

Environment and Sustainability (4300003) - Summer 2022 Solution

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Question 1 [a marks]

3 Write short note: Ecological pyramid.

Solution

Table 1. Types of Ecological Pyramids

| Type | Description | Example |
|---------------------------|---|-------------------------|
| Pyramid of Numbers | Shows number of organisms at each level | Trees → Insects → Birds |
| Pyramid of Biomass | Shows total mass of organisms | Large at producer level |
| Pyramid of Energy | Shows energy flow through levels | Always upright |

- **Energy Transfer:** Only 10% energy transfers to next level
- **Trophic Levels:** Producers, primary consumers, secondary consumers
- **Always Upright:** Energy pyramid never inverts

Mnemonic

Number-Biomass-Energy flows UP

Question 1 [b marks]

4 Describe global ecological overshoot.

Solution

Global ecological overshoot occurs when humanity's demand exceeds Earth's regenerative capacity.

Table 2. Key Components of Ecological Overshoot

| Factor | Description |
|-----------------------------|--|
| Earth Overshoot Day | Date when annual resource consumption exceeds regeneration |
| Ecological Footprint | Human demand on natural resources |
| Biocapacity | Earth's ability to regenerate resources |

- **Current Status:** Using 1.7 Earth's worth of resources annually
- **Consequences:** Climate change, biodiversity loss, resource depletion
- **Solutions:** Sustainable consumption, renewable energy adoption

Mnemonic

Demand Exceeds Supply = Overshoot

Question 1 [c marks]

7 What are the Bio-geochemical cycle? Describe any two cycle of them.

Solution

Bio-geochemical cycles are natural processes that recycle essential elements through biotic and abiotic components.

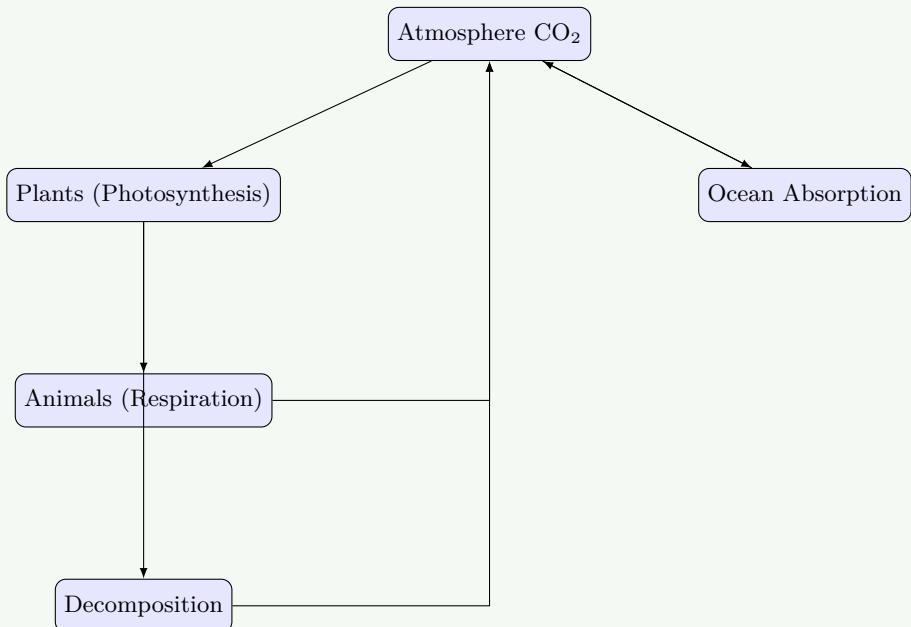
Carbon Cycle:

Table 3. Nitrogen Cycle Stages

| Stage | Process | Organisms |
|--------------------------|-------------------------|---------------------------|
| Nitrogen Fixation | $N_2 \rightarrow NH_3$ | Rhizobium bacteria |
| Nitrification | $NH_3 \rightarrow NO_3$ | Nitrosomonas, Nitrobacter |
| Denitrification | $NO_3 \rightarrow N_2$ | Denitrifying bacteria |

- Importance:** Essential for protein synthesis and DNA formation
- Human Impact:** Fertilizers disrupt natural balance
- Conservation:** Reduce chemical fertilizer use

Mnemonic

Bacteria Fix Nitrogen, Plants Use It

Question 1 [c marks]

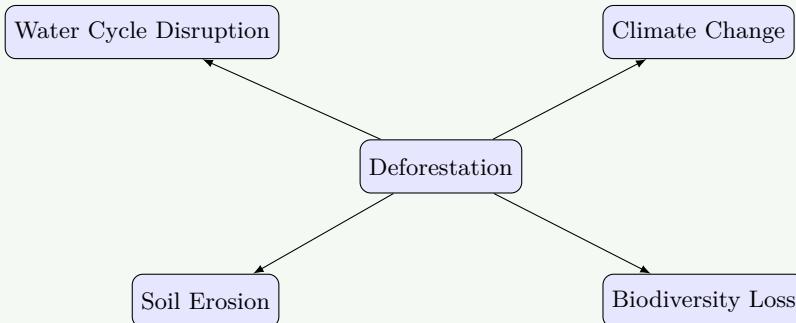
7 Describe the forest ecosystem state and explain the effects of deforestation and suggest the methods to conserve forest ecosystem.

Solution

Table 4. Forest Ecosystem Components

| Component | Examples |
|----------------------------|------------------------|
| Producers | Trees, shrubs, herbs |
| Primary Consumers | Deer, rabbits, insects |
| Secondary Consumers | Carnivores, birds |
| Decomposers | Bacteria, fungi |

Effects of Deforestation:



Conservation Methods:

- **Afforestation:** Planting trees in new areas
- **Reforestation:** Replanting in deforested areas
- **Protected Areas:** National parks and sanctuaries
- **Sustainable Harvesting:** Controlled logging practices

Mnemonic

Plant, Protect, Practice Sustainability

Question 2 [a marks]

3 Write definition on pollution and pollutant.

Solution

Table 5. Pollution Definitions

| Term | Definition |
|------------------|---|
| Pollution | Addition of harmful substances to environment |
| Pollutant | Substance causing environmental contamination |

- **Sources:** Industrial, domestic, agricultural activities
- **Types:** Air, water, soil, noise pollution
- **Effects:** Health problems, ecosystem damage

Mnemonic

Pollutants cause Pollution

Question 2 [b marks]

4 Explain short note on gravity settling chamber equipment to control air pollution.

Solution

Gravity Settling Chamber:

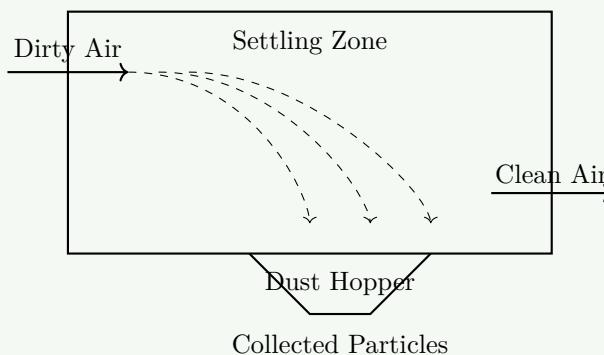


Table 6. Working Principle

| Parameter | Description |
|------------|--|
| Mechanism | Gravitational settling of particles |
| Efficiency | 50-70% for particles $>50 \mu\text{m}$ |
| Velocity | Low gas velocity allows settling |

- **Applications:** Cement, mining, metallurgy industries
- **Advantages:** Simple design, low maintenance cost
- **Limitations:** Ineffective for fine particles

Mnemonic

Gravity Settles Heavy Particles

Question 2 [c marks]

7 Describe solid waste management.

Solution

Solid Waste Management Hierarchy:



Table 7. Solid Waste Management Methods

| Method | Description | Advantages |
|--------------|--------------------------|--------------------------|
| Landfill | Controlled burial | Simple, cost-effective |
| Incineration | High-temperature burning | Volume reduction |
| Composting | Biological decomposition | Nutrient-rich fertilizer |
| Recycling | Material recovery | Resource conservation |

Components:

- **Collection:** Door-to-door pickup systems
- **Transportation:** Efficient vehicle routing
- **Treatment:** Sorting, processing, disposal
- **Monitoring:** Regular quality checks

Mnemonic

Collect, Transport, Treat, Monitor

Question 2 [a marks]**3 Write effect on noise pollution.****Solution****Table 8.** Effects of Noise Pollution

| Type | Effects |
|-----------------------|---------------------------------------|
| Health Effects | Hearing loss, stress, hypertension |
| Psychological | Irritation, sleep disorders, anxiety |
| Environmental | Wildlife disruption, ecosystem damage |

- **Sources:** Traffic, industries, construction, aircraft
- **Measurement:** Decibel (dB) scale
- **Control:** Sound barriers, noise regulations

Mnemonic

Noise Harms Health and Habitat

Question 2 [b marks]**4 What is water pollution? Write list of main water pollutant?****Solution**

Water Pollution Definition: Contamination of water bodies by harmful substances making it unsuitable for use.

Table 9. Major Water Pollutants

| Category | Examples |
|--------------------|---------------------------------------|
| Chemical | Heavy metals, pesticides, fertilizers |
| Biological | Bacteria, viruses, parasites |
| Physical | Suspended solids, thermal pollution |
| Radioactive | Nuclear waste materials |

- **Sources:** Industrial discharge, domestic sewage, agricultural runoff
- **Effects:** Disease transmission, ecosystem disruption
- **Control:** Treatment plants, pollution prevention

Mnemonic

Chemical, Biological, Physical, Radioactive

Question 2 [c marks]

7 What is E-waste? Write impact of E-waste on environment and human health. How to recycle E-waste?

Solution

E-waste Definition: Electronic waste includes discarded electrical and electronic devices.

Environmental Impact:

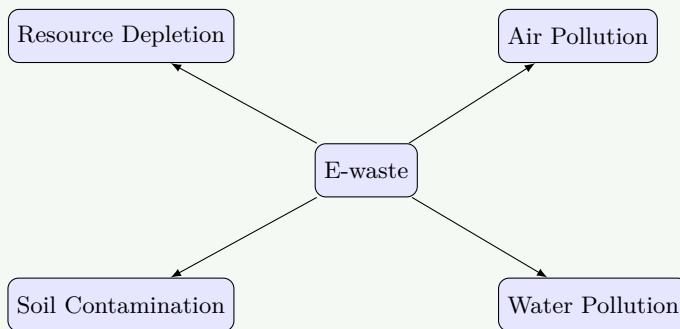


Table 10. Health Impact of E-waste

| Toxic Material | Health Effects |
|----------------|-------------------------|
| Lead | Nervous system damage |
| Mercury | Brain and kidney damage |
| Cadmium | Cancer, lung damage |

E-waste Recycling Process:

- **Collection:** Designated collection centers
- **Dismantling:** Manual separation of components
- **Recovery:** Extraction of valuable materials
- **Disposal:** Safe handling of toxic substances

Mnemonic

Collect, Dismantle, Recover, Dispose Safely

Question 3 [a marks]

3 What is BOD? Give a importance of BOD.

Solution

Table 11. BOD Parameters

| Parameter | Description |
|--------------------|---|
| Definition | Oxygen required by microorganisms to decompose organic matter |
| Unit | mg/L or ppm |
| Test Period | 5 days at 20°C |

Importance:

- **Water Quality:** Indicates organic pollution level
- **Treatment Efficiency:** Monitors treatment plant performance
- **Environmental Health:** Assesses aquatic ecosystem condition

Mnemonic

Bacteria Oxygen Demand measures pollution

Question 3 [b marks]

4 Give a comparison of conventional and Non conventional energy sources.

Solution

Table 12. Energy Sources Comparison

| Parameter | Conventional | Non-Conventional |
|-----------------------|------------------------|----------------------|
| Examples | Coal, oil, natural gas | Solar, wind, biomass |
| Availability | Limited reserves | Unlimited/renewable |
| Environment | High pollution | Environment friendly |
| Cost | Initially cheap | High initial cost |
| Sustainability | Non-sustainable | Sustainable |

- **Conventional:** Depleting rapidly, cause greenhouse gases
- **Non-conventional:** Clean, abundant, future energy solution
- **Transition:** Global shift towards renewable energy

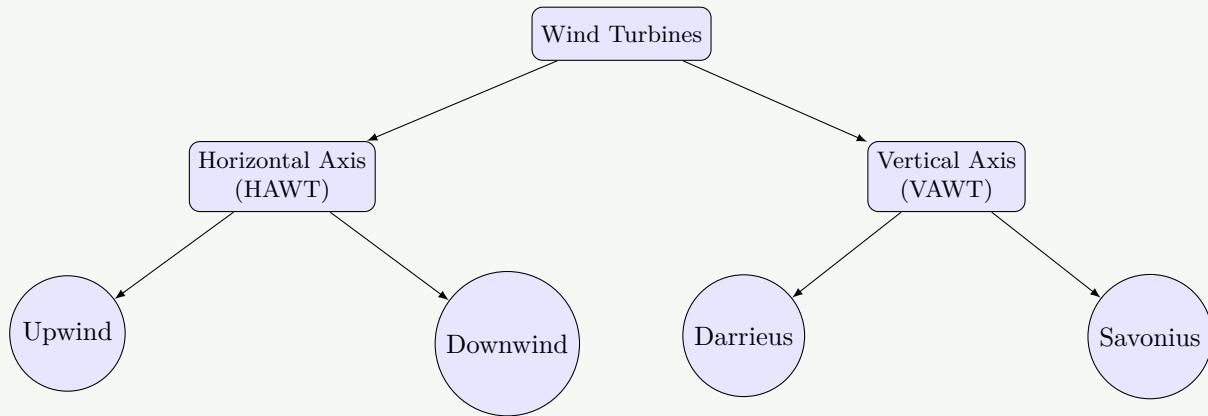
Mnemonic

Conventional Pollutes, Renewable Sustains

Question 3 [c marks]

7 Give classification of wind turbines and explain horizontal axis wind turbine.

Solution**Wind Turbine Classification:**



Horizontal Axis Wind Turbine (HAWT):

Table 13. HAWT Components

| Component | Function |
|---------------------|--|
| Rotor Blades | Convert wind energy to rotational motion |
| Nacelle | Houses generator and gearbox |
| Tower | Supports turbine at optimal height |
| Foundation | Provides structural stability |

Working Principle:

- **Wind Direction:** Parallel to rotor axis
- **Blade Design:** Aerodynamic lift principle
- **Power Generation:** Variable speed operation
- **Efficiency:** 35-45% energy conversion

Advantages:

- **High Efficiency:** Better power coefficient
- **Mature Technology:** Well-established design
- **Cost Effective:** Lower maintenance costs

Mnemonic

Horizontal High Efficiency

Question 3 [a marks]

3 Explain need for renewable energy.

Solution

Table 14. Need for Renewable Energy

| Reason | Description |
|---------------------------------|------------------------------|
| Energy Security | Reduce import dependence |
| Environmental Protection | Zero carbon emissions |
| Economic Benefits | Job creation, cost reduction |

- **Fossil Fuel Depletion:** Limited reserves, increasing prices
- **Climate Change:** Urgent need to reduce greenhouse gases

- **Sustainable Development:** Meet present needs without compromising future

Mnemonic

Security, Environment, Economy need Renewables

Question 3 [b marks]

4 Write a short note on Geo thermal energy.

Solution

Geothermal Energy: Heat energy stored beneath Earth's surface used for power generation.

Table 15. Geothermal Energy Types

| Type | Temperature | Application |
|--------------------|-------------|------------------|
| High Temperature | >150°C | Power generation |
| Medium Temperature | 90-150°C | Direct heating |
| Low Temperature | <90°C | Heat pumps |

- **Sources:** Hot springs, geysers, underground reservoirs
- **Advantages:** Continuous availability, low emissions
- **Applications:** Electricity generation, space heating, industrial processes

Mnemonic

Earth's Heat Powers Homes

Question 3 [c marks]

7 Explain the principal and working of solar photovoltaic cell. Give its uses.

Solution

Solar Photovoltaic Cell Principle: Converts sunlight directly into electricity using photovoltaic effect.

Working Process:

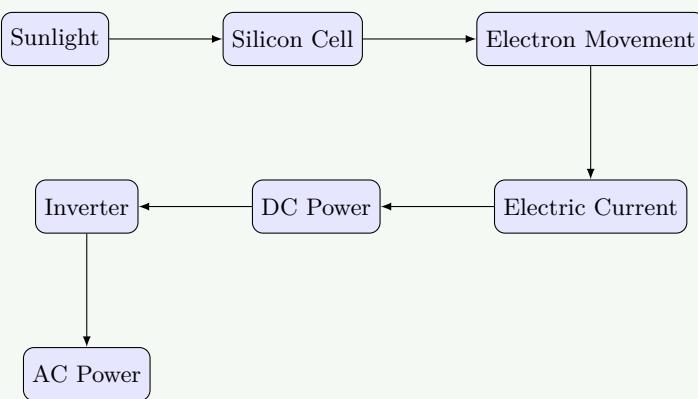


Table 16. Solar Cell Structure

| Layer | Material | Function |
|--------------|----------------|-------------------------|
| Top Layer | N-type silicon | Excess electrons |
| Bottom Layer | P-type silicon | Electron holes |
| Junction | P-N junction | Electric field creation |

Working Steps:

- **Photon Absorption:** Light energy absorbed by silicon
- **Electron Excitation:** Electrons gain energy and move
- **Current Generation:** Electron flow creates electricity
- **External Circuit:** Current flows through load

Applications:

- **Residential:** Rooftop solar systems
- **Commercial:** Solar farms, street lighting
- **Industrial:** Remote power supply, satellites
- **Transportation:** Solar vehicles, charging stations

Advantages:

- **Clean Energy:** No emissions during operation
- **Low Maintenance:** Minimal moving parts
- **Modular:** Scalable installation

Mnemonic

Sun Strikes Silicon, Sparks Current

Question 4 [a marks]

3 Explain Green house effect.

Solution

Greenhouse Effect: Natural process where certain gases trap heat in Earth's atmosphere.

Table 17. Greenhouse Effect Mechanism

| Step | Process |
|--------------------|--------------------------------|
| Solar Radiation | Sun's energy reaches Earth |
| Surface Absorption | Earth absorbs and heats up |
| Re-radiation | Earth emits infrared radiation |
| Gas Trapping | Greenhouse gases trap heat |

- **Natural Effect:** Maintains Earth's temperature for life
- **Enhanced Effect:** Human activities increase greenhouse gases
- **Result:** Global warming and climate change

Mnemonic

Gases Trap Heat, Earth Heats

Question 4 [b marks]

4 Write international protocol to prevent climate change management.

Solution

Table 18. International Climate Protocols

| Protocol | Year | Objective |
|--------------------------|------|---------------------------------|
| Kyoto Protocol | 1997 | Reduce greenhouse gas emissions |
| Paris Agreement | 2015 | Limit global warming to 1.5°C |
| Montreal Protocol | 1987 | Protect ozone layer |

Key Features:

- **Emission Targets:** Binding commitments for developed countries
- **Clean Development:** Technology transfer to developing nations
- **Carbon Trading:** Market-based emission reduction mechanisms
- **Monitoring:** Regular reporting and verification systems

Mnemonic

Kyoto, Paris, Montreal Protect Climate

Question 4 [c marks]

7 Explain biogas plant with neat sketch.

Solution

Biogas Plant:

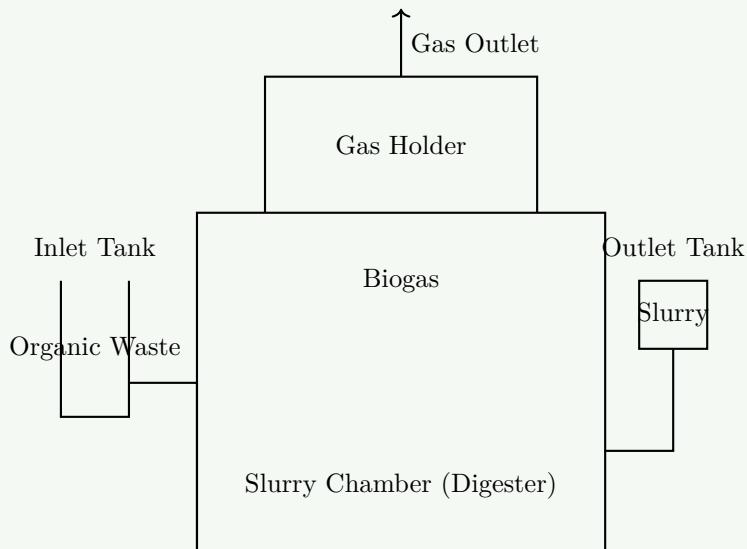


Table 19. Biogas Plant Components

| Component | Function |
|-------------------|--------------------------------|
| Inlet Tank | Receives organic waste |
| Digester | Anaerobic decomposition occurs |
| Gas Holder | Stores produced biogas |
| Outlet | Removes spent slurry |

Working Process:

- **Loading:** Organic waste mixed with water
- **Digestion:** Bacteria decompose waste anaerobically
- **Gas Production:** Methane and CO₂ generated
- **Collection:** Gas stored in holder for use

Raw Materials:

- **Animal Waste:** Cow dung, poultry droppings
- **Plant Waste:** Agricultural residues, kitchen waste
- **Water:** Maintains proper consistency

Products:

- **Biogas:** 50-70% methane for cooking/heating
- **Slurry:** Excellent organic fertilizer

Advantages:

- **Renewable:** Continuous gas production
- **Waste Management:** Converts waste to energy
- **Rural Development:** Suitable for villages

Mnemonic

Waste In, Gas Out, Fertilizer Bonus

Question 4 [a marks]

3 Write short note on green house gases.

Solution

Table 20. Greenhouse Gases Details

| Gas | Source | Contribution |
|--------------------------|-----------------------------|--------------|
| Carbon Dioxide | Fossil fuels, deforestation | 76% |
| Methane | Agriculture, landfills | 16% |
| Nitrous Oxide | Fertilizers, combustion | 6% |
| Fluorinated Gases | Industrial processes | 2% |

- **Properties:** Absorb and emit infrared radiation
- **Impact:** Trap heat causing global warming
- **Control:** Reduce emissions, use alternatives

Mnemonic

CO₂, CH₄, N₂O, F-gases Heat Earth

Question 4 [b marks]

4 Explain ozone layer depletion.

Solution

Ozone Layer Depletion: Reduction of ozone concentration in stratosphere due to human activities.

Table 21. Causes of Ozone Depletion

| Substance | Source | Effect |
|----------------|------------------------|-----------------------------|
| CFCs | Refrigerants, aerosols | Break down ozone molecules |
| Halons | Fire extinguishers | Catalytic ozone destruction |
| Methyl Bromide | Pesticides | Ozone layer thinning |

Process:

- **UV Breakdown:** UV radiation breaks CFC molecules
- **Chlorine Release:** Free chlorine atoms released
- **Ozone Destruction:** Chlorine destroys ozone molecules
- **Chain Reaction:** One CFC molecule destroys many ozone molecules

Effects: Increased UV radiation, skin cancer, crop damage

Mnemonic

CFCs Climb, Chlorine Chops Ozone

Question 4 [c marks]

7 Explain the term "climate changes and state its causes and effects"

Solution

Climate Change Definition: Long-term shifts in global weather patterns and temperatures.

Causes:

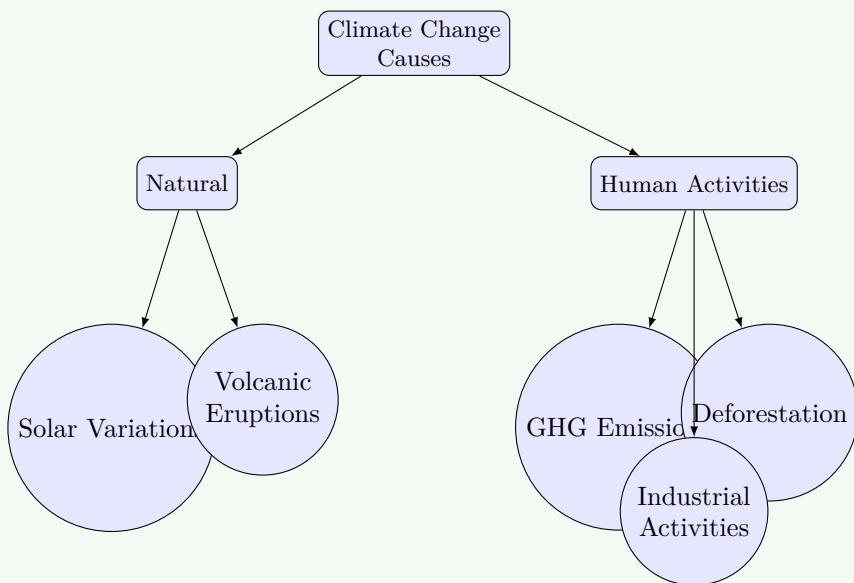


Table 22. Human Causes of Climate Change

| Activity | Contribution |
|----------------------|----------------------------------|
| Fossil Fuel Burning | 65% of CO ₂ emissions |
| Deforestation | 15% of emissions |
| Industrial Processes | 20% of emissions |

Effects:**Environmental Effects:**

- **Temperature Rise:** Global average temperature increase

- **Sea Level Rise:** Thermal expansion and ice melting
- **Weather Extremes:** More frequent droughts, floods

Biological Effects:

- **Species Migration:** Animals moving to cooler regions
- **Ecosystem Disruption:** Food chain alterations
- **Biodiversity Loss:** Species extinction rates increase

Human Effects:

- **Agriculture:** Crop yield changes, food security issues
- **Health:** Heat stress, disease vector changes
- **Economy:** Infrastructure damage, adaptation costs

Mitigation Strategies:

- **Renewable Energy:** Transition from fossil fuels
- **Energy Efficiency:** Reduce consumption
- **Carbon Sequestration:** Forest conservation, tree planting
- **International Cooperation:** Global agreements and policies

Mnemonic

Human Actions Heat Earth, Everyone Affected

Question 5 [a marks]

3 Explain "Khet Talavadi".

Solution

Khet Talavadi (Farm Pond): Small water harvesting structure in agricultural fields for irrigation.

Table 23. Farm Pond Features

| Parameter | Description |
|-----------------|--------------------------|
| Size | 20m x 20m x 3m depth |
| Capacity | 1200 cubic meters |
| Cost | Subsidized by government |

- **Purpose:** Rainwater collection, irrigation during dry periods
- **Benefits:** Increased crop yield, groundwater recharge
- **Construction:** Lined with plastic sheets or cement

Mnemonic

Farm Pond Stores Rain for Crops

Question 5 [b marks]

4 Give goal and advantage of green building.

Solution

Table 24. Green Building Goals

| Goal | Description |
|----------------------------|---------------------------|
| Energy Efficiency | Reduce energy consumption |
| Water Conservation | Minimize water usage |
| Material Efficiency | Use sustainable materials |
| Indoor Environment | Improve air quality |

Advantages:

- **Environmental:** Reduced carbon footprint, waste minimization
- **Economic:** Lower operating costs, increased property value
- **Health:** Better indoor air quality, natural lighting
- **Social:** Enhanced occupant comfort, productivity

Green Building Features:

- **Solar Panels:** Renewable energy generation
- **Rainwater Harvesting:** Water conservation
- **Green Roofs:** Insulation and air purification

Mnemonic

Green Goals: Energy, Water, Materials, Environment

Question 5 [c marks]

7 Explain various methods of rain water harvesting.

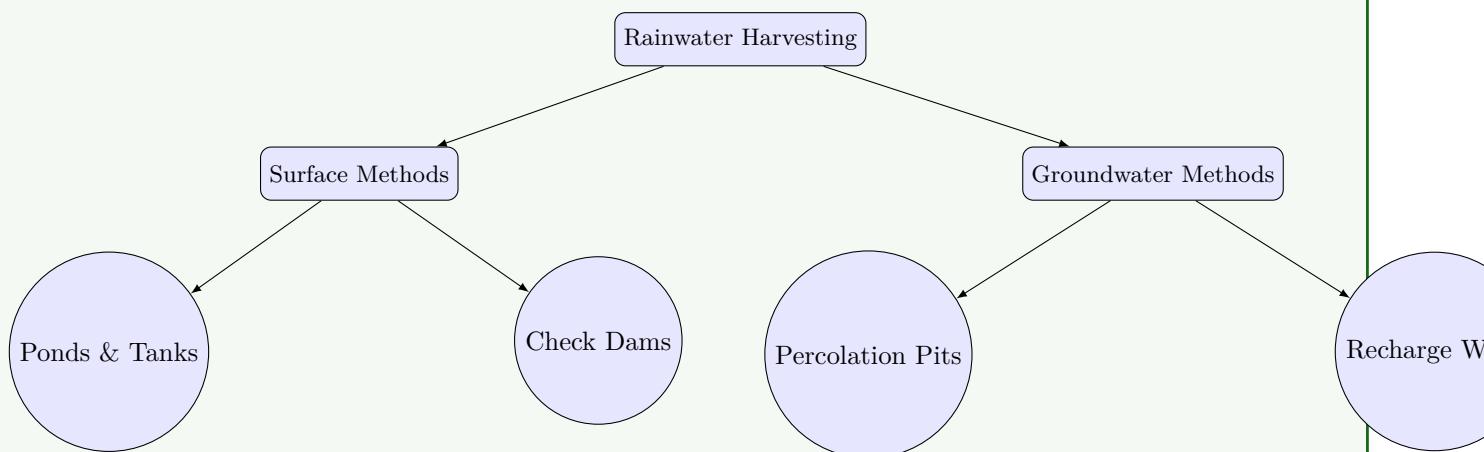
Solution**Rainwater Harvesting Methods:****Surface Methods:**

Table 25. Detailed Rainwater Harvesting Methods

| Method | Description | Application |
|---------------------------|-----------------------------------|----------------------|
| Rooftop Harvesting | Collect water from building roofs | Urban areas |
| Surface Runoff | Capture water from ground surface | Rural areas |
| Check Dams | Small barriers across streams | Hilly regions |
| Percolation Tanks | Allow water to seep underground | Groundwater recharge |

System Components:

- **Catchment Area:** Surface collecting rainwater
- **Conveyance System:** Gutters, pipes for transport
- **Storage System:** Tanks, ponds for holding water
- **Filter System:** Remove debris and contaminants

Rooftop Harvesting Process:

- **Collection:** Rain falls on roof surface
- **Conveyance:** Water flows through gutters and downspouts
- **First Flush:** Initial dirty water diverted
- **Storage:** Clean water stored in tanks
- **Distribution:** Water used for various purposes

Benefits:

- **Water Security:** Reduce dependence on external supply
- **Flood Control:** Reduce surface runoff and flooding
- **Groundwater Recharge:** Replenish underground aquifers
- **Cost Savings:** Reduce water bills

Design Considerations:

- **Rainfall Data:** Annual precipitation patterns
- **Catchment Area:** Available roof/ground area
- **Storage Capacity:** Based on demand and supply
- **Water Quality:** Treatment requirements

Mnemonic

Catch, Convey, Store, Filter, Use

Question 5 [a marks]

3 What is Life cycle analysis (LCA)?

Solution

Life Cycle Analysis (LCA): Systematic evaluation of environmental impacts of a product throughout its entire life cycle.

LCA Stages:

Table 26. LCA Stages

| Stage | Description |
|----------------------|-----------------------|
| Raw Material | Resource extraction |
| Manufacturing | Production processes |
| Use Phase | Product utilization |
| End of Life | Disposal or recycling |

- **Purpose:** Identify environmental hotspots, compare alternatives
- **Applications:** Product design, policy decisions, consumer choices

Mnemonic

Life Cycle: Raw, Make, Use, Dispose

Question 5 [b marks]

4 Give main features of the biological diversity Act, 2002

Solution

Biological Diversity Act, 2002:

Table 27. Main Features

| Feature | Description |
|------------------------------|--|
| Three-tier Structure | National, State, Local Biodiversity Boards |
| Prior Approval | Required for bio-resource access |
| Benefit Sharing | Equitable sharing with local communities |
| Bio-piracy Prevention | Protect traditional knowledge |

Key Provisions:

- **Access Regulation:** Control over biological resources
- **Sustainable Use:** Conservation through utilization
- **Community Rights:** Recognize local community contributions
- **Penalties:** Strict punishment for violations

Objectives: Conservation, sustainable use, equitable benefit sharing

Mnemonic

Biodiversity Act: Access, Benefit, Conserve, Protect

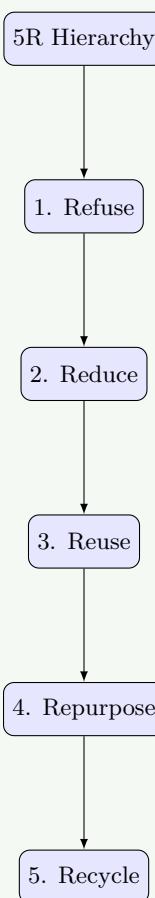
Question 5 [c marks]

7 Explain 5R.

Solution

5R Concept: Waste management hierarchy for environmental sustainability.

The 5Rs:

**Table 28.** Detailed Explanation of 5Rs

| R | Definition | Examples | Benefits |
|------------------|---------------------------|------------------------------|--------------------------|
| Refuse | Avoid unnecessary items | Plastic bags, disposables | Prevent waste generation |
| Reduce | Minimize consumption | Energy, water, materials | Lower resource demand |
| Reuse | Use items multiple times | Containers, clothing | Extend product life |
| Repurpose | Find new uses for items | Tire planters, bottle crafts | Creative waste diversion |
| Recycle | Process into new products | Paper, plastic, metals | Material recovery |

Implementation Strategies:

Personal Level:

- **Refuse:** Say no to single-use plastics
- **Reduce:** Buy only necessary items
- **Reuse:** Repurpose containers and materials
- **Repurpose:** Creative DIY projects
- **Recycle:** Proper sorting and disposal

Community Level:

- **Awareness Programs:** Education about 5R principles
- **Infrastructure:** Recycling facilities and collection systems
- **Policies:** Regulations promoting waste reduction
- **Incentives:** Rewards for sustainable practices

Industrial Level:

- **Design for Durability:** Long-lasting products
- **Material Selection:** Recyclable and biodegradable materials
- **Circular Economy:** Closed-loop production systems
- **Extended Producer Responsibility:** Manufacturer accountability

Environmental Benefits:

- **Resource Conservation:** Reduced raw material extraction
- **Energy Savings:** Lower production energy requirements
- **Pollution Reduction:** Decreased waste generation
- **Climate Protection:** Reduced greenhouse gas emissions

Economic Benefits:

- **Cost Savings:** Lower disposal and material costs
- **Job Creation:** Green jobs in recycling and reuse sectors
- **Innovation:** Development of sustainable technologies
- **Market Opportunities:** New business models

Social Benefits:

- **Community Engagement:** Collective environmental action
- **Health Improvement:** Cleaner environment
- **Education:** Environmental awareness and responsibility
- **Cultural Change:** Sustainable lifestyle adoption

Challenges:

- **Behavior Change:** Overcoming consumption habits
- **Infrastructure:** Adequate recycling facilities
- **Economic Barriers:** Initial investment requirements
- **Policy Support:** Government regulations and incentives

Success Stories:

- **Zero Waste Cities:** San Francisco, Kamikatsu
- **Corporate Initiatives:** Company 5R programs
- **School Programs:** Student environmental education
- **Community Projects:** Local waste reduction efforts

Mnemonic

Really Reduce Reuse Repurpose Recycle