

# ORGANIC CHEMISTRY

ENTHUSIAST | LEADER | ACHIEVER



## **STUDY MATERIAL**

Environmental Chemistry and Qualitative and  
Quantitative analysis of organic compounds

ENGLISH MEDIUM

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## ENVIRONMENTAL CHEMISTRY, PURIFICATION METHODS, QUALITATIVE & QUANTITATIVE ANALYSIS

### ENVIRONMENTAL CHEMISTRY

The branch of science which deals with the chemical phenomena occurring 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<sub>2</sub>, CH<sub>4</sub>, oxide of nitrogen .

**Combustion of gasoline in the automobiles :** The automobiles emit the CO, oxide of nitrogen (NO, NO<sub>2</sub>)

**Deforestation :** Due to this % of CO<sub>2</sub> is increased and % of O<sub>2</sub> is decreased.

**Fast industrialisation :** The smoke of carbon and CO, CO<sub>2</sub>, SO<sub>2</sub>, H<sub>2</sub>S, NO, NO<sub>2</sub> 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 realised 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 atmosphere But the level of CO does not rise too much as CO is converted in CO<sub>2</sub> by the micro organism which is present in the soil.

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

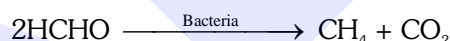
**Harmful effect of CO :**

- (i) The CO is poisonous because it combine with haemoglobin of R.B.C. about 300 times easily than O<sub>2</sub>, to form carboxy haemoglobin.
- (ii) Oxygen deficiency 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) Hydrocarbon :** 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.


**(b) Man made sources :**

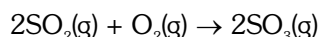
- (i) Due to burning of stationary fuel. (ii) Evaporation of organic solvent.

**(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.

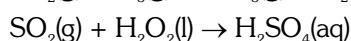
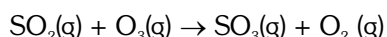
**Harmful effect of Sulphur compounds :**

- (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<sub>2</sub> leads to stiffness of flower buds which eventually fall off from plants.

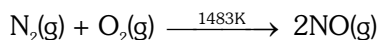
Uncatalysed oxidation of sulphur dioxide is slow. However, the presence of particulate matter in polluted air catalyses the oxidation of sulphur dioxide to sulphur trioxide.



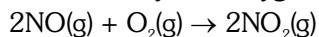
The reaction can also be promoted by ozone and hydrogen peroxide.



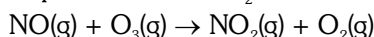
**(D) Nitrogen compound :** At high altitudes when lightning strikes,  $O_2$  and  $N_2$  combine to form oxides of nitrogen.  $NO_2$  is oxidised to nitrate ion,  $NO_3^-$  which is washed into soil, where it serves as a fertilizer. In an automobile engine, (at high temperature) when fossil fuel is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



NO reacts instantly with oxygen to give  $NO_2$



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



### 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.

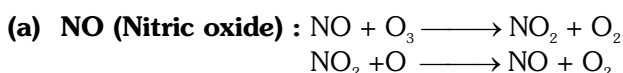
### BEGINNER'S BOX-1

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.



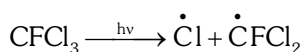
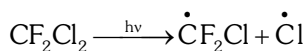
The NO react with  $O_3$  so decrease the amount of  $O_3$  and forms  $NO_2$  which react with oxygen atoms available in the stratosphere and producing back NO.

Thus no NO is consumed but  $O_3$  gets depleted.

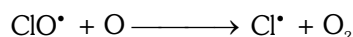
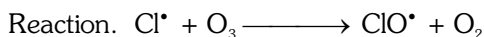


**(b) Chlorofluoro carbons (CFC) or freons :**

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



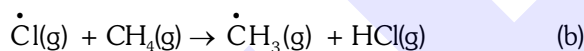
The reactive chlorine atoms then destroy the ozone layer through the following sequence of reaction. Which are repeated because chlorine atom are regenerated in the second reaction :



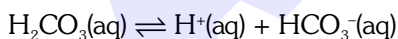
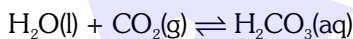
The one molecule CFC can destroy more than one thousand  $\text{O}_3$  molecules in the stratosphere.

**(c) Effect of depletion of  $\text{O}_3$  layer :** Due to depletion of  $\text{O}_3$  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, upset 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.

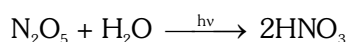
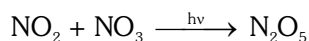
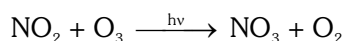
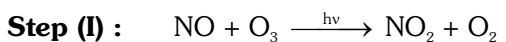


**Acid Rain :** The rain containing  $\text{H}_2\text{SO}_4$ ,  $\text{HNO}_3$  (and small amount of  $\text{HCl}$ ) which are formed from the **oxide of S** and **N** present in the air is called as acid rain. Normally rain water has a pH of 5.6 due to the presence of  $\text{H}^+$  ions formed by the reaction of rain water with carbon dioxide present in the atmosphere.



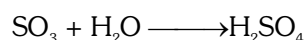
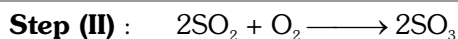
**When the pH of the rain water drops below 5.6, it is called acid rain.**

**Formation of acid rain :** The oxide of nitrogen undergo oxidation reaction. The reaction with the water vapour present in the atm to form  $\text{HNO}_3$ .



$\text{HNO}_3$  come down with rain to Earth.

The  $\text{SO}_3$  react with water vapour and form  $\text{H}_2\text{SO}_4$ .



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.  $\text{SO}_2$  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  $\text{SO}_2$  and other air pollutants released by oil refinery of Mathura. Acid rain reacts with marble,  $\text{CaCO}_3$  of Taj Mahal ( $\text{CaCO}_3 + \text{H}_2\text{SO}_4 \rightarrow \text{CaSO}_4 + \text{H}_2\text{O} + \text{CO}_2$ ) 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  $\text{CO}_2$  molecules and  $\text{H}_2\text{O}$  vapour present near the earth's surface and then its radiation back to the earth, is called as green house effect. So the temperature of the earth is increased is called as global warming.

**Important Green House Gases :** Methane, water vapour, nitrous oxide, CFCs, ozone and  $\text{CO}_2$ .

### 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**.

- 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.
- 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.
- 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.
- 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.

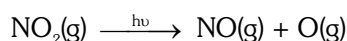
### Smogs

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

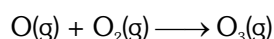
There are two types of smogs :

- (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  $\text{SO}_2$ . Mostly in those cities which have very large populations and high vehicular density.

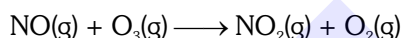
**Formation of photochemical smog :** The chemistry of formation of photochemical smog centres around nitric oxide (NO). At the high temperatures, in the petrol and diesel engines of cars and trucks,  $\text{N}_2$  and  $\text{O}_2$  react to form a small quantity of NO, which is emitted into troposphere with the exhaust gases. This NO oxidised in air to  $\text{NO}_2$  which in turn absorbs energy from sunlight and breaks up into nitric oxide and free oxygen atom. (Photochemical decomposition)



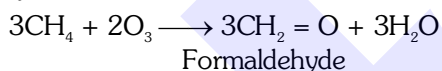
Oxygen atoms are very reactive and can combine with  $\text{O}_2$  to form ozone;



The  $\text{O}_3$  formed in the above reaction reacts rapidly with the  $\text{NO}(\text{g})$  formed in reaction to regenerate  $\text{NO}_2$ .  $\text{NO}_2$  is brown gas at high levels can contribute to haze.



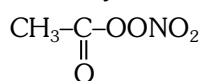
Both NO and  $\text{O}_3$  are strong oxidising agents and can react with the unburnt hydrocarbons in the polluted air to produce chemicals such as formaldehyde, acrolein and peroxyacetyl nitrate (PAN) that cause the eyes to water and burn and are harmful to the respiratory system. The brownish haze of photochemical smog is largely attributed to the brown colour of  $\text{NO}_2$ .



Acrolein and peroxyacetyl nitrate (PAN) are particularly noxious.



Acrolein



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  $\text{NO}_2$  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. Potassium 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 phosphates to water, in the form of the phosphate anion  $\text{PO}_4^{3-}$ , 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 contains sulphuric acid produced by the oxidation of iron pyrites ( $\text{FeS}_2$ ). 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  $1 \text{ mg dm}^{-3}$ . The  $\text{F}^-$  ions make the enamel on teeth much harder by converting hydroxyapatite,  $[\text{Ca}_3(\text{PO}_4)_2 \cdot \text{Ca}(\text{OH})_2]$ , the enamel on the surface of the teeth, into much harder fluorapatite,  $[\text{Ca}_3(\text{PO}_4)_2 \cdot \text{CaF}_2]$ . However,  $\text{F}^-$  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 <sup>-3</sup> )
Zn	5
Fe	0.2
Mn	0.05
Cu	3
Cd	0.005
Al	0.2

**Sulphate :** Sulphate is harmless at moderate levels, 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 Demand (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

- Major pollutant in Jet plane emission is -  
(1)  $SO_2$  (2) CFC (3) CO (4)  $CCl_4$
- 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
- 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
- Which of the following is absent in polluted water  
(1) Hydrilla (2) Water hyacinth (3) Larva of stone fly (4) Blue green algae
- 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 biodegradable products called **organo-phosphates** and **carbmates** 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 microorganisms 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 world. However, the practice 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  $\text{CO}_2$  and  $\text{H}_2\text{O}$ . 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  $1000^\circ\text{C}$ , and a plentiful supply of oxygen. Exhaust gases must be filtered. The process greatly reduced the volume of waste-an inorganic ash is left behind, 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, nonflammable and devoid of any carcinogenic effects.

### Green Chemistry in day-to-day Life

#### (i) Dry Cleaning of Clothes

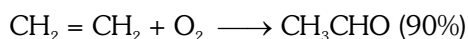
Tetra chloroethene ( $\text{Cl}_2\text{C}=\text{CCl}_2$ ) was earlier used as solvent for dry cleaning. The compound contaminates the ground water and is also a suspected carcinogen. The process using this compound is now being replaced by a process, where liquefied carbondioxide, with a suitable detergent is used. Replacement of halogenated solvent by liquid  $\text{CO}_2$  will result in less harm to ground water. These days hydrogen peroxide ( $\text{H}_2\text{O}_2$ ) is used for the purpose of bleaching clothes in the process of laundry, 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 ( $\text{H}_2\text{O}_2$ ) with suitable catalyst, which promotes the bleaching action of hydrogen peroxide, is used.

#### (iii) Synthesis of Chemicals

Ethanal ( $\text{CH}_3\text{CHO}$ ) is now commercially prepared by one step oxidation of ethene in the presence of ionic catalyst in aqueous medium with a yield of 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 $80^\circ \text{K}$ 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 $10^\circ$	(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.  $P = P_1 + P_2$ Vapour pressure of Organic liquid      Vapour pressure of water	(i) Aniline is separated from water (ii) Turpentine oil (iii) Nitro Benzene (iv) Bromo Benzene (v) Naphthalene (vi) o-Nitrophenol



## CHROMATOGRAPHY

This technique initially used to separate mixture of colour pigment found in plants so named given chromatography (greek word **chroma** = colour). Now a days this technique extensively used to separate mixtures into their components, purify compounds and also to test the purity of compounds.

In this technique, mixture of substances are applied on stationary phase which may be solid or liquid. A pure solvent, mixture of solvent or a gas is allowed to move slowly over stationary phase. The moving phase is called mobile phase. The component of the mixture get gradually separated from one another.

According to principle involved, chromatography is classified into category.

### (i) Adsorption chromatography

Principle – adsorption

Adsorbate – Substances which are being purified

Adsorbent – Silica gel and alumina

### (ii) Partition chromatography

Principle – Continuous differential partitioning of components of a mixture between stationary and mobile phase.

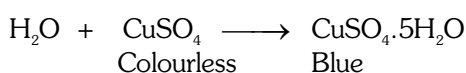
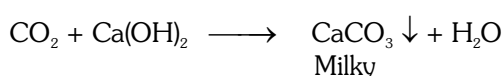
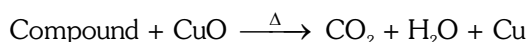
	Adsorption chromatography		Partition chromatography
	(a) Column chromatography	(b) Thin layer chromatography	Paper chromatography
Stationary phase	Silica gel and alumina	Silica gel and alumina	Chromatography paper contain water trapped in it
Mobile phase	Eluant which is a liquid or a mixture of liquid	Liquid or a mixture of liquid	Liquid or a mixture of liquid
Process	Mobile phase flow from top to bottom in a column having stationary phase	Mobile phase flow from bottom to top over a thin layer of an adsorbent coated on glass plate	Mobile phase flow from bottom to top over chromatography paper

## 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  $\text{CuSO}_4$ . If lime water turn milky, it shows presence of  $\text{CO}_2$  or carbon.

If anhydrous  $\text{CuSO}_4$  turn blue than it shows presence of  $\text{H}_2\text{O}$  or hydrogen.

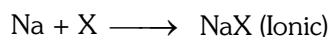
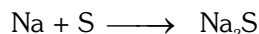
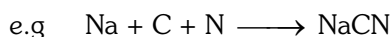


**(ii) Detection of Nitrogen, Sulphur and halogen :-** [Lassaigne's Test]

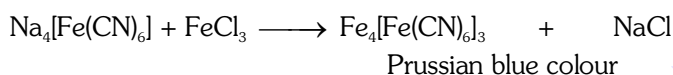
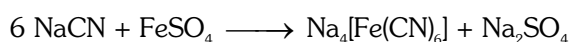
**Preparation of lassaigne's solution or sodium extract.**

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.



- (i) Test of Nitrogen :** Sodium extract is boiled with  $\text{FeSO}_4$  which gives sodium hexacyano ferrate (II). Now few amount of  $\text{FeCl}_3$  is added which gives prussian blue coloured ferro ferri cyanide that shows presence of Nitrogen.



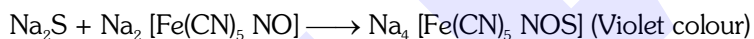
- (ii) Test of sulphur :** Sulphur is present in form of  $\text{Na}_2\text{S}$

- (a)** Sodium Extract is acidified with acetic acid and lead acetate is added to it which gives black ppt of  $\text{PbS}$  and shows the presence of Sulphur

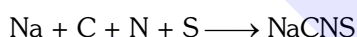


- (b) Nitroprusside test**

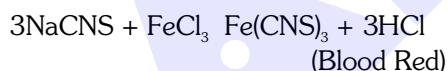
Sodium extract + Sodium Nitroprusside  $\longrightarrow$  Violet colour.



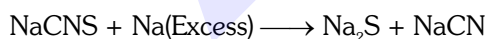
**Note :** If Nitrogen and sulphur both are present in compound then they form sodium thiocyanate in sodium extract.



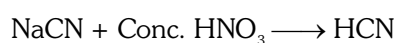
during test of Nitrogen in place of prussian blue, we get blood red colour of  $\text{Fe}(\text{CNS})_3$



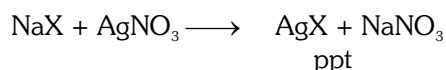
Therefore sodium extract is prepared in presence of excess of sodium which decomposes sodium thiocyanate.

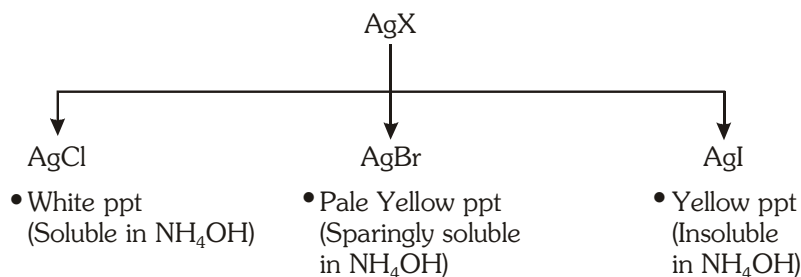


- (iii) Test of halogen :** Before the test of halogen sodium extract is boiled with conc.  $\text{HNO}_3$  to decompose the  $\text{Na}_2\text{S}$  and  $\text{NaCN}$  in form of  $\text{H}_2\text{S}$  and  $\text{HCN}$

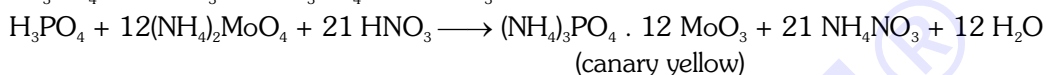
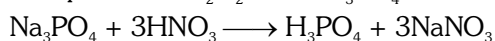
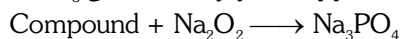


Now sodium extract is treated with silver nitrate which gives precipitate of  $\text{AgX}$ .





- (iv) **Test of phosphorous** : Compound is heated with an oxidising agent [ $\text{Na}_2\text{O}_2$ ] so the phosphorus in compound is converted in to phosphate which on further reaction with ammonium molybdate in presence of  $\text{HNO}_3$  gives canary yellow ppt of ammonium phospho molybdate and shows the presence of phosphorus.



**Quantitative analysis** : Calculation of percentage 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  $\text{CuO}$  so carbon and hydrogen oxidise to  $\text{CO}_2$  and  $\text{H}_2\text{O}$  respectively.

Now above vapour is passed through weighed u-tube having anhyd.  $\text{CaCl}_2$  followed by  $\text{KOH}$  solution. anhyd.  $\text{CaCl}_2$  absorbs  $\text{H}_2\text{O}$  while  $\text{KOH}$  absorbs  $\text{CO}_2$ .

Now we can calculate the amount of  $\text{H}_2\text{O}$  and  $\text{CO}_2$  produced in combustion.

**Calculation of % of C and H :-**

If mass of organic compound is  $W$  gm.

mass of  $\text{H}_2\text{O}$  or  $\text{CO}_2$  produced is  $m$  gm

**For H**  $\text{H}_2\text{O} \equiv 2\text{H}$

$$18 \quad 2$$

$\therefore$  18 gm of  $\text{H}_2\text{O}$  contains 2 gm of hydrogen

$\therefore$  1 gm of  $\text{H}_2\text{O}$  contains  $\frac{2}{18}$  gm of hydrogen

$\therefore$   $m$  gm of  $\text{H}_2\text{O}$  contains  $\frac{2}{18} \times m$  gm of hydrogen

Percentage of hydrogen in  $W$  gm organic substance =

$$\% \text{ of H} = \frac{2}{18} \times \frac{m}{W} \times 100$$

**For C**



$\therefore$  44 gm  $\text{CO}_2$  contain 12 gm carbon

1 gm  $\text{CO}_2$  contain  $\frac{12}{44}$  gm carbon

$m$  gm  $\text{CO}_2$  contain  $\frac{12}{44} \times m$  gm carbon

% of C in  $W$  gm organic substance =

$$\% \text{ of C} = \frac{12}{44} \times \frac{m}{W} \times 100$$

**Estimation of Nitrogen :**

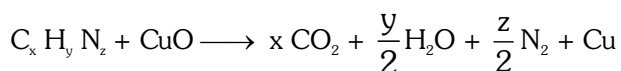
These are two method for the estimation of nitrogen

(i) Duma's method [in form of  $\text{N}_2$ ]

(ii) Kjeldahl's method [in form of  $\text{NH}_3$ ]

**(1) Duma's method :**

Organic compound is heated with CuO to give free Nitrogen, CO<sub>2</sub> and H<sub>2</sub>O.



Now the above mixture is collected over Aq. KOH in nitrometer tube which absorb all the gases except N<sub>2</sub>.

Now volume of nitrogen is calculated at STP.

$$\frac{P_1 V_1}{T_1} = \frac{P_2 V_2}{T_2} \quad V_1 = \text{Volume of } N_2 \text{ gas.}$$

P<sub>1</sub> = Pressure of N<sub>2</sub> – Aqueous tension

T<sub>1</sub> = Room temperature

$$V_2 = \frac{P_1 V_1 \times 273}{T_1 \times 760}$$

**Calculation of % of Nitrogen**

∴ 22400 ml of N<sub>2</sub> at STP weight = 28 gm

∴ V ml of N<sub>2</sub> at STP weight =  $\frac{28}{22400} \times V$  gm

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

**(2) Kjeldahl's method :** Compound containing nitrogen is heated with H<sub>2</sub>SO<sub>4</sub> so compound gets converted in to ammonium sulphate.

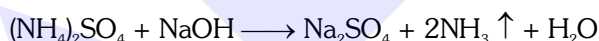
Now above mixture is heated with excess of NaOH which liberates Ammonia gas.

Ammonia gas is absorbed in excess of standard solution of H<sub>2</sub>SO<sub>4</sub>.

The amount of ammonia produced is determined by estimating the amount of H<sub>2</sub>SO<sub>4</sub> consumed.

Estimation of H<sub>2</sub>SO<sub>4</sub> is done by titrating the H<sub>2</sub>SO<sub>4</sub> 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<sub>2</sub>SO<sub>4</sub> used.



If Normality of H<sub>2</sub>SO<sub>4</sub> taken = N<sub>1</sub>

Volume of H<sub>2</sub>SO<sub>4</sub> taken = V<sub>1</sub>

If Normality of NaOH used = N<sub>2</sub>

Volume of NaOH used = V<sub>2</sub>

∴ Milli equivalent of H<sub>2</sub>SO<sub>4</sub> used for neutralisation of produced NH<sub>3</sub> = (N<sub>1</sub>V<sub>1</sub> – N<sub>2</sub>V<sub>2</sub>)

Which is equal to the milli equivalent of NH<sub>3</sub>

∴ 1000 ml of 1N NH<sub>3</sub> contain 14 gm Nitrogen.

∴ (N<sub>1</sub>V<sub>1</sub> – N<sub>2</sub>V<sub>2</sub>) ml of 1N NH<sub>3</sub> contain  $\frac{14}{1000} \times (N_1 V_1 - N_2 V_2)$  gm Nitrogen.

If mass of organic substance is W g.

$$\text{Then \% of N} = \frac{14}{1000} \times \frac{(N_1 V_1 - N_2 V_2)}{W} \times 100$$

$$\% \text{ of N} = \frac{1.4}{W} \times (N_1 V_1 - N_2 V_2) \quad \text{or} \quad \% \text{ of N} = \frac{1.4}{W} \times NV$$

N = Normality of  $\text{H}_2\text{SO}_4$

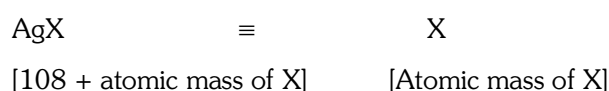
V = Volume of  $\text{H}_2\text{SO}_4$  used in neutralisation.

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

A known mass of organic compound is heated with fuming  $\text{HNO}_3$  in presence of  $\text{AgNO}_3$ . The halogen gets ppt in the form of  $\text{AgX}$  which can be filtered, washed and dried and weighed.

If mass of organic substance = W gm

mass of ppt = m gm



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

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

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

Sulphur is estimated in the form of  $\text{BaSO}_4$ .

Now ppt is filtered, washed, dried and weighed.



mass of sulphur in m gm ppt of  $\text{BaSO}_4$  =  $\frac{32}{233} \times m \text{ gm}$

% of sulphur in W gm organic sub.

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

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

Phosphorus is estimated in the form of magnesium pyrophosphate ( $\text{Mg}_2\text{P}_2\text{O}_7$ )



mass of sulphur in m gm  $\text{Mg}_2\text{P}_2\text{O}_7$  is

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

% of P in W gm organic sub.

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



## SOME SOLVED EXAMPLES

**Q.1** 0.3960 gm of an organic compound on combustion gives 0.792 gm CO<sub>2</sub> and 0.324 gm of H<sub>2</sub>O. Calculate the % of C and H

**Ans.** % of C =  $\frac{12}{44} \times \frac{\text{Wt. of CO}_2}{\text{Wt. of compound}} \times 100$   
 $= \frac{12}{44} \times \frac{0.792}{0.396} \times 100 = 54.55\%$   
 % of H =  $\frac{2}{18} \times \frac{\text{Wt. of H}_2\text{O}}{\text{Wt. of compound}} \times 100$   
 $= \frac{2}{18} \times \frac{0.324}{0.396} \times 100 = 9.09\%$

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

**Ans.** % of N =  $\frac{28}{22400} \times \frac{V}{W} \times 100$   
 $= \frac{28}{22400} \times \frac{31}{0.25} \times 100 = 15.5\%$

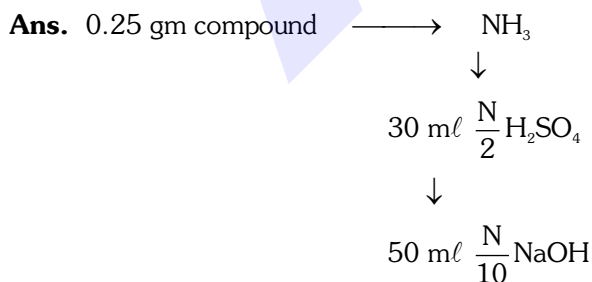
**Q.3** 31.7 ml of moist N<sub>2</sub> was obtained from 0.2033 gm of an organic compound in Duma's method at 14°C and 758 mm pressure. If aq. tension at 14°C = 14 mm then calculate % of N

**Ans.** P<sub>1</sub> = Pressure of N<sub>2</sub> – Aq. tension = 758 – 14 = 744 mm  
 P<sub>2</sub> = 760 mm T<sub>2</sub> = 273  
 V<sub>1</sub> = 31.7  
 T<sub>1</sub> = 273 + 14  
 T<sub>1</sub> = 287  
 $V_2 = \frac{P_1 V_1}{T_1} \times \frac{273}{760} = \frac{744 \times 31.7 \times 273}{287 \times 760} = 29.51$   
 % 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<sub>2</sub>SO<sub>4</sub> are used in neutralizing NH<sub>3</sub> obtained from 0.75 gm of an organic compound in Kjeldahl'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 Kjeldahl's method, NH<sub>3</sub> evolved from 0.25 gm of an organic compound was passed into 30 ml N/2 H<sub>2</sub>SO<sub>4</sub>. 50 ml N/10 NaOH were required to neutralize the unreact acid, calculate % of N.



$$50 \text{ ml} \times \frac{N}{10} = 5 \text{ ml N NaOH} \equiv 5 \text{ ml N H}_2\text{SO}_4$$

Remaining acid = 5 ml N H<sub>2</sub>SO<sub>4</sub>

Consumed acid

$$= \left( 30 \text{ ml} \times \frac{N}{2} - 5 \text{ ml N} \right) = 10 \text{ ml N H}_2\text{SO}_4$$

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

**Q.6** 0.35 gm of an organic compound was analysed by Kjeldahl's method. Ammonia evolved was absorbed in 100 ml  $\frac{N}{10}$  H<sub>2</sub>SO<sub>4</sub>. Unused acid required 30 ml  $\frac{N}{10}$  NaOH for neutralisation calculate % of N

**Ans.** W=0.35 gm → NH<sub>3</sub>

↓

100 ml  $\frac{N}{10}$  H<sub>2</sub>SO<sub>4</sub> (10 ml N H<sub>2</sub>SO<sub>4</sub>)

↓

30 ml  $\frac{N}{10}$  NaOH (3 ml N NaOH)

Remaining acid 3 ml N H<sub>2</sub>SO<sub>4</sub>

Consumed acid (10 ml N – 3 ml N) = 7 ml N H<sub>2</sub>SO<sub>4</sub>

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

**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

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

22,400 ml of N<sub>2</sub> at STP weighs = 28 g

$$41.9 \text{ ml of nitrogen weighs} = \frac{28 \times 41.9}{22400} \text{ g}$$

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

**Q.8** During estimation of nitrogen 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<sub>2</sub>SO<sub>4</sub>. Find out the percentage of nitrogen in the compound.

**Ans.** 1 M of 10 ml H<sub>2</sub>SO<sub>4</sub> = 1M of 20 ml NH<sub>3</sub> 1000 ml of 1M ammonia contains 14 g nitrogen.

20 ml of 1 M ammonia contains  $\frac{14 \times 20}{1000}$  g 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<sup>-1</sup>

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 compound gave 0.4813 g of barium sulphate. What is the percentage of sulphur in the compound ?

**Ans.** Molecular mass of BaSO<sub>4</sub> = 137 + 32 + 64 = 233g

233g BaSO<sub>4</sub> contains 32 g sulphur

0.4813g BaSO<sub>4</sub> 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'S 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	