

ENVIORNMENTAL STUDIES (DEC 2018)

Answer any five questions from the following.

(15 M)

a) What are the reasons for depletion of soil resources?

(3 M)

Ans:

- Soil is the most important component of land. It is the fertile surface layer of the earth capable of supporting life. It is a mixture of mineral matter, air, water, organic matter (humus) and organisms.
 - It influences the distribution of plant species and provides a habitat for a wide range of organisms.
 - It controls the flow of water and chemical substances between the atmosphere and the earth.
 - It acts as both a source and store for gases (like oxygen and carbon dioxide) in the atmosphere.
 - Unfortunately, industrial and agriculture practices continue to damage and deplete this valuable natural resource.
 - Mining activities, urban development, civil structures, factories, canals, and improper waste disposal have reduced productive land.
 - Extensive cultivation on marginal land, improper cultivation practices like mono-cropping, poor manuring, misuse of fertilizers or excess use of fertilizers, excessive irrigation are causes for degradation of the soil.
 - Soil erosion is another major cause of soil degradation. Soil becomes deficient in essential minerals and this results in productivity loss. Deforestation accompanied by reduced frequency of rainfall leads to soil erosion.
 - Soil degradation leads to reduction in crop yield in the affected lands and in extreme cases becomes unfit for cultivation.
 - Soil degradation also has several adverse impacts on the global climate due to changes in the carbon, nitrogen and water cycles.
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b) Explain principle involved in working of photovoltaic cell.

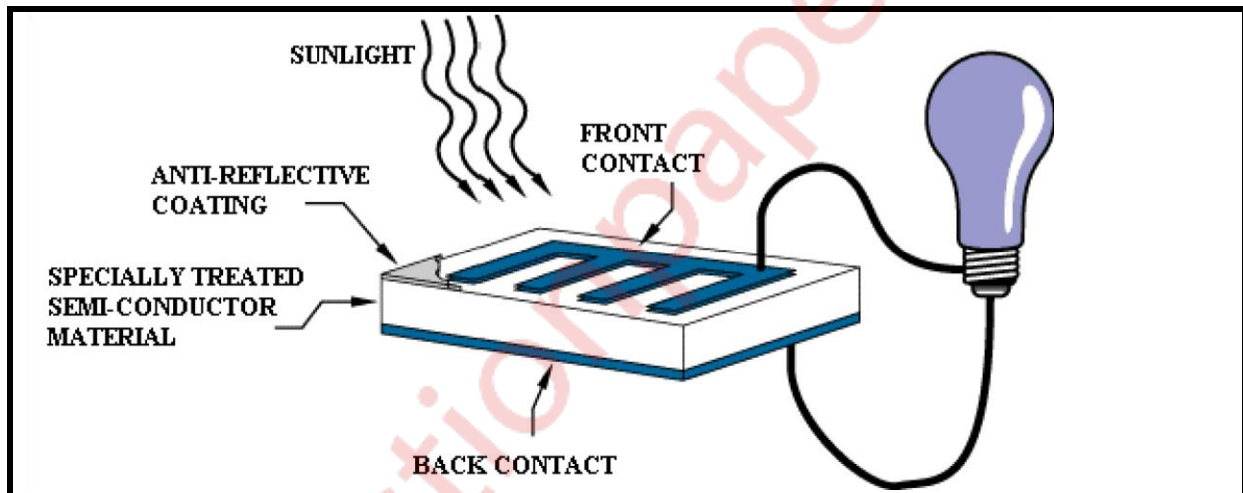
(3 M)

Ans:

A photovoltaic cell is made up of :

- a thin highly pure silicon semiconductor wafer made of two layers
- the layers have been doped with boron on one side and phosphorous on the other side, producing surplus of electrons on one side and a deficit of electrons on the other side.
- metallic contacts on either side of the semiconductor
- anti-reflective coating to reduce reflection and increase light absorption (silicon nitride or titanium oxide)

The schematic of photovoltaic cell is given here.



- When light falls on the cell, photons in the sunlight knock off some of excess electrons, this makes a voltage difference between the two sides as the excess electrons try to move to the deficit side.
- With an external circuit attached to the metallic contacts, the electrons can get back to where they came from and a current flows through the circuit.
- The amount of current is determined by the number of electrons that the light photons knock off. Bigger cells, more efficient cells, or cells exposed to more intense sunlight will deliver more electrons.
- In practice, the typical photovoltaic cell has an overall thickness of between 0.25 and 0.35 mm and is made of mono or multi-crystalline silicon. Generally, it has a surface measuring somewhere between 100 and 225 m² and, with an

irradiation of 1 kW/m^2 at a temperature of 25°C , produces a voltage of approximately 0.5V .

- The photovoltaic cell has no storage capacity, it simply acts as an electron pump.
- A number of photovoltaic cells (36 cells in series) electrically connected to each other and mounted in a support structure or frame is called a module. Modules are designed to supply electricity at a certain voltage, such as a common 12 volts system.
- Multiple modules can be wired together to form an array. In general, the larger the area of a module or array, the more electricity that will be produced.
- Energy produced by photovoltaic modules is stored in batteries to make it accessible when there is a shortage of light. This is the most critical element of the whole system and the only one which requires maintenance.

c) Write a brief note on noise pollution.

(3 M)

Ans:

- Noise is defined as unpleasant or disagreeable loud sound or sound that causes discomfort to the listener. With the rapid growth in population, traffic and urban crowd, noise has emerged as a widely prevalent irritant. The efficiency of humans is higher when they perform their duties under satisfying and comfortable conditions than when they are constantly irritated or annoyed by their surroundings.
- Noise pollution is unwanted or offensive sounds that unreasonably intrude into our daily activities. Noise measurements are expressed as Sound Pressure Level (SPL) which is logarithmic ratio of the sound pressure to reference pressure. It is expressed as a dimensionless unit called decibel (dB).
- **Sources of noise pollution:**
The main identified sources of noise pollution are categorized as:
- **Natural sources:** Some natural phenomena like volcanic eruption, thunder, firestorm etc. are sources of noise pollution which is not humanly possible to control.
- **Man-made sources:** Some sources of noise pollution owing to human activities are occupational noise due to heavy industrial machines, domestic appliances,

transport noise due to road traffic, aircraft, rail traffic and neighbourhood noise due to loud speakers, fireworks, entertainment etc.

Effects of noise pollution:

- Noise pollution does not only affect hearing capabilities on humans but also can cause various other health disorders and so effects of noise pollution can be classified into:
- **Auditory effects:** Exposure to high intensity sound for short duration can cause temporary deafness and continuous exposure to high intensity noise will lead to irreversible hearing loss or permanent deafness.
- **Non-auditory effects:** The other effects of noise pollution in humans include physiological disorders like anxiety, insomnia, high blood pressure, fatigue, etc., loss of working efficiency due to poor concentration and reduced ability to think, annoyance due to noisy surroundings. Some effects on wildlife due to loud noise include an increase in rate of mortality as a result of interference in the predator –prey detection and avoidance, disturbances in sound communication and navigation of species like whales and dolphins, migratory birds, health deterioration of many animals due to continued exposure to high intensity noise. Sometimes buildings and materials may get damaged by exposure to infrasonic / ultrasonic waves and may even get collapsed.

d) Define 'sustainable development'. Why there is need of sustainable development.

(3 M)

Ans:

- Sustainable development is a pattern of economic development in which resource use aims to meet human needs while preserving the environment so that these needs can be met not only in the present, but also for generations to come. Definition: The term 'sustainable development' (SD) was used by the Brundtland Commission which coined what has become the most often-quoted definition of sustainable development as:
- "Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs.
- It contains within it two key concepts:

- the concept of needs, in particular the essential needs of the world's poor, to which overriding priority should be given; and
- the idea of limitations imposed by the state of technology and social organization on the environment's ability to meet present and future needs."
- There is an additional focus on the present generations' responsibility to improve the future generations' life by restoring the previous ecosystem damage and resisting contributions to further ecosystem damage. Sustainable development ties together concern for the carrying capacity of natural systems with the social challenges faced by humanity.

e) Explain the term carbon credits.

(3 M)

Ans:

- Carbon credit is a tradable permit scheme. It is a simple, non-compulsory way to counteract the greenhouse gases that contribute to climate change and global warming.
- Carbon credits create a market for reducing greenhouse emissions by giving a monetary value to the cost of polluting the air.
- A carbon credit represents one tonne of carbon dioxide either removed from the atmosphere or saved from being emitted.

1 credit = 1 tonne of CO₂

- Carbon credits are certificates awarded to countries that are successful in reducing emissions of greenhouse gases. Carbon credits are generated as the result of an additional carbon project.
- Carbon credits can be created in many ways but there are two broad types:
 1. Sequestration (capturing or retaining carbon dioxide from the atmosphere) such as
Afforestation and reforestation activities.
 2. Carbon Dioxide Saving Projects such as use of renewable energies

The concept of carbon credits came into existence as a result of increasing awareness of the need for controlling emissions. Carbon credits were one of the outcomes of the Kyoto Protocol, an international agreement between 169 countries which created legally binding emission targets for developing nations.

f) What are the sources and consequences of Greenhouse Effect?

(3 M)

Ans:

- The greenhouse effect is a naturally occurring process that keeps the Earth's surface and atmosphere warm.
 - It is due to the fact that certain atmospheric gases like carbon dioxide, methane, water vapour, are capable of trapping the sun's heat.
 - This natural trapping of heat or the greenhouse effect has made Earth habitable. This effect helps to maintain the Earth's mean temperature at 15°C while in absence of the greenhouse effect it would have been about -18°C.
 - However, due to human activities the concentrations of the greenhouse gases has increased which will enhance the greenhouse effect thereby, increasing the Earth's surface temperature beyond 15°C. This is referred to as global warming.
 - Besides carbon dioxide, methane, nitrous oxide and water vapour other greenhouse gases are include CFCs and ozone.
 - Methane is produced naturally when vegetation is burnt, digested or rotted in the absence of oxygen.
 - It is also released in paddy fields, coal mines, from rotting garbage dumps and by fossil fuels. Chlorofluorocarbons (CFCs) are man-made industrial chemicals used in air conditioning etc.
 - Nitrous oxide occurs naturally in the environment.
 - In recent years, their quantities have increased significantly due to the use of chemical fertilizers and the burning of fossil fuels.
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g) Why there is need for public awareness on environmental education.

(3 M)

Ans:

- Public awareness of the environment comes from a result of general knowledge, specialist knowledge of a particular problem and a sense of responsibility for the environment.
- As the Earth's resources are dwindling and our environment is being increasingly degraded by human activities, it is evident that something needs to be done. Human beings cannot isolate themselves from the environment. The imbalance that they have created is slowly interfering with their survival and sustenance on Earth.
- Environmental pollution, growing human population, depletion of natural resources, climate changes, calamities and disasters are all environmental

concerns. Environmental protection and conservation is beyond the capacity of one individual, one institution or one government. Hence every citizen of the world needs to be aware and need to actively participate in protecting the global environment.

- **Objectives of Public awareness**

- Conservation of nature and natural resources for the betterment of the society.
- Protection of various species for ecological balance.
- Adoption of appropriate means to solve existing environmental problems.

- **Propagating Public awareness**

- Environmental education: Environmental education must be introduced as a course in schools and colleges.
 - Mass media: Newspapers, magazines, television, radio programs can play an important role in educating masses.
 - Seminars and conferences: Organizing seminars and conferences that may help to spread the environmental information to generate public awareness.
 - Entertainment: Folk songs, street plays, documentaries can help propagate environmental awareness.
 - Public supported movements: Events, marches, campaigns can be organised for an environmental cause.
 - Science centres: Science centres can be established in villages and remote areas to spread information about the environmental problems, causes and control measures.
 - Government and Non-Governmental Organisations: Government and NGOs can work together to carry out public awareness programs.
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Q.2)

a) Write important features of case study on Narmada Bachao Andolan, took place in Gujrat in 1980. (5 M)

Ans:

- Since the early 1980s, the Narmada Project has faced mounting opposition from a variety of sources. Protest groups formed in all three affected states and included or were supported by individuals facing displacement, students, social activists, Indian environmental NGOs, international NGOs, and transnational networks. In Gujarat, nineteen villages, whose submersion the Sardar Sarovar dam ensured, formed the Chhatra Yuva Sangharsh Vahini, a youth protest group. The group engaged in protests and initiated court actions, ultimately forcing the government of Gujarat to offer a more generous resettlement package. The group's belief that Gujarat's water needs made the dam project necessary guided its decision to focus on rehabilitation efforts and to ensure that the government adhered to its promises.
- In contrast, groups in Madhya Pradesh and Maharashtra opposed the dams altogether. Two such groups, the Narmada Ghati Navnirman Samiti in Madhya Pradesh and the Narmada Ghati Dharangrasta Samiti in Maharashtra, subsequently merged to form the Narmada Bachao Andolan in 1989. Under the leadership of the principal figure associated with the movement, Medha Patkar, the NBA initially sought to verify the claims regarding the benefits that would flow from the construction of the dams. In the process, it focused on securing access to documents from the government and the World Bank to ensure greater transparency.
- The success of the NBA campaign resulted from its innovative strategies of resistance that operated simultaneously at the grassroots, national, and international level. As such, the campaign's significance as a social movement extends far beyond India's national borders. Balakrishnan
- Rajagopal—a leading scholar on development and social movements and a long-time observer and researcher of the Narmada struggle— notes that globally, the NBA is “regarded as one of the signature public contestations of the twentieth century that redefined the terms of development, democracy and accountability.”
- While the NBA originally employed “Gandhian methods” such as peaceful marches and protests, after a high-profile hunger fast in 1991 failed, the NBA announced a “noncooperation movement” in the Narmada valley. This movement campaigned against the payment of taxes and sought to deny entry to the villages to all government officials, except teachers and doctors. The NBA subsequently

began to consider litigation as an additional option for a variety of reasons. Their tactics up to this point had frequently drawn violent reactions from the government. In addition, other disadvantaged groups had successfully moved the Supreme Court, inspiring the NBA to do the same.

b) Draw flow sheet diagram and explain the process of industrial waste water treatment. (5 M)

Ans:

- The main objective of wastewater treatment is to allow domestic and industrial effluents to be disposed of without any danger to human health or the natural environment. The type of treatment required depends on the application of water. The wastewater from industrial, commercial and residential areas is collected through a network of underground pipes (sewers) and is then transported through sewerage systems to treatment plants. The conventional water treatment procedure involves mechanical, physical, biological and chemical methods to remove solids, organic matter and, sometimes, nutrients from wastewater. The wastewater treatment procedure in order of the treatment level is as follows:
- **Preliminary treatment:** The objective of preliminary treatment is the removal of coarse solids and other large materials often found in raw wastewater. Removal of these materials is necessary to enhance the operation and maintenance of subsequent treatment units. The primary method consists of screens, grit chamber, and oil-grease trap.
- **Primary treatment:** Primary treatment involves the removal of settleable organic and inorganic solids by sedimentation, and the removal of materials that will float (scum) by skimming. Sedimentation tanks are made either in circular or rectangular and the settled solids are normally removed from the bottom of tanks as sludge. Sedimentation may also be done by adding chemical coagulants.
- **Secondary treatment:** In the secondary treatment, residual organics and suspended solids are removed from the effluent from primary treatment. In most cases, secondary treatment involves the removal of biodegradable dissolved and colloidal organic matter using aerobic biological treatment processes. Common processes include the activated sludge processes, trickling filters, oxidation ditches, and rotating biological contactors.
- **Tertiary treatment:** Tertiary and/or advanced wastewater treatment is employed when specific wastewater constituents such as suspended solids, BOD, dissolved solids, toxic substances and plant nutrients which cannot be removed by

secondary treatment must be removed. This treatment involves electro dialysis, disinfection, filtration methods like reverse osmosis, ultrafiltration, etc.

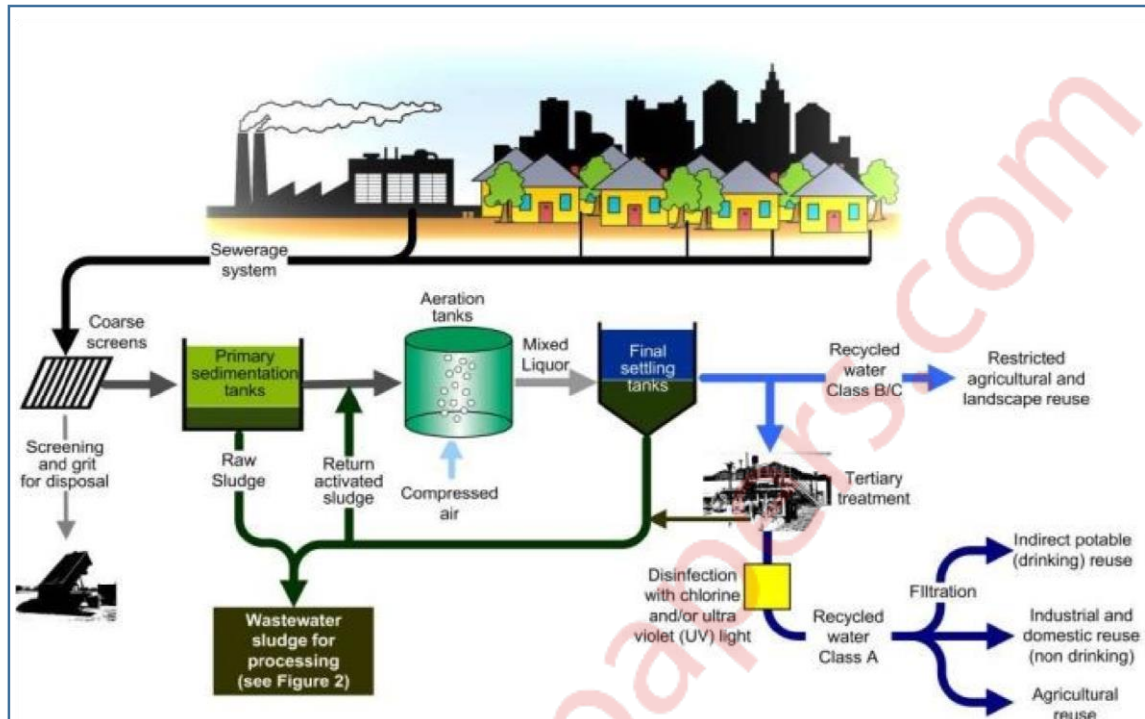


Diagram of waste water treatment procedure

- Treatment of industrial waste water:** The treatment procedure for industrial waste water is the same and consists of the preliminary, primary, secondary and tertiary treatments. The nature of the pollutant determines the type of treatment employed for industrial waste water. For example, waste water from dairy and food industries require biological treatment, metal plating industrial waste are chemically treated. Many industrial wastes may even require neutralization prior to chemical or biological treatment methods.

c) Draw a schematic flat plate collector and explain its role in trapping solar energy. (5 M)

Ans:

- The Earth receives an incredible supply of solar energy. The sun, an average star, is a fusion reactor that has been burning over 4 billion years. It provides enough energy in one minute to supply the world's energy needs for one year. The

amount of solar radiation striking the earth over a three-day period is equivalent to the energy stored in all fossil energy sources.

- Global installed capacity for solar-powered electricity has seen an exponential growth, reaching around 227 GW at the end of 2015. It produced 1% of all electricity used globally.

Solar energy is used in thermal and photovoltaic systems:

- **Thermal systems** concentrates sunlight, converts it into heat, and applies it to a steam generator or engine to be converted into electricity in order to warm buildings, heat water, generate electricity, or destroy dangerous waste. For example, solar thermal collectors.
- **Photovoltaic systems** are composed of cells made of semiconductor material, (silicon). It can produce power when sunlight strikes the semiconductor material and creates an electric current. For example, solar cells.

Flat Plate collectors (Solar thermal collectors):

- The flat-plate solar collectors are probably the most fundamental and most studied technology for solar-powered domestic hot water systems.

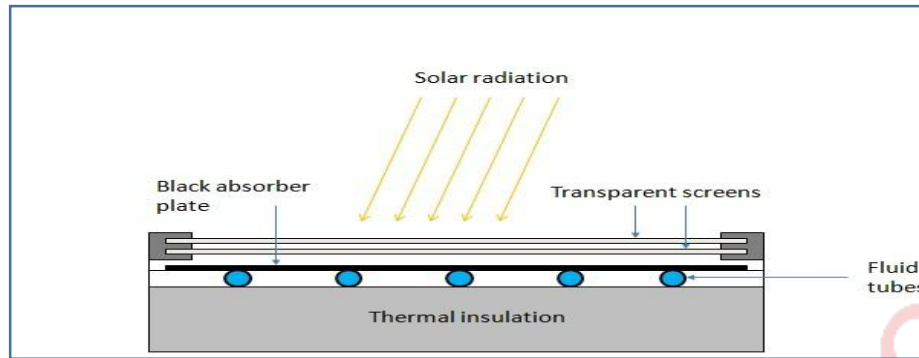
Principle:

- The basic principle for this device is that the sun heats a dark flat surface, which collects as much energy as possible, and then the energy is transferred to water, air, or other fluid for further use.

Construction and Working:

These are the main components of a typical flat-plate solar collector:

- **Black surface** : absorber plate that absorbs the incident solar energy (copper or aluminium sheet coated with selective coating)
- **Glazing cover**: transparent layer that transmits radiation to the absorber, but prevents radiative and convective heat loss from the surface (plastic or glass)
- **Tubes**: contain heating fluid to transfer the heat from the collector
- **Support structure**: protect the components and hold them in place
- **Insulation**: cover sides and bottom of the collector to reduce heat losses (polymeric material)



The schematic of a flat plate solar collector with liquid transport medium is given here.

- The black absorber plate absorbs radiant heat from sunlight.
- The black absorber plate is covered by transparent screens to reduce the heat loss due to convection and radiation to the atmosphere.
- There are tubes carrying water, which gets heated due to the heat absorbed.
- The thermal insulation prevents heat loss during heat transfer.
- The flat-plate systems normally operate and reach the maximum efficiency within the temperature range from 30 to 80 °C, however some new types of collectors that employ vacuum insulation can achieve higher temperatures (up to 100°C).
- Due to introduction of selective coatings, stagnant fluid temperature in flat-plate collectors has been shown to reach 200 °C.
- Flat-plate collectors need to face the sun to obtain maximum sunlight exposure. The installation angle should be equal to or up to 15° higher than the latitude of the location.
- This angle ensures optimal heat output throughout the year. The flat plate solar collectors are highly useful for low temperature heating. The main use of this technology is in residential buildings where the demand for hot water has a large impact on energy bills. Commercial applications include car washes, military laundry facilities and eating establishments.

Q.3)

a) Give a brief account of case study on London Smog occurred in U.K. in December, 1952. (5 M)

Ans:

- London was cold and foggy on December 5, 1952. Damp, chilly air from the English Channel blanketed the city, trapping a dense stagnant layer just above ground level.

- As the 8.3 million Londoners stoked coal furnaces that heated most buildings and fuelled most industry in the city, smoke mingled with the fog to form a dark, acrid smog.
- By midday, visibility dropped to a few meters. Traffic slowed to a standstill, and pedestrians, unable to see landmarks, got lost only blocks from home. Hospitals overflowed with people suffering from respiratory distress and cardiovascular problems. With all beds occupied, patients on stretchers filled hallways.
- As the smog lingered for three more days, visibility dropped until people couldn't see their own feet as they walked down the street. Abandoned cars littered the roads.
- People huddled in their homes, stuffing wet rags around windows and doors trying to keep out the choking smog. Prize cows at the Earl's Court Cattle Show suddenly dropped dead, their lungs black with coal smoke. Humans, also, began to die in alarming numbers. Undertakers ran out of coffins. Several temporary morgues were set up to deal with the sudden influx of corpses. Many of those killed were elderly, or already weak or ill, but young, apparently healthy people also collapsed and died after only a few hours exposure to the toxic cloud.
- By the time winds finally swept away the smog on December 9, more than 4,700 people had died—three times the number for the same period the previous year. The first government reports correctly attributed the deaths to air pollution. Worried, however, that the public might demand costly pollution controls or cleaner-burning fuel, the government later blamed the deaths on an influenza epidemic, even though medical records show no increase in flu diagnoses. In a recent study of historic documents, epidemiologists Devra Davis and Michelle Bell conclude that death rates in London continued to be abnormally high for at least three months after the 1952 episode.
- Altogether, they calculate, at least 12,000 early deaths occurred because of this killer smog, and hundreds of thousands of people suffered from asthma, heart attacks, and other conditions aggravated by polluted air. This would make London's killer smog the greatest air pollution disaster in recorded history. Dirty air wasn't new to London.
- Until the twelfth century, most Londoners burned wood for fuel. As the city grew and the forests shrank, wood became scarce and expensive. Most people switched to abundant supplies of low-quality, bituminous coal for fuel. In 1272, Edward I forbade burning coal in the city and threatened to execute anyone caught breaking his ban.

- Lacking affordable firewood, however, most people ignored this royal proclamation and continued to use coal. In 1578, Queen Elizabeth I complained about the foul air of London, and in 1661, John Evelyn published Fumifugium or the Inconvenience of the Air and Smoke of London Dissipated, in which he deplored the “clouds of smoke and sulphur so full of stink and darkness.” Still, as the population grew, air pollution worsened.
 - A fog in 1879 lasted from November to March, four long months of sunless gloom.
 - Residents described the air as “thick as pea soup.” They complained about the bitter smoke and darkness, but most people assumed that smoky urban air was just an inconvenience or the cost of progress. The high number of deaths in 1952, however, changed attitudes toward air pollution. In 1956, Parliament enacted a Clean Air Act restricting coal use and requiring filters and scrubbers on industrial smokestacks.
 - Subsequently, most other industrial countries have passed similar legislation, and air quality in the developed world has increased dramatically. Still, air pollution is probably responsible for many health problems. In megacities of the developing world, poor air quality remains a major health threat.
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b) Write a brief note on environmental clearance and authorisation mechanism.

(5 M)

Ans:

Environmental Clearance:

- Normally the MPCB's No Objection Certificate (NOC) in the form of combined Consent to establishment under Water Act, Air Act & Hazardous wastes Rules would be required for setting up of an industrial unit.
- In regard to 39 specified industrial and infrastructure projects, environmental clearance from the Ministry of Environment and Forests(MoEF), Government of India (GoI) and State Environment Department are also required as per Environmental Impact Assessment Notification dtd.14/09/2006. For the industrial units, Municipal Solid Waste (MSW) sites and other developmental activities located on the coastal stretches of bays, estuaries, creeks, rivers and back waters, Coastal Regulation Zone (CRZ) clearance also is required.

Authorisation Mechanism:

- The standards are prescribed by the Ministry of Environment & Forest and Government of India, which are minimum uniform national standards, which cannot be relaxed by any authority including CPCB and MPCB. But MPCB can prescribe more stringent standards than whatever laid down by the Ministry of Environment & Forest and Government of India, taking into consideration the local conditions.
 - The authorization for collection/reception/treatment/transport/storage/disposal of Hazardous wastes and Biomedical wastes as defined under the rules needs to be obtained by Board.
 - Monitoring of the industrial unit means sending out the monitoring teams comprised of skilled technical & scientific officers to verify the compliance of conditions imposed in NOC, Consent, Authorization etc. Monitoring includes performance evaluation of Environment Management System (EMS) in respect of Board's notices/directives and checking the compliance of Environmental Clearance conditions and that no violation of law takes place.
 - MPCB has set up mechanisms to analyse the reports received from the monitoring teams and the laboratory verifies the samples and also verifies the compliance of other techno-legal requirements that the unit has to comply with. Based upon the findings so arrived at enforcement measures are taken. In certain cases surprise checking through vigilance squad are also carried out.
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c) Write effects produced by different indoor Air Pollutants.

(5 M)

Ans:

Solvents and Chemicals: Volatile Organic Compounds (VOCs)

- Perfumes, hair sprays, furniture polish, glues, air fresheners, moth repellents, wood preservatives
- Health effect is the irritation of the eye, nose and throat. Severe cases there may be headaches, nausea and loss of coordination, damage to the liver and other parts of the body.

Tobacco smoke: BAP (benzo[a]pyrene)

- Health effects are burning eyes, nose, and throat irritation to cancer, bronchitis, severe asthma, and a decrease in lung function.

Biological pollutants:

- Pollen from plants, mite, hair from pets, fungi, parasites, and some bacteria.
- Health effects cause asthma, hay fever, and other allergic diseases.

Formaldehyde:

- Carpets, particle boards, and insulation foam.
- Health effects is irritation to the eyes and nose and may cause allergies in some people.

Pesticides:

- Health effects include irritation to eye, nose, and throat; damage to central nervous system and kidney, risk of cancer.
- Symptoms may include headache, dizziness, muscular weakness, and nausea.
- Chronic exposure to some pesticides can result in damage to the liver, kidneys, endocrine and nervous systems.

Asbestos:

- Roofing shingles, ceiling and floor tiles, paper products, and asbestos cement products, heat-resistant fabrics, packaging, gaskets, and coatings.
- Health effect is suspected to cause cancer.

Radon:

- Soil, rocks beneath buildings or in certain building materials
 - Radioactive particles can damage the cells that line the lung. Long-term exposure to radon can lead to lung cancer.
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Q.4)

a) What is ecological succession? What is its impact?

(5 M)

Ans:

Ecological succession is defined as an orderly process of changes in the community structure and function with time. These changes are mediated through modifications in the physical environment and ultimately culminating in a stabilized ecosystem.

Two different types of succession have been distinguished:

- **Primary succession** occurs in essentially lifeless areas, regions in which the soil is incapable of sustaining life as a result of factors like lava flows, newly formed sand dunes, or rocks left from a retreating glacier.
- **Secondary succession** occurs in areas where a community that previously existed has been removed; it is typified by smaller-scale disturbances that do not eliminate all life and nutrients from the environment such as fires, floods, and winds, as well as human interference such as logging and clear-cutting.

- **Nudation:** It is a process of developing a bare area without any form of life for the arrival of new species. The causes of nudation may be:
 - **Topographic:** The existing community may disappear due to soil erosion (by gravity, water or wind), land slide, volcanic activity etc.
 - **Climatic:** The existing community may be destroyed due to storm, fire, frost, drought.
 - **Biotic:** The community may also be destroyed by anthropogenic activities like destruction of forest, destruction of grass land etc. Besides, diseases induced by bacteria and virus can also destroy the population.

- **Invasion:** The successful establishment of a species in a bare area is called as invasion. This process of establishment is completed in three successive steps:
 - **Migration (Dispersal):** The seeds, spores or other propagules of the species are brought to the bare area by the agents like air, water etc.
 - **Ecesis (Establishment):** The process of successful establishment (germination and growth) of the species in the new area as a result of adjustment with the prevailing conditions is known as ecesis.
 - **Aggregation:** After ecesis, the individuals of species, the pioneer community increase their number by reproduction and thus, are aggregated in a particular area.

- **Competition and Coaction:** As the species aggregate at a limited space, there happens competition (inter as well as intra specific) mainly for space and nutrition. Secondly the life process of one individual is affected by the surrounding species in various ways which is known as coaction. The species which are found unable to compete with others in the existing environment get discarded.

- **Reaction:** The species present in an environment constantly interact with it there by causing its modification. The mechanism of the modification of the environment through the influence of living organisms on it, is known as reaction. Due to drastic modifications of the environment it may not be suitable for the existing community. Hence, the existing community may be replaced by another community. The whole sequence of communities that substitute one another in the given area is known as sere and the various communities constituting the sere are known as seral communities or seral stages.

- **Stabilisation:** At last a final community is established which is stabilized for a longer period of time and which can maintain an equilibrium with the environment of that

area. This community is known as climax community and the stage is as climax stage.

b) Write important powers and functions of State Pollution Control Board (SPCB).

(5 M)

Ans:

1. Advise the Central Government on any matter concerning prevention and control of water and air pollution and improvement of the quality of air.
2. Plan and cause to be executed a nation-wide programme for the prevention, control or abatement of water and air pollution.
3. Co-ordinate the activities of the State Board and resolve disputes among them.
4. Provide technical assistance and guidance to the State Boards, carry out and sponsor investigation and research relating to problems of water and air pollution, and for their prevention, control or abatement.
5. Plan and organise training of persons engaged in programme on the prevention, control or abatement of water and air pollution.
6. Organise through mass media, a comprehensive mass awareness programme on the prevention, control or abatement of water and air pollution.
7. Collect, compile and publish technical and statistical data relating to water and air pollution and the measures devised for their effective prevention, control or abatement.
8. Prepare manuals, codes and guidelines relating to treatment and disposal of sewage and trade effluents as well as for stack gas cleaning devices, stacks and ducts.
9. Disseminate information in respect of matters relating to water and air pollution and their prevention and control.

10. Lay down, modify or annul, in consultation with the State Governments concerned, the standards for stream or well, and lay down standards for the quality of air.

11. Perform such other function as may be prescribed by the Government of India.

c) Draw a neat labelled diagram and explain the process of generating electricity from geothermal energy. (5 M)

Ans:

Geothermal energy is thermal energy generated and stored in the Earth. The geothermal energy of the Earth's crust originates from the original formation of the planet (20%) and from radioactive decay of minerals (80%).

This thermal energy is contained in the rocks and fluids beneath Earth's crust. It can be found from shallow ground to several miles below the surface, and even farther down to the extremely hot molten rock called magma.

The geothermal gradient, which is the difference in temperature between the core of the planet and its surface, drives a continuous conduction of thermal energy in the form of heat from the core to the surface.

Geothermal energy contributes less than 1% of the world's electricity generation. There were 315 MW of new geothermal power capacity installed in 2015, raising the total capacity to 13.2 GW.

Principle:

Geothermal power plants use steam produced from reservoirs of hot water found a few miles or more below the Earth's surface to produce electricity. The steam rotates a turbine that activates a generator, which produces electricity.

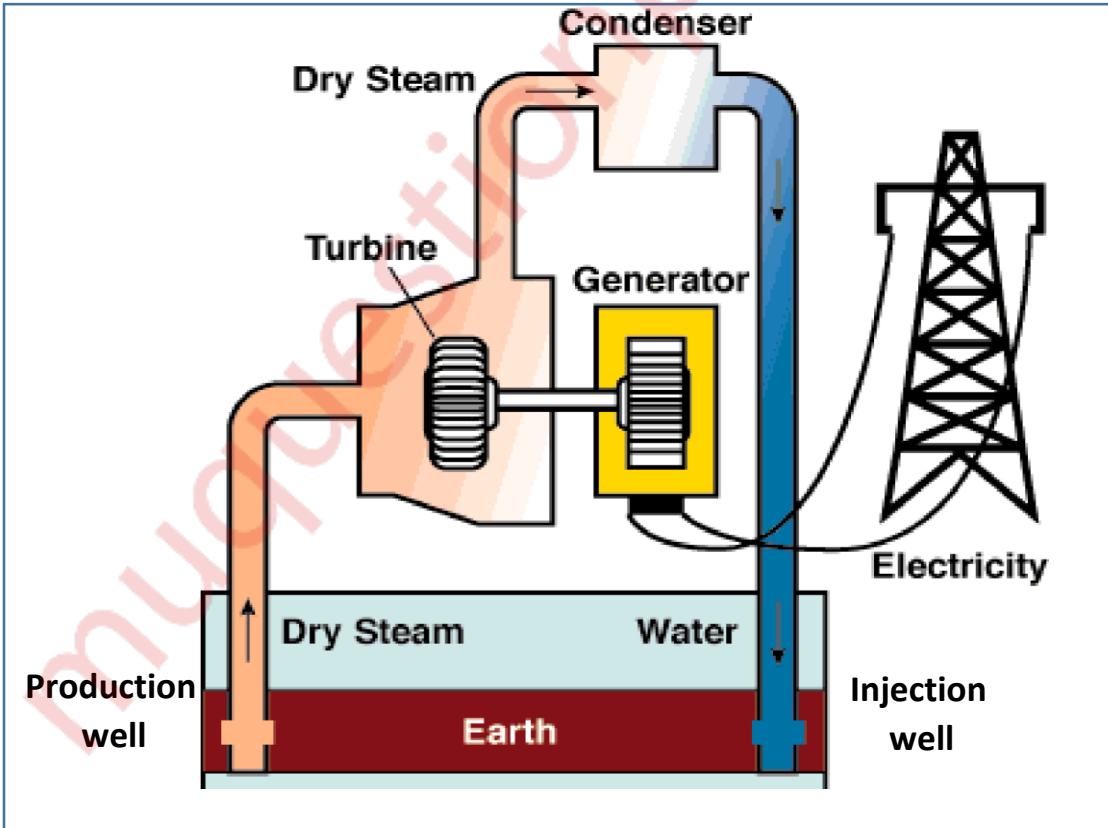
There are three types of geothermal power plants:

1. Dry steam
2. Flash steam

3. Binary steam

Dry Steam:

- Dry steam power plants take advantage of underground resources of steam.
- The steam is piped directly from the **production well**, drilled into the geothermal reservoir.
- The high pressure dry steam passes up the production well and through a series of **mesh filters** which catch any rocks, stones or other debris, which would otherwise damage the turbine blades.
- The steam then passes through a **steam turbine** that drives an **electrical generator**, which produces electricity for the **grid**.
- The steam exits the low pressure stage of the turbine and into the **condenser**.
- The condensate is then re-injected down the **injection well** into the geothermal reservoir.



Flash Steam:

Flash steam power plants are the most common and use **geothermal reservoirs of water** with temperatures greater than 360°F (182°C). This very hot water flows up through wells in the ground under its own pressure. As it flows upward, the pressure decreases and some of the hot water boils into steam. The steam is then separated from the water and used to power a turbine/generator. Any leftover water and condensed steam are injected back into the reservoir, making this a sustainable resource.

Binary Steam: Binary cycle power plants operate on water at lower temperatures of about 225°– 360°F (107°–182°C). Binary cycle plants use the **heat from the hot water to boil a working fluid**, usually an organic compound (isobutane) with a low boiling point. The working fluid is vaporized in a heat exchanger and used to turn a turbine. The water is then injected back into the ground to be reheated. The water and the working fluid are kept separated during the whole process, so there are little or no air emissions.

Q.5)

a) Explain economic and environmental aspects associated with sustainable development. (5 M)

Ans:

Economic: An economically sustainable system must be able to produce goods and services on a continuing basis, to maintain manageable levels of government and external debt, and to avoid extreme sectoral imbalances which damage agricultural or industrial production.

Environmental: An environmentally sustainable system must maintain a stable resource base, avoiding over-exploitation of renewable resource systems or environmental sink functions, and depleting non-renewable resources only to the extent that investment is made in adequate substitutes. This includes maintenance of biodiversity, atmospheric stability, and other ecosystem functions not ordinarily classed as economic resources.

Environmental-Social Aspect: This blending of environmental and social aspects of sustainability deals with how we interact with our environment. This can include how we

plan and design our homes and cities, how we take care of the resources we have available to us, and the ways we interact with the environment. We also have to contend with the natural patterns of nature and how they can affect us. Drought, wildfires and threats of hurricanes and flooding need to be considered when planning new construction projects.

Environmental-Economic Aspect: When it comes to looking at how environmental and economic aspects interact, we need to look at both how economics affects the environment and how the environment affects economics. Environmentally friendly products are becoming more common, making it easier to purchase goods with less packaging, cleaners that are less hazardous to us and our environment and foods that are grown in ways that are better for the environment. However, fossil fuels are becoming harder to come by, and the cost to purchase refined fuels will become more expensive as time goes on. Companies are looking for ways of harnessing renewable sources of energy and in time, these will become more common and less expensive. We need to develop ways to maintain positive economic development that can support itself without negatively impacting the environment.

b) Draw and neat diagram and explain working of Venturi Scrubber.

Ans:

Venturi scrubbers are part of the group of air pollution control systems known as wet scrubbers. These are often installed to remove fine particles from volatile, hazardous or corrosive gas streams, or gas streams containing solid materials that are difficult to handle. These scrubbers use a scrubbing liquid (often water) to capture and remove pollutants.

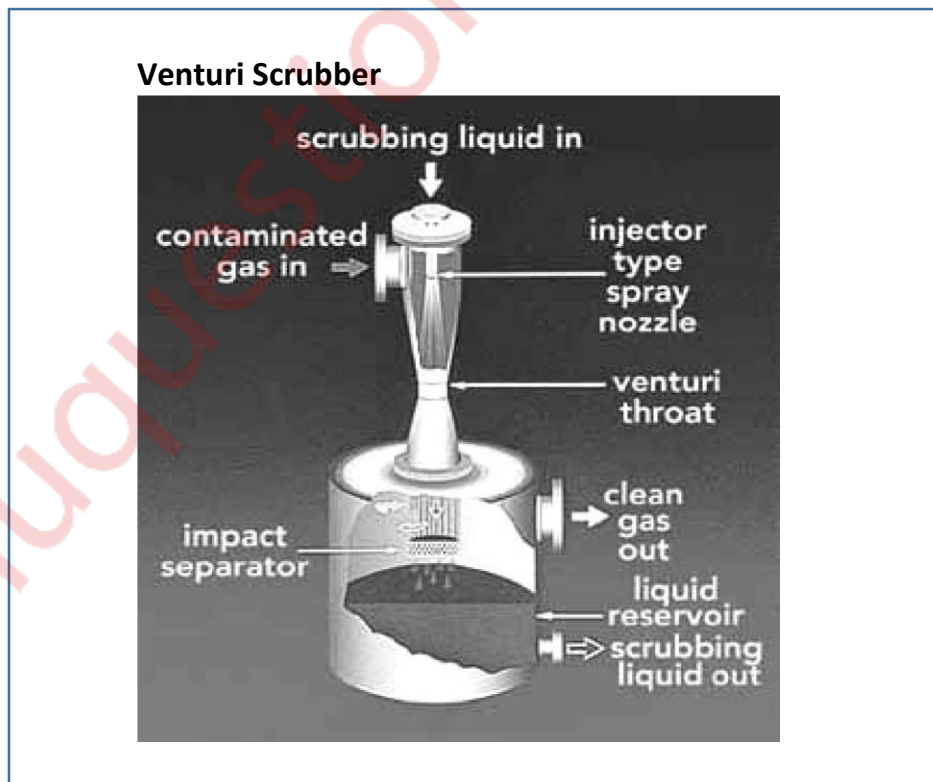
Principle:

In the venturi scrubber, gas laden with particulate matter passes through a constricted section of the scrubber where scrubbing liquid and gas reach high velocities, resulting in high turbulence in the liquid and gas streams, which causes liquid droplet-particle contact.

The scrubbing liquid hence removes the pollutants from the gas stream.

Description and Working:

- Venturi scrubber is a venturi shaped chamber with converging and diverging sections. It consist of a third section called the throat section.
- The scrubbing liquid (generally water) is introduced at the entrance to the converging section through a nozzle .
- The inlet gas stream enters the converging section and, as the area decreases, gas velocity increases.
- The inlet gas, which is forced to move at extremely high velocities in the small throat section, shears the liquid from its walls, producing a tremendous number of very tiny droplets.
- In the throat section, particle and gas pollutant removal occurs as the inlet gas stream mixes with the fog of tiny liquid droplets.
- The inlet stream then exits through the diverging section, where it is forced to slow down.
- Many scrubbers are available with pre-filters or final filters to further reduce emissions. Pre-filters are installed upstream of the scrubber intended to catch larger particles.
- A final filter is often installed downstream of the scrubber, and is intended to catch fine particles that were not removed during the scrubbing process.



Applications:

- The ability of venturi scrubber to handle large gas inlet volumes at high temperatures makes it applicable to many industries. It is capable of removing particulate matter or gases from an industrial exhaust or flue gas stream, handling explosive and flammable gases safely, removing solids, mists, and gases simultaneously while also providing cooling of hot gas stream and neutralising corrosive gases and dust.

Venturi scrubber are applied in chemical industry for the removal of dust and aerosols, metallurgy for several types of degasses, waste combustion installations, glass industry, manure production, pharmaceutical industry, plastic industry.

c) Draw a neat schematic and explain the process of hydropower generation.
(5 M)

Ans:

Principle:

Hydropower uses the natural gradient force of water flowing down from a considerably height under gravity which is capable to turn turbines to generate electricity.

There are three types of hydropower plants:

‘run of river’: where the electricity is generated through the flow of a river

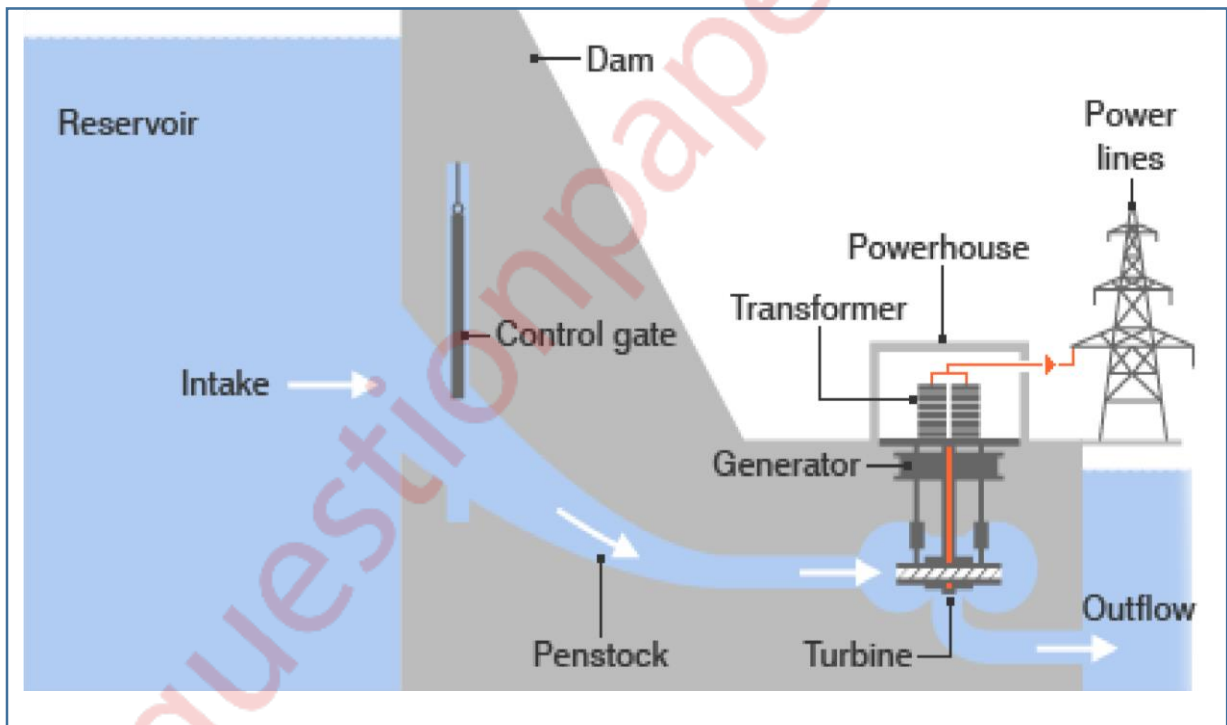
‘reservoir’: where power is generated through the release of stored water

‘pumped storage’: where stored water is recycled by pumping it back up to a higher reservoir in order to be released again

Construction and Working:

- The basic components of a conventional hydropower plant are:
 - **Dam:** a large reservoir that holds back water
 - **Control gates:** gates built on the inside of the dam, when opened the water flows due to gravity through the penstock and towards the turbines

- **Penstock:** a pipe which is connected between dam and turbine blades, used to increase the kinetic energy of water
- **Turbine:** as water falls on the blades of the turbine, the kinetic and potential energy of water is converted into the rotational motion of the blades of the turbine
- **Generators:** generator produces electricity, as the turbine blades turn, so do a series of magnets inside the generator producing a magnetic field which is converted into electricity by electromagnetic field induction
- **Transformer:** the transformer inside the powerhouse takes the alternating current and converts it to higher-voltage current.
- **Transmission lines:** out of every power plant come four wires: the three phases of power being produced simultaneously plus a neutral or ground common to all three
- **Outflow:** used water is carried through pipelines, called tailraces, and re-enters the river downstream



- The water in the reservoir is considered stored energy. The height of water in the reservoir decides how much potential energy the water possesses. The higher the height of water, the more its potential energy. The overall potential energy of water, helps to produce more electricity in the power generation unit.
- When the control gates open, the water flows through the penstock becomes kinetic energy because it's in motion.
- The amount of electricity that is generated is determined by the flow and the head.

- The flow of water through the penstock is controlled by the control gates. The head refers to the distance between the water surface and the turbines, usually dependent upon the amount of water in the reservoir.
 - Water flowing from the penstock is allowed to enter the power generation unit, which houses the turbine and the generator. When water falls on the blades of the turbine, the kinetic and potential energy of water is converted into the rotational motion of the blades of the turbine.
 - The rotating blades causes the shaft of the turbine to also rotate. The turbine shaft is enclosed inside the generator. In most hydroelectric power plants there is more than one power generation unit.
 - The shaft of the water turbine rotates in the generator, which produces alternating current in the coils of the generator. It is the rotation of the shaft inside the generator that produces magnetic field which is converted into electricity by electromagnetic field induction.
 - Hence the rotation of the shaft of the turbine is crucial for the production of electricity and this is achieved by the kinetic and potential energy of water.
 - The electricity produced is then stepped up in voltage through the hydroelectric power station transformers and sent across transmission lines.
 - The used water having performed its intended purpose is channeled out of the power generation station as outflow to the mainstream of the river to continue the cycle of power generation.
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Q.6)

a) Explain the reason and effects of depletion of natural forest resources. (5 M)

Ans:

- The problem of depletion and destruction of forests cause imbalances and enhance threatening the survival of the human species. In the past 100 years the world has lost almost half its forest area. And, as indicated by reports of the FAO (Food and Agriculture) the Earth is losing on net every year 11.2 million hectares of virgin forest.
- Over the years, the area under forest cover has decreased steadily, as forests have been cleared for agriculture, industry, housing, mining and other development activities like the construction of roads, railways, and hydroelectric plants.

- This decline of forests, particularly serious in the case of tropical forests not only increases the greenhouse effect by reducing the absorption of carbon dioxide but also aggravated the decline of water resources.
 - As the dwindling forest cover, logically increases rainfall runoff, which favours floods, soil erosion and reduces the amount that seeps into the ground to recharge aquifers.
 - Since the beginning of civilization, as seen from the Indus Valley Civilization, people have been clearing land for agriculture to meet the food needs of the ever-growing population. Most forest communities follow a method of slash and burn or shifting cultivation, known as Jhum in the Indian subcontinent. They clear a patch of forest, cultivate crops on it, and abandon it the following season. Then they move on to a new area and follow the same pattern. They often return to the same area after a few years. This method is more common in the hilly regions.
 - It is now believed that Jhum was a good method of cultivation as the land was left uncultivated for a long period. This allowed the forest to regenerate and the soil to stabilize. Once the trees are felled, the soil becomes less fertile as it removes the nutrient-giving vegetation layer. This also leads to severe soil erosion. If the land is left to regenerate, the forest re-grows and the soil becomes stable.
 - Today, though, this method of cultivation causes extensive damage to the area. Due to the increase in population, people are compelled to cultivate on the same plot of land more frequently as there is very little forest area available. Forests are also being converted to permanent settlements. Thus, forests cannot regenerate, and, in some cases, forest areas have become wasteland within a few years due to frequent cultivation. **Forest conservation measures:**
 - Adoption of massive plantation (commercial forestry) and forest extensions (social forestry, agro forestry, urban forestry).
 - Prohibition of mining and construction activities.
 - Enforcement of strict environmental laws and legal provisions (reserve forests, sacred forests, reforestation, block cutting).
 - Public awareness through afforestation and forest conservation programmes.
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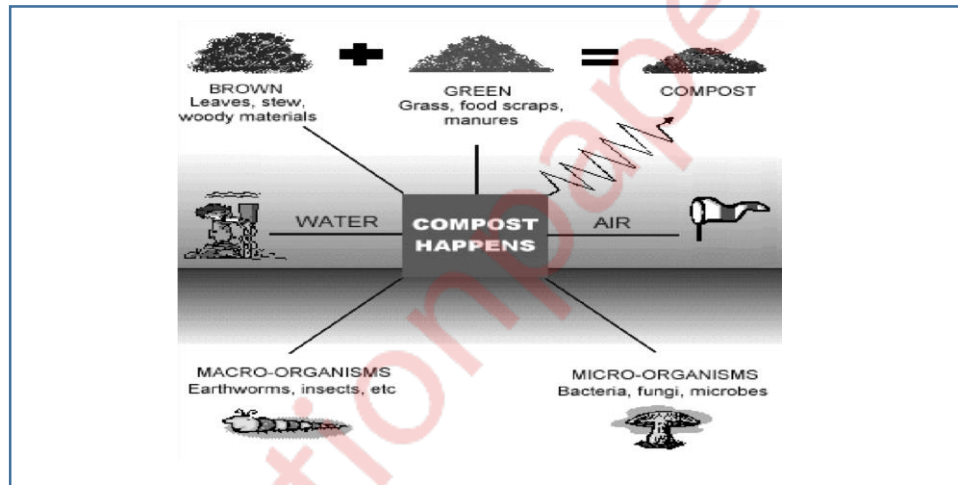
b) How solid waste management is carried out by composting?

(5 M)

Ans:

- Composting is one of the important method for Solid Waste Management.

- Composting is a process by which organic matter is decomposed by microorganisms into nutrient rich, stable humus material called compost.
- Compost is peaty humus, dark in colour and has a crumbly texture, an earthy odour, and resembles rich topsoil.
- The composting process is an environmentally sound and beneficial means of recycling organic materials and not a means of waste disposal.
- It involves four main components: organic matter, moisture, oxygen, and microorganisms.



1. **Organic matter** includes crop residues, food garbage, animal wastes, some municipal wastes and suitable industrial wastes. Organic materials used for compost should include a mixture of brown organic material (dead leaves, twigs) and green organic material (lawn clippings, fruit rinds, vegetable peel etc.). Brown materials supply carbon, while green materials supply nitrogen. The best ratio is 1 part green to 1 part brown material.
2. **Shredding, chopping or mowing** these materials into smaller pieces will help speed the composting process by increasing the surface area. The organic material is then blended together and piled up or put in special pits for composting.
3. **Microorganisms** such as bacteria, fungi, and *actinomyces* (fungi-like bacteria) carry out the composting process. The first stage of the composting is the

consumption of easily available sugars by bacteria, which causes a fast rise in temperature. The second stage involves bacteria and *actinomyces* that cause cellulose breakdown. The last stage is concerned with the breakdown of the tougher lignins by fungi.

Microorganisms in the compost digest C as an energy source and ingest N as a protein source. The **C: N proportion** should be approximately 30 parts C to 1 part N by weight.

4. **Temperatures** between 30-60°C indicate rapid composting. Temperatures greater than 60°C reduce the activity of most organisms.
5. **Aeration** replaces oxygen-deficient air in the center of the compost pile with fresh air. Rapid aerobic decomposition occurs only when there is enough oxygen present. Regular mixing or turning of the pile fluffs up the material and increases air movement, enhances aeration and decreases compaction.
6. **Moisture** is needed for bacterial decomposition. A moisture content of 40-60 percent provides adequate moisture without limiting aeration.

c) Explain the objective of 'Green Building'.

(5 M)

Ans:

Green Building over a conventional building help to retain nature to a maximum extent possible in three ways with reference to the location of the buildings.

1. Retain the external environment at the location of the building.
2. Improve internal environment for the occupants.
3. Preserve the environment at places far away from the building.

Green Buildings Retain the Environment at the location of the Building:

- Land : The landscaping and the exterior design in a green building shall be in such a way that there is more shaded area, the light trespass is eliminated and local species of plants are grown.
- Water : The green building by its design and shape shall not disrupt the natural water flows, it should orient and stand just like a tree. Rain falling over the whole area of the complex shall be harvested in full either to replenish the ground water table in and around the building or to be utilized in the services of the building. The toilets shall be fitted with low flush fixtures. The plumbing system

should have separate lines for drinking and flushing. Grey water from kitchenette, bath and laundry shall be treated and reused for gardening or in cooling towers of air conditioning.

- **Energy:** The solar energy at the top of a green building is harvested to supplement the conventional energy,. The natural light is harvested in the intermediate floors to minimize the usage of electricity. Sunlight is restricted by the high grown trees outside the lower floors of the building. High efficiency light fixtures make a pleasant lighting apart from saving the energy. High-efficiency windows and insulation in walls, ceilings, and floors are used for the benefit of better temperature control.

Green buildings improve internal environment for the occupants:

- **Light:** In a designed green building the occupants shall feel as if they are in outdoor location. The interior and exterior designs shall go hand in hand by blending the natural and artificial lighting and presenting transparent views wherever possible.
- **Air:** In the air conditioned environment, a green building shall be specially equipped to ensure the Indoor Air Quality for a healthy atmosphere. Even the nasal feelings shall be pleasant free from the odour of paints and furnishings.
- A comfortable atmosphere at work stations improve the attendance of the staff and increase the productivity.

Green buildings preserve the environment at places far away from the buildings:

Green buildings shall use the products that are non-toxic, reusable, renewable, and/or recyclable wherever possible. Locally manufactured products are preferred so that the collective material environment of the locality remains a constant and moreover the fuel for the transport of materials is saved.

Green wood : A Stanford team has done a research for wood alternate. Hemp fibers and biodegradable plastic when pressed together and heated form layers and this material is as strong as wood. When buried in land fill, it degrades faster. This wood creates more raw materials when it breaks down. Microbes produce methane gas when they decompose this wood substitute and other debris thrown into landfills. Another type of bacteria absorbs this gas and turns it into plastic that can be used to create a new wooden plank. By this cycle, there is a continuous source of raw

material for this wood. When this material at research comes to market, it may help to control deforestation and promote the rainfall.

Green Cement: Bruce Constantz at Calera, based in Los Gatos, has developed a green method to produce both cement and aggregate, another component of Concrete. Their method sequesters Carbon Dioxide from power plant flues and mixes the gas with sea water to produce the mineral raw materials of concrete. For every ton of green cement Calera manufactures half a ton of fly ash from coal plants is used apart from preventing production and emission of Carbon Dioxide.

Other Green Building materials: Renewable plant materials like bamboo (because bamboo grows quickly) and straw, lumber from forests ecology blocks, dimension stone, recycled stone, recycled metal are some of the other materials used in a Green Building.
