

Chapter 10. Atmospheric Pollution

Exercise 10

Solution 1.

The toxic substances that have an undesirable impact on different components of the environment and are injurious to life and property are known as pollutants.

Solution 2.

Effect of Pollutant on living beings:

- **Fluorides:** Effects teeth and bones.
- **Smoke Particles:** Cause asthma and lung diseases.
- **Lead:** Damages the nervous and digestive systems and can cause cancer .
- **Mercury compounds:** They cause disease like Minamata commonly found in fishermen.
- **Smog:** It reduces visibility and induces respiratory troubles.
- **Nitrogen Oxide:** Causes death of many plants.

Solution 3.

Air pollution: It is defined as the presence of a contaminant in the atmosphere in a concentration large enough to injure human, plant and animal life.

Air pollution takes place due to the presence of gaseous pollutants like oxides of sulphur, hydrocarbons, smoke, oxides of carbon, oxides of nitrogen, dust, particulate pollutants like mist, spray and fume.

Solution 4.

Components of air is:

Pure Air components	By Volume percentage	Concentration parts per million (ppm)
Nitrogen	78.09	780,900
Oxygen	20.94	209,400
Inert Gases Argon	0.93	9300
Neon		18
Helium		5
Krypton		1
Xenon		1
Carbon-dioxide	0.03	315

Methane		1
Hydrogen		0.5
Natural pollutants		
Oxides of nitrogen		0.52
Ozone		0.02

Solution 5.

Particulate Pollutant are dust, smoke, mist, spray and fume.

Solution 6.

Cigarette smoking is harmful not only for one who is smoking but also for sitting nearby and so one should avoid it. Tobacco smoke causes lung cancer and asthma.

Solution 7.

Smog: A smog is a pollutant which is a combination of oxides of sulphur and nitrogen, partially oxidized hydrocarbons and their derivatives produced by industries and automobiles from a dark, thick dust and soot laden fog known as smog.

Damaging Effect: Smog is noxious and irritating. It reduces visibility, induce respiratory troubles and can cause death by suffocation.

Photochemical Smog damages the tissues of certain plants and even decreases the yield of citrus fruits and grapes.

Solution 8.

ppm means parts per million. That is, share in 10, 00000.

Solution 9.

Major air pollutants are: Large amounts of Carbon monoxide, Sulphur dioxide, H₂S, Chlorine, HCl, Hydrocarbons and particulates. Particulate matter like sand, dust etc. Secondary pollutant like (PAN) peroxyaryl.

Solution 10.

Control of: (i) Carbon monoxide, CO emission:

Emission of CO can be controlled by :

- Switching over from internal combustion engine to electrically powered cars. (b) Using alcohols, CNG, LNG in place of gasoline.
- By using Catalytic Mufflers or Convertors.
- Using pollution control devices to burn gasoline completely.
- Using lead free petrol.

(ii) (SO_x) oxides of Sulphur emission: Oxides of sulphur (SO, SO₂) emission can be reduced by- (a) Using coal or oil that has low sulphur content. (b) By using Scrubber, a

device that absorbs gaseous pollutants.

Solution 11.

Acid rain

Factories in big cities release nitrogen dioxide and sulphur dioxide as their wastes. These gases dissolve in rainwater during rains and form nitrous acid and sulphurous acid. As the rain falls, these acids come down to the ground as an acid rain.

The normal rain is slightly acidic having a pH about 5.6 as carbon dioxide gas reacts with it to form a weak carbonic acid.



(Carbonic acid)

The pH of acid rain ranges between 5.6 – 3.5 and in some cases pH can go even lower than 2.

The two forms of deposition of acid rains are:

- Dry deposits-Particles containing sulphates and nitrates
- Wet deposits-dew, rain, fog, smoke

Formation of acid rain

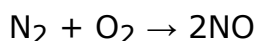
- Acid rain refers to rain which has pH less than 5.6. It is mainly caused by atmospheric pollutants.
- **Natural sources:** Bacterial decomposition, forest fires, volcanic eruptions.
- **Man made sources:** Industries and smelting plants, automobile exhausts, power plants etc.
- **Oxides of nitrogen and sulphur** interact with water vapour in presence of sunlight in the atmosphere to form nitric acid and sulphuric acid mist respectively. This mist remains as vapours at high temperatures and condenses at low temperatures. These acids mix with rain (snow or fog) and fall down on the Earth resulting in acid rain.

Causes of acid rain

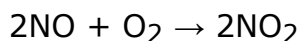
- The formation of mineral acids like carbonic acid, nitric acid and sulphuric acid is the main cause of acid rain.

Formation of Nitric acid and Nitrous acid

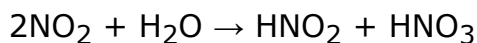
- Nitrogen and oxygen (that is oxides of nitrogen) combines in the presence of thunder and lightning to form nitric acid.
- They are also produced by internal combustion engines (automobile engines). This then gets oxidized in the atmosphere to nitrogen dioxide. Nitrogen dioxide combines with water to form a mixture of nitrous acid and nitric acid.



(Nitrogen oxide)



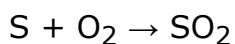
(Nitrogen dioxide)



(Nitrous acid) (Nitric acid)

Formation of Sulphuric acid and Sulphurous acid

Impurities in the coal: Coal used in power plants contains upto 4% sulphur. On combustion it forms pollutant sulphur dioxide (i.e, oxides of sulphur).



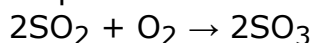
(Sulphur dioxide)

Sulphur dioxide reacts with water vapour to form sulphurous acid.



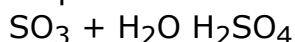
(Sulphurous acid)

Sulphur dioxide can also be oxidized to sulphur trioxide.



(Sulphur trioxide)

Sulphur trioxide reacts with water vapour to form sulphuric acid.



(Sulphuric acid)

Impact of Acid rain

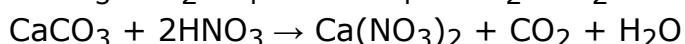
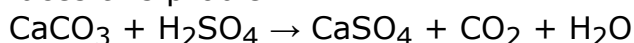
Changes the acidity of soil: The acids present in the acid rain like, nitric acid, nitrous acid and sulphuric acid, sulphurous acid increases the acidity of soil. It removes calcium and potassium minerals i.e., basic ingredients from the soil losing their fertility.

The hydrogen ions H^+ which are added to the soil, when acid rain falls on the Earth interact chemically with existing soil minerals.



Affects water bodies and marine organisms: The water of lakes and rivers is becoming acidic, which may no longer support aquatic life.

Material damage: It increases corrosion of metals, disintegrates paper and leather. Weakens building materials such as statues, marbles, sculptures, limestone, slate, mortar etc. These materials become pitted and weakened mechanically. The Taj Mahal in India faces this problem.



Impact on living things: It damages forests. Acid rain gets absorbed by plants, animals directly or indirectly toxicity enters food chain affecting humans. They can affect a person's breathing, at sufficiently high concentrations. Sulphur dioxide irritates the upper

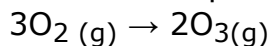
respiratory tract, which serve to expel soot particles and dust in the inhaled air. At even lower concentrations, it does still greater harm by injuring lung tissues.

Solution 12.

Sulphur dioxide pollutes the air, effects the yield of crops and causes damage to lungs, SO_2 gets converted to SO_3 and combines with water drops of air and cause acid rain.

Solution 13.

In the atmosphere ozone is formed by the action of ultraviolet rays of the sun on oxygen.

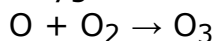


The high energy UV radiations break oxygen molecules into oxygen atoms.



Oxygen molecule Oxygen atoms

Oxygen atom reacts with oxygen molecule to form ozone.



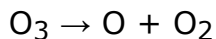
Atom Molecule Ozone

The Net reaction is:



Solution 14.

It is formed by the action of ultraviolet rays of the Sun on oxygen.



Ozone layer acts as a blanket in the atmosphere 16 km height above the Earth's surface. It absorbs harmful ultraviolet rays (UV radiations) coming from the Sun and prevents them to reach the surface of the Earth.

Ultraviolet rays have very harmful effects on living things. It causes skin cancer. It destroys many organic species which are necessary for life.

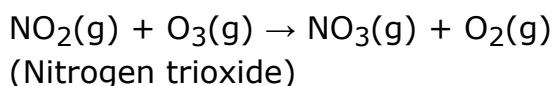
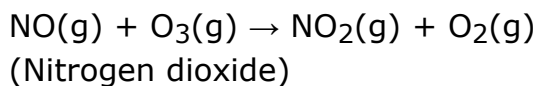
Thus it protects the life on earth from harmful effects of Ultra Violet Rays. Which can cause (a) Skin cancer (b) destroy many organic species necessary for life.

Solution 15.

Chemicals responsible for ozone destruction free radical chlorine (Cl) and nitric oxide (NO) are responsible for ozone depletion i.e. react with O_3 . Free radical chlorine (Cl) is produced by UV rays from chlorofluoro carbons enter the atmosphere because of excessive use as solvents, Aerosol, Spray, Propellants, Refrigerants and blowing agents for plastic foams.

Chemicals responsible for the depletion of ozone layer

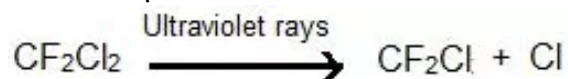
Fuel of planes: Burning of fuels of planes emits large quantity of nitric oxide and other gases in the atmosphere. Nitric oxide reacts with ozone and form nitrogen dioxide and nitrogen trioxide. This causes depletion of ozone.



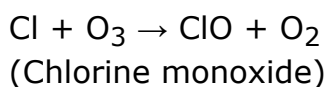
Excessive use of chlorofluoro carbon: It is released by refrigerators and air conditioning systems.

It causes reduction of ozone layer that protects us from harmful ultraviolet rays (UV radiations) of the Sun.

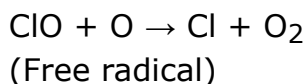
The chlorofluoro carbons are decomposed by the ultraviolet rays to highly reactive chlorine which is produced in the atomic form.



The free radical [Cl] reacts with ozone to form chlorine monoxide.



This causes depletion of ozone layer. Chlorine monoxide then reacts with atomic oxygen to produce more chlorine free radicals.



Again this free radical destroys ozone and the process continues giving rise to depletion of ozone layer.