ENVIRONMENTAL CHEMISTRY, PURIFICATION METHODS, QUALITATIVE AND QUANTITATIVE ANALYSIS

NEET SYLLABUS

Environmental pollution : Air, water and soil pollution, chemical reactions in atmosphere, smoge, major atmospherixc pollutats; acid raihn ozone and its reactions, effects of depletion of ozone layer, greenhouse effect and global warming pollution due to industrial wastes; green chemistry as an alternative tool for reducing pollution, strategy for control of environmental pollution.

OBJECTIVES

After studying this unit, we will be able to :

- understand the meaning of environmental chemistry;
- define atmospheric pollution, list reasons for global warming. green house effect and acid rain;
- identify causes for ozone layer depletion and its effects;
- give reasons for water pollution and know about international standards for drinking water;
- describe causes of soil pollution;
- suggest and adopt strategies for control of environmental pollution;
- appreciate the importance of green chemistry in day to day life.

"Failure will never overtake me if my definition to succeed is strong enough"

A.P.J. Abdul Kalam

ENVIRONMENTAL CHEMISTRY, PURIFICATION METHODS, QUALITATIVE & QUANTITATIVE ANALYSIS

ENVIRONMENTAL CHEMISTRY

The branch of science which deals with the chemical phenomena occuring in the environment is called as environmental chemistry.

INTRODUCTION

The environment means surroundings. It has 4 following component.

Atmosphere

Function of the atmosphere :

- It **contain all the gases** which are essential for the life on the earth.
- It is a **carrier of water vapour** which are needed for all life.
- Ozone (O_3) is present in stratosphere which is responsible for absorption of 99.5% of harmful U.V. radiations.
- It maintain heat balance of the earth by absorbing infrared radiation, coming from the sun and re-emit from the earth.

ENVIRONMENTAL POLLUTION & ENVIRONMENTAL POLLUTANT

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

The undesirable material which is added to the environmental is called as pollutant.

Causes of pollution :

- Fast growth.
- Excessive trialisation.
- Rapid urbanisation.
- Use of pesticides in agriculture.

Types of Pollutants

Bio Degradable and Non Bio Degradable Pollutants

(A) Bio degradable pollutants : The materials (such as cow dungs) which are easily decomposed by the micro-organism. These are not harmful, but in the excess in environment, they do not undergo degradation completely and thus become pollutant. Eg. Discarded vegetables

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

They may react with other compounds present in the environment and produce more toxic compound. Eg. Plastic materials, DDT, heavy metal, many chemicals, nuclear wastes etc.

TYPES OF POLLUTION

Depending on the Part of the Environment Polluted

(A) Air pollution **(B)** Water pollution **(C)** Soil pollution (or land pollution)

(A) Air pollution : It is defined as the undesirable materials into the atmosphere either due to natural phenomena (or due to human activity on the earth). Which affect the quality of the air and also affect the life on the Earth.

Major source of air pollution :

(i) Natural sources :

Ex. due to CO, H_2S, SO_2, Forest fire

(ii) Man made air pollution or source due to human activity :

Natural sources :

Ex. Burning of fossil fuels which produce some poisonous gases as CO, CO_2, CH_4, oxide of nitrogen .

Combustion of gasoline in the automobiles : The automobiles emit the CO, oxide of nitrogen (NO, NO_2)

Deforestation : Due to this % of CO_2 is increased and % of O_2 is decreased.

Fast industrialisation : The smoke of carbon and CO, CO_2, SO_2, H_2S, NO, NO_2 are coming out from the industries. The industries are responsible for 20% of total air pollution.

Agriculture activities : The pesticides are added in the soil. They give a foul smell and affect the health of animals and human being.

Wars : The nuclear weapons are used in war which emit the radiation.

Air pollutants :

(A) CO as pollutant : It is mainly realsed by automobile exhaust due to incomplete combustion of carbon. It binds to haemoglobin to form carboxyhaemoglobin, which is about **300 times** more stable than the oxygen-haemoglobin complex. In blood, if the concentration of carboxyhaemoglobin reaches 3-4 percent then oxygen carrying capacity is greatly reduced.

Sink of CO : A large amount of CO are added in the atm. But the level of CO does not rise too much as CO is converted in CO_2 by the micro organism which is present in the soil.

The micro organism (bacteria) act as sink for CO.

Harmful effect of CO :

(i) The CO is poisonous because it combine with haemoglobin of R.B.C. about 300 times easily than O_2, to form carboxy haemoglobin.

(ii) Oxygen deficient results into headache, weak eyesight, nervouness and cardiovascular disorder.

(iii) In pregnant women who have the habit of smoking the increased CO level in blood may induce premature birth, spontaneous abortions and deformed babies.

(B) Hydro carbon : Hydrocarbons are carcinogenic, i.e., they cause cancer. They harm plants by causing ageing, breakdown of tissues and shedding of leaves, flowers and twigs.

(a) Natural sources :

(i) Due to decomposition of organic matter in soil.

$$2HCHO \xrightarrow{\text{Bacteria}} CH_4 + CO_2$$

(b) Man made sources :

(i) Due to burning of stationary fuel. (ii) Evaporation of organic solvent.

(C) Sulphur compounds : Produced by burning of fossil fuel. The most common species, sulphur dioxide, is a gas that is poisonous to both animals and plants.

Harmful effect of Sulphur compounds :

(i) Even a low concentration of sulphur dioxide causes respiratory diseases e.g., asthma, bronchitis, emphysema in human beings.

(ii) Causes irritation to the eyes, resulting in tears and redness.

(iii) High concentration of SO_2 leads to stiffness of flower buds which eventually fall off from plants.

Sulphur dioxide Uncatalysed oxidation of sulphur dioxide is slow. However, the presence of particulate matter in polluted air catalyses the oxidation of sulphur dioxide to sulphur trioxide.

$$2SO_2(g) + O_2(g) \rightarrow 2SO_3(g)$$

The reaction can also be promoted by ozone and hydrogen peroxide.

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

$$SO_2(g) + H_2O_2(l) \rightarrow H_2SO_4(aq)$$

(D) Nitrogen compound : At high altitudes when lightning strikes, O_2 and N_2 combine to form oxides of nitrogen. NO_2 is oxidised to nitrate ion, NO_3^- which is washed into soil, where it serves as a fertilizer. In an automobile engine, (at high temperature) when fossil fuel is burnt, dinitrogen and dioxygen combine to yield significant quantities of nitric oxide (NO) and nitrogen dioxide (NO_2) as given below:

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

NO reacts instantly with oxygen to give NO_2

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

Rate of production of NO_2 is faster when nitric oxide reacts with ozone in the stratosphere.

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

Harmful effects of nitrogen compounds

(i) The irritant red haze in the traffic and congested places is due to oxides of nitrogen.

(ii) Higher concentrations of NO_2 damage the leaves of plants and retard the rate of photosynthesis.

(iii) Nitrogen dioxide is a lung irritant that can lead to an acute respiratory disease in children.

(iv) It is toxic to living tissues also. It is also harmful to various textile fibres and metals.

(E) Carbon dioxide : Normally it forms about 0.03 per cent by volume of the atmosphere. If the amount of carbon dioxide crosses the delicate proportion of 0.03 percent, the natural greenhouse balance may get disturbed. Carbon dioxide is the major contributor to global warming.

BEGINNER'S BOX–1

1. Domestic waste will lead to -

(1) Biodegradable pollution	(2) Nondegradable pollution
(3) Thermal pollution of soil	(4) Air pollution

2. The major source of BOD in the river Ganga is

(1) Leaf litter	(2) Fishes	(3) Human waste	(4) Aquatic plants

3. If a lake is contaminated with DDT, its highest concentration would be found in

(1) Primary consumer	(2) Secondary consumer	(3) Tertiary consumer	(4) None of these

4. The most harmful air pollutant produced by automobiles is

(1) HNO_2	(2) NO	(3) SO_2	(4) CO

5. Sewage water can be purified by

(1) Aquatic plant	(2) Micro organism	(3) Penicillin	(4) Fishes

STRATOSPHERIC POLLUTION

Depletion of Ozone Layer

Due to human activity 2 compounds **NO** and **CFC** are responsible for depletion of O_3 layer.

(a) NO (Nitric oxide) : $NO + O_3 \longrightarrow NO_2 + O_2$

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

The NO react with O_3 so decrease the amount of O_3 and forms NO_2 which react with oxygen atoms available in the stratosphere and producing back NO.

Thus no NO is consumed but O_3 gets depleted.

(b) Chlorofluoro carbons (CFC) or freons :

The freons decomposes in the presence of U.V. radiation coming from the Sun.

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

$$CFCl_3 \xrightarrow{h\nu} \dot{C}l + \dot{C}FCl_2$$

The reactive chlorine atoms then destroy the ozone layer through the following sequence of reaction. Which are repeated because chlorine atom are regenerated in the second reaction :

Reaction. $Cl^{\bullet} + O_3 \longrightarrow ClO^{\bullet} + O_2$

$ClO^{\bullet} + O \longrightarrow Cl^{\bullet} + O_2$

The one molecule CFC can destroy more than one thousand O_3 molecules in the stratosphere.

(c) Effect of depletion of O_3 layer : Due to depletion of O_3 layer, U.V. radiation fall on the Earth.

- The U.V. radiation, damage the cornea and lens of the eyes.
- The U.V. radiation affect the plant proteins so reduce the chlorophyll.
- The U.V. radiation, up set the heat balance of the Earth.
- **Ozone hole :** It was found that a unique set of conditions was responsible for the ozone hole. In summer season, nitrogen dioxide and methane react with chlorine monoxide (reaction a) and chlorine atoms (reaction b) forming chlorine sinks, preventing much ozone depletion, whereas in winter, special type of clouds called polar stratospheric clouds are formed over Antarctica. These polar stratospheric clouds provide surface on which chlorine nitrate formed (reaction a) gets hydrolysed to form hypochlorous acid (reaction c). It also reacts with hydrogen chloride produced as per (reaction b) to give molecular chlorine.

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

$\dot{C}l(g) + CH_4(g) \rightarrow \dot{C}H_3(g) + HCl(g)$ (b)

$ClONO_2(g) + H_2O(g) \rightarrow HOCl(g) + HNO_3(g)$ (c)

$ClONO_2(g) + HCl\,(g) \rightarrow Cl_2(g) + HNO_3(g)$ (d)

Acid Rain : The rain containig H_2SO_4, HNO_3 (and small amount of HCl) which are formed from the **oxide of S** and **N_2** present in the air is called as acid rain. Normally rain water has a pH of 5.6 due to the presence of H^+ ions formed by the reaction of rain water with carbon dioxide present in the atmosphere.

$H_2O(l) + CO_2(g) \rightleftharpoons H_2CO_3(aq)$

$H_2CO_3(aq) \rightleftharpoons H^+(aq) + HCO_3^-(aq)$

When the pH of the rain water drops below 5.6, it is called acid rain.

Formation of acid rain : The oxide of nitrogen undergo oxidation reaction. The reaction with the water vapour present in the atm to form HNO_3.

Step (I) : $NO + O_3 \xrightarrow{h\nu} NO_2 + O_2$

$NO_2 + O_3 \xrightarrow{h\nu} NO_3 + O_2$

$NO_2 + NO_3 \xrightarrow{h\nu} N_2O_5$

$N_2O_5 + H_2O \xrightarrow{h\nu} 2HNO_3$

HNO_3 come down with rain to Earth.

The SO_3 react with water vapour and form H_2SO_4.

Step (II) : $2SO_2 + O_2 \longrightarrow 2SO_3$

$SO_3 + H_2O \longrightarrow H_2SO_4$

Ammonium salts are also formed and can be seen as an atmospheric haze (aerosol of fine particles). Aerosol particles of oxides or ammonium salts in rain drops result in wet-deposition. SO_2 is also absorbed directly on both solid and liquid ground surfaces and is thus deposited as dry-deposition.

Harmful effect of acid-rain

- It causes respiratory ailments in human beings and animals.
- It **corrodes water pipe.** So heavy metal (like Fe,Pb, Cu) are mixed with water which have toxic effect.
- The acid rain **increase the acidity of the lake**. Which is harmful to aquatic ecosystem.
- It is harmful for **agriculture, trees, plants** as it dissolves and washes away nutrients needed for their growth and also damages buildings.

Taj Mahal and Acid Rain : Taj Mahal is reported to be affected by SO_2 and other air pollutants released by oil refinery of Mathura. Acid rain reacts with marble, $CaCO_3$ of Taj Mahal ($CaCO_3 + H_2SO_4 \rightarrow CaSO_4 + H_2O + CO_2$) causing damage to this wonderful monument that has attracted people from around the world.

Green House Effect : The warming of earth due to remission of sun's energy absorbed by the earth. The remission of earth's energy is absorbed by CO_2 molecules and H_2O vapour present near the earth's surface and then its radiation back to the earth, is called as green house effect. So the temp. of the earth is increased is called as global warming.

Important Green House Gases : Methane, water vapour, nitrous oxide, CFCs, ozone and CO_2.

Particulates in Atmospheric Pollution

Smoke is composed of particulate matter. Particulates are the tiny solid or liquid particles suspended in air. These particles are usually individually invisible to the naked eye. Collectively, however, small particles often form a haze that restricts visibility.

Particulates in the atmosphere may be **viable** or **non-viable** :-

(i) Viable particulates - These are the minute living organisms that are dispersed in atmosphere.

Eg. bacteria, fungi, moulds, algae etc.

(ii) Non-viable - These are formed either by the breakdown of larger materials or by the condensation of minute particles and droplets. There are four types of non-viable particulates in the atmosphere : **mists, smoke, fumes and dust.**

(a) **Mists** are produced by particles of spray liquids and the condensation of vapours in air. Examples are portions of herbicides and insecticides that miss their targets and travel through the air to form mists.

(b) **Smoke** denotes very small soot particles produced by burning and combustion of organic matter. Oil smoke, tobacco smoke and carbon smoke are typical examples of this type of particulate emission.

(c) **Fumes** are condenses vapours : fumes of metals are the well-known particulates of this type. Examples of this category also include metallurgical fumes and alkali fumes.

(d) **Dust** consists of the particles produced during crushing, grinding and attribution of solid materials. Non-viable dust particulates in the atmosphere consist of ground limestone, sand tailings from floatation, pulverised coal, cement, fly ash and silica dust.

The effect of particulate pollutants are largely dependent on the particle size. Airborne particles such as dust, fumes, mist etc., are dangerous for human health. Particulate pollutants bigger than **5 microns are likely to lodge in the nasal passage,** whereas particles of about **10 micron enter into lungs easily.** Lead used to be a major air pollutant emitted by vehicles. Leaded petrol used to be the primary source of air-borne lead emission in Indian cities. Lead interferes with the development and maturation of red blood cells.

Smogs

Smogs which describe the "smoke-fog" like condition, are the best-known examples of air pollution that occurs in many cities throughout the world.

There are two types of smogs :

(i) **Classical smogs** - Which occur in cool humid climate and are the result of buildup of **sulphur oxides** and **particulate matter** from fuel combustion. Chemically it is a reducing mixture so also called **reducing smog**.

(ii) **Photochemical smogs** - Which occur in warm, dry and sunny climate and result from the action of sunlight on the nitrogen oxides and hydrocarbons produced by automobiles and factories. Photochemical smog is an **oxidising smog** having a high concentration of oxidising agents whereas classical smog is chemically reducing smog with high concentrations of SO_2. Mostly in those cities which have very large populations and high vehicular density.

Formation of photochemical smog : The chemistry of formation of photochemical smog centres around nitric oxide (NO). At the high temperatures, in the petrol and diesel engines of cars and trucks, N_2 and O_2 react to form a small quantity of NO, which is emitted into troposphere with the exhaust gases. This NO oxidised in air to NO_2 which in turn absorbs energy from sunlight and breaks up into nitric oxide and free oxygen atom. (Photochemical decomposition)

$$NO_2(g) \xrightarrow{h\upsilon} NO(g) + O(g)$$

Oxygen atoms are very reactive and can combine with O_2 to form ozone;

$$O(g) + O_2(g) \longrightarrow O_3(g)$$

The O_3 formed in the above reaction reacts rapidly with the NO(g) formed in reaction to regenerate NO_2. NO_2 is brown gas at high levels can contribute to haze.

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

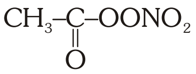
Both NO and O_3 are strong oxidising agents and can react with the unburnt hydrocarbons in the polluted air to produce chemicals such as formaldehyde, acrolein and peroxyacetyl nitrate (PAN) that cause the eyes to water and burn and are harmful to the respiratory system. The brownish haze of photochemical smog is largely attributed to the brown colour of NO_2.

$$3CH_4 + 2O_3 \longrightarrow \underset{\text{Formaldehyde}}{3CH_2 = O} + 3H_2O$$

Acrolein and peroxyacetyl nitrate (PAN) are particularly noxious.

$CH_2 = CHCH = O$

Acrolein



$$CH_3-\underset{\underset{O}{\|}}{C}-OONO_2$$

Peroxyacetyl nitrate (PAN)

Effects of Photochemical Smog

The common components of photochemical smog are ozone, nitric oxide, acrolein, formaldehyde and peroxyacetyl nitrate (PAN). Photochemical smog causes serious health problems. Both ozone and PAN act as powerful eye irritants. Ozone and nitric oxide irritate the nose and throat and their high concentration causes headache, chest pain, dryness of the throat, cough and difficulty in breathing. Photochemical smog leads to cracking of rubber and extensive damage to plant life. It also causes corrosion of metals, stones, building materials, rubber and painted surfaces.

Control of Photochemical Smog

If we control the primary precursors of photochemical smog, such as NO_2 and hydrocarbons, the secondary precursors such as ozone and PAN, the photochemical smog will automatically be reduced. Usually catalytic converters are used in the automobiles, which prevent the release of nitrogen oxide and hydrocarbons to the atmosphere. Certain plants **e.g., Pinus, Juniparus, Quercus, Pyrus** and **Vitis** can metabolise nitrogen oxide and therefore, their plantation could help in this matter.

(B) WATER POLLUTION

The quality of drinking water is very important for human welfare. The pollution of water by sewage has been linked to the spread of diseases such as cholera and typhoid fever. Potesium permanganate or bleaching powder are used in water tanks.

Point Source : Easily identified source or place of pollution is called as point source. e.g., municipal and industrial discharge pipes

Non-point Sources : Those where a source of pollution cannot be easily identified, e.g., agricultural run off (from farm, animals and crop-lands), acid rain, storm-water drainage (from streets, parking lots and lawns) etc.

Table lists the major water pollutants and their sources.

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

In addition, industrial wastes also contaminate water.

(i) Heavy Metals : Metals such as Cd, Pb and Hg may be present in industrial or mining waste. These metals can prove poisonous to humans – Cadmium and mercury can damage kidneys, liver brain and central nervous system. All of these metals are cumulative poisons the body does not excrete them and their concentration builds up.

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

(iii) Acid-polluted water (pH < 3) : This is deadly to most forms of aquatic life. Water downstream from a mine may be contaminated by acid mine drainage, the result of microbial oxidation of discarded waste material at the mine site. Acid mine water principally contain suhphuric acid produced by the oxidation of iron pyrites (FeS_2). Industrial wastes and acid rain may also contribute to the acidity of natural waters.

(iv) Polychlorinated biphenyls (PCBs) : These chemicals are relatively recent additions to the list of contaminants of water. Having high stabilities, PCBs find many applications, for example they are used as fluids in transformer capacitors. PCBs are resistant to oxidation and their release into the environment causes skin disorders in humans. They are reported to be carcinogenic.

Chemical Pollutant

Acids (like sulphuric acid) from mine drainage and salts from many different sources including raw salt used to melt snow and ice in the colder climates (sodium and calcium chloride) are water soluble chemical pollutants. The organic chemicals are another group of substances that are found in polluted water. Petroleum products pollute many sources of water e.g., major oil spills in oceans.

The quality of water is of vital concern for mankind since it is directly linked with human welfare. There are some international standards for drinking water, which must always be obeyed if water is to be used for drinking purposes. These are :

Fluoride : Soluble fluoride is often added to drinking water to bring it up to a concentration of 1 ppm or 1 mg dm^{-3}. The F^- ions make the enamel on teeth much harder by converting hydroxyapatite, $[3(Ca_3(PO_4)_2.Ca(OH)_2]$, the enamel on the surface of the teeth, into much harder fluorapatite, $[3(Ca_3(PO_4)_2.CaF_2]$. However, F^- ion concentration above 2 ppm causes brown mottling of teeth. At the same time, excess fluoride (over 10 ppm) causes harmful effect to bones and teeth.

Lead : The upper limit for the concentration of lead ions in drinking water is 50 ppb. If water is relatively acidic and lead pipes are used for water transport, then the water is liable to get contaminated with lead.

pH : The pH of drinking water should be between 5.5 and 9.5. A decrease in the pH of the water increases the solubility of metal ions.

Other Metals : The maximum recommended levels of common metals in drinking water are as follows.

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

Sulphate : Sulphate is harmless at moderate levles, but excessive sulphate (> 500 ppm) is thought to have a laxative effect.

Nitrate : Excess nitrate in drinking water can lead to methemoglobinemia (blue-baby syndrome). A maximum limit of 50 ppm for the nitrate ion in drinking water has been set.

Causes of Water Pollution

(i) Pathogens: The most serious water pollutants are the disease causing agents called pathogens. Pathogens include bacteria and other organisms that enter water from domestic sewage and animal excreta. Human excreta contain bacteria such as Escherichia coli and Streptococcus faecalis which cause gastrointestinal diseases.

(ii) Organic wastes: The other major water pollutant is organic matter such as leaves, grass, trash etc. They pollute water as a consequence of run off. Excessive phytoplankton growth within water is also a cause of water pollution. These wastes are biodegradable.

Importance of Dissolved Oxygen in Water

The large population of bacteria decomposes organic matter present in water. They consume oxygen dissolved in water. The amount of oxygen that water can hold in the solution is limited. In cold water, dissolved oxygen (DO) can reach a concentration up to 10 ppm (parts per million), whereas oxygen in air is about 200,000 ppm. That is why even a moderate amount of organic matter when decomposes in water can deplete the water of its dissolved oxygen. The concentration of dissolved oxygen in water is very important for aquatic life . If the concentration of dissolved oxygen of water is below 6 ppm, the growth of fish gets inhibited. Oxygen reaches water either through atmosphere or from the process of photosynthesis carried out by many aquatic green plants during day light. However, during night, photosynthesis stops but the plants continue to respire, resulting in reduction of dissolved oxygen. The dissolved oxygen is also used by microorganisms to oxidise organic matter.

Biochemical Oxygen Demand (BOD) and Chemical Oxygen Deman (COD)

If too much of organic matter is added to water, all the available oxygen is used up. This causes oxygen dependent aquatic life to die. Thus, anaerobic bacteria (which do not require oxygen) begin to break down the organic waste and produce chemicals that have a foul smell and are harmful to human health. Aerobic (oxygen requiring) bacteria degrade these organic wastes and keep the water depleted in dissolved oxygen. Thus, the amount of oxygen required by bacteria to break down the organic matter present in a certain volume of a sample of water, is called **Biochemical Oxygen Demand (BOD)**. The amount of BOD in the water is a measure of the amount of organic material in the water, in terms of how much oxygen will be required to break it down biologically. Clean the water, in terms of how much oxygen will be required to break it down biologically. Clean water would have BOD value of less than 5 ppm whereas highly polluted water could have a BOD value of 17 ppm or more.

Chemical Oxygen Demand (COD) :

COD is the oxygen requirement by chemical $K_2Cr_2O_7$ for oxidation of total organic matter (biodegradable + non biodegradable) in water.

Note : COD value is always higher than BOD value.

BEGINNER'S BOX-2

1. Major pollutant in Jet plane emission is -
(1) SO_2 (2) CFC (3) CO (4) CCl_4

2. What is B.O.D.
(1) The amount of O_2 utilised by organisms in water
(2) The amount of O_2 utilized by micro organisms for decomposition
(3) The total amount of O_2 present in water
(4) All of the above

3. What is the intensity of sound in normal conversation
(1) 10 – 20 decibal (2) 30 – 60 decibal (3) 70 – 90 decibal (4) 120 – 150 decibal

4. Which of the following is absent in polluted water
(1) Hydrilla (2) Water hyacinth (3) Larva of stone fly (4) Blue green algae

5. Maximum green house gas released by which country
(1) India (2) France (3) U.S.A (4) Britain

(C) LAND OR SOIL POLLUTION

Most of the land pollution is caused by pesticides and other chemicals which are added to the soil grow better crops. Often, a pesticide poisons many more organisms than those intended. Some of these poison pass through food chains and eventually reach harmful proportions. Solid wastes are another cause of land pollution.

Pesticides

Pesticides are substances that are used to kill or block the reproductive processes of unwanted organisms. Pesticides are basically synthetic toxic chemicals with ecological repercussions. **Eg. DDT, Malathion**

The repeated use of the same or similar pesticides give rise to pests that are resistant to that group of pesticides thus making the pesticides ineffective. Therefore, as insect resistance of DDT increased, other organic toxins such as **Aldrin** and **Dieldrin** were introduced in the market by pesticide industry. Most of the organic toxins are water insoluble and nonbiodegradable. These high persistent toxins are, therefore, transferred from lower trophic level to higher trophic level through food chain. Over the time, the concentration of toxins in higher animals reach a level which causes serious metabolic and physiological disorders.

In respon chlorinated org; to high persistence of ; toxins, a new series of less persistent or more bio-degradable products called **organo-phosphates** and **carbamates** have been introduced in the market. But these chemicals are severe nerve toxins and hence more harmful to humans. As a result, there are reports of some pesticides related deaths of agricultural field workers. Insects have become resistant to these insecticides also. The insecticide industry is engaged in developing new groups of insecticides.

These days, the pesticide industry has shifted its attention to **herbicides** such as **sodium chlorate ($NaClO_3$)**, **sodium arsinite (Na_3AsO_3)** and many others. During the first half of the last century, the shift from mechanical to chemical weed control had provided the industry with flourishing economic market. But one must remember that these are also not environment friendly.

Most herbicides are toxic to mammals but are not as persistent as organo-chlorides. These chemicals decompose in a few months. Like organo-chlorides, these too become concentrated in the food web. Some herbicides cause birth defects. Studies show that cornfields sprayed with herbicides are more prone to insect attack and plant disease than fields that are weeded manually.

INDUSTRIAL WASTE

Industrial solid wastes : (i) Biodegradable - Biodegradable wastes are generated by cotton mills, food processing units, paper mills and textile factories.

(ii) Non-biodegradable - These wastes are generated by thermal power plants which produce fly ash; integrated iron and steel plants which produce blast furnace slag and steel melting slag.

Industries manufacturing aluminium, zinc and copper produce mud and tailings. Fertilizer industries produce gypsum. Hazardous wastes such as inflammables, composite explosives or highly reactive substances are produced by industries dealing in metals, chemicals, drugs, pharmaceuticals, dyes, pesticides, rubber goods etc.

STRATEGY FOR CONTROL OF ENVIRONMENTAL POLLUTION

The management of waste : The production and improper disposal of waste are causes for a great deal of environmental pollution. In addition to the household waste which included sewage and municipal garbage, many toxic industrial wastes from manufacturing processes require treatment and/or safe disposal.

Recycling : When materials are recycled, there are several benefits, apart from saving on the cost of raw materials, waste disposal costs are reduced. Examples of recycling by industry are :

1. the collection and recycling of glass (in bottle banks);
2. the use of scrap metal in the manufacture of steel;
3. the recovery of energy from burning combustible waste.

Thus recycling converts waste into wealth.

Green Fuel : Fuel obtained from plastic waste has high octane rating. It contains no lead and is known as “green fuel”.

Biogas : A pilot plant has been set up, where after removing ferrous metals, plastic, glass, paper etc. from garbage, it is mixed with water. It is then cultured with bacterial species for producing methane, commonly known as biogas. The remaining product is used as manure and biogas is used to produce electricity.

Digestion : Anaerobic digestion occurs when microganisms degrade wastes in the absence of oxygen. It may be used to treat sewage sludge, but the process can also be used to degrade a variety of toxic organic wastes. Carbon dioxide and methane, which may be used as a fuel, are the products. The overall process is the conversion of the organic material into carbon dioxide and methane i.e.

Dumping : Ocean dumping of sewage sludge has been widely practiced in the seas around the worked. However, the parctice of application to sludge the land is increasing. The sludge contains nitrogen and phosphorus which make it useful as a fertilizer. Urban areas produce sludge with high toxic metal content, so the amount of such sludge dumped in this way must be carefully controlled.

Incineration : Incineration converts organic materials to CO_2 and H_2O. It may serve to destroy household waste, chemical waste and biological waste (e.g. from hospitals). A high temperature is required usually in excess of 1000°C, and a plentiful supply of oxygen. Exhause gases must be filtered. The process greatly reduced the volume of waste-an inorganic ash is left behing, which is disposed of as landfill.

GREEN CHEMISTRY (A NEW ROUTE TO PROTECTION OF ENVIRONMENT)

Green chemistry is a way of thinking and is about utilising the existing knowledge and principles of chemistry and other sciences to reduce the adverse impact on environment. Green chemistry is a production process that would bring about minimum pollution or deterioration to the environment. The byproducts generated during a process, if not used gainfully, add to the environmental pollution. Such processes are not only environmental unfriendly but also cost-ineffective. The waste generation and its disposal both are economically unsound. Utilisation of existing knowledge base for reducing the chemical hazards along with the developmental activities is the foundation of green chemistry.

Green chemistry, in a nutshell, is a cost effective approach which involves reduction in material, energy consumption and waste generation.

It is well known that organic solvents such as benzene, toluene, carbon tetrachloride etc., are highly toxic. It may be worthwhile to carry out synthetic reactions in aqueous medium since water has high specific heat and low volatility. Water is cost effective, noninflammable and devoid of any carcinogenic effects.

Green Chemistry in day-to-day Life

(i) Dry Cleaning of Clothes

Tetra chlroroethene ($Cl_2C{=}CCl_2$) was earlier used as solvent for dry cleaning. The compound contaminates the ground water and is also a suspected carcinogen. The process using this compound is now being replaced by a process, where liquefied carbondioxide, with a suitable detergent is used. Replacement of halogenated solvent by liquid CO_2 will result in less harm to ground water. These days hydrogen peroxide (H_2O_2) is used for the purpose of bleaching clothes in the process of laundary, which gives better results and makes use of lesser amount of water.

(ii) Bleaching of Paper

Chlorine gas was used earlier for bleaching paper. These days, hydrogen peroxide (H_2O_2) with suitable catalyst, which promotes the bleaching action of hydrogen peroxide, is used.

(iii) Synthesis of Chemicals

Ethanal (CH_3CHO) is now commercially prepared by one step oxidation of ethene in the presence of ionic catalyst in aqueous medium with a yield of 90%.

$CH_2 = CH_2 + O_2 \longrightarrow CH_3CHO$ (90%)

Some important points :

- Stratosphere - In this ozone is present and it extends from 10 - 50 km from sea level.
- The lowest region of atmosphere in which human beings along with other organisms live is called troposphere. which extends upto 10 km from sea level
- Bhopal gas tragedy - A major gas tragedy took place on the night of december 2, 1984, when a dense cloud of deadly methyl isocyanate (MIC) gas leaked from a storage tank of the Union Carbide Ltd. plant in Bhopal.

PURIFICATION METHODS

Distillation Techniques :

Type	Conditions	Examples
(A) Simple distillation	(i) When liquid sample has non volatile impurities (ii) When boiling point difference is 80° K or more.	(i) Mixture of chloroform (BP = 334K) and Aniline (BP = 457K) (ii) Mixture of Ether (BP = 308K) & Toluene (BP = 384K) (iii) Hexane (342K) and Toulene(384K)
(B) Fractional distillation	When BP difference is 10°	(i) Crude oil in petroleum industry (ii) Acetone (329) and Methyl alcohol(338K)
(C) Distillation under reduced pressure (Vacuum distillation)	When liquid boils at higher temperature and it may decompose before BP is attained.	(i) Concentration of sugar juice (ii) Recovery of glycerol from spent lye. (iii) Glycerol
(D) Steam distillation	When the substance is immiscible with water and steam volatile. $\underset{\text{Vapour pressure}}{P} = \underset{\text{Vapour pressure of Organic liquid}}{P_1} + \underset{\text{Vapour pressure of water}}{P_2}$	(i) Aniline is separated from water (ii) Turpentine oil (iii) Nitro Benzene (iv) Bromo Benzene (v) Naphthalene (vi) o-Nitrophenol

QUALITATIVE AND QUANTITATIVE ANALYSIS OF ORGANIC COMPOUND

Qualitative analysis : Detection of element present in compound :-

(i) Detection of C and H : Compound heated with cupric oxide and produced vapour is passes through lime water or anhydrous $CuSO_4$. If lime water turn milky, it shows presence of CO_2 or carbon. If anhydrous $CuSO_4$ turn blue than it shows presence of H_2O or hydrogen.

$$\text{Compound} + CuO \xrightarrow{\Delta} CO_2 + H_2O + Cu$$

$$CO_2 + Ca(OH)_2 \longrightarrow \underset{\text{Milky}}{CaCO_3 \downarrow} + H_2O$$

$$H_2O + \underset{\text{Colourless}}{CuSO_4} \longrightarrow \underset{\text{Blue}}{CuSO_4 . 5H_2O}$$

(ii) Detection of Nitrogen, Sulphur and halogen :- [Lassaigne's Test]

Preparation of lassaigne's solution or sodium extract.

Compound is heated with sodium in combustion tube and poured in cold water and heated for some time it gives lassaigne's solution or sodium extract.

In lassaigne solution elements present in compound get converted from covalent to ionic.

e.g $Na + C + N \longrightarrow NaCN$

$Na + S \longrightarrow Na_2S$

$Na + X \longrightarrow NaX$ (Ionic)

(i) **Test of Nitrogen :** Sodium extract is boiled with $FeSO_4$ which gives sodium hexacyano ferrate (II). Now few amount of $FeCl_3$ is added which gives prussian blue coloured ferro ferri cyanide that shows presence of Nitrogen.

$$6\ NaCN + FeSO_4 \longrightarrow Na_4[Fe(CN)_6] + Na_2SO_4$$

$$Na_4[Fe(CN)_6] + FeCl_3 \longrightarrow \underset{\text{Prussian blue colour}}{Fe_4[Fe(CN)_6]_3} + NaCl$$

(ii) **Test of sulphur :** Sulphur is present in form of Na_2S

(a) Sodium Extract is acidified with acetic acid and lead acetate is added to it which gives black ppt of PbS and shows the presence of Sulphur

$$Na_2S + (CH_3COO)_2\,Pb \longrightarrow 2CH_3COONa + PbS(\text{Black})\downarrow$$

(b) **Nitroprusside test**

Sodium extract + Sodium Nitroprusside $\longrightarrow$ Violet colour.

$$Na_2S + Na_2\,[Fe(CN)_5\,NO] \longrightarrow Na_4\,[Fe(CN)_5\,NOS]\ (\text{Violet colour})$$

Note : If Nitrogen and sulphur both are present in compound then they form sodium thiocyanate in sodium extract.

$$Na + C + N + S \longrightarrow NaCNS$$

during test of Nitrogen in place of prussian blue, we get blood red colour of $Fe(CNS)_3$

$$3NaCNS + FeCl_3 \longrightarrow \underset{\text{(Blood Red)}}{Fe(CNS)_3} + 3HCl$$

Therefore sodium extract is prepared in presence of excess of sodium which decomposes sodium thiocyanate.

$$NaCNS + Na(\text{Excess}) \longrightarrow Na_2S + NaCN$$

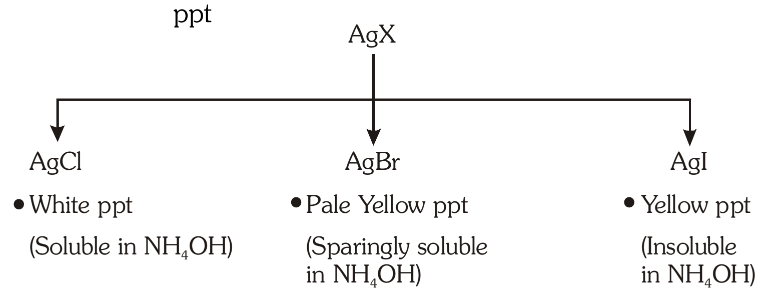
(iii) Test of halogen : Before the test of halogen sodium extract is boiled with conc. HNO_3 to decompose the Na_2S and NaCN in form of H_2S and HCN

$$Na_2S + \text{Conc. } HNO_3 \longrightarrow H_2S \uparrow$$

$$NaCN + \text{Conc. } HNO_3 \longrightarrow HCN$$

Now sodium extract is treated with silver nitrate which gives precipitate of AgX.

$$NaX + AgNO_3 \longrightarrow \underset{\text{ppt}}{AgX} + NaNO_3$$



(iv) Test of phosphorous : Compound is heated with an oxidising agent [Na_2O_2] so the phosphorus in compound is converted in to phosphate which on further reaction with ammonium molybdate in presence of HNO_3 gives canary yellow ppt of ammonium phospho molybdate and shows the presence of phosphorus.

$$\text{Compound} + Na_2O_2 \longrightarrow Na_3PO_4$$

$$Na_3PO_4 + 3HNO_3 \longrightarrow H_3PO_4 + 3NaNO_3$$

$$H_3PO_4 + 12(NH_4)_2MoO_4 + 21\ HNO_3 \longrightarrow \underset{\text{(canary yellow)}}{(NH_4)_3PO_4 \cdot 12\ MoO_3} + 21\ NH_4NO_3 + 12\ H_2O$$

Quantitative analysis : Calculation of precentage of element in compound.

(i) Estimation of carbon and hydrogen : [Leibigs method]

A known mass of organic compound is burnt in presence of excess of CuO so carbon and hydrogen oxidise to CO_2 and H_2O respectively.

Now above vapour is passed through weighed u-tube having anhyd. $CaCl_2$ followed by KOH solution. anhyd. $CaCl_2$ absorbs H_2O while KOH absorbs CO_2.

Now we can calculate the amount of H_2O and CO_2 produced in combustion.

<u>Calculation of % of C and H</u> :-

If mass of organic compound is W gm.

mass of H_2O or CO_2 produced is m gm

<u>For H</u> $\underset{18}{H_2O} \equiv \underset{2}{2H}$

$\therefore$ 18 gm of H_2O contains 2 gm of hydrogen

$\because$ 1 gm of H_2O contains $\frac{2}{18}$ gm of hydrogen

$\because$ m gm of H_2O contains $\frac{2}{18} \times$ m gm of hydrogen

Precentage of hydrogen in W gm organic substance = $\boxed{\%\text{ of H} = \frac{2}{18} \times \frac{m}{W} \times 100}$

<u>For C</u> $\underset{44\text{ gm}}{CO_2} \equiv \underset{12\text{ gm}}{C}$

$\because$ 44 gm CO_2 contain 12 gm carbon

1 gm CO_2 contain $\frac{12}{44}$ gm carbon

m gm CO_2 contain $\frac{12}{44} \times$ m gm carbon

% of C in W gm organic substance = $\boxed{\%\text{ of C} = \frac{12}{44} \times \frac{m}{W} \times 100}$

Estimation of Nitrogen :

These are two method for the estimation of nitrogen

(i) Duma's method [in form of N_2]

(ii) Kjeldhal's method [in form of NH_3]

(1) Duma's method :

Organic compound is heated with CuO to give free Nitrogen, CO_2 and H_2O.

$$C_x H_y N_z + CuO \longrightarrow x\,CO_2 + \frac{y}{2}H_2O + \frac{z}{2}\,N_2 + Cu$$

Now the above mixture is collected over Aq. KOH in nitrometer tube which absorb all the gases except N_2. Now volume of nitrogen is calculated at STP.

$$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$$

V_1 = Volume of N_2 gas.

P_1 = Pressure of N_2 – Aqueous tension

T_1 = Room temperature

$$\boxed{V_2 = \frac{P_1V_1 \times 273}{T_1 \times 760}}$$

Calculation of % of Nitrogen

$\therefore$ 22400 ml of N_2 at STP weight = 28 gm

$\because$ V ml of N_2 at STP weight = $\frac{28}{22400} \times V$ gm

% of Nitrogen in W gm organic substance = $\boxed{\%\text{ of N} = \frac{28}{22400} \times \frac{V}{W} \times 100}$

(2) Kjeldhal's method : Compound containing nitrogen is heated with H_2SO_4 so compound gets converted in to ammonium sulphate.

Now above mixture is heated with excess of NaOH which liberates Ammonia gas.

Ammonia gas is absorbed in excess of standard solution of H_2SO_4.

The amount of ammonia produced is determined by estimating the amount of H_2SO_4 consumed.

Estimation of H_2SO_4 is done by titrating the H_2SO_4 left after absorption of ammonia with standard alkali solution.

The difference between the initial amount of acid taken and that left after absorption of ammonia is the amount of H_2SO_4 used.

Organic substance + $H_2SO_4 \longrightarrow (NH_4)_2SO_4$

$$(NH_4)_2SO_4 + NaOH \longrightarrow Na_2SO_4 + 2NH_3\uparrow + H_2O$$

$$NH_3 + H_2SO_4 \longrightarrow (NH_4)_2SO_4$$

If Normality of H_2SO_4 taken = N_1

Volume of H_2SO_4 taken = V_1

If Normality of NaOH used = N_2

Volume of NaOH used = V_2

$\because$ Milli equivalent of H_2SO_4 used for neutralisation of produced NH_3 = $(N_1V_1 - N_2V_2)$

Which is equal to the milli equivalent of NH_3

$\because$ 1000 ml of 1N NH_3 contain 14 gm Nitrogen.

$\because$ $(N_1V_1 - N_2V_2)$ ml of 1N NH_3 contain $\frac{14}{1000} \times (N_1V_1 - N_2V_2)$ gm Nitrogen.

If mass of organic substance is W g.

Then % of N = $\frac{14}{1000} \times \frac{(N_1V_1 - N_2V_2)}{W} \times 100$

$$\boxed{\%\ of\ N = \frac{1.4}{W} \times (N_1V_1 - N_2V_2)} \quad \text{or} \quad \boxed{\%\text{ of N} = \frac{1.4}{W} \times NV}$$

N = Normality of H_2SO_4 V = Volume of H_2SO_4 used in neutralisation.

(3) Estimation of halogen : (by carius method)

A known mass of organic compound is heated with fuming HNO_3 in presence of $AgNO_3$. The halogen gets ppt in the form of AgX which can be filtered, washed and dried and weighed.

If mass of organic substance = W gm

mass of ppt = m gm

AgX	≡	X
[108 + atomic mass of X]		[Atomic mass of X]

mass of halogen in m gm AgX is = $\frac{\text{Atomic mass of X}}{\text{Molar mass of AgX}} \times \text{m gm}$

$$\boxed{\%\text{ of halogen} = \frac{\text{Atomic mass of X}}{\text{Molar mass of AgX}} \times \frac{m}{W} \times 100}$$

(4) Estimation of sulphur : (by Carius method)

Sulphur is estimated in the form of $BaSO_4$.

Now ppt is filtered, washed, dried and weighed.

$BaSO_4$	≡	S
233 gm		32 gm

mass of sulphur in m gm ppt of $BaSO_4$ = $\frac{32}{233} \times \text{m gm}$

% of sulphur in W gm organic sub.

$$\boxed{\%\text{ of S} = \frac{32}{233} \times \frac{m}{W} \times 100}$$

(5) Estimation of phosphorus : (by Carius method)

Phosphorus is estimated in the form of magnesium pyrophosphate ($Mg_2P_2O_7$)

$Mg_2P_2O_7$	≡	P_2
222 gm		31 × 2 gm

mass of sulphur in m gm $Mg_2P_2O_7$ is

$$\frac{62}{222} \times \text{m gm}$$

% of P in W gm organic sub.

$$\boxed{\%\text{ of P} = \frac{62}{222} \times \frac{m}{W} \times 100}$$

SOME SOLVED EXAMPLES

Q.1 0.3960 gm of an organic compound on combustion gives 0.792 gm CO_2 and 0.324 gm of H_2O. Calculate the % of C and H

Ans. $\% \text{ of C} = \frac{12}{44} \times \frac{\text{Wt. of } CO_2}{\text{Wt. of compound}} \times 100$

$$= \frac{12}{44} \times \frac{0.792}{0.396} \times 100 = 54.55\%$$

$$\% \text{ of H} = \frac{2}{18} \times \frac{\text{Wt. of } H_2O}{\text{Wt. of compound}} \times 100$$

$$= \frac{2}{18} \times \frac{0.324}{0.396} \times 100 = 9.09\%$$

Q.2 0.25 gm of an organic compound at NTP gives 31 ml of N_2 gas by Duma's method. Find out of % of N

Ans. $\% \text{ of N} = \frac{28}{22400} \times \frac{V}{W} \times 100$

$$= \frac{28}{22400} \times \frac{31}{0.25} \times 100 = 15.5\%$$

Q.3 31.7 ml of moist N_2 was obtained from 0.2033 gm of an organic compound in Duma's method at 14°C and 758 mm pressure. If aq. tension at 14°C = 14 mm than calculate % of N

Ans. P_1 = Pressure of N_2 – Aq. tension = 758 – 14 = 744 mm

$P_2 = 760$ mm $T_2 = 273$

$V_1 = 31.7$

$T_1 = 273 + 14$

$T_1 = 287$

$$V_2 = \frac{P_1V_1}{T_1} \times \frac{273}{760} = \frac{744 \times 31.7 \times 273}{287 \times 760} = 29.51$$

$$\% \text{ N} = \frac{28}{22400} \times \frac{V}{W} \times 100 = \frac{28}{22400} \times \frac{29.51}{0.2033} \times 100 = 18.15\ \%$$

Q.4 30 ml 0.25 N H_2SO_4 are used in neutralizing NH_3 obtained from 0.75 gm of an organic compound in Kjeldhal's method find out % of N in the compound

Ans. $N\% = \frac{1.4}{W} \times NV = \frac{14}{0.75} \times 30 \times 0.25 = 14\%$

Q.5 In Kjeldhal's method, NH_3 evolved from 0.25 gm of an organic compound was passed into 30 ml N/2 H_2SO_4. 50 ml N/10 NaOH were required to neutralize the unreact acid, calculate % of N.

Ans. 0.25 gm compound $\longrightarrow$ NH_3

$$\downarrow$$

$$30\ m\ell\ \frac{N}{2} H_2SO_4$$

$$\downarrow$$

$$50\ m\ell\ \frac{N}{10} \text{NaOH}$$

$$50\ m\ell \times \frac{N}{10} = 5\ m\ell \text{ N NaOH} \equiv 5\ m\ell \text{ N } H_2SO_4$$

Remaining acid = 5mℓ N H_2SO_4

Consumed acid

$$=\left(30\ \text{m}\ell \times \frac{N}{2} - 5\ \text{m}\ell\ N\right) = 10\ \text{m}\ell\ N\ H_2SO_4$$

$$\%\ N = \frac{1.4}{W} \times NV = \frac{1.4}{0.25} \times 10 = 56\ \%$$

Q.6 0.35 gm of an organic compound was analysed by Kjeldhal's method. Ammonia evolved was absorbed in 100 mℓ $\frac{N}{10}$ H_2SO_4. Unused acid required 30 mℓ $\frac{N}{10}$ NaOH for neutralisation calculate % of N

Ans. W=0.35 gm → NH_3

$$\downarrow$$

$$100\ \text{m}\ell\ \frac{N}{10}\ H_2SO_4\ (10\ \text{m}\ell\ N\ H_2SO_4)$$

$$\downarrow$$

$$30\ \text{m}\ell\ \frac{N}{10}\ NaOH\ (3\ \text{m}\ell\ N\ NaOH)$$

Remaining acid 3mℓ N H_2SO_4

Consumed acid (10 ml N – 3mℓ N) = 7 mℓ N H_2SO_4

$$\%\ \text{of}\ N = \frac{1.4}{W} \times NV = \frac{1.4}{0.35} \times 1 \times 7 = 28\ \%$$

Q.7 In Duma's method estimation of nitrogen, 0.3g of an organic compound gave 50 ml of nitrogen collected at 300 K temperature and 715 mm pressure. Calculate the percentage composition of nitrogen in the compound. (Aqueous tension at 300K = 15 mm)

Ans. Volume of nitrogen collected at 300K and 715 mm pressure is 50 mℓ

Actual pressure = 715 – 15 = 700 mm

$$\text{Volume of nitrogen at STP} = \frac{273 \times 700 \times 50}{300 \times 760} = 41.9\text{m}\ell$$

22,400 mℓ of N_2 at STP weighs = 28 g

$$41.9\ \text{m}\ell\ \text{of nitrogen weights} = \frac{28 \times 41.9}{22400}\ g$$

$$\text{Percentage of nitrogen} = \frac{28 \times 41.9 \times 100}{22400 \times 0.3} = 17.46\%$$

Q.8 During estimation of nirtogen present in an organic compound by Kjeldahl's method, the ammonia evolved from 0.5 g of the compound in Kjeldahl's estimation of nitrogen, neutralized 10 mℓ of 1 M H_2SO_4. Find out the percentage of nitrogen in the compound.

Ans. 1 M of 10 ml H_2SO_4 = 1M of 20 mℓ NH_3 1000 mℓ of 1M ammonia contains 14 g nitrogen.

$$20\ \text{m}\ell\ \text{of 1 M ammonia contains} \frac{14 \times 20}{1000}\ g\ \text{nitrogen.}$$

$$\text{Percentage of nitrogen} = \frac{14 \times 20 \times 100}{1000 \times 0.5} = 56.0\%$$

Q.9 In carius method of estimation of halogen, 0.15g of an organic compound gave 0.12 g of AgBr. Find out the percentage of bromine in the compound.

Ans. Molar mass of AgBr = 108 + 80 = 188 g mol^{-1}

188g AgBr contains 80 g bromine.

0.12 g AgBr contains $\frac{80 \times 0.12}{188}$ g bromine.

Percentage of bromine $= \frac{80 \times 0.12 \times 100}{188 \times 0.15} = 34.04\%$

Q.10 In sulphur estimation, 0.157g of an organic compoud gave 0.4813 g of barium sulphate. What is the percentage of sulphur in the compound ?

Ans. Molecular mass of $BaSO_4$ = 137 + 32 + 64 = 233g

233g $BaSO_4$ contains 32 g sulphur

0.4813g $BaSO_4$ contains $\frac{32 \times 0.4813}{233}$ g sulphur

Percentage of sulphur $= \frac{32 \times 0.4813 \times 100}{233 \times 0.157} = 42.10\%$

ANSWER KEY

BEGINNER'S BOX-1	Que.	1	2	3	4	5
	Ans.	**1**	**3**	**3**	**4**	**2**

BEGINNER'S BOX-2	Que.	1	2	3	4	5
	Ans.	**2**	**2**	**2**	**3**	**3**

EXERCISE-I (Conceptual Questions)

Build Up Your Understanding

1. Which is not a renewable source
(1) Forest (2) Coal
(3) Water (4) Forest organism

2. Noosphere is synonyms of
(1) Environment (2) Atmosphere
(3) Hydrosphere (4) Stratosphere

3. When biosphere turns into human dominated environment it is called
(1) Noosphere (2) Troposphere
(3) Mesosphere (4) Man sphere

4. The living organisms on or around the earth consitute
(1) Biome
(2) Biosphere
(3) Community
(4) Biocoenosis

5. What is the correct sequence of atmospheric layers starting from earth
(1) Stratosphere troposphere, mesosphere, thermosphere
(2) Troposphere, startosphere, mesosphere, thermosphere
(3) Mesosphere, troposphere, stratosphere, thermosphere
(4) Thermosphere, mesophere, stratosphere, troposphere

6. On earth all living organisms constitute
(1) Community (2) Biome
(3) Association (4) Biosphere

7. Which of the following is the non conventional source of energy
(1) Coal
(2) Petroleum
(3) Electricity from nuclear power plants
(4) Solar radiations

8. Petroleum resource is
(1) Renewable
(2) Non renewable
(3) Synthetic & biodegradable
(4) Infinite & unconventional

9. The main aim of plant conservation is -
(1) To conserve the necessary ecological activities and life supporting systems
(2) To conserve species diversity and range of genetic meterial
(3) Both the above
(4) None of the above

10. Which will not cause any atmospheric pollution
(1) Hydrogen (2) Sulphur dioxide
(3) Carbon dioxed (4) Carbon monoxide

11. Which of the following is the main factor of water pollution
(1) Smoke (2) Industrial waste
(3) Detergent (4) Ammonia

12. Main air pollutant among the following is
(1) CO (2) CO_2
(3) N_2 (4) Sulphur

13. Which is more important for water pollution
(1) Sound (2) SO_2
(3) Salts of arsenic (4) Sewage

14. Pollution can be controlled by
(1) Sewage treatment
(2) Checking atomic blasts
(3) Manufacturing electrically operated vehicles
(4) All the above

15. In cities like Bombay and Calcultta the major air pollutants are
(1) Ozone
(2) Carbon monoxide and oxides of Sulphur
(3) Hydrocarbons and not air
(4) Algal spores and marsh gas

16. Which is the greatest air pollutant these days
(1) Factories (2) Motor vehicles
(3) Domestic appliances (4) animals

17. Removal of the soil by the action of wind and water is known as
(1) Erosion (2) Fossilization
(3) Leaching (4) Calcification

18. Acid rain occure due to atmospheric pollution of
(1) SO_2 (2) NH_3
(3) CO_2 (4) N_2O

19. Photochemical smog was first observed in -
(1) London (2) Lons Angeles
(3) Paris (4) Tokyo

20. Ozone layer of upper atmosphere is being destroyed by
(1) Sulphurdioxide (2) Carbondioxide
(3) Chlorofluorocarbon (4) Smog

21. Most hazardous metal pollutant of automobile exhaust is
(1) Hg (2) Cd (3) Pb (4) Cu

22. SO_2 pollution is indicated by
(1) Grasses (2) Mosses (3) Lichens (4) Fossils

23. B.O.D. is connected with
(1) Organic matter (2) Microbes
(3) Both (4) None

24. Acid rain is due to increase in atmospheric concentration of
(1) Ozone and dust (2) CO_2 and CO
(3) SO_3 and CO (4) SO_2 and NO_2

25. Soil erosion is greater when
(1) No rain occurs
(2) Winds do not blow
(3) The rainfall is evenly distributed
(4) The Rainfall is received in heavy down pour

26. Soil erosion can be prevented by
(1) Over grazing
(2) Removal of vagetation
(3) Afforestation (Plantation)
(4) Increasing bird population

27. Soil conservation is the process where
(1) Soil is aerated
(2) Soil erosion is allowed
(3) Soil is protected against loss
(4) Sterile soil is converted into fertile soil

28. Ether and benzene can be separated by :-
(1) Filtration (2) Distillation
(3) Crystallization (4) Sublimation

EXERCISE-I (Conceptual Questions) ANSWER KEY

Que.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans.	**2**	**1**	**1**	**2**	**2**	**4**	**4**	**2**	**1**	**1**	**2**	**1**	**3**	**4**	**2**
Que.	16	17	18	19	20	21	22	23	24	25	26	27	28		
Ans.	**2**	**1**	**1**	**2**	**3**	**3**	**3**	**3**	**4**	**4**	**3**	**3**	**2**		

EXERCISE-II (Previous Year Questions) AIPMT/NEET & AIIMS (2006-2018)

AIPMT 2008

1. An organic compound contains carbon, hydrogen and oxygen. Its elemental analysis gave C, 38.71% and H, 9.67%. The empirical formula of the compound would be :-

(1) CHO (2) CH_4O (3) CH_3O (4) CH_2O

AIPMT Pre.-2011

2. Which one of the following statement is not true ?

(1) pH of drinking water should be between 5.5–9.5

(2) Concentration of DO below 6 ppm is good for the growth of fish

(3) Clean water would have BOD value of less then 5 ppm

(4) Oxides of sulphur, nitrogen and carbon are the most widepread air pollutant

3. In Dumas' method of estimation of nitrogen 0.35g of an organic compound gave 55 mL of nitrogen collected at 300 K temperature and 715 mm pressure. The percentage compostion of nitrogen in the compound would be :

(Aqueous tension at 300 K = 15 mm)

(1) 15.45 (2) 16.45 (3) 17.45 (4) 14.45

4. The Lassaigne's extract is boiled with conc HNO_3 while testing for the halogens. By doing so it :-

(1) decomposes Na_2S and NaCN, if formed

(2) helps in the precipitation of AgCl

(3) increases the solubility product of AgCl

(4) increases the concentration of NO_3^- ions

AIPMT Pre.-2012

5. Which one of the following statements regarding photochemical smog is not correct?

(1) Photochemical smog is formed through photochemical reaction involving solar energy

(2) Photochemical smog does not cause irritation in eyes and throat.

(3) Carbon monoxide does not play any role in photochemical smog formation

(4) Photochemical smog is an oxidising agent in character

AIIMS 2013

6. Which of the following is not a green house gas:-

(1) Hydrogen (2) Carbon dioxide

(3) Methane (4) Nitrous oxide or N_2O

AIPMT 2014

7. Which one of the following is **not** a common component of Photochemical Smog?

(1) Ozone (2) Acrolein

(3) Peroxyacetyl nitrate (4) Chlorofluorocarbons

8. In the Kjeldahl's method for estimation of nitrogen present in a soil sample, ammonia evolved from 0.75 g of sample neutralized 10 mL of 1 M H_2SO_4. The percentage of nitrogen in the soil is :

(1) 37.33 (2) 45.33

(3) 35.33 (4) 43.33

AIIMS 2014

9. Concentration of Peroxy Acetyl Nitrate (PAN) is maximum in :-

(1) Fog (2) Smoke

(3) Smog (4) Photochemical smog

AIPMT 2015

10. In Duma's method for estimation of nitrogen, 0.25 g of an organic compound gave 40 mL of nitrogen collected at 300 K temperature and 725 mm pressure. If the aqueous tension at 300 K is 25 mm, the percentage of nitrogen in the compound is :-

(1) 18.20 (2) 16.76

(3) 15.76 (4) 17.36

AIIMS 2015

11. If BOD of a water body has a 20 ppm then what can you conclude?

(1) polluted (2) light polluted

(3) clean water (4) highly polluted

NEET(UG) 2017

12. The most suitable method of separation of 1 : 1 mixture of ortho and para-nitrophenols is :

(1) Chromatography (2) Crystallisation

(3) Steam distillation (4) Sublimation

13. Which of the following is a sink for CO ?

(1) Micro organism present in the soil

(2) Oceans

(3) Plants

(4) Haemoglobin

AIIMS 2017

14. Which of the following is Herbiside

(1) Sodium chlorate

(2) Organo carbonates

(3) Potassium dihydrogen phosphate

(4) Ammonium nitrate

NEET(UG) 2018

15. Which oxide of nitrogen is ***not*** a common pollutant introduced into the atmosphere both due to natural and human activity ?

(1) N_2O_5 (2) NO_2

(3) N_2O (4) NO

EXERCISE-II (Previous Year Questions) ANSWER KEY

Que.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans.	**3**	**2**	**2**	**1**	**2**	**1**	**4**	**1**	**4**	**2**	**4**	**3**	**1**	**1**	**1**

EXERCISE-III (Analytical Questions) Check Your Understanding

1. The term biosphere is used for the zone of the earth where life exists

(1) On the lithospere
(2) In the hydrosphere
(3) In the lithosphere and hydrosphere
(4) In the lithosphere, hydrosphere and atmosphere

2. The population of India is 15% of the world but its annual energy consumption is only

(1) 0.2% (2) 2.0% (3) 10% (4) 25%

3. Environmental laning organisation is

(1) CSIR (2) CEPHERI
(3) ICAR (4) NEERI

4. Which of the following atmospheric pollutants is not produced by the exhaust of motor vehicle in Delhi

(1) SO_2 (2) Hydrocarbon gases
(3) Fly ash (4) CO

5. If water pollution continues at its present rate, it will eventually

(1) Stop water cycle
(2) Prevent precipitation
(3) Make oxygen molecules unavailable to water plants.
(4) Make nitrate molecules unavailable to water plants.

6. Recent reports of acid rains industrial cities are due to the effect of atmospheric pollution by

(1) Excessive release of NO_2 and SO_2 by burning of fossil fuels.
(2) Excessive release of CO_2 by burning of fuel like wood and charcoal, cutting of forests and increased animal population.
(3) Excessive release of NH_3 by industrial plants and coal gas.
(4) Excessive release of CO in atmosphere by incomplete combustion of cock, charcoal and other carbonaceous fuels in pancity of oxygen,

7. Pollution is a change in physical, chemical or biological characters of our land and water that may be

(1) Desirable and harmful to human
(2) Desirable and useful to human
(3) Undesirable and harmful to human
(4) undesirable and useful to human

8. An increase in CO_2 concentration in the atmosphere will result in

(1) Adverse effects of natural vegetation
(2) Global warming
(3) Temperature decrease in global atmosphere
(4) Genetic disoders in plants and animals

9. Identify the incorrect statement from the following:-

(1) Oxides of nitrogen in the atmosphere can cause the depletion of ozone layer
(2) Ozone absorbs the intense ultraviolet radiation of the sun
(3) Depletion of ozone layer is because of its chemical reactions with chlorofluoro alkanes
(4) Ozone absorbs infrared radiation

EXERCISE-III (Analytical Questions) ANSWER KEY

Que.	1	2	3	4	5	6	7	8	9
Ans.	4	2	4	3	3	1	3	2	4

EXERCISE-IV (Assertion & Reason)

Target AIIMS

Directions for Assertion & Reason questions

These questions consist of two statements each, printed as Assertion and Reason. While answering these Questions you are required to choose any one of the following four responses.

(A) If both Assertion & Reason are True & the Reason is a correct explanation of the Assertion.

(B) If both Assertion & Reason are True but Reason is not a correct explanation of the Assertion.

(C) If Assertion is True but the Reason is False.

(D) If both Assertion & Reason are false.

1. ***Assertion :-*** Classical smog is different from photo chemical smog.

Reason :- Because classical smog is oxidising and photo chemical smoge is reducing.

(1) A (2) B (3) C (4) D

EXERCISE-IV (Assertion & Reason) ANSWER KEY

Que.	1
Ans.	**3**

IMPORTANT NOTES