

SECTION-01 - BE-01

BASICS OF SCIENCE AND ENGINEERING

PHYSICS

1. Units and Measurements
2. Classical Mechanics
3. Electric Current
4. Heat and Thermometry
5. Wave Motion, Optics and Acoustics

CHEMISTRY

6. Chemical Reactions and Equations
7. Acids, Bases and Salts
8. Metals and Non-Metals

COMPUTER PRACTICE

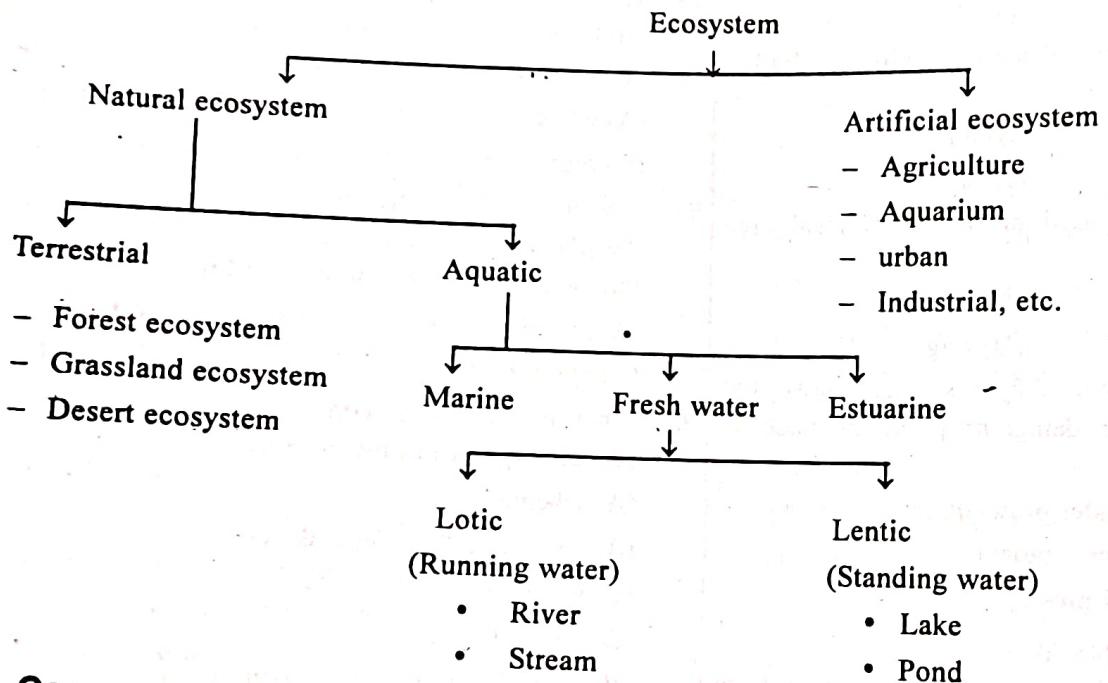
9. Computer Practice
10. Environmental Sciences

ENVIRONMENT SCIENCES

10. Environmental Sciences

[1] Classification of Ecosystem :

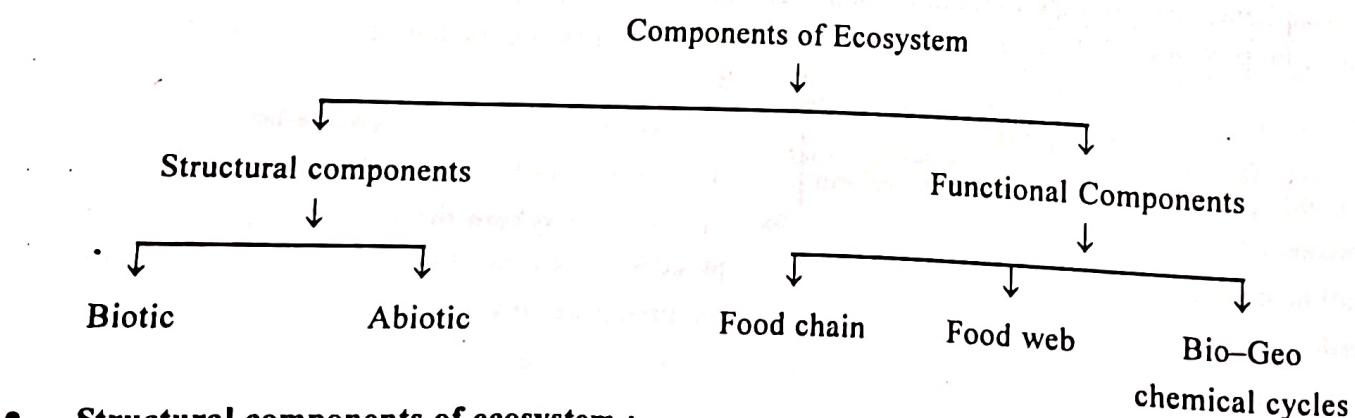
Earth is the giant ecosystem where biotic and abiotic components are constantly interacting with each other bringing structural and functional changes in it. Due to the vastness, it is classified as under :



[2] Components of Ecosystem :

An ecosystem comprises of two basic components :

- (a) Structural components
- (b) Functional components



- **Structural components of ecosystem :**

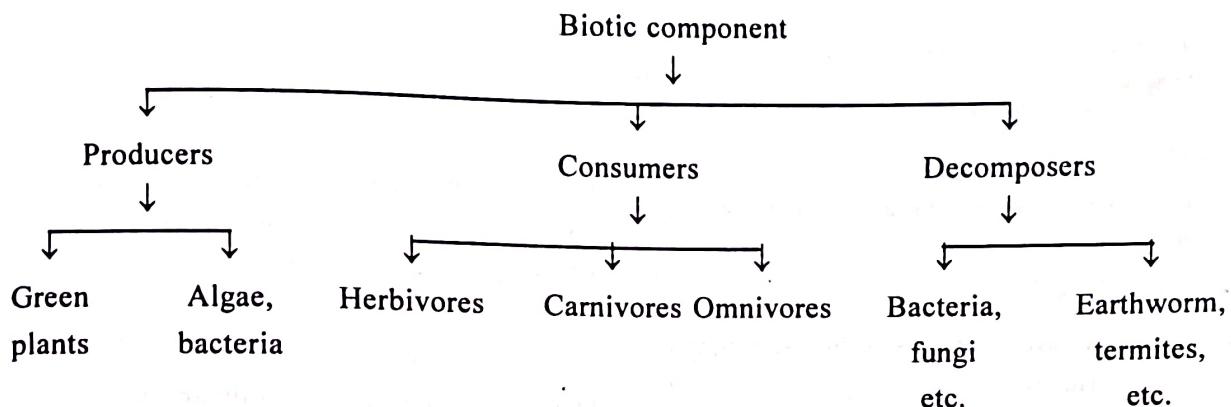
There are two basic structural components of ecosystem :

1. Biotic components (living)
2. Abiotic components (non-living)

Biotic components :

The living organisms including plants, animals and micro-organisms (bacteria and fungi) that are present in an ecosystem form the biotic component of the ecosystem.

On the basis of their role in the ecosystem the biotic components are further classified into :



(i) Producers (Autotrophs) :

The set of living organisms which are capable of producing the food on their own are known as producers or autotrophs.

e.g. green plants, algae.

Green plants and algae, directly utilize the sunlihgt energy to convert CO_2 and water to simplest carbohydrates called glucose and release oxygen as a by-product. This process is called photosynthesis.

Some bacteria are able to use the energy in some inorganic chemicals to form organic matter from CO_2 and water. This process is called chemosynthesis. Such organisms are also called producers.

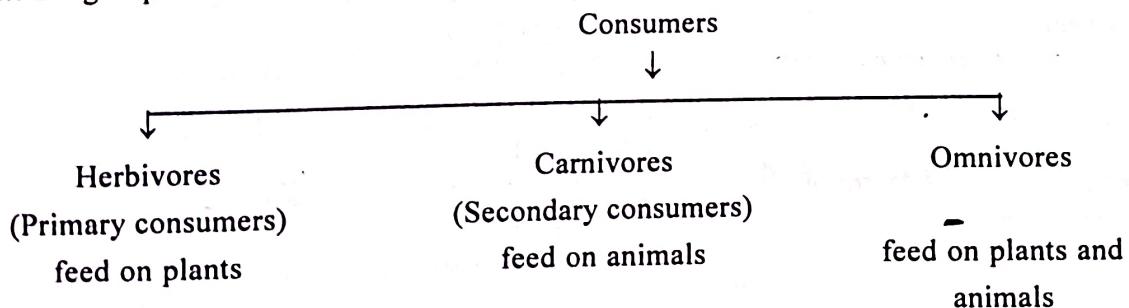
All other organisms in an ecosystem get the energy and nutrients they need by feeding on producers. Thus, producers are the building blocks of every ecosystem.

(ii) Consumers :

The set of living organisms feeding on producers are consumers.

They are also called heterotrophs. i.e. nourish on others.

The subgroups of consumers are :



Herbivores :

Herbivores are animals and other organisms that feed directly on plants.

e.g.

- cow
- deer
- goat
- grasshopper, etc.

9. In the food chain and food web, which component convert solar energy into food ?

- Animals
- Vegetation
- Carnivores
- Bacteria

Ans. : (b)

10. The biotic component which feed on grass and vegetations is

- Herbivores
- Carnivores
- Omnivores
- Decomposers

Ans. : (a)

11. Which of the following is an artificial ecosystem ?

- Forest
- Desert
- Fish house
- Pond

Ans. : (c)

12. Which is the largest ecosystem on the earth ?

- Forests
- Sea
- Deserts
- Grasslands

Ans. : (b)

13. Which of the following is an artificial ecosystem ?

- Fishhouse
- Farm
- Space station
- All the above

Ans. : (d)

14. Which of the following drug used for veterinary purpose is the cause for death of vultures ?

- Chloroquine
- Diclofenac
- Azithromycine
- Paracetamol

Ans. : (b)

15. In a foodchain

- energy flows from tropic level-1 to tropic level-4
- energy flows from tropic level-4 to tropic level-1
- energy does not flow
- energy flows from tropic level-4 to tropic level-3

Ans. : (a)

16. In the pyramid of numbers, the population of is maximum.

- Producers
- Primary consumers
- Secondary consumers
- Tertiary consumers

Ans. : (a)

17. Organisms contain about % carbon.

- 78 %
- 49 %
- 21 %
- 6 %

Ans. : (b)

18. In cell of organisms, DNA, RNA the important element is

- Carbon
- Nitrogen
- Sulphur
- Phosphorous

Ans. : (d)

19. The forests found near sea shore on marshy land are

- Deciduous forest
- Desert forest
- Mangrove forest
- Coniferous forest

Ans. : (c)

20. is the critically endangered species in small desert of Kutch.

- Flemingo
- Wild Ass
- Black deer
- Desert cat

Ans. : (b)

21. Leather back turtles are only found at

- Gulf of Kutch
- Andaman Nicobar islands
- Kerala sea coast
- Jamnagar sea coast

Ans. : (b)

22. Hungal dear is found in

- Assam
- Meghalaya
- Jammu-Kashmir
- Uttaranchal

Ans. : (c)

23. Which pair is incorrect ?

- Great Indian bustard - Thar desert, Rajasthan
- Wild Ass - Small desert of Kutch
- Unicorn rhino - Sundarban forests
- Barsinga dear - Gujarat Gir forests

Ans. : (d)

24. IUCN is located at

- USA
- Australiya
- Newzealand
- Switzerland

Ans. : (d)

25. At present how many earths are required to sustain present population on earth ?

- 1.25
- 1.75
- 2.50
- 3.25

Ans. : (b)

[2] Pollution & its Types :

Environmental pollution can be defined as any undesirable change in the physical, chemical or biological characteristics of any component of the environment (i.e. air, water and land) which can cause harmful effects on various forms of life or property.

Environmental pollution dates back to the time when man discovered the use of fire. The burning of fossil fuels (coal, oil, natural gas) and wood releases a number of poisonous gases into the atmosphere. Environmental pollution includes air, water, land, noise and radioactive pollution.

Causes of Pollution

↓

Natural causes

- Volcanic eruptions
- Earthquakes
- Storms and dust
- UV radiations
- Decay of organic matter
(release of H_2S and microplastics)

↓

Man-made causes

- Commercial activities
- Industrial activities
- Over Population
- Urbanisation
- Insecticides, pesticides
- Organic chemicals
- Use of vehicles
- Mining
- Nuclear explosions
- Explosives used in wars
- Construction of buildings, roads, dams

At the beginning of the human Civilization our environment was pure, virgin and uncontaminated. It was most supportive and hospitable to living organisms. The advancement of science and technology led to the exploitation of natural resources. Progress in agriculture, followed by rapid industrialization has left us with barren land, contaminated soil, polluted rivers and lakes, depleted wildlife and exhausted our natural resources.

Pollutants and Their Classification :

A pollutant may be defined as any substance present in the environment in such concentration, that alter the quality of environment and affect the living things adversely.

Pollutants are those agents which cause pollution due to production of end waste products or by-products by consumption of natural resources which may deteriorate the quality of environment. All pollutants are not always harmful, if not present in excess amount. For example, phosphorus, nitrogen and sulphur increases the fertility of soil and helps in the growth of plants if not present in excess amount than their requirement.

Classification of pollutants :

1. On the basis of nature of material :

(a) Biodegradable pollutants :

These are the pollutants which are degraded/decomposed naturally by the action of bacteria.

e.g. • municipal waste water (sewage)
• Wood
• Paper
• garbage
• Cardboard, etc.

• Types of Environmental Pollution :

The various types of environmental pollution are:

- Water pollution
- Air pollution
- Land pollution
- Noise pollution
- Radioactive pollution
- Thermal pollution

Today, environmental pollution is a serious problem. Air, water and land are essential for survival of life on earth but unfortunately pollution is causing them irreparable harm.

- Polluted water causes fish and other aquatic life to perish and is also dangerous to human health.
- Beyond certain limits air pollution can cause illness and even death.
- Soil or land pollution reduces the amount of land available for growing crops, fruits and vegetables.

• Air Pollution :

Air pollution is defined as the presence of unwanted and undesirable foreign particles and gases (in sufficient quantity and duration) in the air which may have adverse effects on human beings, animals, plants, vegetations and important structures.

As per IS : 4167 (1966) air pollution is defined as under :

"Air pollution is the presence in ambient atmosphere of substances, generally resulting from the activity of man, in sufficient concentration, present for a sufficient time and causes the harmful effects on humans, plants and animals."

Air pollution is of public health concern and can occur as :

- (i) Indoor air pollution - Micro scale
- (ii) Outdoor air pollution (ambient) - Meso scale
- (iii) Air pollution at global level - Macro scale

Pollutant :

Any substance present in the environment in harmful concentration which adversely alters the environment by damaging the growth-rate of a species and by interfering with the food chains, is toxic and affects the health, comfort and property etc. is considered as a pollutant.

e.g. smoke (industries and automobiles), domestic sewage, discarded items (tins, bottles etc.)

• Major gases of air :

Nitrogen (N ₂).....	78.08 %
Oxygen (O ₂)	20.95 %
Argon (Ar)	0.93 %

• Sources of Air Pollution :

The sources of air pollution may be classified into two groups :

1. Natural sources
2. Man made sources

1. Natural sources :

The following are the different forms of natural sources :

(i) Atmospheric reactions :

In the atmosphere, different types of chemical reactions are always going on. In the lower atmosphere, the gases or vapours are converted in solids and liquids by condensation or oxidation.

In the upper atmosphere, the photochemical reactions are going on by the absorption of ultra-violet solar radiation. It breaks the complex molecules of organic matters.

The products of atmospheric reactions come down to earth by rain, snowfall, etc.

(ii) Gases and ash released from volcanic eruptions.

(iii) Smoke and green house gases released by forest fires.

(iv) Harmful gases, particulates and chemicals from dust storms, electric storms etc.

(v) Marsh gases due to decay of vegetable matter in marshy places.

(vi) Pollen. These may enter the atmosphere from the flowers of trees, grasses and weeds and may be transported from place to place by wind.

(vii) Salt spray from oceans.

(viii) Microorganisms :

These are in the form of algae, fungi, bacteria, yeast, etc. These organisms can be transported by wind to far distances and can affect plants, animals and human beings.

Radioactive substances :

The radioactive substances like uranium, radium, thorium, etc. present in the earth crust are responsible for imparting the radioactivity of air.

2. Man-made sources :

The following are the man made sources of air pollution :

(i) **Combustion of fuel** : In domestic areas, the burning of coal, wood, oil, LPG, etc. forms harmful gases which pollute the air.

(ii) **Automobile exhaust** :

Automobiles like truck, buses, cars, two wheelers, autorickshaws, etc. exhaust carbon monoxide (CO) which is dangerous to human health.

(iii) **Industries** : The industries like iron and steel manufacturing oil refinery, chemical factories, petro-chemical plants, pulp and paper, etc. cause serious air pollution.

(iv) **Thermal and Nuclear power plants** : The thermal power plants contribute sulphur dioxide (SO_2) and nuclear power plants contribute radioactive fly ashes to the atmospheric air.

(v) **Agricultural activities** : Use of pesticides for growing crops may cause air pollution.

(vi) **Construction materials** : The manufacture of bricks, cement, stone chips, etc. pollute the atmosphere by discharging smoke, gases and dusts.

(vii) **System of sanitation** : The unscientific disposal of garbage produces foul gases, bad odour and insanitary condition.

In towns where the conservancy system is followed, the system of disposal of night soil produces foul gases and fly nuisance.

(viii) **Mining**

(ix) **Nuclear explosions**

(x) **Air crafts**

(xi) **Waste water treatment plants**

• Effects of Air pollution :

(a) Effects of Air pollution on Human health :

The general health effects of air pollution are :

1. Carbon monoxide (CO) and nitric oxide (NO) combine with haemoglobin to form carboxy haemoglobin (COHb) which reduces oxygen carrying capacity of blood.

2. Oxides of nitrogen (NO_x) and oxides of sulphur (SO_x) cause irritation to eye, throat and nose.

They also cause diseases like asthma and bronchitis, etc.

3. Secondary pollutant (PAN) produced by hydrocarbons and NO_x , results in the formation of photochemical smog, which causes irritation of eyes, nose, throat and respiratory diseases.
4. Some aromatic hydrocarbons may cause cancer.
5. Exposure to dust, smoke, smog and soot may induce several respiratory diseases like asthma, bronchitis and lung cancer.
6. Atmospheric dust containing silica may cause silicosis.
7. Air borne asbestos and toxic metals are carcinogenic.
8. Heavy metals like lead may cause poisoning effects on nervous system, damage to kidney and vision problems.
9. Pollens initiate asthmatic attacks.
10. Mercury from combustion of fossil fuels, plants result in nerve brain and kidney damage.
11. Nickel particulates in tobacco smoke result in respiratory damage.
12. Radioactive substances cause lung diseases and affect kidney, liver, brain and sometimes may cause cancer.

(b) Effects of Air pollution on plants and vegetations :

- Air pollutants affect plants by entering through stomata (leaf pores through which gases diffuse), destroy chlorophyll and affect photosynthesis. During the day time the stomata are wide open to facilitate photosynthesis. Air pollutants during day time affect plants by entering the leaf through these stomata more than night.
- Pollutants also erode waxy coating of the leaves called cuticle. Cuticle prevents excessive water loss and damage from diseases, pests, drought and frost. Damage to leaf structure causes dropping of leaves.
- Particulates like dust, fog, soot deposit on plant leaves, block stomata and affect the rate of transpiration.

Following are some of the effects of air pollutants on plants and vegetations.

(c) Effects of air pollution on Materials and Buildings :

- Sulphur dioxide effects marble, limestone, roofing, paper, building, textile and monuments.
- NO_x fades away textile dyes like cotton, rayon etc. Higher level of NO_x causes 10% loss of fibre strength in cotton and rayon.
- Leather also has affinity for SO_2 which affects its strength and causes it to disintegrate.
- Low concentration of ozone induces chemical alteration in natural synthetic textiles, paper, rubber and polymers.
- Particulates accelerate corrosion of metals. Dust, soot, mist, aerosols bring about severe damage to soil, building, sculpture and monuments.
- H_2S and organic sulphides react with lead paints to form lead sulphide thereby producing brown to black discolouration.
- Hydrocarbons (HC) pollutants damage long chains of carbon atoms losing tensile strength of polymers.

(d) Effects of air pollution on climate :

- Due to man made activities like industrialization, automobiles, deforestations etc., concentration of CO_2 and other green house gases in atmosphere will increase. About 50% of Green House Effect may be attributed to CO_2 , which resulted in the increase in temperature of earth. This increase in temperature caused the melting of ice caps and glaciers. Thus the increase in ambient air temperature will increase the mean sea level.

(e) Effect of air pollution on Aesthetic beauty :

- The most noticeable effect of air pollution on the properties of atmosphere is the reduction in visibility, which may lead to safety hazards. Visibility is reduced by absorption and scattering of light. The aesthetic beauty of

nature is not visible due to scattering of light by air borne particles (0.1 to 1 mm size). Industrial and automobiles emissions, sewage and garbage emit foul odours causing loss of aesthetic beauty.

(f) Effects of air pollution on Animals :

Animals are indirectly affected by air pollution mainly by eating contaminated vegetation.

- Lead poisoning occurs in animals grazing near smelters and lead mines. It causes paralysis and difficulty in breathing. It also leads to loss of appetite and diarrhoea.
- Arsenic poisoning in animals causes severe salivation, thirst, vomiting irregular pulse and respiration, abnormal body temperature and death.
- Farm animals like cattle and sheep are quite susceptible to fluorine toxicity. It affects to lack of appetite, periodic diarrhoea, muscular, weakness loss of weight and death.

• Control of Air Pollution :

The following steps may be taken to control air pollution :

1. Use of LPG/CNG instead of diesel/Petrol in automobiles. Using lead free Petrol in vehicles.
2. Growing more trees, because trees absorb atmospheric CO_2 .
3. Do not burn plastic wastes.
4. Use bicycle instead of car or motorbyke. Use public transports like metro, citybus, local train for travelling.
5. Process changes involving new or modified techniques in industries. e.g. washing coal before pulverization to reduce flyash emissions.
6. Controlling dust in the rotary kiln in cement plant.
7. Fixing catalytic converter in vehicles, regular maintenance of vehicles.
8. Reducing use of Pesticides, chemical fertilizers in agriculture.
9. In thermal power plants, electrostatic precipitators shall be fixed to prevent escape of flyash particles.
10. Using controlling equipments like cyclone separator, fabric filter, wet scrubber, etc. in industries.

- **Air Pollution Control Equipments :**

Following equipments or devices are used to control the emission of particulate pollutants :

1. Gravitational settling chamber
2. Cyclone separator
3. Electrostatic Precipitators
4. Fabric filters
5. Wet scrubbers

- **Water Pollution :**

Any physical, biological or chemical change in water quality that adversely affects living organisms or makes water unsuitable for certain uses is referred as water pollution.

It can also be defined as the presence of some foreign substances or impurities (organic, inorganic, biological, radioactive) in water in such quantity so as to constitute a health hazard by lowering the water quality and making it unfit for use.

- **Signs of polluted water :**

- Water has a bad taste or odour.
- Offensive odours from rivers, lakes, oceans.
- There is a reduction in the number of aquatic lives (fish) in rivers, sea or fresh water.
- Oil or grease floating on the surface of water.
- Unchecked growth of aquatic weeds in water bodies.
- Presence of colour due to organic matter.

- **Major sources of surface water pollution :**

- Sewage : discharge of sewers and drains.
- Industrial effluents –chemical, dying, paper, tannery, etc.
- Intensive use of chemical fertilizers for agriculture.
- Use of insecticides in agricultural fields.
- Synthetic detergents used for washing and cleaning.
- Oil spillage during drilling and shipment.
- Discharge from nuclear power plant.
- Discharge from nuclear research centre.
- Radioactive ash which may spread due to nuclear explosion.
- Throwing of dead animals in water bodies.
- Waste heat from industrial discharge and thermal power plants.

- **Solid Waste Management (SWM) :**

- **Solid waste :**

The term 'solid waste' includes all those solid and semi-solid materials that are discarded by a community. Solid wastes are arising from the human and animal activities. It includes both homogeneous and heterogeneous mass of throwaways from residential, industrial and commercial activities.

The solid waste generated through domestic and commercial activities is classified as 'Municipal Solid Waste (MSW)' and is also called 'refuse'. It includes garbage, rubbish, ashes, dust, demolition and construction wastes, dead animals, etc.

With increase in population, urbanization and industrialization, most of the cities are facing the issue of solid waste management. Rising incomes, unplanned urbanization and changing lifestyles have resulted in increased volumes and changing composition of municipal solid waste in India.

Presently, India generates about 65 million tons of MSW per year which requires about 1250 hectares of land per year, if this waste remains untreated. The volume of waste is projected to increase from 65 million tons at present to about 125 million tons by 2031. Untreated waste from Indian cities lies for months and years at dumpsites, causing land, water and air pollution. Hence, there is acute need to develop proper solid waste management system in India.

- **Solid waste Management :**

Uncontrolled pollution will destroy the ecosystem and the process is irrecoverable. Hence the goal of solid waste management is to minimise hazards to environment due to indiscriminate disposal of solid wastes. Based on the knowledge of solid waste generation, characteristics and treatment methods, certain materials can be recovered or re-used and electrical energy can be generated.

In ensuring better sanitary environments for the people and promoting their general health, the proper collection of refuse (solid waste), its haulage, treatment and disposal with minimum possible nuisance or risk to public health are fundamental to 'solid waste management'.

Objectives of solid waste management :

1. To remove discarded materials from inhabited places in a timely manner.
2. To prevent the spread of disease.
3. To minimise the likelihood of fires.
4. To reduce aesthetic insults arising from putrifying organic matter.
5. To dispose the refuse in such a manner so as to minimise hazards to environment.

The three basic functional elements of solid waste management (SWM) are :

1. Collection
2. Disposal
3. Recycling or Reutilization

Some Definitions :

1. Refuse :

Refuse is a general term used to indicate what is rejected or left out as worthless.

All sorts of solid wastes from a community may be termed as refuse.

Refuse includes all putrescible and non-putrescible solid wastes.

For example,

▪ garbage	▪ rubbish
▪ ashes	▪ dead animals
▪ industrial wastes, etc.	

Body waste (excreta) is not included in refuse.

2. Garbage :

This consists of all sorts of putrescible organic waste from kitchens, hotels, restaurants, in the form of waste food products, vegetable and fruit peelings.

It is organic in nature and decomposes quickly. Its density varies from 450 to 900 kg/m³.

3. Rubbish :

It consists of all non-putrescible wastes, excluding ashes.

For example,

- Paper pieces, paper packets
- rags
- glass and plastic bottles
- broken pieces of glass
- Broken crockery
- Broken furniture, card boards, etc.

The density of rubbish varies between 50 to 400 kg/m³.

4. Ashes :

Ashes are incombustible waste products from houses, industries, hearths (chulhas) and furnaces. Its density varies between 700 to 850 kg/m³.

5. Putrefaction :

Anaerobic decomposition of organic matter caused by the anaerobic bacteria and facultative bacteria in absence of oxygen is called putrefaction.

6. Leachate :

Liquid that has travelled through solid waste or other medium and has extracted, dissolved or suspended materials from it.

When dumped refuse contains non-biodegradable and carcinogenic substances, such as plastics, unused medicines, paints, pesticides, sanitary napkins, etc. which may start troubling on coming in contact with rain water seeping through it, producing a coloured liquid called leachate.

• Noise Pollution :

Sound :

Sound is what we hear.

Noise :

Noise is unpleasant and unwanted sound.

Difference between sound and Noise :

Sound

→ Sound is what we hear.

→ It has a constant pitch (frequency).

→ It has a periodic motion.

→ It produces meaningful communication.

→ Its unit is Hertz (Hz).

Noise

→ Noise is unpleasant and unwanted sound.

→ It has a variable pitch (frequency).

→ It has a non-periodic motion.

→ It does not produce meaningful communication.

→ Its unit is decibel (dB).

The difference between sound and noise depends upon the listener and the circumstances.

e.g.

rock music can be pleasant sound to one person and an annoying noise to another. Sound can be hazardous to a person's hearing if it is loud and if a person is frequently exposed for a long time.

- **Noise Pollution and sources :**

The presence of unwanted and unpleasant sound in the atmosphere, which may cause discomfort is called noise pollution.

- **Measurement of sound :**

The amount of sound energy received per second from the source of sound, per unit area perpendicular to the direction of wave is called intensity of sound.

The intensity of sound is expressed in watt/m^2 .

The value of reference intensity is $10^{-12} \text{ watt}/\text{m}^2$.

Sound is measured in decibel (dB) which measures how much intense is the sound compared to reference quantity.

$$\text{decibel (dB)} = 10 \log_{10} \left(\frac{\text{measured intensity}}{\text{reference intensity}} \right)$$

$$\therefore \text{dB} = 10 \log_{10} \left(\frac{I}{I_0} \right)$$

where,

I = measured intensity

I_0 = reference intensity = $10^{-12} \text{ W}/\text{m}^2$

- **Effects of Noise Pollution :**

The major effects of noise pollution are :

1. Physical effects
2. Physiological effects
3. Psychological effects

1. **Physical effects :**

- Loss of hearing - long time exposure of loud sound (80 -90 dBA) for more than 8 hours a day, may cause loss in hearing.
- Total deafness (acoustic trauma).
- Sudden loudness particularly from crackers and explosions may affect the ear drum and sensitive ear membranes.

2. **Physiological effects :**

- Headache, nausea
- Dizziness, gastric ulcers
- High rate of heart beat
- Fluctuations in blood pressure and sugar

3. **Psychological effects :**

These includes,

- Annoyance, sleep interference (insomnia)
- Depression, fatigue
- Mental stress
- Speech interference
- Effects on performance
- Decrease in efficiency

- **Control of Noise Pollution :**

Noise is a serious Environmental problem and a health hazard. Noise pollution can be effectively controlled by taking the following measures :

- (1) **Control at Receiver's End :**

People working in a noisy installations, ear-protection aid like ear-plugs, ear-muffs, noise helmets, headphones etc. must be provided to reduce occupational exposure.

- (2) **Supression of Noise at source :**

If working methods are improved by :

- (a) Installing noisy machines in sound proof chambers.
- (b) Proper maintenance and lubrications of machine.
- (c) Use of sound absorbing materials for covering noise-producing machines.
- (d) Using silencers to control noise from automobiles, ducts, exhausts etc.
- (e) designing, fabricating and using quieter machines to replace the noisy ones.
- (f) reducing noise from vibrating machine by vibration damping. i.e. damping materials e.g. rubber, neoprene, cork and plastic beneath the machine.

- (3) **Acoustic Zoning :**

- Silence zones near the educational, hospitals and residential area should require.
- Increasing distance between source and receiver of noisy industrial areas, bus terminals and railway stations, aerodromes etc. away from the residential areas would go a long way in minimising noise pollution.

(4) Planting Trees :

Planting green trees along the roadside, near hospitals, schools, educational institutions etc. help in noise reduction.

(5) Sound Insulation at construction stages :

- Gap between the door and wall should be packed with sound absorbing material.
- In sound proof recording rooms, acoustical tiles, perforated plywood etc can be fixed on walls and ceilings etc.

(6) Legislative Measures :

Strict legislative measures need to be enforced to reduce noise pollution.

- Framing a separate Noise Pollution Act.
- Minimum use of loud speakers and amplifiers especially near silence zones.

Plastic Wastes and Its Hazards :

Plastics are made up of synthetic organic polymers which are widely used in different applications ranging from water bottles, clothing, food packaging, medical supplies, electronic goods, construction materials, etc. In the last six decades, plastics became an indispensable and versatile product with a wide range of properties, chemical composition and applications. Although, plastic was initially assumed to be harmless and inert, however, many years of plastic disposal into the environment has led to diverse associated problems. Environmental pollution by plastic wastes is now recognized widely to be a major environmental burden, especially in the aquatic environment where there is prolong biophysical breakdown of plastics, detrimental negative effects on wildlife, and limited plastic removal options.

Plastics have several toxic constituents among which are :

- phthalates,
- poly-fluorinated chemicals,
- bisphenol A (BPA),
- brominated flame retardants and
- antimony trioxide,

which can leach out to have adverse effects on environmental and public health. Plastics in electronic waste (e-waste) have become a serious global environmental and public health concern due to its large production volume and the presence of inadequate management policies in several countries.

Long term usage and exposure of plastics and plastic products to high temperature can lead to leaching of toxic chemical constituents into food, drinks and water. Indiscriminate disposal of plastics on land and open air burning can lead to the release of toxic chemicals into the air causing public health hazards.

In human occupational and residential environment, plastics made of petrol-based polymer are present in high quantity. At the end-of-life of these plastics, they are usually land-filled together with municipal solid waste.

Globally, plastic production was estimated to be 380 million tonnes in 2018. Since 1950 to 2018, plastics of about 6.3 billion tonnes have been produced worldwide, 9% and 12% of which have been recycled and incinerated, respectively. Plastics of about 5 million tonnes are yearly consumed in UK alone, with only about one-quarter recycled, and the rest land filled. It has been suggested by researchers that by 2050, oceans might contain more plastics than fish in terms of weight. Yearly, approximately 500 billion plastic bags are used out of which an estimated 13 million tonnes ends up in the ocean, killing approximately 100,000 marine lives.

• **Environmental pollution by plastic wastes :**
[Bad Effects]

Distribution of plastic waste is associated with human populations. Increase in human population has led to increase demands for plastics and plastic products. Indiscriminate disposal of wastes from plastics and plastic products can lead to environmental pollution.

The various effects of plastic waste are as under :

- Environmental natural beauty deterioration,
- Entanglement and death of aquatic organisms,
- Sewage system blockage in towns and cities resulting in creating conducive environment for breeding mosquitoes and other disease causing vectors and production of foul smells,
- Reduction in water percolation and normal agricultural soils aeration thus causing reduced productivity in such lands.
- Dumping of plastics on land or land filling plastics leads to abiotic and biotic degradation of the plastics, where plastic additives (e.g.

stabilizers, harmful colorant moieties, plasticizers and heavy metals) can leach and eventually percolate into various aspects of the environment, thereby causing soil and water contamination.

- Chlorinated plastics are capable of leaching out toxic chemicals into the soil and subsequently seep into the underground water or surrounding aquatic system thereby polluting the ecosystem.
- Methane, a dangerous greenhouse gas, which significantly contributes to global warming is released during microbial biodegradation of plastics.
- Plastics in the oceans can degrade within a year but not completely. During this plastic degradation process, toxic chemicals like polystyrene and BPA can be released into the water causing water pollution.
- More than 260 species of marine organisms such as turtles, invertebrates, seabirds, fish and mammals ingested or are entangled in or with plastic debris, leading to reduced movement, feeding, reproductive output, ulcers, lacerations and eventual death.
- Many birds, turtles, fishes, seals and other marine animals have died by drowning or suffocation as a result of entanglement in plastic debris.
- Most animals in the oceans mistaking plastic wastes dumped in the ocean for food, thereby ingesting them. Marine pollution by plastic wastes majorly affects sea turtles and other species whose main food are jelly fishes because they often confuse discarded plastic bags for jelly fish.
- Carbon dioxide and methane are released into the air when plastic wastes which were land filled finally decompose.
- Open burning of plastics and plastic products releases pollutants such as heavy metals, dioxins, PCBs and furans which when inhaled can cause health risks especially respiratory disorders.

▪ Most of the additives present in plastics are potential carcinogens and endocrine disruptors. Ingestion, skin contact and inhalation are the main routes of exposure of humans to these additives.

▪ Micro plastics are major contaminants that can bioaccumulate in the food chain after ingestion by a wide range of freshwater and marine lives leading to a public health risk. Human consumption of animals exposed to micro plastics and plastic additives can be detrimental.

▪ Inner linings of food cans, reusable water bottles, and baby bottles are manufactured using BPA (Bisphenol A). As a result of repeated usage of beverage and food containers over a long period of time, BPA molecules can leach from the plastics into the drinks and food. Women exposed to BPA have damaged health system such as polycyclic ovarian syndrome, obesity, and recurrent miscarriages.

• E-WASTE :

‘E-waste’ means electrical and electronic equipment, whole or in part discarded as waste by the consumer or bulk consumer as well as rejects from manufacturing, refurbishment and repair processes.

Rapid growth of technology, upgradation of technical innovations, and a high rate of obsolescence in the electronics industry have led to one of the fastest growing waste streams in the world which consist of end of life electrical and electronic equipment product such as Refrigerator, Washing machines, Computers and Printers, Televisions, Mobiles, Ipods etc. Many of which contain toxic materials.

E-waste (Management) Rules, 2016, were published by the Government of India, Ministry of Environment, Forest and Climate Change. [Amended in 2018].

• Classification of E-waste (Sources of E-waste):

E-waste composed of discarded electrical and electronic appliances which have reached the end of their life and no longer serve the purpose they were intended for.

Categories of electrical and electronic equipment covered under the e-waste management rules, 2016 are :

(I) Information technology and telecommunication equipment :

Centralized data processing : Mainframes, Minicomputers

Personal Computing : Personal Computers (Central Processing Unit with input and output devices)

Personal Computing : Laptop Computers (Central Processing Unit with input and output devices)

Personal Computing : Notebook Computers

Personal Computing : Notepad Computers

Printers including cartridges

Copying equipment

Electrical and electronic typewriters

User terminals and systems

Facsimile

Telex

Telephones

Pay telephones

Cordless telephones

Cellular telephones

Answering-systems

(II) Consumer electrical and electronics :

Television sets (including sets based on (Liquid Crystal Display and Light Emitting Diode technology)

Refrigerator

Washing Machine

Air-conditioners excluding centralized air conditioning plants

Fluorescent and other Mercury containing lamps.

• Constituent materials of E-waste :

Various elements and substances contained in e-waste are as under :

1. Useful metals like-iron, steel, copper, aluminum.
2. Precious metals like-platinum, gold, silver.
3. Hazardous materials like- mercury, lithium, barium, radioactive isotopes.
4. Toxic substances like- Dioxins, polychlorinated biphenyls (PCBs), Lead, Zinc, Cadmium.
5. Plastics like- High Impact Polystyrene (HIPS), Acrylonitrile Butadiene Styrene (ABS), Polycarbonate (PC).

6. Glass materials like- Cathode Ray Tube (consists of glasses such as SiO_2 , CaO , NaO).

E-waste mainly consists of Ferrous & Non-ferrous Metals, Plastics, Glass, Wood etc.

Iron & Steel - 50%

Plastics - 21%

Non-ferrous metal

Mercury, Arsenic, Lead etc. - 13%

• E-waste Generation in India :

India has emerged as fourth largest electronic waste producer in the world. Computer devices account for nearly 70% of e-waste, with the contribution of telecom sector being 12%, medical equipment being 8%, and electric equipments being 7% of the annual e-waste production.

Projection by International Association of Electronic Recycler (IAER)

- 3 billion electronic and electrical appliances became e-waste in 2010.
- Globally about 20 – 50 million tons of E-Waste is disposed of each year.
- Which accounts for 5% of all Municipal Solid Waste.

According to Comptroller and Auditor-General's (CAG) Report, over 7.2 MT of Industrial Hazardous Waste, 4 lakh Tones of electronic waste, 1.5 MT of Plastic waste, 1.7 MT of medical waste and 48 MT of municipal waste are generated in the country annually.

- CPCB has estimated that E-Waste exceeded 8 lakh tones mark in 2012.
- Annual growth rate of E-Waste generation – 10%
- There are 10 states that contribute to 70% of the total E-Waste generated in the country.
- 65 cities generate more than 60% of the total E-Waste in India.
- Among the top ten cities generating E-Waste, Mumbai ranks first followed by Delhi, Bengaluru, Chennai, Kolkata, Ahmedabad, Hyderabad, Pune, Surat & Nagpur.
- Maharashtra ranks first in generation of e-waste followed by Tamil Nadu and U.P.
- Main source of electronic waste in India are the government, public and private (Industrial) sectors - 70%.

- Contribution of individual house hold – 15%
- Rest being contributed by manufacturers.

Out of total E-Waste volume in India :

Computer devices	70 %
Telecom sector	12 %
Medical equipment	8 %
Electrical equipment	7 %

Despite 23 units currently registered with Govt. of India, Ministry of Environment and Forest / Central Pollution Control Board, as E-Waste recyclers / preprocessors, the entire recycling process more or less still exists in the unorganized sector.

- **Impact of E-waste on Environment and Human Health :**

Electronic waste or e-waste is one of the rapidly growing problems of the world. E-waste comprises of a multitude of components, some containing toxic substances that can have an adverse impact on human health and the environment if not handled properly. In India, e-waste management assumes greater significance not only due to the generation of its own e-waste but also because of the dumping of e-waste from developed countries. This is coupled with India's lack of appropriate infrastructure and procedures for its disposal and recycling.

The predictions highlight the urgent need to address the problem of E-Waste in developing countries like India where the collection and management of E-Waste and the recycling process is yet to be properly regulated. It may cause rising environmental damage and health problems if E-Waste recycling is left to the vagaries of the informal sector.

1. Effect on Human Health :

- The impact is found to be worse in developing countries like India where people engaged in recycling E-Waste are mostly in the unorganized sector, living in close proximity to dumps or landfills of untreated E-Waste and working without any protection or safe guards.
- E-waste is much more hazardous than many other municipal wastes because electronic gadgets contain thousands of components made of deadly chemicals and metals like lead, cadmium, chromium, mercury, polyvinyl chlorides (PVC), brominated flame retardants,

beryllium, antimony and phthalates. Long-term exposure to these substances damages the nervous systems, kidney, bones, reproductive and endocrine systems. Some of them are carcinogenic and neurotoxic.

Children are especially vulnerable to the health risks that may result from e-waste exposure and, therefore, need more specific protection. Children may be exposed through dump sites located close to their homes, schools and play areas.

2. Effect on Environment :

- Disposal of e-wastes is a critical problem faced and poses a threat to both health and vital components of the ecosystem. There are number of channels through which e-waste goes to the environment. E-waste that is land filled produces contaminated leachates, which eventually pollute the groundwater.
- Acids and sludge obtained from melting computer chips, if disposed on the ground causes acidification of soil, leading to contamination of water resources.
- Due to dumping of e-waste in to the land filling site, many toxic heavy metals and chemicals from e-waste enter the soils and then it follows the 'soil-crop-food pathway', which is one of the most significant routes for heavy metals exposure to humans.
- Incineration of e-wastes can emit toxic fumes and gases, thereby polluting the surrounding air.
- Improper recycling and recovery methods can have major impacts on the environment. Crude forms of dismantling can often lead to toxic emissions, which pollute the air and thereby also expose the workers to the harmful materials.
- The most dangerous form of recycling and recovery from e-waste is the open air burning of circuit boards (made of plastic) in order to recover copper, aluminum, silver and other metals. This will cause air pollution.
- Extraction of metals through acid bath method or through mercury amalgamation also contributes to environmental degradation.
- Burning of plastic casing of e-waste leads to liberation of toxic air pollutants.

- (ix) Burning of computer monitors and other electronics produces dioxins causing cancer.
- (x) Mercury will leach when certain electronic devices, such as circuit breakers are destroyed. Not only does the leaching of mercury pose problems, the vaporization of metallic mercury and dimethylene mercury is also of concern.

• Recycling of E-waste :

1. **Plastic** : All the plastic materials retrieved are sent to recyclers who use them to manufacture items such as fence posts, plastic sleepers, plastic trays, vineyard stakes, and equipment holders or insulators among other plastic products.
2. **Metal** : Scrap metals materials retrieved are sent to recyclers to manufacture new steel and other metallic materials.
3. **Glass** : Glass is retrieved from the Cathode Ray Tubes (CRTs) mostly found in televisions and computer monitors. Extracting glass for recycling from CRTs is a more complicated task since CRTs are composed of several hazardous materials.
4. **Mercury** : Mercury containing devices are sent to mercury recycling facilities that uses a specialized

technology for elimination for use in dental amalgams and metric instruments, and for fluorescent lighting. Other components such as glass and plastics are reused for manufacture of their respective products.

5. **Printed Circuit Boards** : Circuit boards are sent to specialized and accredited companies where they are smelted to recover non-renewable resources such as silver, tin, gold, palladium, copper and other valuable metals.
6. **Hard Drives** : Hard drives are shredded in whole and processed into aluminum ingots for use in automotive industry.
7. **Ink and Toner Cartridges** : Ink and toner cartridges are taken back to respective manufacturing industries for recycling. They are remanufactured while those that can't are separated into metal and plastic for re-use as raw materials.
8. **Batteries** : Batteries are taken to specialized recyclers where they are hulled to take out plastic. The metals are smelted in specialized conditions to recover nickel, steel, cadmium and cobalt that are re-used for new battery production and fabrication of stainless steel.

Multiple Choice Questions (MCQs)

1. Which of the following gas emitted by factories, power plants, human population is more harmful to the atmosphere ?
 - (a) Oxygen
 - (b) Nitrogen
 - (c) Chlorine
 - (d) Carbon dioxide

Ans. : (d)

2. The gas produced from refrigerators, air conditioners and paints business is
 - (a) Carbon dioxide
 - (b) CFC
 - (c) Nitrogen
 - (d) Ozone

Ans. : (b)

3. As per IS code, the acceptable noise level in urban residential area is
 - (a) 35-45 dBA
 - (b) 45-55 dBA
 - (c) 30-40 dBA
 - (d) 40-50 dBA

Ans. : (a)

4. The noise pollution is measured in
 - (a) decibel
 - (b) dyne
 - (c) Eco
 - (d) Newton

Ans. : (a)

5. Which of the following is not a green house gas ?
 - (a) CO₂
 - (b) O₂
 - (c) CH₄
 - (d) CFC

Ans. : (b)

6. Which of the following is biodegradable ?
 - (a) Paper
 - (b) DDT
 - (c) Plastic
 - (d) Aluminium

Ans. : (a)

7. What is carbon dioxide content in atmosphere ?
 - (a) 3 %
 - (b) 0.1 %
 - (c) 0.03 %
 - (d) 10 %

Ans. : (c)

8. In Dec.-1984, from union carbide company at Bhopal, which toxic gas was leaked ?
 - (a) Methane
 - (b) Methyl isosynate
 - (c) Acetelene
 - (d) Carbon monoxide

Ans. : (b)

9. Which of the following is not an aerosol ?

- (a) radiation
- (b) mist
- (c) dust
- (d) Fog

Ans. : (a)

10. What is the size of aerosol particles ?

- (a) Less than $1 \mu\text{m}$
- (b) less than 1 mm
- (c) Less than $0.1 \mu\text{m}$
- (d) Less than 10 mm

Ans. : (b)

11. Repeated sound of dB on our ear reduce hearing capacity

- (a) 15 dB
- (b) 80 dB
- (c) 110 dB
- (d) 150 dB

Ans. : (d)

12. Which fuel used in automobiles produce least Pollution ?

- (a) Petrol
- (b) diesel
- (c) LPG
- (d) CNG

Ans. : (d)

13. BOD measures

- (a) content of bacteria
- (b) content of inorganic matter
- (c) carbonic matter in domestic sewage
- (d) None of the above

Ans. : (c)

14. What is the pH value of acidic water ?

- (a) 7
- (b) more than 7
- (c) Less than 7
- (d) 0

Ans. : (c)

15. Which component of environment contains maximum pollutants ?

- (a) Biosphere
- (b) Hydrosphere
- (c) Atmosphere
- (d) Lithosphere

Ans. : (b)

16. 'Minamata' disease is caused by

- (a) Mercury
- (b) Lead
- (c) Zinc
- (d) Manganese

Ans. : (a)

17. 'BOD' means

- (a) Basic oxygen demand
- (b) Biological oxygen demand
- (c) Biochemical oxygen demand
- (d) Biological organic demand

Ans. : (c)

18. Which gas has produced adverse effect on Taj Mahal ?

- (a) CO
- (b) SO_2
- (c) CFC
- (d) Hydrogen

Ans. : (b)

19. Which air pollutant reduces oxygen carrying capacity of blood ?

- (a) Ammonia
- (b) Hydrogen sulphide
- (c) Carbon monoxide
- (d) Sulphur dioxide

Ans. : (c)

20. In the atmosphere, reaction between Nitrogen Oxides, hydrocarbon and sunlight produces

- (a) SO_2
- (b) Benzene
- (c) CO
- (d) PAN

Ans. : (d)

21. What is the main product of photochemical smog ?

- (a) PAN
- (b) Oxygen
- (c) Carbon dioxide
- (d) Methane

Ans. : (a)

22. In cyclone separator, to remove particulate matter from gas the force used is

- (a) Electrostatic force
- (b) Centrifugal force
- (c) Gravitational force
- (d) Hydrostatic force

Ans. : (b)

23. The automobile exhaust mainly contains

- (a) Hydrocarbon, carbon monoxide
- (b) Lead vapour
- (c) Sulphur dioxide
- (d) Carbon dioxide

Ans. : (a)

24. In waste water treatment plant, detritus tank removes

- (a) Floating matter
- (b) Grit and sand
- (c) Oil, grease
- (d) Bacteria

Ans. : (b)

25. Which of the following is not a secondary treatment method of waste water treatment ?

- (a) Trickling filter
- (b) Sludge digestion tank
- (c) Sedimentation tank
- (d) Activated sludge process

Ans. : (c)

26. Which of the following is found maximum in e-waste ?

- (a) Plastic
- (b) Ferrus metal
- (c) Non-ferrus metal
- (d) glass

Ans. : (b)

[3] Climate Change :

Climate change refers to any significant change in climatic factors such as temperature, wind, precipitation, lasting for an unexpected period.

The term **climate change** is very often used interchangeably with the global warming. But, the term **global warming** refers to rise in temperature of earth, while **climate change** refers to other changes in addition to global warming.

• Causes of climate change :

1. Change in the sun's intensity.
2. Slow changes in the Earth's orbit around the sun.
3. Change in ocean circulation.
4. Human activities that change the composition of atmosphere and land e.g.,
 - burning fossil fuels
 - deforestation
 - desertification
 - urbanization
 - industrialization, etc.

• Effects of climate change :

- extreme hot and cold spells of temperature
- wet or dry spells of rainfall
- cyclones
- Floods
- rise in sea level
- global warming

• Green house effect :

The average temperature of the global atmosphere has increased by about 1°C in the last century. The main cause of this temperature rise is the abnormal increase in the concentration of green house gases in the atmosphere.

• Main green house gases :

1. Carbon dioxide (CO_2)
2. Methane (CH_4)
3. Nitrous Oxide (N_2O)
4. Chloro Fluoro Carbon (CFC)
5. Ozone (O_3)
6. Water vapour

• Effects of 'Global warming' :

- Climate change
- Change in rainfall pattern
- Serious water shortage
- Change in crop pattern
- Growth of microorganisms and spread of diseases.
- Rise in sea level
- Melting of polar ice.
- Adverse effects on ecosystem.

• Steps to control global warming :

1. Reduction in the use of fossil fuel for energy generation.
2. Promoting non-conventional energy sources like wind energy, solar energy, nuclear energy, etc.
3. Hydrogen as an energy source of the future is another proposal.
4. Reduction in N_2O emission by minimising the use of nitrogen fertilizers in agriculture.
5. Increase of the vegetation cover, particularly forest as it is sink for CO_2 absorption.

• Ozone layer :

The layer in the upper atmosphere (stratosphere), some 15 to 30 km above the earth's surface, in which most of the atmospheric ozone (about 90%) is concentrated is called the ozone layer.

The ozone layer, absorbs most of the sun's ultra violet (uv) radiation and protects various life form on the earth. It acts like a natural sunscreen for the earth. Therefore, the ozone layer is often called the ozone shield or earth's protective umbrella.

• Effects of Ozone Depletion :

- Ozone depletion in the stratosphere will result in more UV radiation reaching the earth especially UV-B (200 – 280 nm). The UV-B radiations affect DNA and the photosynthetic chemicals. Any change in DNA can result in mutation and cancer. Cases of skin cancer which do not cause death but cause disfigurement will increase.
- Easy absorption of UV rays by the lens and cornea of eye will result in increase in incidents of cataract.

- Melanin producing cells of the epidermis will be destroyed by UV-rays resulting in immunosuppression. Fair people (can't produce enough melanin) will be at a greater risk of UV exposure.
- Phytoplankton are sensitive to UV exposure. Ozone depletion will result in decrease in their population thereby affecting the population of Zooplankton, fish, marine animals, in fact the whole aquatic food chain.
- Yield of vital crops like corn, rice, soyabean, cotton, bean, pea and wheat will decrease.
- Degradation of paints, plastics and other polymer

material will result in economic loss due to effects of UV radiation resulting from Ozone depletion.

• **Various agreement / protocols for mitigating climate change at global level :**

- (1) Paris agreement (2015)
- (2) Montreal Protocol
- (3) Earth summit
- (4) Kyoto protocol
- (5) Copenhagen International Conference
- (6) Vienna Convention
- (7) Doha Climate Change Conference (2012)

Multiple Choice Questions (MCQs)

1. The ozone layer absorbs

- (a) x-rays
- (b) G-rays
- (c) Infrared rays
- (d) Ultraviolet rays

Ans. : (d)

2. Which of the following is not a green house gas ?

- (a) CO_2
- (b) O_2
- (c) CH_4
- (d) CFC

Ans. : (b)

3. Due to 'ozone hole' in the earth's atmosphere which rays comes to earth surface ?

- (a) Laser rays
- (b) X-rays
- (c) Ultraviolet rays
- (d) None of these

Ans. : (c)

4. Which of the following is mainly responsible for ozone layer depletion ?

- (a) CFC
- (b) SO_2
- (c) CO
- (d) CH_4

Ans. : (a)

5. Which of the following is a green house gas ?

- (a) Oxygen
- (b) Nitrogen
- (c) Carbon dioxide
- (d) Sulphur dioxide

Ans. : (c)

6. CFC used in refrigerator contains

- (a) Carbon
- (b) Hydrogen
- (c) Chlorine and fluorine
- (d) all the above

Ans. : (d)

7. Which of the following is a green house gas ?

- (a) Nitrogen
- (b) Oxygen
- (c) Water vapour
- (d) Argon

Ans. : (c)

8. The reason for sea level rise is

- (a) Depletion in ozone layer
- (b) Smog
- (c) Global warming
- (d) Acid rain

Ans. : (c)

9. Which gas is mainly responsible for green house effect ?

- (a) CO_2
- (b) CFC
- (c) CH_4
- (d) N_2O

Ans. : (b)

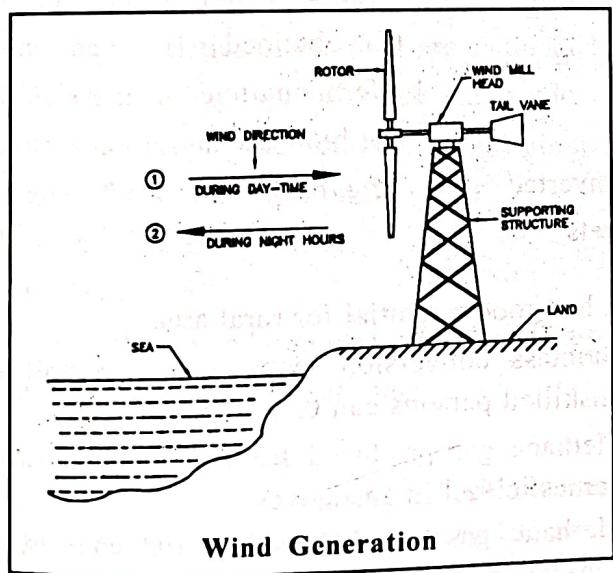
[4] Renewable sources of energy such as hydro, solar, wind, biomass, tidal and geothermal - their availability and limitations :

- **Wind Energy :**

Wind is essentially air in motion. It is caused by the uneven heating of the earth's surface by the sun. The kinetic energy possessed by moving air is proportional to the wind speed.

Wind energy can be used for running turbines to generate electricity which can be used for different purposes. Wind energy is cheap and pollution free energy resource. Installation of wind power mills requires such locations where wind speed is more than 6.5 m/sec.

According to the department of Non-conventional Energy sources (DNCES) in India, the total wind energy potential is about 6000 Mw is located in Tamilnadu and 5000 Mw is located in Gujarat. But India has been able to harness only 2000 Mw.



In Gujarat wind farms have been located at Mandvi-Kutch and Lambha near Dwarka.

- **Applications of wind energy :**

1. To generate electricity through wind mills.
2. To run water pumps to supply water for irrigation fields.
3. To run flour mills for grinding grains.
4. To run any machine without use of electric power.

- **Advantages of wind energy :**

1. Completely non-polluting source of energy.

2. Initial investment is moderate.
3. Easy and quick construction.
4. Operation and maintenance costs are smaller.
5. Generation is cheaper.
6. Mostly used in hilly and coastal areas.
7. No raw material is required.
8. Wind energy farms can be installed in a highly decentralized manner.
9. Land below the turbines can be utilized for growing crops and stock grazing.

- **Limitations of wind energy :**

 1. Location must have high wind speed (> 6.5 m/sec)
 2. Direction of winds are continuously changing.
 3. Motion of wind is variable and unsteady.
 4. Steady winds are needed. Otherwise the power production rate will not be uniform and sometimes production becomes intermittent.
 5. Noise produced by the turbine makes it unsuitable for installation in populated localities/cities.
 6. Located only in vast open areas.
 7. High wind speed during thunderstorm may seriously damage the system.

- **Wind Mills :**

A machine which converts kinetic energy of wind into mechanical energy of shaft is called **wind mill**. Wind mill can be used to run grain crushing mill, water pump and small machines.

Wind mill is also called **wind turbine**.

By connecting generator to the wind turbine, mechanical energy can be converted to electrical energy. When wind mill is used for electricity generation, it is called **wind turbine generator** or **aerogenerator**.

- **Applications of wind Mills :**

1. For water pumping and small irrigation schemes.
2. For electric power generation.
3. For running flour mills
4. For electro-metallurgical processes
5. As a stand by energy source.
6. To run farm machineries and equipments.
7. In diamond cutting-polishing factory.
8. For Domestic electrical use and lighting.
9. With hybrid power plants like solar energy.
10. Fishing and salt industries.
11. Battery charging.
12. For telecommunication in remote areas.

13. For rural forestry projects.
14. To run machineries in cottage industries.

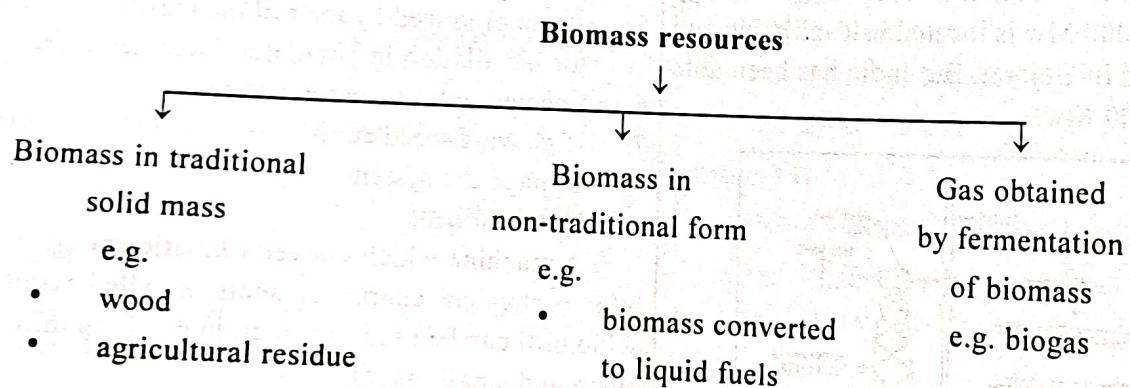
- **Advantages of wind mill :**

1. It uses wind energy, which is a renewable source of energy.
2. It does not require any power.
3. Wind energy produced by wind mill is cheaper.
4. Its maintenance cost is very low.
5. It does not produce any type of pollution.
6. It does not produce green house gases.
7. It does not produce any toxic or radioactive waste.

- **Biomass Energy :**

All types of biological substances like plant products (wood, crop, algae, aquatic plants), their residues (straw, husk, sawdust, cow dung, animal droppings) and also waste materials like garbage and night soil are collectively known as **biomass**.

Biomass resources fall into three categories :



Biomass is used as a source of energy in many parts of the world. Burning of biomass in the presence of air (oxidation of biomass) produces heat energy known as bioenergy. The residue left after burning of biomass is used as manure in agriculture fields.

Burning of 1 kg of wood produces about 4000 to 5000 kcal of heat. Wood is inexpensive and lights up easily, but the burning of wood causes depletion of forest cover, which in turn leads to the accumulation of CO_2 in the atmosphere, green house effect and soil erosion.

- **Advantages of Bio-mass energy :**

1. Bio-mass is a perennial source of energy as bio-mass plants grow continuously.
2. Bio-mass does not contribute in pollution and global warming.
3. Biomass is very cheap.
4. Biomass is available everywhere.

5. It has good potential for rural areas.
6. Biomass conversion technology is simple and unskilled persons can use it.
7. Methane gas produced from biomass is used as domestic fuel in gas stoves.
8. Methane gas can be used to run engines, and generators.
9. The biomass can be grown in nearby seas and lakes. Thus, the land can be spared for food crops.
10. Biomass conversion gives good quality manures as by products which can be used as fertiliser.

- **Disadvantages of bio-mass energy :**

1. Biomass contains 50 to 90% of water and it is heavy. Hence, transportation if needed is difficult.
2. Direct combustion of bio-mass produces smokes and smells.
3. Calorific value of biomass if burnt in the raw form is very less.

4. To convert biomass into biogas energy, biogas plants are necessary.
5. Bio-gas plants occupy large land areas.
6. Biogas plants need lots of care and maintenance for its successful operations.
7. Biogas plants cannot be used in urban areas where the space availability is limited.
8. Biogas plants may have odour problem and insect problem.

- **Uses of bio-mass energy :**

1. Waste organic biomass can be directly used as domestic fuels.
2. Bio-gas is used as domestic fuels in gas stoves like LPG gas.
3. Biogas can be used to run engines, boilers, turbines, etc.
4. Biogas can be used for heating of water.
5. Biogas (methane) can be used to run farm machineries.

- **Characteristics of Biomass :**

The characteristics of biomass are as under :

1. Biomass is in huge quantity and renewable.
2. It does not produce environmental pollution.
3. It gives fuels of high calorific value.
4. It is available every where.
5. It is very cheap.
6. It can be burned and it gives liquid or gaseous fuel.
7. Biomass is a carbonic material.

- **Geothermal Energy :**

As the depth below ground level increases, temperature of earth increases. For every 125 m depth the temperature rises by 1°C. The temperature of the interior of the earth is about 600°C to 6000°C.

The interior of earth contains huge thermal energy in the form of lava. When rain water penetrates deep into the earth, due to heat of the earth the water is converted in vapour. At some places this vapour comes out of the surface of the earth and produce hot vapour / water springs. In Gujarat, such type of hot water springs are found at Tulsiyam, Lasundra and Tuva. This vapour can be used to run turbines.

In Himachal Pradesh, 5 kN capacity geothermal power plant at Manikarnam is already working. In Ladakh, geophysical thermal wells have been dug and the thermal energy is used to obtain salt, sulphur and borex.

The geothermal energy can be used in following four ways :

1. Hot water method
2. Wet vapour method
3. Dry vapour method
4. Hot rock method

- **Uses of thermal energy :**

1. To generate electric power
2. For green houses
3. For fisheries
4. In Paper industry

- **Limitations of geothermal energy :**

1. The hot water obtained from earth contains sulphur, ammonia and salts. It causes corrosion of water pipes and machine parts.
2. The vapour obtained from earth produces sharp noise when released through a valve.
3. It is very difficult to obtain sufficient pressure by such vapour.

In France, a tidal power plant of 230MW capacity is operating. In India, IIT-Chennai has prepared 150MW tidal power plant in Kerala.

- **Tidal Energy :**

The periodic rise and fall of sea water is called tide. The gravitational forces of sun and moon on earth causes tides in seas and oceans. The magnitude of the tide at given location is the result of the changing positions of the moon and sun relative to the earth, earth's rotation, and the shape of the sea floor and coastlines.

During high tides, water is filled up in the tidal basin to maximum height, providing sufficient potential head of water. When there is low tide, water level outside the tidal basin is lower than that in the basin. The gates which pass water through turbines are open. Turbine generator sets are started producing electricity. This will continue till there is sufficient difference in water levels outside and inside the basin. When the

level difference is reduced, the power generation is stopped and basin is again required to be filled up during high tides.

In India places like the Gulf of Kutch, Cambay and Sundarbans are the most prospective tidal energy harnessing sites.

- **Advantages of tidal energy :**

1. Power generation is cheaper. It does not require any fuels like coal, uranium, natural gas, etc.
2. Tidal power plant does not produce any harmful waste.
3. It is pollution free.
4. Power is generated by the natural process of tides.
5. No raw material is required.
6. As tidal power plant is set up in sea, it does not occupy costly land space.
7. Tidal power plant site can be used for fishing purpose.
8. Tidal power is inexhaustible.

- **Disadvantages of tidal energy :**

1. Due to high tide and low tide cycle, the generation of power is not continuous.
2. When sufficient head of water is not available, the power generation is required to be stopped.
3. Can be used only in coastal areas.
4. Efficiency of tidal power plant is very low.
5. Cost of capital investment in tidal power plant is high.
6. Operational problems and accidents may occur during cyclones and storms.
7. Transmission is costly.
8. Due to tidal water movements, there is heavy silting in the basin needing frequent dredging of silt.

- **Hydrogen Energy :**

Hydrogen is a clean fuel. It is the most abundant element in the universe. The sun and other stars are composed largely of hydrogen. Astronomers estimate that 90% of the atoms in the universe are hydrogen atoms. Hydrogen is a component of more compounds than any other element. Water is the most abundant compound of hydrogen found on earth.

Hydrogen is considered an alternative fuel. It is due to its ability to power fuel cells in zero-emission electric vehicles, its potential for domestic production, and the fuel cell's potential for high efficiency. In fact, a fuel cell coupled with an electric motor is two to three times more efficient than an internal combustion engine running on gasoline. Hydrogen can also serve as fuel for internal combustion engines. The energy in 1 kilogram of hydrogen gas contains about the same as the energy in 2.8 kilograms of gasoline.

- **Potential Applications :**

- Production of electricity, heat and water for various end uses
- Industrial applications
- Vehicular transportation
- Residential applications
- Commercial applications, including in telecom towers for providing back-up power

A fuel cell is an electrochemical conversion device that converts hydrogen and Oxygen into water, producing electricity and heat in the process. It operates like battery. It does not require recharging. Hydrogen burns in fuel cell to produce electricity.

- **Advantages of Hydrogen fuel cell :**

1. It is readily available.
2. It does not produce harmful emissions
3. It is environmentally friendly.
4. It is renewable.
5. Unit is lighter and smaller
6. It can be used as fuel in rockets
7. It gives higher fuel efficiency

- **Disadvantages of Hydrogen fuel cell :**

1. High initial cost
2. Low voltage
3. Low service life
4. It is difficult to store
5. It is highly flammable

Multiple Choice Questions (MCQs)

1. For sustainable development the use of energy recommended is
 (a) Nuclear energy (b) Renewable energy
 (c) Conventional energy (d) Natural gas

Ans. : (b)

2. By using conventional energy sources
 (a) Does not produce pollution
 (b) Reduce pollution
 (c) Produce pollution
 (d) All the above

Ans. : (c)

3. Which of the following is not a renewable energy source ?
 (a) Wind energy (b) Solar energy
 (c) Ocean energy (d) Fossil fuels

Ans. : (d)

4. Which type of energy is continuously available ?
 (a) Solar energy (b) Natural gas
 (c) Petroleum (d) Nuclear energy

Ans. : (a)

5. Which of the following is a renewable source of energy ?
 (a) Petroleum
 (b) Forests and vegetation
 (c) Natural gas
 (d) None of the above

Ans. : (b)

6. In horizontal axis wind turbine (HAWT) where generator is placed ?
 (a) In the nessel (b) above the tower
 (c) at ground level (d) In the gear box

Ans. : (a)

7. Large size wind turbine rotor rotates by
 (a) Drag force
 (b) Lift force
 (c) Resultant of drag and life force
 (d) Reactive force

Ans. : (b)

8. The type of generator used in HAWT which supply power to the grid line is
 (a) Synchronous induction generator
 (b) D.C. generator
 (c) Asynchronous generator
 (d) A.C. generator

Ans. : (a)

9. In Savonious wind turbine the rotor axis is
 (a) Horizontal (b) Inclined
 (c) Vertical (d) Connected to Nessel

Ans. : (c)

10. Nessel is used in
 (a) Darious wind turbine
 (b) Savonious wind turbine
 (c) Water pumping wind mill
 (d) Horizontal axis wind turbine

Ans. : (d)

11. The minimum average annual wind speed required to setup wind mill is
 (a) 25 km/hr (b) 35 km/hr
 (c) 15 km/hr (d) 45 km/hr

Ans. : (c)

12. The design of blades of HAWT is
 (a) Aerospace design (b) Aerodynamic design
 (c) Aerometer design (d) All the above

Ans. : (b)

13. In India, which state has maximum wind energy installed capacity ?
 (a) Tamilnadu (b) Gujarat
 (c) Maharashtra (d) Karnatak

Ans. : (a)

14. Wind farm converts
 (a) wind energy into solar energy
 (b) wind energy into tidal energy
 (c) wind energy into physical energy
 (d) wind energy into electrical energy

Ans. : (d)

15. The control system which rotates the wind mill rotor in the direction of wind is called

- (a) Yaw control
- (b) Pitch control
- (c) Generator control
- (d) Emergency tripping system

Ans. : (a)

16. Which material produces free electrons for solar rays?

- (a) P-type
- (b) N-type
- (c) A-type
- (d) P-N type

Ans. : (b)

17. Silicon material

- (a) can resist very high temperature
- (b) has high boiling point
- (c) is very hard
- (d) All the above

Ans. : (d)

18. The value of solar constant is

- (a) $1327 \text{ W/m}^2 \mu\text{m}$
- (b) $1447 \text{ W/m}^2 \mu\text{m}$
- (c) $1367 \text{ W/m}^2 \mu\text{m}$
- (d) $1587 \text{ W/m}^2 \mu\text{m}$

Ans. : (c)

19. A strip made by connecting two metals is called

- (a) Thermocouple
- (b) collector
- (c) Absorber plate
- (d) Flat plate

Ans. : (a)

20. Which gas has maximum content in biogas?

- (a) Carbon dioxide
- (b) Oxygen
- (c) Nitrogen
- (d) Methane

Ans. : (d)

21. Biomass is a Energy source.

- (a) conventional
- (b) alternate
- (c) renewable
- (d) modern

Ans. : (c)

22. In biogas plant, digestion takes place in the absence of

- (a) Oxygen
- (b) Carbon dioxide
- (c) Hydrogen
- (d) Methane

Ans. : (a)

23. In which process dry biomass is used?

- (a) Pyrolysis
- (b) Hydrogeneration
- (c) Hydrogasification
- (d) All the above

Ans. : (a)

24. Pyrolysis process provides fuel in the form of

- (a) solid
- (b) liquid
- (c) gas
- (d) All the above

Ans. : (d)

25. Normally is used to manufacture ethanol.

- (a) ethasis
- (b) Molasis
- (c) Methanol
- (d) waste

Ans. : (b)

26. To produce tidal energy, the minimum difference in water levels of high tide and low tide is

- (a) 5 m
- (b) 10 m
- (c) 15 m
- (d) 20 m

Ans. : (a)

27. Hydrogen fuel cell

- (a) produce electric power by burning of hydrogen gas
- (b) works like a battery
- (c) does not require recharging
- (d) All the above

Ans. : (b)

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