CHAPTER

6 Environmental Pollution

1. The pollutants may be inorganic, biological or radiological in nature.

(i) Bio-degradable pollutants are domestic wastes which are rapidly decomposed by micro-organisms.

(ii) Non-biodegradable pollutants include chemicals, mercuric salts, lead compounds, pesticides, etc.

(iii) Natural pollution is caused by radioactive substances, volcanic eruptions, forests and mines fires floods, etc.

(iv) Artificial pollution is caused by industries, thermal plants, automobile, exhausts, sewage, etc.

2. Environment : The conditions existing around animal or human life.

Atmosphere: The gaseous envelop surrounding the earth. It has been classified into following regions:-

(i) Stratosphere : The layer of the earth's atmosphere above the troposphere and below the mesosphere.

(ii) Troposphere : The lowest region of the atmosphere extending from earth's surface to the lower boundary of the stratosphere. In this region, human beings along with other organisms live. It contains water vapour and is greatly affected by air pollution.

Note : The other two layers are Thermosphere and Mesosphere.

3. Air pollution : The major air pollutants are

(i) Carbon monoxide (CO) : It is produced by incomplete combustion of gasoline in motor vehicles, wood, coal, inceneration and forest fires.

It is treacherous and deadly poisonous gas. It induces headache, visual difficulty coma and death. It blocks the normal transport of oxygen from the lungs to other parts of the body.

(ii) Sulphur dioxide (SO_2) : It is produced by petrol combustion, coal combustion, petrol refining and smelting operations.

It hinders the movement of air in and out of lungs. It is particularly poisonous to trees causing chlorosis and dwarfing. In presence of air it is oxidised to SO_3 which is also irritant.

$$2SO_2 + O_2 \text{ (air)} \longrightarrow 2SO_3$$

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

$$SO_3 + H_2O \text{ (moisture)} \longrightarrow H_2SO_4$$

It attacks marble, limestone,vegetation, paper and textiles and injurious to human beings.

(iii) Oxides of nitrogen : NO_2 and NO, Source - combustion of coal, gasoline, natural gas, petroleum refining, chemical plants, manufacturing explosives and fertilizers, tobacco smoke.

Breathing NO_2 causes chlorosis to plants and chronic lung conditions leading to death. NO_2 reacts with moisture to form acids.

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

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

(iv) Smoke, dust :

Sources : cement works, iron and steel works, gas works, power generating stations.

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

(a) London smog or classical smog : It is coal smoke plus fog. The fog part is mainly SO_2 and SO_3. It has sulphuric acid aerosol. It causes bronchial irritation and acid rain. It is reducing in nature.

(b) Photochemical smog or Los Angeles smog : 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.

Acid rain : The oxides of C, N and S present in the atmosphere, dissolve in water and produce acids and lower the pH of water below 5.5.

$$H_2O + CO_2 \longrightarrow H_2CO_3 \rightleftharpoons 2H^+ + CO_3^{2-}$$

$$2H_2O + 2SO_2 + O_2 \rightarrow 2H_2SO_4 \rightleftharpoons 2H^+ + SO_4^{2-}$$

$$2H_2O + 4NO_2 + O_2 \rightarrow 4HNO_3 \rightleftharpoons H^+ + NO_3^-$$

The acids are toxic to vegetation, react with marble and damage buildings.

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

Acids corrode water pipes and produce salts with heavy metals ions viz Cu, Pb, Hg and Al toxic in nature.

(v) Green House effect : The retention of heat by the earth and atmosphere from the sun and its prevention to escape into

the outer space is known as green house effect.

Global warming is average increase in the temperature of earth due to increase in concentration of green house gases (CO_2, O_3, NO_x etc).

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.

(vi) Ozone layer and its depletion : 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. The U. V. radiations cause skin cancer, cataract of eye, and harm to vegetation.

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 chlorofluorocarbons also increase the decomposition of O_3.

$$CF_2Cl_2 + h\upsilon \longrightarrow CF_2Cl + Cl$$

$$CFCl_3 + h\upsilon \longrightarrow CFCl_2 + Cl,$$

$$Cl + O_3 \longrightarrow ClO + O,$$

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

$$O_3 + O \longrightarrow 2O_2 \text{ (Net reaction)}$$

(vii) Control of air pollution : It can be controlled by

1. Dissolving HCl, HF, SiF_4 in water and SO_2, Cl_2, H_2S in alkaline solution.
2. Adsorbing gas and liquid molecules over activated charcoal and silica gel.
3. Chemical reactions.
4. Use of precipitators to settle charge particles.
5. Use of settling chambers under the action of gravity.
6. Use of natural gas in place of diesel, petrol, etc.

4. 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.

(i) Sources of water pollution

(a) ***Domestic sewage :*** Discharges from kitchens, baths, lavatories, etc.

(b) ***Industrial waters :*** Wastes from manufacturing processes which includes acids, alkalines, pesticides, insecticides, metals like copper, Zinc, lead, mercury, fungicides, etc.

(c) ***Oil :*** From oil spills or washings of automobiles.

(d) ***Atomic explosion*** and processing of radioactive materials.

(e) ***Suspended particles*** (organic or inorganic) viruses, bacterias, algae, protozoa, etc.

(f) ***Wastes from fertilizer*** plants such as phosphates, nitrates ammonia, etc.

(g) ***Clay :*** Ores, minerals, fine particles of soil.

(ii) Aerobic and anaerobic oxidation : The oxidation of organic compounds present in sewage in presence of good amount of dissolved or free oxygen (approx. 8.5 ml/l) by aerobic bacterials is called *aerobic oxidation*. When dissolved or free oxygen is below a certain value the sewage is called *stale*. Anaerobic bacterias bring out putrefaction producing H_2S, NH_3, CH_4, $(NH_4)_2S$, etc. This type of oxidation is called *anaerobic* oxidation.

(iii) Biological Oxygen Demand (BOD) : 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. An average sewage has BOD of 100 to 150 mg/*l*.

(iv) Chemical Oxygen Demand (COD) : It is a measure of all types of oxidisable impurities present in the sewage. COD values are higher than BOD values.

5. Soil pollution : The addition of substances in an indefinite proportion changing the productivity of the soil is known as soil or land pollution.

Sources of soil pollution :

(i) ***Agricultural pollutants :*** Chemicals like pesticides, fertilizers, bacteriacides, fumigants, insecticides, herbicides, fungicides.

(ii) ***Domestic refuge*** and industrial wastes.

(iii) ***Radioactive wastes*** from research centres, and hospitals.

(iv) ***Soil conditioners*** containing toxic metals like Hg, Pb, As, Cd, etc.

(v) ***Farm wastes*** from poultries, dairies and piggery farms.

(vi) ***Improper disposal*** of human and animal extreta.

(vii) ***Pollutants*** present in air from chemical works.

6. Pesticides : The chemical substances used to kill or stop the growth of unwanted organisms are called pesticides. They are further classified as

(i) ***Insecticides :*** They are used to kill insects. The most common insecticides are

(i) D.D.T (ii) BHC, 666, game xene
(iii) Baygon (iv) Sevin Carbaryl
(v) Parathion (vi) Methoxychlor
(vii) Aldrin

(ii) ***Herbicides :*** They are used to kill weeds

(i) 2, 4-dichlorophenoxy acid
(ii) Triazines
(iii) $NaClO_3$ Sodium chlorate
(iv) Na_3AsO_3 Sodium arsenite

The (iii) and (iv) are not used now-a-days.

Addition of phosphate fertilizers to water leads to nutrient enrichment (eutrophication).

EXERCISE

1. 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.
2. 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
3. Which of the following is not a consequence of greenhouse effect?
   (a) Climatic conditions will be changed
   (b) Plants in warmer climates with adequate rainfall would grow faster
   (c) The incidence of infectious diseases is likely to increase
   (d) Malaria will be controlled as the mosquitoes will not survive.
4. Which of the following gases is not a green house gas?
   (a) CO (b) O_3
   (c) CH_4 (d) H_2O vapour
5. The substance having the largest concentration in acid rain?
   (a) H_2CO_3 (b) HNO_3
   (c) HCl (d) H_2SO_4
6. The non-viable particulate is among the following is
   (a) Dust (b) Bacteria
   (c) Moulds (d) Fungi
7. 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
8. 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.
9. Which of the following statements is 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.
10. 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 the 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.
11. 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
12. 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
13. 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
14. The type of pollution caused by spraying of DDT
   (a) Air and soil (b) Air and water
   (c) Air (d) Air, water and soil
15. Which among the following statements is *false*?
   (a) Oil slick in sea water increases D.O. value.
   (b) The main reason for river water pollution is industrial and domestic sewage discharge.
   (c) Surface water contains a lot of organic matter mineral nutrients and radioactive materials.
   (d) Oil spill in sea water causes heavy damage to fishery.
16. 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

17. 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.

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

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

20. 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

21. 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)

22. 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

23. 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.

24. Frequent occurrence of water blooms in a lake indicates
(a) nutrient deficiency
(b) oxygen deficiency
(c) excessive nutrient availability
(d) absence of herbivores in the lake

25. 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

26. 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

27. Identify the wrong statement in the following.
(a) Chlorofluorocarbons are responsible for ozone layer depletion.
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(d) Acid rain is mostly because of oxides of nitrogen and sulphur.

28. 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.

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

30. 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

31. The substance which is not regarded as a pollutant?
(a) NO_2 (b) CO_2
(c) O_3 (d) Hydrocarbons

32. The greatest affinity for haemoglobin is shown by which of the following :
(a) NO (b) CO
(c) O_2 (d) CO_2

33. Which of the following is not involved in the formation of photochemical smog?
(a) Hydrocarbon (b) NO
(c) SO_2 (d) O_3

34. 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

35. 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 particles in the diameter range 5-20 microns
    (d) Wet scrubbers are used to wash away all types of particulates
36. 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
37. Minamata disease is due to pollution of
    (a) aresenic into the atmosphere
    (b) organic waste into drinking water
    (c) oil spill in water
    (d) industrial waste mercury into fishing water
38. BOD is connected with
    (a) microbes and organic matter
    (b) organic matter
    (c) microbes
    (d) None of these
39. Eutrophication causes reduction in
    (a) dissolved oxygen (b) nutrients
    (c) dissolved salts (d) All of these
40. Which among the following statements is *false*?
    (a) Oil slick in sea water increases D.O. value
    (b) The main reason for river water pollution is industrial and domestic sewage discharge
    (c) Surface water contains a lot of organic matter mineral nutrients and radioactive materials
    (d) Oil spill in sea water causes heavy damage to fishery
41. Presence of which of the following 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
42. Which one of the following statements about ozone and ozone layer is true?
    (a) Ozone layer is beneficial to us because ozone cuts out the ultraviolet radiation of the sun
    (b) The conversion of ozone to oxygen is an endothermic reaction
    (c) Ozone has a triatomic linear molecule
    (d) None of these

ANSWER KEY													
1	(a)	**7**	(a)	**13**	(a)	**19**	(c)	**25**	(a)	**31**	(b)	**37**	(d)
2	(c)	**8**	(b)	**14**	(d)	**20**	(a)	**26**	(a)	**32**	(a)	**38**	(a)
3	(d)	**9**	(a)	**15**	(a)	**21**	(c)	**27**	(c)	**33**	(c)	**39**	(a)
4	(a)	**10**	(c)	**16**	(c)	**22**	(b)	**28**	(c)	**34**	(a)	**40**	(a)
5	(d)	**11**	(a)	**17**	(d)	**23**	(b)	**29**	(d)	**35**	(a)	**41**	(c)
6	(a)	**12**	(c)	**18**	(d)	**24**	(b)	**30**	(a)	**36**	(a)	**42**	(a)

HINTS AND SOLUTIONS

3. (d) The mosquitoes will increase their population and spread malaria.

5. (d) Acid rain contains $H_2SO_4 > HNO_3 > HCl$.

6. (a) Dust

13. (a) Phosphate pollution is caused by sewage and agricultural fertilizers.

14. (d) DDT causes water, air and soil pollution.

15. (a) Oil slick in sea water decreases D.O value.

18. (d) 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 (d) is wrong statement and so it is the correct answer.

19. (c) water is often treated with Cl_2 to kill germs.

20. (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.

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

22. (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).

23. (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.

25. (a) Normal rain water has pH 5.6 Thunderstorm results in the formation NO and HNO_3 which lowers the pH.

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

27. (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.

28. (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.

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

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

31. (b) CO_2 is generally not regarded as an pollutant.

32. (a) Haemoglobin has great affinity for NO.

33. (c) Photochemical smog does not involve SO_2.

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

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

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

37. (d) Minamata is caused by Hg poisoning.

38. (a) BOD is connected with microbes and organic matter.

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

40. (a) Oil slick in sea water decreases D.O value.

41. (c) Presence of CO in the exhaust fumes shows incomplete combustion.