

Environmental Chemistry

COMPONENTS OF ENVIRONMENT

- 1. Atmosphere: It is a protective blanket of gases which is surrounding the earth.
 - (i) Composition: The constituents which make up the atmosphere are gases, water vapours and aerosols. The major gases in the air are nitrogen and oxygen. Pure dry air, on an average, constitutes 78% nitrogen and 21% oxygen by volume. Remaining 1% accounts for other gases.
 Major components: N₂, O₂, water vapours
 Minor components: Ar, CO₂
 - Tracer components: He, Ne, Kr, Xe, CH₄, H₂, CO, N₂O, NO, NO₂, SO₂, NH₃, O₃ HCHO, etc.
 - (ii) Structure or Regions of the atmosphere: The atmosphere is divided into four major regions depending on the height as shown below:

Region	Region Height range (km)		Main constituents		
Troposphere	0–11	15 to -56	O ₂ , N ₂ , H ₂ O, CO ₂		
Stratosphere	11–50	−56 to −2	O ₃		
Mesosphere	50–90	-2 to -92	O ₂ ⁺ , NO ⁺		
Thermosphere	90–500	-92 to 1200	O ₂ ⁺ , O ⁺ , NO ⁺ , N ⁺		

- **2. Hydrosphere:** The total water present on the earth in solid, liquid and gaseous phases constitutes the hydrosphere, Water covers 71% of the total surface of the earth. Earth is sometimes called a water planet.
- **3.** Lithosphere: It is the solid component of the earth consisting of soil, rocks, mountains, etc. It is the region which interacts with hydrosphere, atmosphere and biosphere. The earth comprises of three layers, viz., crust, mantle and outer and inner core.
- **4. Biosphere:** It refers to that part of the earth in which all life forms exist. Biosphere represents an interface between the non-living and the living organisms.

TYPE OF POLLUTANTS

The agents causing pollution are termed as pollutants.

Classification

(A) On the basis of their occurrence

- (i) **Primary pollutants** These are present in the same form in which they are produced, e.g., carbon monoxide, DDT.
- (ii) Secondary pollutants These are formed by reaction between the primary pollutants in the presence of sunlight e.g., PAN, Ozone, HNO₃ H₂SO₄, etc.

Nitrogen oxides and hydrocarbons react photochemically to produce peroxyacetyl nitrates (PAN) and ozone. The secondary pollutants may be more toxic than the primary once. The phenomenon is called **synergism**.

(B) On the basis of their degradation

- (i) **Biodegradable Pollutants** Pollutants which are decomposed or degraded by biological or microbial action are called biodegradable pollutants e.g. domestic sewage.
- (ii) Non-biodegradable Pollutants Pollutants which are not decomposed or degraded by living organisms or microorganisms are called non-biodegradable pollutants, e.g., DDT, glass, plastics, aluminium cans, phenolic compounds, pesticides, radioactive substance, heavy metals like mercury, lead, cadmium etc.

(C) On the basis of their existence in nature

- (i) Quantitative pollutants These are naturally present in nature and are also added by man. These become pollutants only when their concentration reaches beyond a threshold value in the environment, e.g., CO_2 .
- (ii) **Qualitative pollutants** These are not present in the nature but are added in nature only due to human activities, e.g., insecticides, fungicides, herbicides, etc.

Kinds of Polution

On the basis of environmental study pollution is of following types.

- (1) Air pollution
- (2) Water pollution
- (3) Soil pollution
- (4) Noise pollution
- (5) Radioactive pollution

(1) AIR POLUTION

- Air pollution is mainly caused by industries and automobiles.
- Automobiles are the greatest polluters of the atmosphere and are responsible for 75% of noise pollution and about 60–80% of air pollution of big cities.
- Combustion of fossil fuels (coal, oil, gas, etc.) releases CO, CO₂, nitrogen oxides, fluorides, hydrocarbons, etc., into atmosphere usually in the form of smoke causing air pollution.
- Particulate matters released by mills, factories and mines also cause air pollution.
- Some of the natural air pollutants are pollen grains, spores, volcanoes, etc.

Major Air Pollutants:

(1) Carbon monoxide (CO)

- Carbon monoxide is formed by incomplete combustion of fuels in various industries, automobiles, etc.
- CO accounts for about 50% of total air pollution.
- CO combines with haemoglobin producing **carboxyhaemoglobin** and therefore decreases oxygen carrying capacity leading to hypoxia, headache, decreased vision, muscular weakness, nausea, exhaustion, etc.
- When 50% of haemoglobin has been transformed into carboxyhaemoglobin, then death occurs due to CO-poisoning leading to anoxia (oxygen starvation).

(2) Carbon dioxide (CO₂)

- Carbon dioxide is a greenhouse gas.
- It is produced due to combustion of fuels, volcanic eruptions and during the process of respiration.
- Its average concentration in the atmosphere is 300 ppm (0.03%).
- It is normally not an atmospheric pollutants, but under very high concentration it may act as a pollutant.
- It causes Global warming.

(3) Sulphur dioxide (SO₂)

- Sulphur dioxide is produced during combustion of fossil fuels (mainly coal) and smelting of sulphur containing ores.
- It causes acid rain (gaseous SO₂ oxidises to SO₃, which on combination with water forms H₂SO₄).
- Acid rain is 60-70% due to SO₂ and SO₃, and 30-40% due to NO₂ and NO₃.

- Due to acid rain leaves of trees develop chlorotic and necrotic spots.
- SO_2 corrodes stones, metals, leather, paper and fabrics. There is fading of colour and deterioration of lustre of fabrics, stones and painted surfaces.
- In plants and animals, SO₂ destroys all membrane systems.
- In human beings SO₂ increase the chances of occurrence of asthma.

(4) Hydrocarbons

- Hydrocarbons are produced naturally (e.g., natural discharge of marsh gas, CH₄) and by burning of petroleum.
- Benzene (C₆H₆) is a major constituent of petrol and automobile exhaust.
- Hydrocarbons are carcinogenic, cause irritation of eyes and mucous membrane.
- Benzene is a known leukaemia-causing carcinogen.
- Ethylene (C₂H₄) causes premature senescence and abscission in many plants especially in orchids and cotton.
- Methane (marsh gas) has the potential of destroy ozone.

(5) Nitrogen oxides

- There are three oxides of nitrogen which act as air pollutants: nitric oxide (NO), nitrogen dioxide (NO₂) and nitrogen trioxide.
- NO is less toxic but NO₂ is a poisonous gas.
- Nitrogen oxides are responsible for forming photochemical smog.
- They also cause acid rain due to formation of HNO₃.
- They produce lesions, necrosis, defoliation, dieback and death of many plants.
- Like SO₂, they corrode metals and deteriorate paints, textiles as well as various articles.
- They cause eye irritation, dilation of arteries, and injury of lungs, liver and kidneys.

(6) Fluorides

- · Fluorides are emitted during refinement of aluminium and rock phosphates.
- Fluorides cause necrosis and chlorosis of leaf tips and leaf margins.
- In human, fluorides cause mottling of teeth, weak bones, boat-shaped posture, knocking knees etc.
- Disease caused by fluoride is known as fluorosis.

(7) Particulate matter

- Particulate matter is the non-gaseous matter in the atmosphere.
- It consists of soot, dust, mist, fibres, fly ash, fur, spores pollen grains, etc.
- It is of two types: settleable (larger than 10 μ m) and suspended (less than 10 μ m).
- SPM (suspended particulate matter) is classified into 3 categories-
 - (a) Aerosols (less than $1 \ \mu m$)
 - (b) Dust (solid particles with more than $1 \ \mu m$ diameter)
 - (c) Mist (liquid particles with more than 1 μ m diameter)
- Particulate matter is added in the atmosphere by burning of fuels.
- Particulate matter causes about 10-15% of air pollution

(8) Aerosols

- · Aerosols are chemicals released in the air with force in the form of mist or vapour by jet planes.
- Aerosols contain **CFC** (**chlorofluoro-carbons**) which destroys ozone layer in the stratosphere, thereby allowing U.V. radiations that cause skin cancer and increase mutation rates, to reach the earth.
- Ozone acts as preventive shield against the U.V. rays.
- Freons are several CFMS (chlorofluoromethanes) released into troposphere where they dissociate and release free chlorine that causes depletion of ozone.
- Freon or CFC is also used in refrigerator, air conditioners and in making plastic foams.
- Effect of air pollutants: Air pollutants are involved in causing four major environmental effects:

(i) Smog, (ii) Acid rain, (iii) Global warming, and (iv) Ozone layer depletion.

(i) SMOG

- The term smog was coined by Des Voeux.
- Smog is produced by the combination of smoke and fog.
- It causes silvering/glazing and necrosis in plants, allergies and asthma/bronchitis in human.
- Smog is of two types:

(a) Classical smog:

- Classical smog is also called London smog or sulphurous acid smog.
- It occurs at low temperature.
- This smog is produced from gases like SO₂, H₂S, smoke, dust and particles particulates at high humidity.
- It produces irritation in eyes, nose and throat.

(b) Photochemical smog:

- Photochemical smog is also called Los Angeles smog.
- It occurs at high temperature.
- This type of smog is formed by combination of particulates (smoke, dust, fog) with oxides of nitrogen and hydrocarbons in presence of sunlight to produce ozone (O₃) and PAN (peroxy acetyl nitrate).
- It is highly harmful to human beings, animals and plants.

(ii) ACID RAIN

• Both SO₂ and NO₂ are converted to acids (H_2SO_4 and HNO_3 , respectively), when the gases combine with water vapour in the presence of O₂ in the atmosphere. These acids return to the earth as acid rain.

- Pure rain has a pH of about 5.6 while the acid rain has pH below 5.6.
- Ph of drinking water lies between 5.5 and 9.5.
- Acid rain is actually a mixture of H₂SO₄ and HNO₃ (usually 60-70% H₂SO₄ and 30-40% HNO₃)

(iii) GREEN HOUSE EFFECT AND GLOBAL WARMING:

- Gases like CO₂, CH₄, CFCs, NO₂ are strong absorbers of long-wave or infra-red radiation emitted by the surface of the earth, and warm the earth's atmosphere. This is called the **Greenhouse effect** because it is like the glass panel of a greenhouse that allows sunlight to pass through and then traps the resulting heat inside the structure.
- CO₂ is the principal greenhouse gas responsible for warming of the earth.

(iv) OZONE LAYER DEPLETION:

- The ozone layer present in the stratosphere acts as an ultraviolet absorbent thus protecting the earth form its harmful effect.
- The ozone layer depletion is caused by chlorine atoms. These chlorine atoms come from the breakdown of CFCs. These atoms combine with ozone and remove the oxygen atoms one by one.

$$CF_2Cl_2 \xrightarrow{hv} CF_2Cl + Cl$$

$$CFCl_3 \xrightarrow{hv} CFCl_2 + Cl$$

$$Cl + O_3 \longrightarrow ClO + O_2$$

$$ClO + O \longrightarrow Cl + O_2$$

Net reaction $O_3 + O \xrightarrow{Cl} 2O_2$

• One atom of chlorine can destroy upto 100,000 molecules of ozone.

(2) WATER POLLUTION:

- Water pollution is caused by the addition of some substances or factors (i.e., heat).
- It degrades the quality of water so that it either becomes health hazard or unfit for use.

Kind of water pollution:

- (a) **Physical pollution:** It involves the changes in the physical properties of water, e.g., colour, taste, odour, temperature, turbidity, etc.
- (b) Chemical pollution: It is caused due to change in the chemical properties of water. They mainly include the pH, dissolved O₂, inorganic or organic chemicals, heavy metals, etc.
 Inorganic shamicals include fluerides, phoenheates and nitrates. Organic shamicals include phoenels, dues

Inorganic chemicals include fluorides, chlorides, phosphates and nitrates. Organic chemicals include phenols, dyes, pesticides and chlorocompouds.

(c) Biological pollution: It is caused due to the presence of living organisms in water such as algae, fungi, bacteria, viruses, protozoans, insects, etc.

Sources of water pollution and effects of water pollutants: The principal sources of water pollution and effects of water pollutants are as follows.

Domestic wastes and sewage:

- Sewage containing human faeces, urine, kitchen and cloth washings, organic waste, industrial waste, etc. is usually poured into water bodies, which cause water pollution.
- Decomposers/microorganisms causing decomposition of sewage take up most of the oxygen present dissolved in water. So in this water BOD (Biological oxygen demand or Biochemical oxygen demand) increased very much.
- BOD of clean water is less than 5 ppm.
- A weak organic waste will have BOD below 1500 mg/L, medium organic waste between 1500-4000 mg/L while in strong waste above 4000 mg/L.
- The degree of pollution is directly proportional to BOD.

Industrial effluents (or industrial discharges): Industries usually discharge waste water into ponds, lakes and rivers. Industrial waste water contains heavy metals (mercury, lead, copper, arsenic and cadmium), inorganic pollutants (acids, alkalies and bleaching liquors), organic pollutants (phenol, naphtha, proteins, aromatic compound, cellulose fibres, etc.) industrial effluents are the most hazardous pollutants on land and water.

(A) Mercury (Hg):

- Mercury is released during combustion of coal, smelting of metallic ores, paper and paint industries.
- Mercury is highly persistent. In water it gets changed into water soluble dimethyl form [(CH₃)₂]Hg and enters the food chain (undergoes biomagnification).
- It kills fish and poisons the remaining fauna. Human beings feeding on such poisoned animals develop a crippling deformity called minamata disease which is characterized by impairment of various senses, diarrhoes, haemolysis, meningitis and death.

(B) Lead (Pb):

- The sources of lead pollution are smelters, battery industry, paint, chemical and pesticide industry, automobiles exhausts, etc.
- Lead is pollutant of air, soil and water.
- It is used as anti-knock reagent in petrol and released by automobile exhausts.
- Lead is persistant pollutant and may show biological amplification or biomagnification.
- It is a mutagenic and causes anaemia, headache, vomiting, colic, loss of muscle power, bluish lines around the gumes, loss of appetite and damage of liver, kidney and brain.

(C) Cadminum (Cd):

- Cadmium is added to the environment by metal industries, welding and electroplating, pesticides, and phosphate industries.
- Cd shows biological amplification and accumulates inside kidneys, liver, pancreas and spleen.
- It causes hypertension, anaemia, diarrhoea and damages liver and kidneys.

(3) SOIL POLUTION:

- Unfavourable alteration of soil by addition or removal of substances and factors which decrease soil productivity, quality of plant products and ground water is called soil pollution.
- Soil pollutants include pesticides, fertilizers, industrial wastes, salts, radio-nuclides, tin, iron, lead, copper, mercury, aluminium, plastics, paper, glass, broken bottles, discarded food, etc.
- Soil pollution is of two main types.

(1) Negative soil pollution:

- Negative soil pollution includes overuse of soil and erosion.
- Soil erosion is caused by water and wind.
- Water erosion of soil is found near the hills where high speed flooding removes top soil.
- Soil erosion also occurs by high speed winds which bring sand particles from dry desert.

(2) Positive soil pollution:

- Positive soil pollution is caused by addition of undesirable substance (e.g., pesticides, fertilizers, industrial waste, air pollutant washed down from atmosphere through rain)
- Dichloro diphenyl trichloroethane (DDT), benzene hexachloride (BHC) or gamaxine, aldrin, dieldrin, endrin, hep-tachlor, etc., are chlorinated hydrocarbons used as pesticides.

(4) NOISE POLLUTION:

- Various kinds of undesirable loud sounds, which disturb our environment are called noise pollutants.
- Noise pollution is produced by loud sounds of various machines, loudly played radio, automobiles, thundering of jet planes, loud speakers, etc.
- Green plants are being planted along the road sides to check the noise pollution. This is called as Green muffler.
- Noise may damage ear drum and eye sight.

(5) RADIOACTIVE POLLUTION:

- Radioactive pollution is a special type of physical pollution of air, water and soil with radioactive materials.
- Nuclear explosion results into production of radioactive substances as Sr^{90} , U^{235} . I^{131} , and cause pollution of air, water and soil.

BHOPAL GAS TRAGEDY

The tragedy in Bhopal occurred on 2nd December 1984, when a poisonous gas **methyl isocynate** (**MIC**) leaked in the atmosphere from a fertilizer plant of Union Carbide company. MIC was used to manufacture an insecticide marked in the name of SAVIN. The gas caused death of about 2500 persons. December 2 is recalled as National Pollution Prevention Day.

SOLVED EXAMPLE

- 1. Which of the following is a primary pollutant?
 - (1) PAN (2) CO
 - (3) Aldehydes (4) H_2SO_4
- Sol. [2]
 - CO is a primary pollutant.
 - **2.** Choose the biodegradable pollutant out of the following.
 - (1) DDT
 - (2) Cow dung
 - (3) Alkyl benzene sulphonate
 - (4) Mercury
- Sol. [2]

Cow dung is a biodegradable pollutant.

- 3. Identify the incorrect statement from the following.
 - (1) Oxides of nitrogen in the atmosphere can cause the depletion of ozone layer
 - (2) Ozone absorbs infrared radiation
 - (3) Depletion of ozone layer is because of its chemical reactions with chlorofluoroalkanes
 - (4) Ozone absorbs the intense ultraviolet radiation of the sunlight
- Sol. [2]

Ozone absorbs the intense ultraviolet radiation of the sunlight not infrared radiation.

- 4. Phosphate pollution is caused by
 - (1) Sewage and agricultural fertilizers

- (2) Agricultural fertilizers only
- (3) Phosphate rocks and sewage
- (4) Weathering of phosphate rocks only
- Sol. [1]

Phosphate pollution is caused by sewage and agricultural fertilizers.

- **5.** Lead is considered as:
 - (1) Water pollutant
 - (3) Air pollutant
- (2) Soil pollutant
- (4) Radioactive pollutant

Sol. [3]

EXERCISE 1

- Lead is an air pollutant.
- **1.** Which of the following chemical, harmful to ozone,
 - it released by chlorofluorocarbon?
 - (1) Sulphur dioxide (2) Chlorine
 - (3) Fluorine (4) Nitrogen dioxide
- 2. Pick up the correct statement:
 - (1) Classical smog is good for health but not photochemical smog
 - (2) During formation of smog ozone level in atmosphere decreases
 - (3) Classical smog has an oxidizing character while photochemical smog is reducing in character
 - (4) Photochemical smog occurs in day time whereas the classical smog occurs in early morning
- **3.** Which one of the following dissolves more rapidly in haemoglobin than oxygen?
 - (1) Ozone (2) SO_2
 - (3) N₂O (4) CO
- 4. The type of pollution caused by spraying of DDT
 - (1) Air, water, and soil (2) Air and water
 - (3) Air (4) Air and soil
- 5. Water pollution is caused by
 - (1) Aeroplanes (2) Fly ash
 - (3) Auto exhaust (4) Pesticides
- 6. The greenhouse effect is caused by
 - (1) CO (2) NO₂
 - (3) NO (4) CO₂
- 7. The substance having the largest concentration in acid rain?

(1)	H_2CO_3	(2)	HNO_3

- (3) HCl (4) H_2SO_4
- **8.** Which of the following is not a consequence of greenhouse effect?
 - (1) Climatic conditions will be changed
 - (2) Plants in warmer climates with adequate rainfall would grow faster
 - (3) The incidence of infectious diseases is likely to increase

- (4) Malaria will be controlled as the mosquitoes will not survive
- **9.** Presence of which fuel gas in exhaust fumes shows incomplete combustion of fuel?
 - (1) Sulphur dioxide
 - (2) Carbon monoxide and water vapour
 - (3) Carbon monoxide
 - (4) Nitrogen dioxide
- **10.** Formation of ozone in the upper atmosphere from oxygen takes place by the action of
 - (1) Nitrogen oxides (2) Ultraviolet rays
 - (3) Cosmic rays (4) Free radicals
- **11.** The chemical entities present in thermosphere of the atmosphere are
 - (1) O^{+2} , O^{+} , NO^{+} (2) O_{3}
 - (3) N_2 , O_2 , CO_2 , H_2O (4) O3, O_2^+ , O_2
- 12. What is not correct about greenhouse effect?
 - (1) It results in global warming.
 - (2) CO₂ is one of the main chemical species responsible for it.
 - (3) It results in lowering of levels of ocean over the years.
 - (4) CH_4 , O_3 , CFC also contribute to greenhouse effect.
- **13.** Which of the following belongs to secondary air pollutant?
 - (1) CO (2) Hydrocarbon
 - (3) Peroxyacetyl Nitrate (4) None of these
- **14.** Which of the following is not considered to be a pollutant?

(4) SO₃

(1) NO_2 (2) CO_2

(3) O_3

- 15. Environmental pollution affects:
 - (1) biotic components
 - (2) human beings only
 - (3) plants only
 - (4) biotic and abiotic components of environment

EXERCISE 2

- **1.** Persistent pesticides such as DDT pass into food chain and increase in amount per unit weight of organism due to their accumulation in fat. This phenomenon is called
 - (1) biomagnification (2) biodegradation
 - (4) decomposition
- (3) biosynthesis**2.** Negative soil pollutant is
 - (1) converting fertile land into barren land by dumping ash, sludge, and garbage
 - (2) reduction in soil productivity due to addition of pesticides and industrial wastes
 - (3) reduction in soil productivity due to erosion and over use
 - (4) None of the above
- **3.** Which of the following is the coldest region of atmosphere?
 - (1) Thermosphere (2) Troposphere
 - (3) Mesosphere (4) Stratosphere
- 4. The biggest particulate matter is
 - (1) HNO_3 droplets (2) Fly ash
 - (3) H_2SO_4 droplets (4) Soot
- **5.** Which causes death of fish in water bodies polluted by sewage?
 - (1) Decreases in DO
 - (2) Pathogens
 - (3) Clogging of gills by silt
 - (4) Foul smell
- **6.** Ozone is an important constituent of stratosphere because it
 - (1) destroys bacteria which are harmful to human life
 - (2) prevents the formation of smog over large cities
 - (3) absorbs ultraviolet radiation which is harmful to human life
 - (4) removes poisonous gases of the atmosphere by reacting with them
- 7. Which of the following statements about polar stratosphere clouds (PSCs) is not correct?
 - (1) PSCs do not react with chlorine nitrate and HCl
 - (2) Type I clouds are formed at about -77°C and contain solid HNO₃.3H₂O
 - (3) Type II clouds are formed at about 85°C and contain some ice
 - (4) A tight whirlpool of wind called polar vortex is formed which surrounds Antarctica

- **8.** Fluorosis, the bone disease, is caused by the presence of:
 - (1) pesticides in water
 - (2) fluorides in water
 - (3) carbon monoxide in air
 - (4) sulphur dioxide in air
- **9.** The point of temperature inversion between troposphere and ionosphere is called
 - (1) stratopause (2) mesopause
 - (3) ionopause (4) tropopause
- 10. Identify the wrong statement in the following.
 - (1) Chlorofluorocarbons are responsible for ozone layer depletion.
 - (2) Greenhouse effect is responsible for global warming.
 - (3) Ozone layer does not permit infrared radiation from the sun to reach the earth.
 - (4) Acid rain is mostly because of oxides of nitrogen and sulphur.
- **11.** Ozone layer of stratosphere required protection from indiscriminate use of
 - (1) balloons (2) pesticides
 - (3) aerosols and high flying jets
 - (4) atomic explosions
- **12.** Particulate air pollutants are finely divided solids and liquids. Which of the following is not a particulate?
 - (1) Dust and mists
 - (2) Smoke and fumes
 - (3) Photochemical smog and soot
 - (4) None of the above
- **13.** Which of the following statement about photochemical smog is not correct?
 - (1) Carbon monoxide does not play any role in photochemical smog formation
 - (2) Photochemical smog is an oxidizing agent in character
 - (3) Photochemical smog is formed through photochemical reactions involving solar energy
 - (4) Photochemical smog does not cause irritation in eyes and throat
- 14. Ozone in the stratosphere is depleted by:
 - (1) CF_2Cl_2 (2) C_9F_{16}
 - (3) $C_6H_6Cl_6$ (4) C_6F_6
- **15.** Which forms the part of hazy fumes of photochemical smog?
 - (1) SO₂ (2) Aldehydes
 - (3) PAN formation (4) Nitrogen dioxide

EXERCISE 3

One and More Than One Option Correct Type Question

- Which is correct statement for classical smog?
 (1) It occurs in cool humid climate
 - (2) It is a mixture of smoke, fog and sulphur dioxide
 - (3) It is called reducing smog
 - (4) It is called oxidising smog
- **2.** Which of the following statements is True (T) and which one is False (F)? Mark them and select the answer from the codes given below.
 - (I) Ozone is not responsible for greenhouse effect.
 - (II) Ozone can oxidize SO_2 present in the atmosphere to SO_3 .
 - (III) Ozone hole is thinning of ozone layer present in stratosphere.
 - (IV) Ozone is produced in the upper stratosphere by the action of UV-rays on oxygen.

Code

	Ι	II	III	IV
(1)	F	Т	Т	Т
(2)	Т	F	Т	F
(3)	F	F	Т	Т

- (4) T T F F
- **3.** Select the correct statement(s) about stratosphere.
 - (1) Temperature increase slowly from 220 to 270 K.
 - (2) Supersonic aircrafts fly in the lower region of the stratosphere.
 - (3) Both (a) and (b) are correct.
 - (4) None of the two are correct.
- **4.** The gases which are responsible for photochemical smog are:
 - (1) oxides of nitrogen (2) hydrocarbons
 - (3) carbon monoxide (4) inert gases
- **5.** If the greenhouse effect or global warming remains unchecked, it alters:
 - (1) sea levels (2) ozone layer
 - (3) rainfall (4) temperature
- 6. The following reactions occur in the stratosphere:

(1) $O_2 + UV \rightarrow O + O$

(2) $O_2 + O \rightarrow O_3$

- (3) $Cl + O_3 \rightarrow ClO + O_2$
- (4) $SO_3 + H_2O \rightarrow H_2SO_4$

Assertion and Reason Type Question

- (1) If both Statement-I and Statement-II are correct and Statement-II is the correct explanation for Statement-I
- (2) If both Statement-I and Statement-II are correct and Statement-II is not the correct explanation for Statement-I
- (3) If Statement-I is correct and Statement-II is incorrect
- (4) If Statement-I is incorrect and Statement-II is correct
- **7. Assertion:** Photochemical smog is produced by nitrogen oxides

Reason: Vehicular pollution is a major source of nitrogen oxides:

8. Assertion: Rain water is slightly acidic.

Reason: Water dissolves atmospheric CO_2 forming H_2CO_3 .

 $H_2O + CO_2 \Longrightarrow H_2CO_3$

- 9. Assertion: IF BOD level of water in a reservoir is less than 5 ppm, it is highly polluted.
 Reason: High biological oxygen demand means low activity of bacteria in water
- **10. Assertion:** PAN is main constituent of photochemical smog.

Reason: It is formed by the action of oxides of nitrogen and hydrocarbons in presence of sunlight.

- Assertion: CO is a toxic air pollutant.
 Reason: CO binds with haemoglobin of blood and reduces oxygen transport efficiency of blood.
- **12. Assertion:** For greenhouse effect, presence of green plants is essential.

Reason: Greenhouse effect is responsible for global warming.

13. Assertion: Photochemical smog is produced by oxides of nitrogen.

Reason: Automobiles are a major source of oxides of nitrogen.

Column Matching Type Question

14. Match List-I with List-II and select the correct answer using the codes given below the lists:

	Lis	t-I (Po	List-II (Source)						
	(A)	Micro	organisms		(1)	Chen	nical fertiliz	ers	
	(B)	Plant	nutrients		(2)	Aban mine	idoned coal s		
	(C)	Sedim		(3)	Dom	estic sewage	•		
	(D)	Miner		(4)	Erosi	on of soil b	y		
					strip mining				
					(5)	Deter	rgents		
		Α	В	С		D			
	(1)	1	3	2		4			
	(2)	2	5	3		1			
	(3)	3	1	4		2			
	(4)	4	2	1		5			
15.	Col	umn-I					Column-II		
	(A)	CO		(p) Gr	reenho	ouse effect		
	(B)	CO_2		(q) M	ost ab	undant		
				hydrocarbon pollutant					
	(C)	SO_2		(r) Chlorosis					
	(D)	CH_4		(s) De	ecrease	es oxygen		
					ca	rrying	ability of b	lood	
		Α	В	С		D			
	(1)	S	р	r	ľ	o, q			
	(2)	р	S	r	I	o, r			
	(3)	r	S	r	Ç	l, p			
	(4)	p, s	q	S		r			
16.	Col	umn-I				Colu	mn-II		
	(A)	Classi	cal smog		(p)	Oxid	es of nitrog	en	
	(B)	Volcar	nic eruptio	ons	(q)	Oxid	es of sulphu	ır	
	(C)	Acid	rain		(r)	Oxid	ising nature		
	(D)	Photo	smog	(s)	Redu	cing nature			
		Α	В	С		D			
	(1)	S	q	p, q	I	o, r			
	(2)	S	q, r	p, q		р			
	(3)	q	S	p, q	P), r,			
	(4)	S	q	р		r			
17	Ma	tch the	different	regio	me	of the	atmosphar	o in	

17. Match the different regions of the atmosphere in Column-I with their temperature range in Column-II and select answer from the codes given below.

	Column-I		Column-II
(A)	Stratosphere	(p)	180–1500 K
(2)	Mesosphere	(q)	220–270 K
(3)	Thermosphere	(r)	270–180 K
	(ionosphere)		
(4)	Troposphere	(s)	290–220 K

Code

	Α	В	С	D
(1)	q	r	р	s
(2)	р	q	S	r
(3)	r	р	S	q
(4)	S	р	q	r

18. Match the terms in Column-I with the compounds in Column-II and select answer from the answer codes given below

Column-I				Column-II				
	(A)	Acid ra	ain		(p)	CHO	Cl_2 – CHF_2	
	(B)	Photoc	hemica	l smog	(q)	CO		
	(C)	Combin haemog	nation v globin	with	(r)	CO ₂	2	
	(D)	Depleti laver	ozone	(s)	SO ₂			
	(E)	Global warming			(t)	Uns hydi	aturated rocarbon	
Code				5				
		Α	B	С		D	Ε	
	(1)	р	q	r		S	t	
	(2)	S	р	r		q	t	
	(3)	р	r	S		t	q	
	(4)	S	t	q		р	r	
19.	Mat	tch the	Columr	n-I with	Col	umn-	·II:	
Column-I					Col	umn-II		
	(A)	A) Greenhouse effect				Primary pollutant		
	(B) Smoke			(q)	Part	iculate		
	(C)) Nitric oxide			(r)	Global warming		
	(D)	PAN			(s)	Pho	tochemical	
						oxic	lant	
	Coc	le						
		Α	В	С		D		
	(1)	q	р	S		r		
	(2)	r	q	р		S		
	(3)	q	r	р		S		
	(4)	r	q	S		р		
20.	Mat	tch the	Columr	n-I with	Col	umn-	·II:	
		Colum	n-I			Col	umn-II	
	(A)	Fluoros	sis		(p)	Non	-biodegradable	
	(B)	Noise			(q)	Bon	e disease	
	(C)	Plastic			(r)	Phy	sical pollutant	
	(D)	Ozone	depleti	on	(s)	Chlo	orofluorocarbons	
	Cod	le	-					
	200	Α	В	С		D		
	(1)	r	р	q		s		
	(2)	р	q	r		s		
	(3)	q	r	р		s		

q

р

(4)

r

р

q

S

EXERCISE 4

1. When rain is accompanied by a thunderstorm, the collected rain water will have a pH value

[JEE Main-2003]

- (1) Slightly lower than that of rain water without thunderstorm
- (2) Slightly higher than that when the thunderstorm is not there
- (3) uninfluenced by the occurrence of thunderstorm
- (4) Which depends on the amount of dust in air
- 2. The smog is essentially caused by the presence of

[JEE Main-2004]

- (1) O_2 and O_3
- (2) O_2 and N_2
- (3) oxides of sulphur and nitrogen
- (4) O_3 and N_2
- 3. Identify the wrong statements in the following.

[JEE Main-2008]

- (1) Chlorofluorocarbons are responsible for ozone layer depletion.
- (2) Greenhouse effect is responsible for global warming.
- (3) Ozone layer does not permit infrared radiations from the sun to reach the earth.
- (4) Acid rain mostly occurs because of oxides of nitrogen and sulphur.
- 4. Identify the incorrect statement from the following. [JEE Main-2011]
 - (1) Oxides of nitrogen in the atmosphere can cause the depletion of ozone layer.
 - (2) Ozone absorbs the intense ultraviolet radiations of the sun.
 - (3) Depletion of ozone layer is because of its chemical reactions with chlorofluoroalkanes.
 - (4) Ozone absorbs infrared radiations.
- 5. What is DDT among the following?

[JEE Main-2012]

- (1) Greenhouse gas
- (2) A fertiliser
- (3) Biodegradable pollutant
- (4) Non-biodegradable pollutant
- **6.** The gas leaked from a storage tank of the Union Carbide plant in Bhopal gas tragedy was

[JEE Main-2013]

- (1) methyl isocyanate (2) methylamine
- (3) ammonia (4) phosgene

7. Smoke is an example of:

[JEE Main Online-2013]

- (1) solid dispersed in solid
- (2) solid dispersed in gas
- (3) gas dispersed in solid
- (4) gas dispersed in liquid
- **8.** Which of the following compounds is not expected to show Lassaigne's test for nitrogen?

[JEE Main Online-2013]

- (1) Propanenitrile
- (2) Hydroxylamine hydrochloride
- (3) Nitromethane
- (4) Ethanamine
- 9. Global warming is due to increase of:

[JEE Main Online-2014]

- (1) methane and nitrous oxide in atmosphere
- (2) methane and CO in atmosphere
- (3) methane and CO_2 in atmosphere
- (4) methane and CO_3 in atmosphere
- Photochemical smog consists of excessive amount of X, in addition to aldehydes, ketones, peroxy acetyl nitrite (RCO₃NO₂) and so forth. (X) is

[JEE Main online-2015]

(1)	CH ₄	(2)	CO
(3)	CO_2	(4)	O ₃

- 11. Addition of phosphate fertilizers to water-bodies causes [JEE Main Online-2015]
 - (1) enhanced growth of algae
 - (2) increase in amount of dissolved oxygen in water
 - (3) deposition of calcium phosphate
 - (4) increase in fish population
- 12. Statement I: Nitrogen and oxygen are the main components in the atmosphere but these do not react to form oxides of nitrogen. [JEE Main-2015]
 Statement II: The reaction between nitrogen and oxygen requires high temperature.
 - If both Statement-I and Statement-II are correct and Statement-II is the correct explanation for Statement-I
 - (2) If both Statement-I and Statement-II are correct and Statement-II is not the correct explanation for Statement-I
 - (3) If Statement-I is correct and Statement-II is incorrect
 - (4) If Statement-I is incorrect and Statement-II is correct

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EXERCISE # 3

1. [1, 2, 3]

Classical smog occurs in humid climate. It is a mixture of smoke, fog and SO2 which is reducing in nature. It is not the oxidising smog.

- 2. [1]
 - (I) There are several gases that are even stronger IR absorbers than CO₂. These are CH₄, O₃, N₂ and CFC.

Thus, these gases are responsible for greenhouse effect.

Thus, given statement is false.

- (II) $SO_2 + O_3 \longrightarrow SO_3 + O_2$ (True)
- (III) (True)

(IV)
$$O_2 \xrightarrow{(hv)} 2[O]$$

 $O_2 + O \longrightarrow O_3$ [True]

3. [3]



(1) Temperature in the layer of air from 10 to 40 km increases slowly from 220 K to 270 K-correct.

(2) Supersonic aircrafts fly in lower region-correct.

8. [1]

Rain water has dissolved CO_2 in the form of weak acid.

$$H_2O + CO_2 \rightleftharpoons H_2CO_3$$

 $H_2CO_3 \Longrightarrow H+ + HCO_3^-$

It is feebly ionized hence is slightly acidic pH = 7 (but < 7) Thus, Statement-I and Statement-II are correct and statement-II is the correct explanation of Statement-I

9. [4]

If BOD < 5 ppm, it means water is pure. High BOD means low activity of bacteria in water.

Thus, Statement-I is incorrect and Statement-II is correct.

10. [1]

This type of smog is formed by combination of particulates (smoke, dust, fog) with oxides of nitrogen and hydrocarbons in presence of sunlight to produce ozone (O_3) and PAN (peroxy acetyl nitrate).

11. [1]

CO combines with haemoglobin, produces carboxyhaemoglobin (200 times more affinity than oxygen for haemoglobin). Due to formation of carboxylhaemoglobin (HbCO), the quantity of oxygen available to the body cells gets reduced.

18. [4]

(A) Acid rain is due to SO_2 .

- (A) \rightarrow (s)
- (B) Photochemical smog is due to unsaturated hydrocarbons. CH₂=CH CHO. (along with PAN)

Thus,
$$(B) \rightarrow (t)$$

- (C) $\text{HbO}_2 + \text{CO} \rightarrow \text{HbCO} + \text{O}_2$ (C) \rightarrow (q)
- (D) CFC is responsible for depletion of ozone layer.
 - Thus, $(D) \rightarrow (p)$
- (E) Global warming is due to CO₂. (E) \rightarrow (r)

EXERCISE #4

1. [1]

During thunderstorm, there is the formation of NO which changes to NO_2 and ultimately to HNO_3 (acid rain)

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

 $4NO_2 + O_2 + 2H_2O \longrightarrow 4HNO_3 [pH < 7]$

2. [1]

Smog is formed by the action of sunlight on unsaturated hydrocarbons and nitrogen oxides.

Smog mainly contains higher concentration of Peroxy acetyl nitrate (PAN) formed by the reaction of NO_2 , O_3 and unsaturated hydrocarbons.

$$NO_{2} \xrightarrow{hv} NO + O$$

$$O + O_{2} \rightleftharpoons O_{3}$$

$$NO + O_{3} \longrightarrow NO_{2} + O_{2}$$

$$NO + O_{3} + \text{unsaturated hydrocarbons} \longrightarrow PAN$$

3. [3]

Ozone layer permits the infrared radiations to pass through but doesn't permit the higher range of ultraviolet radiations to pass through.

4. [4]

(1) NO + O₃
$$\longrightarrow$$
 NO₂ + O₂
O₃ + hv \longrightarrow O₂ + O
NO₂ + O \longrightarrow NO + O₂
Net reaction 2O₃ + hv \longrightarrow 3O₂
Thus, ozone layer is depleted by oxides of nitrogen.

- (1) is the correct statement.
- (2) Ozone layer is a protective layer and absorbs harmful UV rays from the sun.

Thus, (2) is also the correct statement.

(3)
$$Cl + O_3 \longrightarrow ClO + O_2$$

 $O_3 + hv \longrightarrow \dot{O} + O_2$
 $ClO + \dot{O} \longrightarrow \dot{Cl} + O_2$
Net reaction
 $2O_3 + hv \longrightarrow 3O_2$
Thus, ozone layer is also depleted by reaction
with freons.

- (3) is also the correct statement.
- (4) it is an incorrect statement as ozone layer is permeable for infrared rays.

5. [4]

DDT is a non-biodegradable pollutant. It is the first chlorinated organic insecticide.

6. [1]

Methyl isocyanate, CH_3 –N=C=O (MIC) gas was leaked from the storage tank of the Union carbide plant in Bhopal gas tragedy.

- 7. [2]
- 8. [2]
- 9. [3]
- 10. [4]

In polluted cities, there is smog that causes irritation. Gases in smog are mainly PAN, RCHO, RCOR and O_3 .

11. [1]

Addition of phosphate fertilisers enhance algae growth, thus O_2 concentration in water is decreased.

12. [1]

Nitrogen is an inert gas because of the presence of strong bond. That's why although there is $78\% N_2$ in the atmosphere but nitrogen oxide in not formed under ordinary conditions.

But when temperature is high enough i.e., ≈ 2000 K, it reacts with oxygen to form nitrogen oxide.

$$N_2 + O_2 \xrightarrow{\approx 2000 \text{K}} 2\text{NO}$$

Thus,

If both Statement-I and Statement-II are correct and Statement-II is the correct explanation for Statement-I