of O_3 layer depletion

Due to depletion of O_3 layer, U.V. radiations fall on the earth.

(i) The U.V. radiations, damage the cornea and lens of the eyes.

(ii) The U.V. radiations affect the plant proteins and thus reduce the chlorophyll.

(iii) The U.V. radiations, disturb the heat balance of the earth.

WATER POLLUTION

The contamination of water by foreign substances which would constitute a health hazard and make it harmful for all purposes (domestic, industrial or agriculture etc.) is known as water pollution. The polluted water may have offensive odour, bad taste, unpleasant colour, murky oily, etc.

Sources of Water Pollution

Easily identified source or place of pollution is called point source, ex: municipal and industrial discharge pipes. Non point sources of pollution are those where a source of pollution cannot be easily identified, ex: agricultural run-off, acid rain, storm water drainage etc. The major water pollution and their sources :

Pollutant	Source
Microorganisms	Domestic sewage
Organic wastes	Domestic sewage, animal waste, decaying animals and plants and discharge from food processing factories
Plant nutrients	Chemical fertilizers
Toxic heavy metals	Industries and chemical factories
Sediments	Erosion of soil by agriculture and strip mining.
Pesticides	Chemicals used for killing insects, fungi and weeds
Radioactive substances	Mining of uranium containing minerals
Heat	Cooling water used by industrial plants (which is discharged as hot water)

Important Causes of Water Pollution

(i) **Pathogens:** They are disease causing agents and include bacteria and other organisms that enter water from domestic sewage and animal excreta.

(ii) **Organic wastes:** It includes organic matter such as leaves, grass, trash, etc. Excessive phytoplankton growth is also a cause of water pollution. These wastes are biodegradable.

They consume oxygen dissolved in water. If excess of organic matter is added to water, all the available O_2 is used up. This causes the death of aquatic life.

It is defined as the amount of free oxygen required for biological oxidation of the organic matter by aerobic conditions at 20°C for a period of five days. Its unit is mg/l or ppm.

The amount of BOD in water is a measure of the amount of organic material in water, in terms of how much O_2 will be required to break it down biologically. Clean water would have a BOD value of less than 5 ppm whereas highly polluted river water could have a BOD value of 17 ppm or more.

A large number of organic and inorganic compounds, however, are resistant to microbial oxidation. They, therefore, don't contribute to the BOD, though their presence makes water unfit for consumption.

Note : Estimation of BOD requires 5 days so another parameter called chemical oxygen demand (COD) can also be used. It is a measure of all types of oxidisable impurities present in the sewage. COD values are higher than BOD values.Oxidising agent used in COD determination is acidified $K_2Cr_2O_7$.

(iii) **Chemical pollutants:**

(a) Heavy metals water soluble inorganic chemicals that include heavy metals like Cd, Hg, Ni, etc. constitute an important class of pollutants. These metals are not excreted by the body and can damage kidneys, central nervous system, liver, etc.

(b) **Acid-polluted water (pH < 3) :** This is deadly to most forms of aquatic life.Acid mine water principally contain sulphuric acid produced by the oxidation of iron pyrites (FeS_2). Industrial wastes and acid rain may also contribute to the acidity of natural waters.

(c) Organic chemicals like petroleum products, pesticides, industrial chemicals like polychlorinated biphenyl (PCB's) are also a source of water pollution. PCB's are carcinogenic.

(d) **Detergents and Fertilizers:** These may contain phosphates as additives. The addition of phosphours to water, in the form of the phosphate anion PO_4^{3-}, encourages the formation of algae, which reduces the dissolved oxygen concentration of water. The process, known as eutrophication, impedes the development of higher life forms, such as fish.

International Standards for Drinking Water

(i) **Fluoride:** Soluble F^- is added to drinking water to bring its conc upto 1 ppm or 1 mg dm^{-3}. F^- ions makes the teeth enamel much harder. However, F^- ion conc above 2 ppm causes brown motting of teeth. Above 10 ppm, it causes harmful effect to bones and teeth.

(ii) **Lead:** Drinking water gets contaminated with lead if water is relatively acidic and lead pipes are used for water transportation. The accepted limit is 50 ppb. It can damage kidney, liver, reproductive system, etc.

(iii) **Sulphate:** Sulphate is harmless at moderate levels, but excess SO_4^{2-} (> 500 ppm) in drinking water causes laxative effect.

(iv) **Nitrate:** Maximum limit is 50 ppm. Excess level can cause disease called methemoglobinemia (blue baby syndrome)

(v) **Other Metals :** The maximum recommended levels of common metals in drinking water are :

Metal	Max. concentration (ppm or mg dm^{-3})
Zn	5
Fe	0.2
Mn	0.05
Cu	3
Cd	0.005
Al	0.2

SOIL POLLUTION

Causes of Soil Pollution

Pesticides: Pesticides are substances that are used to kill or block the reproductive processes of unwanted organisms. The repeated use of same or similar pesticides make the pests resistant to them. Being water insoluble, non-biodegradable and high persistent toxins are transferred from lower trophic level to higher trophic level through food chain, resulting in serious metabolic and physiological disorders in higher animals.

Insecticides: Control of insects by insecticides helps to cure diseases (for example malaria and yellow fever) and protect crops. They are organophosphates and carbamates which are less persistent and more biodegradable than pesticides. However, they are severe nerve toxins and are harmful to humans. Insects have become resistant to them also.

Herbicides: Herbicides are used to kill weeds. Ex: Sodium Chlorate ($NaClO_3$), sodium arsenite (Na_3AsO_3) etc. They are not persistent and decompose in a few months. They are toxic to mammals, cause birth defects.

Organic herbicides are, therefore, now used. They are much more toxic to certain types of plants than to others.

Fungicides: Fungicides are used to check the growth of fungi. (Fungi are the plants without chlorophyll). Organic compounds of mercury have been used as fungicides.

Industrial Waste

(i) They are biodegradable and non-biodegradable.

(ii) Biodegradable wastes are generated by cotton mills, food processing units, paper mills and textile factories.

(iii) Non-biodegradable wastes are generated by thermal power plants which produce fly ash, integrated iron and steel plants, fertilizer industries, industries manufacturing Al, Zn, Cu, chemical, drugs, pharmaceuticals, dyes, pesticides, rubber goods, etc.

STRATEGIES TO CONTROL ENVIRONMENTAL POLLUTION

(i) Waste management i.e., reduction of waste and proper disposal, also recycling of materials and energy.

(ii) Adopting methods in day-to day life which result in reduction of the pollution, i.e., proper collection and disposal.

GREEN CHEMISTRY

Green Chemistry focuses on processes and products that reduce or eliminate the use and generation of hazardous substances. The use of starting materials-reagents and solvents that pose less hazard to man and his environment, is one aspect. Using raw materials more efficiently and generating less waste is another.

Use of Green Chemistry in Day-to-Day Life:

(i) **Dry cleaning of clothes:**
Earlier, tetrachloroethene was used as a solvent for dry cleaning but it contaminates ground water and is a carcinogen. It is being replaced by liquified CO_2 with a suitable detergent which causes less harm to ground water.
Now, H_2O_2 is used for bleaching clothes which makes less use of water.

(ii) **Bleaching of paper:**
Earlier, Cl_2 gas was used but now H_2O_2 with a suitable catalyst is being used for bleaching paper.

(iii) **Synthesis of Chemicals:**

$$CH_2 = CH_2 + O_2 \xrightarrow[\substack{Pd(II)\\Cu(II)\\\text{in water}}]{\text{Catalyst}} CH_3CHO(90\%)$$

(iv) Development of a method for catalytic dehydrogenation of diethanolamine in which a new technique allows the production of an environmentally friendly herbicide in a less dangerous way.

(v) Development of processes using carbon dioxide as the blowing agent, for manufacture of polystyrene foam sheet packaging material.

Note : Thus, green chemistry is a cost effective approach which involves reduction in material, energy consumption and waste generation.

CONCEPT MAP

Pollutants are

- Bio-degradable: decomposed by micro-organisms
- Non-biodegradable: includes chemicals, mercuric salts etc.
- Natural emitted in radioactivity, Volcanoes, etc.
- Artificial: emitted by industries, automobiles, etc.

Major air pollutants are:

- CO: emitted mainly by automobiles. Blocks normal transport of oxygen in the bodies.
- SO_2: produced by petrol, coal combustion, etc. causes acid rain
  NO_x (x = 1 or 2): produced in combustion of coal, natural gas, etc. causes acid rain.
- Smoke, dust: Sources are cement works, power generating stations, etc.
- Smog: Smoke + fog

Environmental Chemistry

Two important air pollution phenomena are:

(a) Green House effect: Retention of heat in the atmosphere of the earth leading to Global warming. It is causing due to rise in the sea level by melting .

(b) Ozone layer depletion: Depletion of the ozone layer above the earth's surface by NO_x (x=1,2) and CFCs, etc. Ozone layer cuts the harmful UV radiations from reaching the earth

Water Pollution:

is contamination of water by making it unfit for drinking and other purposes. Presence of substances causing reduction in soil productivity are called soil pollution. There are many sources of air & soil pollution. Pesticides cause both – soil & water pollution.

Biological Oxygen Demand (BOD)

is the amount of free oxygen required for biological oxidation of the organic matter by aerobic conditions at 20°C for a period of five days.

Chemical Oxygen Demand (COD)

is a measure of all types of oxidisable impurities present in the sewage. COD values are always greater than BOD values.

EXERCISE - 1
Conceptual Questions

1. The pollutants which came directly in the air from sources are called primary pollutants. Primary pollutants are sometimes converted into secondary pollutants. Which of the following belongs to secondary air pollutants?
(a) CO (b) Hydrocarbon
(c) Peroxyacetyl nitrate (d) NO

2. The green house effect is caused by
(a) CO_2 (b) NO_2
(c) NO (d) CO

3. The gas responsible for ozone depletion :
(a) NO and freons (b) SO_2
(c) CO_2 (d) CO

4. Sewage mostly constitutes
(a) Non-biodegradable pollutants
(b) Biodegradable pollutants
(c) Effluents
(d) Air pollutants

5. In Antarctica ozone depletion is due to the formation of following compound
(a) acrolein (b) peroxyacetyl nitrate
(c) SO_2 and SO_3 (d) chlorine nitrate

6. The main element of smog is
(a) O_3 and PAN (b) O_3
(c) PAN (d) PPN and PBN

7. Classical smog occurs in places of
(a) excess SO_2 (b) low temperature
(c) high temperature (d) excess NH_3

8. CFC which is a main reason behind air pollution, is produced by
(a) sewage pollutant (b) aerosols
(c) industrial remains (d) Above all

9. Which is related to 'Green House Effect'?
(a) Farming of Green plants
(b) Farming of Vegetables in Houses
(c) Global Warming
(d) Biodegradable pollutant

10. Phosphate pollution is caused by
(a) sewage and agricultural fertilizers
(b) weathering of phosphate rocks only
(c) agriculutral fertilizers only
(d) phosphate rocks and sewage

11. The uppermost region of the atmosphere is called
(a) Ionosphere (b) Stratosphere
(c) Troposphere (d) Exosphere

12. Which of the following is the coldest region of atmosphere
(a) Thermosphere (b) Mesosphere
(c) Troposphere (d) Stratosphere

13. Acid rain is due to
(a) CH_3 (b) N_2O_5
(c) SO_2 and NO_2 (d) C_2H_5OH

14. The region which is greatly affected by air pollution is
(a) Thermosphere (b) Stratosphere
(c) Troposphere (d) Mesosphere

15. The substance which is a primary pollutant?
(a) H_2SO_4 (b) CO
(c) PAN (d) Aldehydes

16. Formation of London smog takes place in
(a) winter during day time
(b) summer during day time
(c) summer during morning time
(d) winter during morning time

17. Green house gases –
(a) allow shorter wavelength to enter earth's atmosphere while doesn't allow longer wavelength to leave the earth's atmosphere.
(b) allow longer wavelength to enter earth atmosphere while doesn't allow shorter wavelength to leave the surface
(c) don't have wavelength specific character.
(d) show wavelength specific behaviour near the earth while far from earth these have wavelength independent behaviour.

18. Which of the following is/are the hazardous pollutant(s) present in automobile exhaust gases?
(i) N_2 (ii) CO
(iii) CH_4 (iv) Oxides of nitrogen
(a) (ii) and (iii) (b) (i) and (ii)
(c) (ii) and (iv) (d) (i) and (iii)

19. Carbon monoxide (CO) is harmful to man because
(a) it forms carbolic acid
(b) it generates excess CO_2
(c) it is carcinogenic
(d) it competes with O_2 for haemoglobin

20. Today the concentration of green house gases is very high because of
(a) use of refrigerator
(b) increased combustion of oils and coal
(c) deforestation
(d) All of the above

21. The non-viable particulate among the following is
(a) Dust (b) Bacteria
(c) Moulds (d) Fungi

22. BOD of pond is connected with
(a) microbes & organic matter
(b) organic matter
(c) microbes
(d) None of these

23. Lead is
(a) Radiological pollutant (b) Sound pollutant
(c) Soil pollutant (d) Air pollutant

24. When rain is accompanied by a thunderstorm, the collected rain water will have a pH value
(a) slightly lower than that of rain water without thunderstorm
(b) slightly higher than that when the thunderstorm is not there
(c) uninfluenced by occurrence of thunderstorm
(d) which depends upon the amount of dust in air

25. Minamata disease of Japan is due to pollution of
(a) Aresenic (b) Lead
(c) Cynide (d) Mercury

26. Select the process that does not add particulate materials to air.
(a) Use of air conditioner
(b) Burning of fosssil fuels
(c) Paper industry
(d) Incomplete combustion of coal

27. Which causes death of fish in water bodies polluted by sewage?
(a) Foul smell (b) Pathogens
(c) Herbicides (d) Decrease in D.O.

28. Sewage water is purified by
(a) aquatic plants (b) microoganisms
(c) light (d) fishes

29. Which pollutant is harmful for 'Tajmahal'?
(a) Hydrogen (b) O_2
(c) SO_2 (d) Chlorine

30. The biggest particulate matter is
(a) HNO_3 droplets (b) Soot
(c) H_2SO_4 droplets (d) Fly ash

31. Negative soil pollution is
(a) reduction in soil productivity due to erosion and over use
(b) reduction in soil productivity due to addition of pesticides and industrial wastes
(c) converting fertile land into barren land by dumping ash, sludge and garbage
(d) None of the above

32. The quantity of DDT in food chain
(a) decreases (b) remains same
(c) increases (d) changes

33. Which is known as 'Third poison of environment' and also creates 'Blue baby syndrome'
(a) Nitrate present in water
(b) Phosphate and detergents found in water
(c) Cynide
(d) Pesticides

34. The aromatic compounds present as particulates are
(a) Polycyclic aromatic hydrocarbons
(b) Benzene
(c) Toluene
(d) Nitrobenzene

35. Water is often treated with chlorine to
(a) remove hardness
(b) increase oxygen content
(c) kill germs
(d) remove suspended particles

36. Thermal pollution affects mainly –
(a) vegetation (b) aquatic creature
(c) rocks (d) air

37. B.O.D. test or biochemical oxygen demand test is made for measuring
(a) air pollution (b) water pollution
(c) noise pollution (d) soil pollution

38. A dental disease characterised by mottling of teeth is due to presence of a certain chemical element in drinking water. Which is that element?
(a) Boron (b) Chlorine
(c) Fluorine (d) Mercury

39. The viable particulate among the following is
(a) Fumes (b) Algae
(c) Smoke (d) Mist

40. The high amount of E. coli in water is the indicator of
(a) hardness of water
(b) industrial pollution
(c) sewage pollution
(d) presence of chlorine in water

41. A lake with an inflow of domestic sewage rich in organic waste may result in
(a) drying of the lake very soon due to algal bloom
(b) an increase production of fish due to lot of nutrients
(c) death of fish due to lack of oxygen
(d) increased population of aquatic food web organisms

42. Which of the following is the major cause of global warming?
(a) re-radiation of U.V. rays by CO_2 and H_2O
(b) re-radiation of I.R. rays by CO_2 and H_2O
(c) re-radiation of I.R. rays by O_2 and N_2
(d) re-radiation of U.V. rays by O_2 and N_2

43. Select the one that is an oxygen demanding waste.
(a) Grease (b) Oil
(c) Pesticides (d) Domestic sevage

44. The greenhouse effect is because of the
(a) presence of gases, which in general are strong infrared absorbers, in the atmosphere
(b) presence of CO_2 only in the atmosphere
(c) pressure of O_3 and CH_4 in the atmosphere
(d) N_2O and chlorofluorohydrocarbons in the atmosphere

45. Which one of the following statement is **not** true ?
(a) pH of drinking water should be between 5.5 – 9.5.
(b) Concentration of DO below 6 ppm is good for the growth of fish.
(c) Clean water would have a BOD value of less than 5 ppm.
(d) Oxides of sulphur, nitrogen and carbon are the most widespread air pollutant.

46. Identify the wrong statement in the following:
(a) Chlorofluorocarbons are responsible for ozone layer depletion
(b) Greenhouse effect is responsible for global warming
(c) Ozone layer does not permit infrared radiation from the sun to reach the earth
(d) Acid rain is mostly because of oxides of nitrogen and sulphur

47. Identify the incorrect statement from the following :
(a) Ozone absorbs the intense ultraviolet radiation of the sun.
(b) Depletion of ozone layer is because of its chemical reactions with chlorofluoro alkanes.
(c) Ozone absorbs infrared radiation.
(d) Oxides of nitrogen in the atmosphere can cause the depletion of ozone layer.

48. The smog is essentially caused by the presence of
(a) Oxides of sulphur and nitrogen
(b) O_2 and N_2
(c) O_2 and O_3
(d) O_3 and N_2

49. What is DDT among the following ?
(a) Greenhouse gas
(b) A fertilizer
(c) Biodegradable pollutant
(d) Non-biodegradable pollutant

50. The gas leaked from a storage tank of the Union Carbide plant in Bhopal gas tragedy was :
(a) Methyl isocyanate (b) Methylamine
(c) Ammonia (d) Phosgene

EXERCISE - 2
Applied Questions

1. The statement which is not true
(a) NO_2 does not play any role in photochemical smog
(b) SO_3 is more harmful air polluntant than SO_2
(c) SO_2 dos not affect larynx (voice box)
(d) NO is more toxic to living tissues than NO_2

2. Black-foot disease is caused due to groundwater contaminated with excess of
(a) Nitrate (b) Fluoride
(c) Arsenic (d) Sulphur

3. The false statement among the followings :
(a) The average residence time of NO is one month
(b) Limestone acts as a sink for SO_x
(c) SO_x can be removed from flue gases by passing through a solution of citrate ions
(d) Ammonia acts as a sink for NO_x

4. Exposure of an organism to UV system causes
(a) photodynamic action
(b) formation of thymidine
(c) splitting of H-bonds of DNA
(d) splitting of phosphodiester bonds

5. Under column-I, a list of gases that are known to have a greenhouse effect' is given. Relate them to their main source selecting from the list given under Column - II

	Column-I		Column-II
A.	Nitrous oxide	1.	Secondary pollutant from car exhausts
B.	Chlorofluorocarbon (CFCs)	2.	Combustion of fossil fuels, wood, etc
C.	Methane	3.	Denitrification
D.	Ozone (O_3)	4.	Refrigerators, aerosol, sprays
E.	Carbon dioxide	5.	Cattle, rice fields, toilets.

(a) A – 3, B – 4, C – 5, D – 1, E – 2
(b) A – 5, B – 1, C – 3, D – 4, E – 2
(c) A – 4, B – 5, C – 1, D – 2, E – 3
(d) A – 1, B – 3, C – 4, D – 5, E – 2

6. Air pollution causing photochemical oxidants production include
(a) Carbon monoxide, sulphur dioxide
(b) Nitrous oxide, nitric acid fumes, nitric oxide
(c) Ozone, peroxyacetyl nitrate, aldehydes
(d) Oxygen, chlorine, fuming nitric acid

7. Photochemical smog formed in congested metropolitan cities mainly consists of
(a) ozone, peroxyacetyl nitrate and NO_x
(b) smoke, peroxyacetyl nitrate and SO_2
(c) hydrocarbons, SO_2 and CO_2
(d) hydrocarbons, ozone and SO_x

8. Which of the following statements about polar stratosphere clouds (PSCs) is not correct?
(a) PSCs do not react with chlorine nitrate and HCl
(b) Type I clouds are formed at about –77ºC and contain solid $HNO_3 . 3H_2O$
(c) Type II clouds are formed at about –85ºC and contain some ice
(d) A tight whirlpool of wind called Polar Vortex is formed which surrounds Antarctica

9. Which one of the following statements is correct ?
(a) Extensive use of chemical fertilizers may lead to eutrophication of nearby water bodies
(b) Both Azotobacter and Rhizobium fix atmospheric nitrogen in root nodules of plants
(c) Cyanobacteria such as Anabaena and Nostoc are important mobilizers of phosphates and potassium for plant nutrition in soil
(d) At present it is not possible to grow maize without chemical fertilizers

10. Which of the following metal is a water pollutant and causes sterility in human being
(a) As (b) Mn
(c) Mg (d) Hg

11. Eutrophication causes reduction in
(a) Dissolved oxygen (b) Nutrients
(c) Dissolved salts (d) All the above

12. Lichens do not like to grow in cities
(a) because of absence of the right type of algae and fungi
(b) because of lack of moisture
(c) because of SO_2 pollution
(d) because natural habitat is missing

13. Which one of the following pairs is mismatched
(a) Fossil fuel burning – release of CO_2
(b) Nuclear power – radioactive wastes
(c) Solar energy – Greenhouse effect
(d) Biomass burning – release of CO_2

14. In a coal fired power plant electrostatic precipitators are installed to control emission of
(a) SO_2 (b) NO_x
(c) SPM (d) CO

15. Presence of which fuel gas in the exhaust fumes shows incomplete combustion of fuel.
(a) Sulphur dioxide
(b) Carbon monoxide and water vapour
(c) Carbon monoxide
(d) Nitrogen dioxide

16. The term "Bio-magnification" refers to the
(a) growth of organism due to food consumption
(b) increase in population size
(c) blowing up of environmental issues by man
(d) increase in the concentration of non-degradable pollutants as they pass through food chain

17. The statement which is not correct about control of particulate pollution
(a) In electrostatic precipitator, the particulates are made to acquire positive charge which are then attracted by the negative electrode and removed
(b) Gravity settling chamber removes larger particles from the air
(c) Cyclone collector removes fine particls in the diameter range 5-20 microns
(d) Wet scrubbers are used to wash away all types of particulates

18. Which of the following is/are the hazardous pollutant(s) present in automobile exhaust gases?
(i) N_2 (ii) CO
(iii) CH_4 (iv) Oxides of nitrogen
(a) (ii) and (iii) (b) (i) and (ii)
(c) (ii) and (iv) (d) (i) and (iii)

19. Green chemistry means such reactions which :
(a) produce colour during reactions
(b) reduce the use and production of hazardous chemicals
(c) are related to the depletion of ozone layer
(d) study the reactions in plants

20. Which one of the following statements regarding photochemical smog is not correct?
(a) Carbon monoxide does not play any role in photochemical smog formation.
(b) Photochemical smog is an oxidising agent in character.
(c) Photochemical smog is formed through photochemical reaction involving solar energy.
(d) Photochemical smog does not cause irritation in eyes and throat.

DIRECTIONS for Qs. 21 to 25 : These are Assertion-Reason type questions. Each of these question contains two statements : Statement-1 (Assertion) and Statement-2 (Reason). Answer these questions from the following four options.

(a) Statement- 1 is True, Statement-2 is True, Statement-2 is a correct explanation for Statement -1
(b) Statement -1 is True, Statement -2 is True ; Statement-2 is NOT a correct explanation for Statement - 1
(c) Statement - 1 is True, Statement- 2 is False
(d) Statement -1 is False, Statement -2 is True

21. **Statement-1 :** Inhabitants close to very busy airports are likely to experience health hazards.
Statement-2 : Sound level of jet aeroplanes usually exceeds 160 dB.

22. **Statement-1 :** Suspended particulate matter (SPM) is an important pollutant released by diesel vehicles.
Statement-2 : Catalytic converters greatly reduce pollution caused by automobiles.

23. **Statement-1 :** Eutrophication shows increase in productivity in water.
Statement-2 : With increasing eutrophication, the diversity of the phytoplankton increases.

24. **Statement-1 :** The main cause of Bhopal gas tragedy was phosgene.
Statement-2 : Phosgene is a volatile liquid.

25. **Statement-1 :** CO_2 causes green house effect.
Statement-2 : Other gases do not show such effect.

EXERCISE - 3
Exemplar & Past Years NEET/AIPMT Questions

Exemplar Questions

1. Which of the following gases in not a green house gas?
(a) CO (b) O_3
(c) CH_4 (d) H_2O vapour

2. Photochemical smog occurs in warm, dry and sunny climate. One of the following is not amongst the components of photochemical smog, identify it.
(a) NO_2
(b) O_3
(c) SO_2
(d) Unsaturated hydrocarbon

3. Which of the following statements is not true about classical smog?
(a) Its main components are produced by the action of sunlight on emissions of automobiles and factories

(b) Produced in cold and humid climate
(c) It contains compounds of reducing nature
(d) It contains smoke, fog and sulphur dioxide

4. Biochemical Oxygen Demand, (BOD) is a measure of organic material present in water. BOD value less than 5 ppm indicates a water sample to be
(a) rich in dissolved oxygen
(b) poor in dissolved oxygen
(c) highly polluted
(d) not suitable for aquatic life

5. Which of the following statement(s) is/are wrong?
(a) Ozone is not responsible for green house effect
(b) Ozone can oxidise sulphur dioxide present in the atmosphere to sulphur trioxide
(c) Ozone hole is thinning of ozone layer present in stratosphere
(d) Ozone is produced in upper stratosphere by the action of UV rays on oxygen

6. Sewage containing organic waste should not be disposed in water bodies because it causes major water pollution. Fishes in such a polluted water die because of
(a) large number of mosquitoes
(b) increase in the amount of dissolved oxygen
(c) decrease in the amount of dissolved oxygen in water
(d) clogging of gills by mud

7. Which of the following statements about photochemical smog is wrong?
(a) It has high concentration of oxidising agents
(b) It has low concentration of oxidising agent
(c) It can be controlled by controlling the release of NO_2, hydrocarbons, ozone etc
(d) Plantation of some plants like pinus helps in controlling photochemical smog

8. The gaseous envelope around the earth is known as atmosphere. The lowest layer of this is extended upto 10 km from sea level, this layer is
(a) stratosphere (b) troposphere
(c) mesosphere (d) hydrosphere

9. Dinitrogen and dioxygen are main constituents of air but these do not react with each other to form oxides of nitrogen because ..... .
(a) the reaction is endothermic and requires very high temperature
(b) the reaction can be initiated only in presence of a catalyst
(c) oxides of nitrogen are unstable
(d) N_2 and O_2 are unreactive

10. The pollutants which come directly in the air from sources are called primary pollutants. Primary pollutants are sometimes converted into secondary pollutants. Which of the following belongs to secondary air pollutants?
(a) CO (b) Hydrocarbon
(c) Peroxyacetyl nitrate (d) NO

11. Which of the following statements is correct?
(a) Ozone hole is a hole formed in stratosphere from which ozone oozes out
(b) Ozone hole is a hole formed in troposphere from which ozone oozes out
(c) Ozone hole is thinning of ozone layer of stratosphere at some places
(d) Ozone hole means vanishing of ozone layer around the earth completely

12. Which of the following practices will not come under green chemistry?
(a) If possible, making use of soap made of vegetable oils instead of using synthetic detergents.
(b) Using H_2O_2 for bleaching purpose instead of using chlorine based bleaching agents
(c) Using bicycles for travelling small distances instead of using petrol/ diesel based vehicles
(d) Using plastic cans for neatly storing substances

NEET/AIPMT (2013-2017) Questions

13. Roasting of sulphides give the gas X as a by product. This is colorless gas with choking smell of burnt sulphur and caused great damage to respiratory organs as a result of acid rain. Its aqueous solution is acidic, acts as a reducing agent and its acid has never been isolated. The gas X is : ***[2013]***
(a) SO_2 (b) CO_2
(c) SO_3 (d) H_2S

14. Which one of the following statements is not true? ***[NEET Kar. 2013]***
(a) Dissolved oxygen (DO) in cold water can reach a concentration upto 10 ppm.
(b) Clean water would have a BOD value of 5 ppm.
(c) Fluoride deficiency in drinking water is harmful. Soluble fluoride is often used to bring its concentration upto 1 ppm.
(d) When the pH of rain water is higher than 6.5, it is called acid rain.

15. Which of the following is not a common component of Photochemical Smog? ***[2014]***
(a) Ozone
(b) Acrolein
(c) Peroxyacetyl nitrate
(d) Chlorofluorocarbons

16. Which of the following is a sink for CO ? ***[2017]***
(a) Microorganism present in the soil
(b) Oceans
(c) Plants
(d) Haemoglobin

Hints & Solutions

EXERCISE - 1

1. (c)
2. (a) CO_2 causes Green House Effect.
3. (a) NO and freons are responsible for ozone depletion.
4. (b) Domestic sewage constitute biodegradable pollutants.
5. (a) In antarzctica ozone depletion is due to formation of acrolein.
6. (a) 7. (b) 8. (b) 9. (c)
10. (a) Phosphate pollution is caused by sewage and agricultural fertilizers.
11. (d) The uppermost region of atmosphere is exosphere.
12. (b) The coldest region is mesosphere (temp. –27ºC to – 92ºC)
13. (c) Acid rain is rain or any other form of precipitation that is unusually acidic. It has harmful effects on plants, aquatic animals, and infastructure. Acid rain is mostly caused by human emissions of sulfur and nitrogen compounds which react in the atmosphere to produce acids. In recent years, many governments have introduced laws to reduce these emissions.
14. (c) Air pollution greatly affect the troposphere.
15. (b) CO is primary pollutant.
16. (d) London smog is formed in morning during winter.
17. (a) Radiation coming from sun or outerspace have high energy or short wavelength, which are allowed to enter by green house gases. However, radiation emitted by earth is in infrared region, having long wavelength, are reflected back by the envelope of green house gases.
18. (c) CO and oxides of Nitrogen are poisnous gases present in automobile exhaust gases.
19. (d) CO is highly toxic and impairs respiration. CO combine with haemoglobin of blood and reduces its O_2 carry capacity.
20. (d)
21. (a) Dust
22. (a) BOD of pond is connected with microbes and organic matter.
23. (c)
24. (a) Normal rain water has pH 5.6. Thunderstorm results in the formation of NO and HNO_3 which lowers the pH.
25. (d) Minamata is caused by Hg poisoning.
56. (a)
27. (d) Decrease in D.O causes death of fish
28. (b) Sewage water is purified by micro-organisms.
29. (c)
30. (d) Fly ash.
31. (a) 32. (c) 33. (b)
34. (a) PAH (Poly Aromatic Hydrocarbon)
35. (c) Water is often treated with Cl_2 to kill germs.
36. (b) Thermal pollution is caused by power plants. Power plant requires a larger quantity of water for cooling. The water after cooling is left in the water body. The temperature of left water is generally very high and affects aquatic life.
37. (b) Strength of sewage or degree of water pollution is measured in terms of BOD (Biochemical oxygen demand) value.
38. (c) The excess of fluorine in water causes fluorosis. The symptoms of fluorosis are mottling of teeth (yellowish streaks) and abnormal bones liable to fracture etc. It is an example of endemic disease.
39. (b) Algae
40. (c) 41. (c) 42. (b)
43. (d) [Many organic substances break up into simpler substances by taking up dissolved oxygen in presence of some bacteria. As they continue, dissolved oxygen, runs short for aquatic life, which is then badly affected. Moreover many harmful products are formed]
44. (a) Green house gases such as CO_2, ozone, methane, the chlorofluorocarbon compounds and water vapour form a thick cover around the earth which prevents the IR rays emitted by the earth to escape. It gradually leads to increase in temperature of atmosphere.

45. (b) The ideal value of D.O for growth of fishes is 8 mg/ℓ. 7mg /ℓ is desirable range, below this value fishes get susceptible to disease. A value of 2 mg/ ℓ or below is lethal for fishes.

46. (c) Ozone layer acts as a shield and does not allow ultraviolet radiation from sun to reach earth. It does not prevent infra-red radiation from sun to reach earth.

Thus option (c) is wrong statement and so it is the correct answer.

47. (c) The ozone layer, existing between 20 to 35 km above the earth's surface, shield the earth from the harmful U. V. radiations from the sun.

Depletion of ozone is caused by oxides of nitrogen

$$N_2O + h\upsilon \longrightarrow NO + N$$

reactive nitric oxide

$$NO + O_3 \longrightarrow NO_2 + O_2$$

$$O_3 + h\upsilon \longrightarrow O_2 + O$$

$$NO_2 + O \longrightarrow NO + O_2$$

$$2O_3 + h\upsilon \longrightarrow 3O_2 \text{ (Net reaction)}$$

The presence of oxides of nitrogen increase the decomposition of O_3.

48. (a) Smog is caused by oxides of sulphur and nitrogen.

49. (d) DDT is a non-biodegradable pollutant.

50. (a) Methyl isocyanate, $CH_3 - N = C = O$

EXERCISE - 2

1. (b) SO_3 is more harmful pollutant than SO_2.

2. (c)

3. (a) The average residence time of NO is 4 days.

4. (c) 5. (a) 6. (c) 7. (a)

8. (a) PSCs react with chlorine nitrate and HCl to give HOCl and Cl_2.

9. (a) 10. (b)

11. (a) Eutrophication causes reduction in D.O.

12. (c) Because they are very sensitive to sulphur dioxide and in cities the amount of SO_2 is high so lichen do not grow in cities.

13. (c) Solar energy is not responsible for green house effect instead it is a source of energy for the plants and animals.

14. (c) SPM $\rightarrow$ Suspended Particulates matter.

15. (c) Prsence of CO in the exhaust fumes shows incomplete combustion.

16. (d)

17. (a) Particulates acquire negative charge and are attracted by the positive electrode.

18. (c) CO and oxides of Nitrogen are poisnous gases present in automobile exhaust gases.

19. (b) Green chemistry may be defined as the programme of developing new chemical products and chemical processes or making improvements in the already existing compounds and processes so as to make less harmful to human health and environment. This means the same as to reduce the use and production of hazardous chemicals.

i.e. correct answer is option (b).

20. (d) The oxidised hydrocarbons and ozone in presence of humidity cause photochemical smog.

Hydrocarbons + O_2, NO_2, NO, O, O_3 $\rightarrow$ Peroxides, formaldehyde, peroxyacetylnitrate (PAN), acrolein etc.

It is oxidising in nature and causes irritation to eyes, lungs, nose, asthamatic attack and damage plants.

21. (a) Noise level upto 64 dB (decibel) is well tolerated. Prolonged exposure to noise level to 80 dB or more leads to loss of hearing ability, fatigue, nervousness, fever, hypertension, gastric disorder, increase in cholesterol level and dilation of pupil of the eye. As the jet aeroplanes have the noise upto 150-160 dB, the inhabitants in the vicinity of busy airports are likely to experience above health hazards. Maximum noise level is recorded in rockets, i.e., 180 dB.

22. (b) SPM (Suspended Particulate Matter) is defined as particles floating in the air with a diameter below 10 μm. Studies have shown that high SPM concentrations in the air can have a detrimental impact on respiratory organs. SPM is generated from natural sources (e.g., volcanoes or dust storms) and human activities (vehicles, incinerators and industrial plants).

SPM	Other aerosols
Less than 10 μm Tend to float longer in air due to small size	Less than 100 μm Tend to settle fairly quickly due to comparative heaviness

Catalytic converters is a device designed to reduce the amount of emissions from automobiles. The current (so-called three-way) systems use a heated metal catalyst to reduce the emissions of carbon monoxide (CO), hydrocarbons, and nitric oxide (NO), all of which contribute to the formation of photochemical smog. In an automobile's exhaust system, a catalytic converter provides an environment for a chemical reaction where unburned hydrocarbons completely combust.

23. (b) Eutrophication is a natural process which literally means well nourished or enriched. It is a natural state in many lakes and ponds which have a rich supply of nutrients. Eutrophication become excessive, however when abnormally high amount of nutrient from sewage, fertilizers, animal wastage and detergent, enter streams and lakes causes excessive growth or blooms of microorganisms. With increasing eutrophication, the diversity of the phytoplankton community of a lake increases and the lake finally becomes dominated by blue - green algae.

24. (d) Phosgene ($COCl_2$) is a poisonous and suffocating volatile liquid. Release of methyl isocyanate in industrial accident of Bhopal was the main reason of Bhopal gas tragedy.

25. (c) Other gases like CFCs, Ozone, water vapour and nitrous oxide also show green house effect.

EXERCISE - 3

Exemplar Questions

1. (a) Those gases which absorb sunlight near the earth's surface and then radiates back to the earth are called green house gases.

Carbon dioxide, water vapour, methane, ozone, oxides of nitrogen, chlorofluoro carbons (CFCs) etc; are green house gases. CO is not a green house gas.

2. (c) The smog which is formed in presence of sunlight is called photochemical smog. The main components of the photochemical smog results from the action of sunlight on unsaturated hydrocarbons and nitrogen oxides produced by automobiles and factories.

3. (a) Classical smog occurs in cold humid climate. It is a mixture of smoke, fog and sulphur dioxide.

4. (a) Water considered to be clean if it has BOD less than 5 ppm whereas highly polluted water has BOD more than 17 ppm.

Therefore, water having BOD less than 5 ppm is rich in dissolved oxygen.

5. (a) O_3 is responsible for greenhouse effect. Its contribution is about 8%.

6. (c) The large population of bacteria decomposes organic matter present in water. They consume oxygen dissolved in water. Hence, oxygen from water decreases. It is harmful for aquatic life.

7. (b) Photochemical smog has high concentration of oxidants such as O_3, organic oxidant and is therefore called as oxidising agent.

8. (b) The lowest region of the atmosphere in which human beings along with other organisms live is called troposhere. It extends upto the height of ~ 10 km from sea level. Troposphere is a turbulent, dusty zone containing air, much water vapour and clouds.

9. (a) Nitrogen and oxygen do not react with each other at normal temperature. At high altitude when lightning strikes, they combine to form oxides of nitrogen.

$$N_2(g) + O_2(g) \xrightarrow{3000^\circ C} 2NO(g)$$

10. (c) Hydrocarbons present in atmosphere combine with oxygen atom produced by the photolysis of NO_2 to form highly reactive intermediate called free radical. Free radical initiates a series of reaction.

Peroxyacetyl nitrates are formed, which can be said as secondary pollutants.

$$\text{Hydrocarbon} + O \rightarrow RCO^{\cdot} \text{ (free radicals)}$$

$$RCO^{\cdot} + O_2 \rightarrow RCO_3$$

$$RCO_3^{\bullet} + NO_2 \rightarrow \underset{\text{Peroxyacetyl nitrate}}{RCO_3NO_2}$$

11. (c) Ozone hole is thinning of ozone layer of stratosphere at some place. NO and chlorofluorocarbon have been found to be the most responsible for depleting the ozone layer.

12. (d) Using plastic cans for neatly storing substances will not come under green chemistry. The plastic materials are non-biodegradable.

NEET/AIPMT (2013-2017) Questions

13. (a) Based on the features given gas must be SO_2 .

14. (d) Acid rain is the rain water containing sulphuric acid and nitric acid which are formed from the oxides of sulphur and nitrogen present in the air as pollutants and rain water has a pH range of 4-5.

15. (d) The oxidised hydrocarbons and ozone in presence of humidity cause photochemical smong.
Hydrocarbons + O_2, NO_2, NO, O, O_3 $\rightarrow$ Peroxides, formaldehyde, peroxyacetyl-nitrate (PAN), acrodein etc.
Hence chlorofluoro carbons are not common component of photochemical smog.

16. (a) Microorganisms present in the soil is a sink for CO.