DAY TWENTY SIX

# Environmental Chemistry

*Learning & Revision for the Day*

- Pollutants
- Pollution
- Atmospheric Pollution
- Water Pollution
- Soil and Land Pollution
- Strategies to Control Environmental Pollution

Environmental chemistry deals with the study of origin, transport, reactions, effects and fates of chemical species in the environment.

## Pollutants

Any substance which pollutes the environment is known as **pollutant**. A substance becomes a pollutant when it is present in larger concentrations which is harmful to the natural environment. It can be solid, liquid or gaseous.

The pollutants are classified into following categories:

1. **Primary pollutants** are the pollutants persisting in the environment in the form they are produced, e.g. carbon monoxide.
2. **Secondary pollutants** are formed by the combination of primary pollutants present in the environment, e.g. two primary pollutants, nitrogen oxides and hydrocarbons, react together in the presence of sunlight to form secondary pollutant, peroxyacetyl nitrate (PAN).
3. **Biodegradable pollutants** are those pollutants which are decomposed by microorganisms either by itself or by suitable treatment, e.g. sewage, various oxides of nitrogen and sulphur etc.
4. **Non-biodegradable pollutants** are those pollutants which are not decomposed naturally and are not recycled. They are harmful to environment even in low concentrations, e.g. DDT, nuclear waste, lead components etc.

## Pollution

Contamination of the environment (i.e. our surroundings such as air, water, soil etc.) with harmful wastes arising mainly from certain human activities is called environmental pollution.

In the process of environmental pollution, pollutants originate from a source and get transported by air, water or dumped into the soil by human being.

- On the basis of pollutants, the pollution can be classified as:
  (i) Thermal pollution (ii) Noise pollution
  (iii) Chemical pollution (iv) Metal pollution
  (v) Smog pollution (vi) Oil pollution

On the basis of part of environment polluted, the pollution can be classified as:
(i) Atmospheric pollution (ii) Water pollution
(iii) Soil pollution

# Atmospheric Pollution

Atmospheric pollution occurs when the concentration of a normal component of the air or a new chemical substance added or formed in air, build up to undesirable proportions causing harm to humans, animals, vegetation and materials.

## Structure of Atmosphere

- The lowest region of atmosphere in which the human beings along with other organisms live is called the **troposphere**. It extends upto the height of ~10 km from sea level. Above troposphere, between 10 and 50 km above sea level, lies the **stratosphere**. Troposphere contains about 80% of the total mass of air and water vapours while stratosphere contains nitrogen, oxygen and ozone.
- **Mesosphere** extends 50-85 km from earth's surface. $N_2$ and $O_2$ are present in low concentration in this region.
- **Thermosphere** extends between 85-500 km from earth's surface and in it temperature rises to 1200°C.
- The outermost part of atmosphere is **exosphere** and unbounded area beyond exosphere is known as **inter-stellar space**.
- Mesosphere and thermosphere are collectively known as **ionosphere**.
- Sources of air pollution are as follows:
  (i) Burning of fossil fuels such as coal, wood and oil.
  (ii) Exhaust gases emitted by internal combustion engines of vehicles.
  (iii) Chemical industries and their released products.
- Atmospheric pollution is generally studied as tropospheric and stratospheric pollution.

## Tropospheric Pollution

It is caused by gaseous pollutants and particulate matter.

### Gaseous Air Pollutants

Some gaseous pollutants are as follows :

#### 1. Oxides of Sulphur

Two main oxides of sulphur that act as pollutants are $SO_2$ and $SO_3$.

**Sources**

(i) Burning of sulphur containing fossil fuels, roasting and smelting of sulphide ore.
(ii) Particulate matter in the air oxidises $SO_2$ to $SO_3$.

**Harmful Effects**

- $SO_2$ in lower concentration irritates the upper respiratory tract, causes cough etc.
- $SO_3$ is more harmful than $SO_2$ because it combines with water to form $H_2SO_4$ and causes acid rain.

**Prevention** They can be removed by non-regenerative process

$$CaCO_3 \longrightarrow CaO + CO_2$$
$$CaO + SO_2 \longrightarrow CaSO_3$$
$$CaO + SO_3 \longrightarrow CaSO_4$$

#### 2. Oxides of Nitrogen

Nitric oxide (NO) and nitrogen oxide ($NO_2$) act as pollutant.

**Sources**

$N_2$ and $O_2$ are the main constituents of air but are unreactive at normal temperature. They form oxides when lightening occurs at high altitudes.

$$N_2 + O_2 \xrightarrow[\text{or } 1210^\circ C]{\text{Lightening}} 2NO\,, \quad 2NO + O_2 \xrightarrow[\text{or } 1100^\circ C]{\text{Lightening}} 2NO_2$$

**Harmful Effects**

- These oxides can cause pulmonary odema, dilation of arteries, eye irritation, damage to liver and kidney.
- They also retard the rate of photosynthesis.

**Prevention**

$NO_x$ is controlled by using catalytic converters in automobile exhausts which convert $NO_x$ to free $N_2$ or to a small amount of $NH_3$.

#### 3. Oxides of Carbon

The two main oxides of carbon that causes pollution are carbon monoxide (CO) and carbon dioxide ($CO_2$).

**Sources**

(i) CO is the product of incomplete combustion of a carbonaceous fuel. Petroleum fuel contribute about 60% of the total CO produced by human activities.
(ii) Main sources of $CO_2$ production are agricultural burning, metallurgical processes using coke as a reducing agent etc.

**Harmful Effects**

- CO enters the respiratory system along with $O_2$ and combines with haemoglobin to form carboxy-haemoglobin, which results in giddiness, headache, decreased vision etc.
- $CO_2$ is non-toxic upto a certain level, but causes climate changes like greenhouse effect, global warming etc.

**Prevention**

- Fuel substitution LPG and CNG in place of oil, electric or solar power in place of fossil fuels.
- Use of catalytic converter in automobile exhaust pipe.

### 4. Hydrocarbons

Hydrocarbons like methane ($CH_4$) mixed in air act as pollutants.

**Sources**

These are produced by an aerobic decay of organic matter (like vegetables, dead animal bodies etc), incomplete combustion of fuels and various chemical industries.

**Harmful effect**

These are carcinogenic and causes suffocation at higher concentration. They also harm plants by causing ageing, breakdown of tissues and shedding of leaves, flowers and twigs.

**Prevention**

- Adsorption of hydrocarbons on activated charcoal.
- Burning hydrocarbons or catalytic oxidation to $CO_2$ and $H_2O$.

NOTE **Leakage of methyl isocyanate** (MIC) gas caused death of approximately 3200 persons (Bhopal gas tragedy).

## Greenhouse Effect and Global Warming

- The phenomenon in which atmosphere of earth traps the heat coming from the sun and prevents it from escaping into the outer space is called **greenhouse effect**.
- Certain gases, called greenhouse gases [carbon dioxide, methane, ozone, chlorofluorocarbon compounds (CFCs) and water vapour] in the atmosphere absorb the heat given by earth and radiate back it to the surface of the earth.
- Thus, warming of the earth led to the warming of air due to greenhouse gases, which is called **global warming**.

Some consequences of greenhouse effect are as follows:

(i) The greenhouse gases are useful in keeping the earth warm with an average temperature of about 15° to 20°C.

(ii) There may be less rainfall in this temperature zone and more rainfall in the dried areas of the world.

(iii) Increase in the concentration of $CO_2$ in the atmosphere leads to increase in the temperature of the earth's surface. As a result, evaporation of surface water will increase which further help in the rise of temperature and results in the melting of glaciers and polar ice-caps and hence, level of sea water may rise.

## Acid Rain

- The pH of normal rain water is 5.6 due to the dissolution of $CO_2$ from atmosphere.

$$H_2O + CO_2 \rightleftharpoons H_2CO_3 \text{ (carbonic acid)}$$

$$H_2CO_3 \rightleftharpoons H^+ + HCO_3^-$$

- When the pH of rain water drops below 5 ppm, it is called acid rain (by Robert Augus). Oxides of N and S are responsible for making rain water acidic.
- Much of the $NO_x$ and $SO_x$ entering in the atmosphere are converted into $HNO_3$ and $H_2SO_4$ respectively. The detailed photochemical reactions occurring in the atmosphere are given as:

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

$$NO_2 + O_2 \longrightarrow NO_3 + O_2$$

$$NO_2 + NO_3 \longrightarrow N_2O_5$$

$$N_2O_5 + H_2O \longrightarrow 2HNO_3$$

- $HNO_3$ is removed as a precipitate or as particulate nitrate after reaction with bases (like $NH_3$, particulate lime etc).

$$SO_2 + \frac{1}{2}O_2 + H_2O \xrightarrow[\text{Soot particles}]{(\text{Hydrocarbon, } NO_x)} H_2SO_4$$

- The presence of hydrocarbons and $NO_x$ step up the oxidation rate of the reaction.
- Soot particles are also known to be strongly involved in catalysing the oxidation of $SO_2$.
- Acid rain is harmful for agriculture, trees and plants. It causes respiratory ailments in human beings and animals.
- It also causes extensive damage to buildings and sculptural materials of marble, limestone, slate, mortar etc. e.g. acid rain reacts with marble, $CaCO_3$ of Taj Mahal causing damage to this wonderful monument.

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

## Particulate Pollutants

- Particulate pollutants are the tiny pieces of solid or liquid matter associated with the earth's atmosphere.
- Particulates in atmosphere may be viable or non-viable.
- The **viable particulates** are the minute living organisms such as bacteria, fungi that are dispersed in atmosphere. Human beings are allergic to some of the fungi found in air.
- Mist, smoke, fumes and dust are non-viable particulates in atmosphere.

(i) **Smoke** particulates consist of solid or mixture of solid and liquid particles formed during combustion of organic matter, e.g. cigarette smoke, smoke from garbage, fossil fuel etc.

(ii) **Dust** is composed of fine solid particles produced during crushing, grinding and attribution of solid materials, e.g. fly ash from factories, dust storms etc.

(iii) **Mists** are produced by particles of spray liquids and by condensation of vapours in air e.g. sulphuric acid mist and herbicides and insecticides that miss their target and travel through air and form mists.

(iv) **Fumes** are generally obtained by condensation of vapours during sublimation, boiling and several other chemical reactions. Generally organic solvents, metals and metallic oxides form fume particles.

**Harmful Effects** The effect of particulate pollutants are larger as they are dependent on the particle size. Thus,

particulate particles are dangerous for human health lead is used to be a major air pollutant emitted by vehicle. Leaded petrol used as the primary source for air borne lead mission in Indian cities. It interferes with the development and maturation of red blood cells.

### Smog

Smog is the combination of smoke particles with tiny droplets of fog.

### Classical Smog (London Smog)

$SO_2$ and particulate matter are main components of London smog. It is mostly observed in cool humid climate. It is chemically reducing in nature.

### Photochemical Smog (Los Angeles Smog)

Photochemical smog contains a mixture of primary pollutants such as nitrogen oxides, carbon monoxide and secondary pollutants such as $O_3$ and HCHO. It occurs in warm, dry and sunny climate and are caused by the action of sunlight on nitrogen oxides and hydrocarbons. It is oxidising in nature.

Its formation can be shown as follows:

$$N_2 + O_2 \longrightarrow 2NO$$

(In automobile engines or power plant)

$$2NO + O_2 \xrightarrow{\text{Sunlight}} 2NO_2 \qquad \text{(Oxidation in air)}$$

$$NO_2 \xrightarrow{h\nu} NO + \underset{\text{Atomic oxygen}}{[O]}$$

$$[O] + O_2 \rightleftharpoons O_3$$

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

Both $NO_2$ and $O_3$ are strong oxidising agents.

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

$$\text{Hydrocarbons} + O_3, O_2, O, NO, NO_2 \longrightarrow \underbrace{\underset{\text{PAN}}{R-\overset{\overset{O}{\|}}{C}-O-O-NO_2} + HCHO + \underset{\text{Acrolein}}{CH_2=CH-CHO}}_{\text{Photochemical smog}}$$

### Preventions

Industries should purify the smoke to a certain extent before releasing into air. They should use chimneys. Planting more and more trees is also a method to maintain the oxygen-carbon dioxide balance.

## Stratospheric Pollution

Stratospheric pollution is mainly concerned with ozone layer depletion. In stratosphere, there is a region of high concentration of ozone (10 ppm), at a height of 23 km, called ozone layer. This layer does not allow the UV rays coming from the sun to reach on the earth. Thus, protects us from harmful effects of UV-rays.

### Ozone Depletion

- Chlorofluorocarbons present in aerosols, air conditioning and refrigeration devices destroy ozone layer and reduce our protection against UV rays from the sun.

$$CF_2Cl_2 + h\nu \longrightarrow \dot{C}l + \dot{C}F_2Cl$$

$$\dot{C}l + O_3 \longrightarrow \dot{C}lO + O_2$$

$$\dot{C}lO + O \longrightarrow \dot{C}l + O_2$$

- One molecule of CFC can destroy more than thousand molecules of $O_3$. This leads to the formation of ozone hole.
- CFCs are stable in lower atmosphere but when they reach the stratosphere, they split and become unstable by sunlight.

#### Ozone Depletion in Antarctica

- A large scale depletion in the concentration of $O_3$ observed over Antarctica is called **ozone hole**.
- In stratosphere, $NO_2$ and $CH_4$ act as scavangers for $\dot{C}lO$ and $\dot{C}l$.

$$\dot{C}lO + NO_2 \longrightarrow \underset{\text{Chlorine nitrate}}{ClONO_2}$$

$$\dot{C}l + CH_4 \longrightarrow \dot{C}H_3 + HCl$$

- Polar stratospheric clouds (PSCs) are formed over Antarctica in winter. These are of two types:
  Type I clouds (contain solidified $HNO_3 \cdot 3H_2O$) and type II clouds (contain some ice).

$$ClONO_2 + H_2O \longrightarrow HOCl + HNO_3$$

$$ClONO_2 + HCl \longrightarrow Cl_2 + HNO_3$$

- The ozone depletion over Antarctica occurs during spring but gets replenished after spring is over.

$$HOCl + h\nu \longrightarrow \dot{O}H + \dot{C}l$$

$$Cl_2 + h\nu \longrightarrow 2\dot{C}l$$

- Stable wind patterns in stratosphere are called polar vortex. It does not allow the $O_3$ rich air to fill up the gap.

#### Effects of Depletion of the Ozone Layer

Depletion of ozone layer allows UV rays to reach earth's surface. Hence, causes the following problems.

(i) It increases transpiration, therefore decreases soil moisture.

(ii) It results in increased causes of skin cancer in human along with adverse effect on plants and crops.

## Water Pollution

Water pollution is the degradation of quality of water due to addition of inorganic, organic, biological or radiological substances, factors (e.g. heat) and deprivation that makes it health hazard, unfit for human use and growth of aquatic biota.

The various pollutants of water pollution are:

(i) **Pathogens** These include bacteria and other organisms that enter water from domestic sewage and animal excreta.

(ii) **Organic Wastes** Organic matter such as leaves, grass, trash etc. pollute water as a consequence of sun off. These wastes are biodegradable.

(iii) **Chemical Pollutants** Water soluble inorganic chemicals that include heavy metals such as Cd, Hg, Ni etc. constitute an important class of pollutants. All these metals are dangerous to humans because our body can't excrete them. They can damage kidneys, CNS, liver etc. The degree of water pollution is measured in terms of BOD and COD.

(a) **Biochemical Oxygen Demand** (BOD) The amount of oxygen consumed by microorganisms in decomposing the waste present in a certain volume of sample of water is called BOD.

- $\text{BOD} = \frac{\text{number of milligrams of } O_2 \text{ needed}}{\text{number of litres of the sample}}$
- To determine BOD, water sample is first saturated with oxygen and then incubated at constant temperature for five days.

(b) **Chemical Oxygen Demand** (COD) In COD determination, a known quantity of water sample is oxidised by acidified $K_2Cr_2O_7$. The unused amount of dichromate is determined by back titration. The amount of oxygen used in oxidation is calculated from consumed concentration of $K_2Cr_2O_7$.

### Harmful Effects of Water Pollution

- High concentration of fluoride are poisonous and are harmful to bones and teeth at levels over 10 ppm.
- Excessive sulphate (>500 ppm) have a laxative effect.
- Excess nitrate in drinking water can lead to blue baby syndrome (methemoglobinemia).

### Prevention of Water Pollution

- Removal of large solids from waste water by filtration (solids are disposed of in landfill sites).
- Settlement of the filtered waste water to remove suspended solids, oily and greasy materials which float on the surface can be skimmed off.
- Degradation of organic content of waste water by microbial oxidation.
- Removal of phosphates, coagulation, filtration and disinfection using chlorine for improving the quality of waste water.

## Soil or Land Pollution

Soil pollution is the addition of such chemical substances which decreases its productivity, quality of plants and ground water to the soil system. The polluted soil produces inferior quality of crop.

The major pollutant of soil pollution are :

(i) **Pesticides** like insecticides (e.g. DDT, BHC), herbicides (e.g. $NaClO_3$, $Na_2AsO_3$), fungicides (e.g. organo mercury compounds), fertilisers and soil conditioners (e.g. compounds of As, Hg, Pb etc).

**Harmful Effects** These pollutants enter into food or drinking water which adversely affect the health of human beings.

(ii) Dumping of waste such as garbage, industrial wastes, ash, sludge, broken cans and bottles etc.

**Harmful Effects** They affect the fertility, pH level, microbial population and humidity of soil.

### Prevention of Land Pollution

- Forestation to check the spread of desert.
- Pesticides and herbicides should be used only when necessary.

## Strategies to Control Environmental Pollution

1. **Waste management and green chemistry** are used to control environmental pollution. Waste management is done by recycling, digestion, incineration, dumping and sewage treatment.
2. **Recycling**, i.e. conversion of waste into useful products. It saves raw materials and reduces the cost of waste disposal, e.g. recycling glass bottles, scrap metal in the manufacture of steel, generation of energy by burning combustible wastes.
3. **Incineration**, i.e. reduction of many combustible wastes from households, hospitals etc., to ash by burning it at very high temperature (> 1000°C) in excess of oxygen. This is one of the best methods for disposal of polychlorinated biphenyls (PCBs) as high temperature breaks C—Cl bonds. The chief disadvantage of incineration is that it leads to air pollution.
4. **Green fuel**, the plastic waste is being converted into fuel which has high octane number and does not contain any lead.
5. **Digestion**, i.e. conversion of the organic material (C, H, O) into carbon dioxide and methane by microorganisms (anaerobic digestion).

### Green Chemistry

- It is an alternative tool for reducing pollution. It refers to the production of substances of daily use by chemical reactions which neither employ toxic chemicals nor release the same to atmosphere.
- Green chemistry includes concepts such as waste minimisation, solvent selection, atom utilisation, intensive processing and alternative synthetic routes from sustainable resources.

DAY PRACTICE SESSION 1

# FOUNDATION QUESTIONS EXERCISE

**1** Environmental pollution affects
(a) biotic components
(b) human beings only
(c) plants only
(d) biotic and abiotic components of environment

**2** Which of the following is not a pollutant?
(a) Carbon monoxide (b) Sulphur trioxide
(c) Sulphur dioxide (d) Nitrogen peroxide

**3** Which of the following is not considered to be a pollutant?
(a) $NO_2$ (b) $CO_2$ (c) $O_3$ (d) $SO_3$

**4** The lowest layer of earth's atmosphere is
(a) troposphere (b) mesosphere
(c) stratosphere (d) ionosphere

**5** Ultraviolet radiation is absorbed by
(a) exosphere (b) ionosphere
(c) mesosphere (d) stratosphere

**6** Pollutants released from iron and steel industry are
(a) $CO_2$, $NO_2$, $H_2S$ (b) CO, $CO_2$, $SO_2$
(c) $CO_2$, $SO_3$, $NO_2$ (d) $CO_2$, NO, $SO_3$

**7** $SO_2$ causes
(a) respiratory and lung disease
(b) acid rain
(c) corrosion of building materials
(d) All of the above

**8** Main pollutant from automobile exhaust is
(a) CO (b) $CO_2$
(c) NO (d) hydrocarbons

**9** Carbon monoxide, emitted by automobiles, prevents transport of oxygen in the body due to
(a) combining with oxygen to form carbon dioxide
(b) destruction of haemoglobin
(c) preventing reaction between oxygen and haemoglobin
(d) formation of stable compound with haemoglobin

**10** Which of the following pollutants is not emitted during volcanic eruptions?
(a) $SO_2$ (b) $H_2S$
(c) Hydrocarbons (d) CO

**11** The gas leaked from a storage tank of the Union Carbide Plant in Bhopal gas tragedy was ➞ JEE Main 2013
(a) methylamine (b) phosgene
(c) ammonia (d) methyl isocyanate

**12** Lead pollution is mainly caused by
(a) sewage (b) insecticide
(c) coal gasoline (d) None of these

**13** Which of the following is not a greenhouse gas?
(a) Methane (b) Carbon dioxide
(c) CFCs (d) $CH_3Br$ vapour

**14** Acid rains are produced by
(a) excess $NO_2$ and $SO_2$ from burning fossil fuels
(b) excess production of $NH_3$ by industry and coal gas
(c) excess release of carbon monoxide by incomplete combustion
(d) excess formation of $CO_2$ by combustion and animal respiration

**15** Which of the following statements is false?
(a) London smog is oxidising in nature
(b) London smog causes bronchitis
(c) London smog is formed in winter
(d) London smog contains $H_2SO_4$ droplets

**16** The smog is essentially caused by the presence of
(a) $O_2$ and $O_3$
(b) $O_2$ and $N_2$
(c) oxides of sulphur and nitrogen
(d) $O_3$ and $N_2$

**17** Which one of the following is not a common component of photochemical smog?
(a) Ozone (b) Acrolein
(c) Peroxyacetylnitrate (d) Chlorofluorocarbons

**18** Persons working in cement plants and limestone quarries are more prone to disease like
(a) asthma (b) cancer
(c) silicosis (d) pneumoconiosis

**19** Which of the following protects life on earth from harmful effects of UV radiations from sun?
(a) $N_2$ (b) $CO_2$
(c) $O_2$ (d) $O_3$

**20** Ozone has the ability to absorb
(a) UV radiations (b) electromagnetic radiations
(c) CFC (d) greenhouse gases

**21** Ozone depletion in the stratosphere is mainly caused by
(a) $SO_2$ (b) $NO_2$
(c) NO (d) chlorofluorocarbons

**22** Increased UV radiations due to hole in ozone layer
(a) will cause increase in cases of skin diseases
(b) will cause more ice to melt
(c) will cause summer to be more warmer
(d) will cause more rain

**23** Ozone hole is maximum over
(a) India (b) Pakistan
(c) Australia (d) Antarctica

**24** In Antarctica, ozone depletion is due to the formation of
(a) chlorine nitrate (b) peroxyacetyl nitrate
(c) $SO_2$ (d) $SO_3$

**25** Identify the incorrect statement from the following. ➞ AIEEE 2011

(a) Oxides of nitrogen in the atmosphere can cause the depletion of ozone layer
(b) Ozone absorbs the intense ultraviolet radiation of the sun
(c) Depletion of ozone layer is because of its chemical reactions with chlorofluoroalkanes
(d) Ozone absorbs infrared radiations

**26** Eutrophication of a lake means it

(a) is low in nutrients
(b) is high in nutrients
(c) has excess amount of organic matter
(d) has a high temperature

**27** Which of the following does not cause water pollution?

(a) Heavy metals such as Cd, Pb, Hg
(b) Detergents
(c) Polychlorobiphenyls
(d) Freons

**28** Fish die in water-bodies polluted by sewage is due to

(a) pathogens (b) reduction in oxygen
(c) foul smell (d) None of these

**29** BOD is

(a) waste decomposed in 5 days
(b) oxygen used in 5 days
(c) microorganisms killed in 5 days
(d) dissolved oxygen left after 5 days

**30** Mottling of teeth is due to the presence of which of the following element in drinking water?

(a) Mercury (b) Fluorine (c) Boron (d) Chlorine

**31** Water is treated with chlorine to

(a) increase oxygen content
(b) increase taste
(c) remove suspended particles
(d) kill germs

**32** Sewage water is purfied by

(a) microorganism (b) fishes
(c) aquatic plants (d) All of these

**33** Match the pollutants given in Column I with their effects in Column II.

| Column I | Column II |
|---|---|
| A Unsaturated hydrocarbons | 1. BOD level of water increases |
| B Methane in air | 2. Acid rain |
| C. Synthetic detergents in water | 3. Global warming |
| D. Nitrogen oxides in air | 4. Photochemical smog |

**Codes**

| | A | B | C | D |
|---|---|---|---|---|
| (a) | 4 | 3 | 1 | 2 |
| (c) | 1 | 4 | 2 | 3 |

| | A | B | C | D |
|---|---|---|---|---|
| (b) | 4 | 1 | 3 | 2 |
| (d) | 4 | 3 | 2 | 1 |

**34** Drawback of DDT as pesticides is that

(a) it is less effective than others
(b) it becomes ineffective after some time
(c) it is a non-biodegradable substance
(d) it is very costly

**35** What is DDT among the following?

(a) Greenhouse gas
(b) A fertiliser
(c) Biodegradable pollutant
(d) Non-biodegradable pollutant ➞ AIEEE 2012

**36** Green chemistry involves

(a) production of chemicals of our daily use from green house gases
(b) such chemical processes in which green plants are used
(c) those reactions which are of biological origin
(d) use of non-toxic reagents and solvents to produce environment friendly products

**Direction** (Q. Nos. 37-38) *In the following questions, Assertion (A) followed by Reason (R) is given. Choose the correct option out of the choices given below:*

(a) Both A and R are true and R is correct explanation of A
(b) Both A and R are true but R is not correct explanation of A
(c) A is true but R is false
(d) Both A and R are false

**37** **Assertion** (A) Greenhouse effect was observed in houses used to grow plants and these are made of green glass.

**Reason** (R) Greenhouse name has been given because glass houses are made of green glass.

**38** **Assertion** (A) Excessive use of chlorinated synthetic pesticides causes soil and water pollution.

**Reason** (R) Chlorination synthesis pesticides are non-biodegradable.

**Direction** (Q. Nos. 39 and 40) *Each of these questions contains two statements : Statement* I *and Statement* II. *Each of these questions also has four alternative choices, only one of which is the correct answer. You have to select one of the codes (a), (b), (c) and (d) given below:*

(a) Statement I is true, Statement II is true; Statement II is the correct explanation for Statement I
(b) Statement I is true, Statement II is true; Statement II is not the correct explanation for Statement I
(c) Statement I is true; Statement II is false
(d) Statement I is false; Statement II is true

**39** **Statement I** Deforestation is one main factor contributing to global warming.

**Statement II** Besides $CO_2$, two other gases methane and CFCs are also included under greenhouse gases.

**40** **Statement I** Photochemical smog is produced by nitrogen oxides.

**Statement II** Vehicular pollution is a major source of nitrogen oxides.

DAY PRACTICE SESSION 2

# PROGRESSIVE QUESTIONS EXERCISE

**1** 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

**2** 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

**3.** Which of the following statements is wrong?

(a) Polar stratospheric clouds (PSCs) are clouds formed over Antarctica
(b) Acid rain dissolves heavy metals such as Cu, Pb, Hg and Al from soil, rocks and sediments
(c) $H_2SO_4$ is major contributor to acid rain, $HNO_3$ ranks second and HCl third in this respect
(d) Fishes grow in warm as well as in cold water

**4** 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 bicycle for travelling small distances instead of using petrol/diesel based vehicles
(d) Using plastic cans for neatly storing substances

**5** Identify the incorrect 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

**6** The ozone layer forms naturally by

(a) the interaction of CFC with oxygen
(b) the interaction of UV radiation with oxygen
(c) the interaction of IR radiation with oxygen
(d) the interaction of oxygen and water vapour

**7** The basic component of smog is

(a) PAN (b) PBN
(c) $NO_2$ (d) All of these

**8** Which of the following statements is false?

(a) The main reason for river water pollution is industrial and domestic sewage discharge
(b) Surface water contains a lot of organic matter, mineral nutrients and radioactive materials
(c) Oil spill in sea water causes heavy damage to fishery
(d) Oil slick in a sea water increases DO value

**9.** 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 agents
(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

**10.** Oxidation of sulphur dioxide into sulphur trioxide in the absence of a catalyst is a slow process but this oxidation occurs easily in the atmosphere. Which substance here catalyse the reaction?

(a) Oxygen
(b) Particulate
(c) UV rays
(d) IR rays

**11.** 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

**12** 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 of rain water when the thunderstorm is not there
(c) uninfluenced by occurrence of thunderstorm
(d) which depends on the amount of dust in air

**13** Which of the following statements about polar stratospheric clouds (PSCs) is not correct?

(a) Type I clouds are formed at about –77°C and contain solid $HNO_3 \cdot 3H_2O$
(b) Type II clouds are formed at about –85°C and contains some ice
(c) A tight whirlpool of wind called polar vortex is formed which surrounds Antarctica
(d) PSCs do not react with chlorine nitrate and HCl

**14** For dry cleaning, in the place of tetrachloroethene, liquefied carbon dioxide with suitable detergent is an alternative solvent. What type of harm to the environment will be prevented by stopping use of tetrachloroethene?

(a) It results in tropospheric pollution
(b) It causes depletion of ozone layer
(c) It causes particulate pollution
(d) Both (a) and (b)

**15** Average ozone concentration in Jakarta, Indonesia have been reported to be 0.015 mg $m^{-3}$ and those in Tokyo, Japan are 20 ppmV. What is the approximate ratio of these two values, when expressed in the same unit?

(a) 1:0.3 (b) 1: 3
(c) 1: 33 (d) 1: 2

# ANSWERS

**SESSION 1**

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **1** (d) | **2** (d) | **3** (c) | **4** (a) | **5** (d) | **6** (b) | **7** (d) | **8** (a) | **9** (d) | **10** (c) |
| **11** (d) | **12** (c) | **13** (d) | **14** (a) | **15** (a) | **16** (c) | **17** (d) | **18** (c) | **19** (d) | **20** (a) |
| **21** (d) | **22** (a) | **23** (d) | **24** (a) | **25** (d) | **26** (b) | **27** (d) | **28** (b) | **29** (b) | **30** (b) |
| **31** (d) | **32** (a) | **33** (a) | **34** (c) | **35** (d) | **36** (d) | **37** (a) | **38** (a) | **39** (b) | **40** (b) |

**SESSION 2**

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **1** (c) | **2** (c) | **3** (d) | **4** (d) | **5** (c) | **6** (b) | **7** (d) | **8** (d) | **9** (b) | **10** (b) |
| **11** (a) | **12** (a) | **13** (d) | **14** (a) | **15** (b) | | | | | |

# Hints and Explanations

## SESSION 1

**1** Environmental pollution affects biotic and abiotic components of environment.

**2** Nitrogen peroxide is not a pollutant.

**3** $NO_2$, $CO_2$ and $SO_3$ are gaseous pollutants.

**4** The lowest layer of earth's atmosphere is troposphere.

**5** Ultraviolet radiations are absorbed by the ozone layer present in stratosphere.

**6** Major pollutant released from steel industry are CO, $CO_2$ and $SO_2$.

**7** $SO_2$ causes eye irritation, damages respiratory tract, produces asthma and bronchitis. It also causes acid rain and destroys building material.

**8** CO is the main pollutant from automobile exhaust.

**9** Carbon monoxide is highly toxic to living being because it has an ability to form more stable carboxyhaemoglobin complex with haemoglobin due to which the delivery of oxygen to the organs and tissues is blocked.

**10** During volcanic eruptions, pollutants like $SO_2$, $H_2S$ and CO are emitted.

**11** The gas leaked from a storage tank of the union carbide plant in Bhopal gas tragedy was methyl isocyanate.

**12** Lead pollution is mainly caused by coal gasoline.

**13** Methane ($CH_4$), carbon dioxide ($CO_2$) CFCs are green house gases.

**14** $NO_2$ and $SO_2$ released during burning of fossil fuels are responsible for acid rain.

**15** London smog is reducing in nature.

**16** The smog is caused by the presence of oxides of sulphur and nitrogen.

**17** Among the given, CFCs are responsible for ozone depletion. It is not a component of photochemical smog.

**18** Persons working in cement plant and limestone quarries are more prone to diseases like silicosis.

**19** Ozone protects life on earth by absorbing UV radiations from sun.

**20** Ozone layer in the stratosphere (light bluish gas) shields the earth from the harmful ultraviolet radiations of the sun.

**21** Chlorofluorocarbons destroy ozone. When CFCs reach the stratosphere, they split and produce reactive free radicals.

**22** UV radiations possess high energy and are harmful to human life. They cause skin cancer, swelling of skin, sunburns, burning sensation on the skin. Undesirable mutation may cause more severe problems.

**23** Ozone hole is maximum over Antarctica.

**24** $\dot{Cl}O + NO_2 \longrightarrow \underset{\text{Chlorine nitrate}}{ClONO_2}$

$ClONO_2 + H_2O \longrightarrow HOCl + HNO_3$

$HOCl \xrightarrow{h\nu} \dot{O}H + \dot{Cl}$

The HOCl so formed can get converted into chlorine radicals thus, facilitating ozone depletion.

**25** Ozone layer is depleted by oxides of nitrogen and by freons (chlorofluorocarbons). It absorbs harmful UV radiations coming from the sun but it does not absorb infrared radiations.

**26** Eutrophication means high concentration of phosphates and nitrates from fertilizers and detergents in aquatic ecosystem.

**27** Freons do not cause water pollution, they are responsible for air pollution.

**28** As sewage decreases the concentration of dissolved oxygen (concentration) in water and hence fish die in water bodies.

**29** To determine BOD (Biochemical Oxygen Demand), water sample is first saturated with oxygen and then it is incubated at constant temperature (20°C) for 5 days.

**30** Mottling of teeth is due to the presence of fluorine in drinking water.

**31** Chlorine kills germs present in water.

**32** Organic matter in sewage water is decomposed by microorganism.

**33** A → 4, B → 3, C → 1, D → 2

**34** DDT is a pesticide. It is a non-biodegradable substance which causes soil pollution.

**35** DDT is a non-degradable pollutant which causes soil pollution.

**36** Green chemistry involves uses of non toxic reagent and solvents to produce environment friendly products.

**37** In cold countries, sunlight required to grow plants is less. Hence, plants are kept in a house made of glass, placed in such a manner, so that sunlight enters the greenhouse, heat up the soil and plants.

**38** Insecticides, pesticides and herbicides cause soil and water pollution.They are non-biodegradable.

**39** If $CO_2$ concentration increases in the atmosphere, the $CO_2$ layer also becomes thick. This prevents the heat from being re-radiated back into the outer space. This results in heating up of the earth's surface. $CO_2$ contributes 57% part in greenhouse effect. Besides it, CFCs 15%, methane 12%, nitrogen oxides 6% and 5% of water contribute to greenhouse effect.

**40** It is correct that photochemical smog is produced by oxides of nitrogen and it is also a fact that vehicular pollution is a major source of nitrogen oxides but it is not the correct explanation.

## SESSION 2

**1** Peroxyacetyl nitrate (PAN) is known as secondary pollutant.

**2** Fishes in polluted water die because of the decrease in the amount of dissolved oxygen in water.

**3** Fishes do not grow in warm as well as in cold water because warm water contains less amount of dissolved oxygen.

**4** Using plastic cans for neatly storing substances will not come under green chemistry. Water in lakes and rivers have been polluted by the use of plastic materials. The plastic materials are non-biodegradable.

**5** Ozone layer permits the infrared radiation to pass through it but does not permit the higher range ultraviolet radiation to pass.

**6** The ozone layer forms naturally by the interaction of UV radiation with oxygen.

$$O_2 \xrightarrow{\text{UV rays}} O + O$$

$$O_2 + O \longrightarrow \underset{\text{Ozone}}{O_3}$$

**7** The basic component of smog is $NO_2$ which interact with light and ozone to form PAN and PBN.

Formation of smog can be represented as follows:

$$NO_2 \xrightarrow{h\nu} NO + O$$

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

$$RCO_3^{\bullet} + NO_2 \longrightarrow RCO_3NO_2$$

If $R = CH_3$, it is called PAN.

If $R = C_6H_5$, it is called PBN.

**8** Oil slick causes water pollution, thus it decreases DO value (dissolved oxygen value) of sea water.

**9** Photochemical smog has high concentration of oxidising agents and it can be controlled by controlling the release of $NO_2$, hydrocarbons, ozone ($O_3$) etc. Plantation of some plants like pinus helps in controlling photochemical smog.

**10** The presence of particulate matter in polluted air catalyses the oxidation of $SO_2$ to $SO_3$.

$$2SO_2 + O_2 \xrightarrow{\text{Particulates}} 2SO_3$$

**11** Negative soil pollution is the reduction in soil productivity due to erosion and over use.

**12** During thunderstorm there is formation of NO which changes to $NO_2$ and ultimately to $HNO_3$ (acid-rain).

$$N_2 + O_2 \longrightarrow NO \xrightarrow{O_2} NO_2$$

$$\longrightarrow N_2O_5 \xrightarrow{H_2O} HNO_3 \ (pH < 7)$$

**13** PSCs (Polar Stratospheric Clouds) of type II provide a surface for the conversion of chlorine nitrate ($ClONO_2$) and HCl into HOCl and $Cl_2$.

$$ClONO_2 + H_2O \xrightarrow{PSCs} HOCl + HNO_3$$

$$ClONO_2 + HCl \longrightarrow Cl_2 + HNO_3$$

**14** Tetrachloroethene, $Cl_2C = CCl_2$ is suspected to be carcinogenic and also contaminates the ground water. This harmful effect will be prevented using liquefied $CO_2$ along with suitable detergent.

Use of liquefied $CO_2$ along with detergent will not be completely safe because most of the detergents are non-biodegradable and they cause water pollution. Moreover, liquefied $CO_2$ will ultimately enter into the atmosphere and contribute to the green house effect.

**15** Ozone concentration in Jakarta, Indonesia

$= 0.015 \text{ mg m}^{-3}$

$= 0.015 \text{ mg L}^{-1}$

Ozone concentration in Tokyo, Japan is 20 ppmV (i.e. by volume). This means that there are 20 μmol of ozone for every 1.0 mol of the components of air.

∴22.4 L (1 mol) mixture of gases contains = 20 μmol of ozone

1 L mixture of gases will contain

$$= \frac{20 \times 10^{-6}}{22.4} \text{ mol of ozone}$$

$= 0.892 \times 10^{-6}$ mol

$= 0.892 \times 10^{-6} \times 48$ g ozone

$= 42.82 \times 10^{-3}$ mg ozone

$= 0.043 \text{ mg L}^{-1}$ ozone

Hence,

$$\frac{\text{concentration of ozone in Jakarta}}{\text{concentration of ozone in Tokyo}}$$

$$= \frac{0.015}{0.043} = \frac{1}{3}$$