

# 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
<b>Pyramid of Numbers</b>	Shows number of organisms at each level	Trees → Insects → Birds
<b>Pyramid of Biomass</b>	Shows total mass of organisms	Large at producer level
<b>Pyramid of Energy</b>	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
<b>Earth Overshoot Day</b>	Date when annual resource consumption exceeds regeneration
<b>Ecological Footprint</b>	Human demand on natural resources
<b>Biocapacity</b>	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**

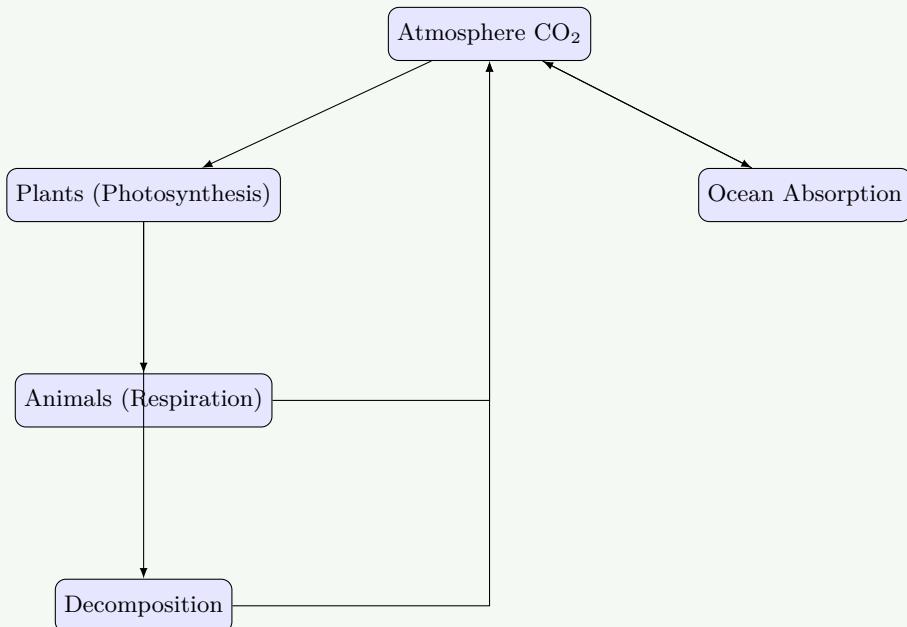
Demand Exceeds Supply = Overshoot

**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
<b>Nitrogen Fixation</b>	$N_2 \rightarrow NH_3$	Rhizobium bacteria
<b>Nitrification</b>	$NH_3 \rightarrow NO_3$	Nitrosomonas, Nitrobacter
<b>Denitrification</b>	$NO_3 \rightarrow N_2$	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]**

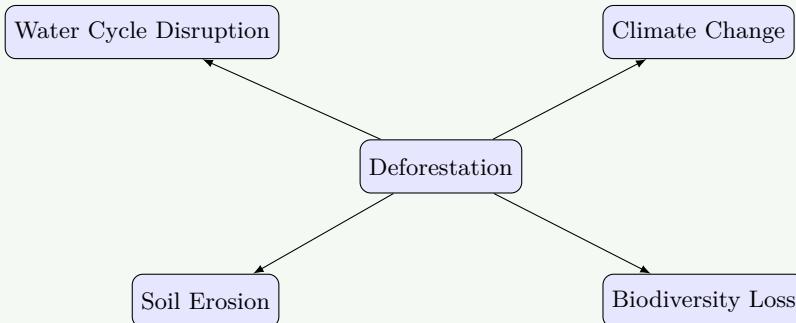
7 Describe the forest ecosystem state and explain the effects of deforestation and suggest the methods to conserve forest ecosystem.

## Solution

**Table 4.** Forest Ecosystem Components

Component	Examples
<b>Producers</b>	Trees, shrubs, herbs
<b>Primary Consumers</b>	Deer, rabbits, insects
<b>Secondary Consumers</b>	Carnivores, birds
<b>Decomposers</b>	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
<b>Pollution</b>	Addition of harmful substances to environment
<b>Pollutant</b>	Substance causing environmental contamination

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

### Mnemonic

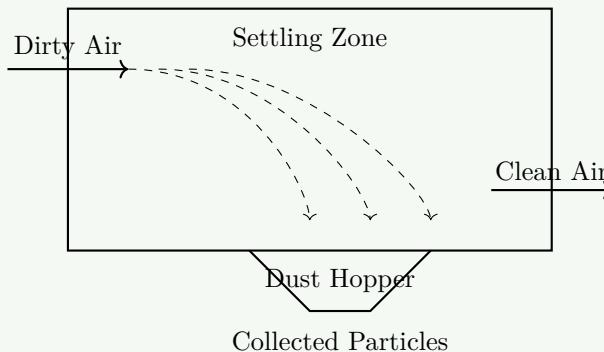
Pollutants cause Pollution

## 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
<b>Health Effects</b>	Hearing loss, stress, hypertension
<b>Psychological</b>	Irritation, sleep disorders, anxiety
<b>Environmental</b>	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
<b>Chemical</b>	Heavy metals, pesticides, fertilizers
<b>Biological</b>	Bacteria, viruses, parasites
<b>Physical</b>	Suspended solids, thermal pollution
<b>Radioactive</b>	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

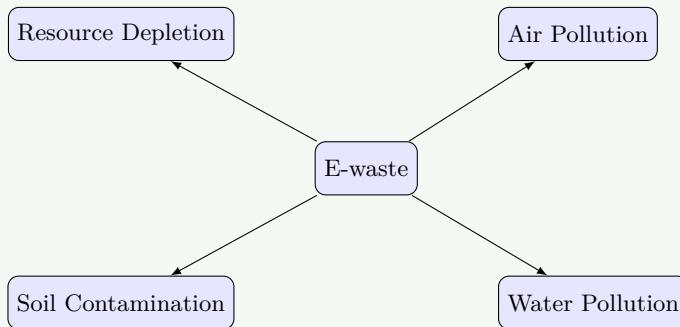
**Question 2 [c marks]**

**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
<b>Definition</b>	Oxygen required by microorganisms to decompose organic matter
<b>Unit</b>	mg/L or ppm
<b>Test Period</b>	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
<b>Examples</b>	Coal, oil, natural gas	Solar, wind, biomass
<b>Availability</b>	Limited reserves	Unlimited/renewable
<b>Environment</b>	High pollution	Environment friendly
<b>Cost</b>	Initially cheap	High initial cost
<b>Sustainability</b>	Non-sustainable	Sustainable

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

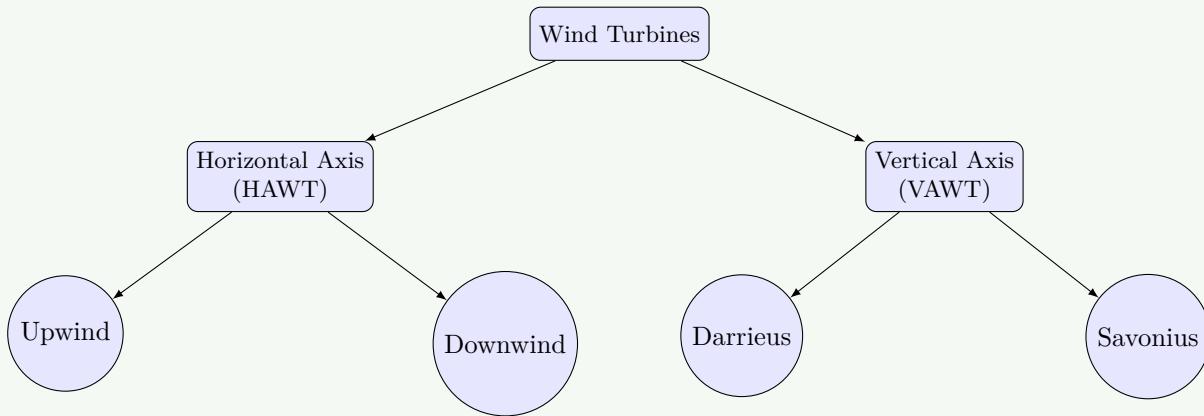
**Mnemonic**

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
<b>Rotor Blades</b>	Convert wind energy to rotational motion
<b>Nacelle</b>	Houses generator and gearbox
<b>Tower</b>	Supports turbine at optimal height
<b>Foundation</b>	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
<b>Energy Security</b>	Reduce import dependence
<b>Environmental Protection</b>	Zero carbon emissions
<b>Economic Benefits</b>	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

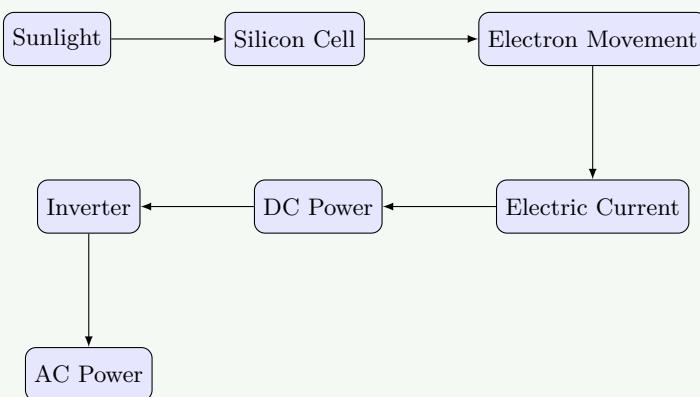
## Question 3 [c marks]

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
<b>Kyoto Protocol</b>	1997	Reduce greenhouse gas emissions
<b>Paris Agreement</b>	2015	Limit global warming to 1.5°C
<b>Montreal Protocol</b>	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

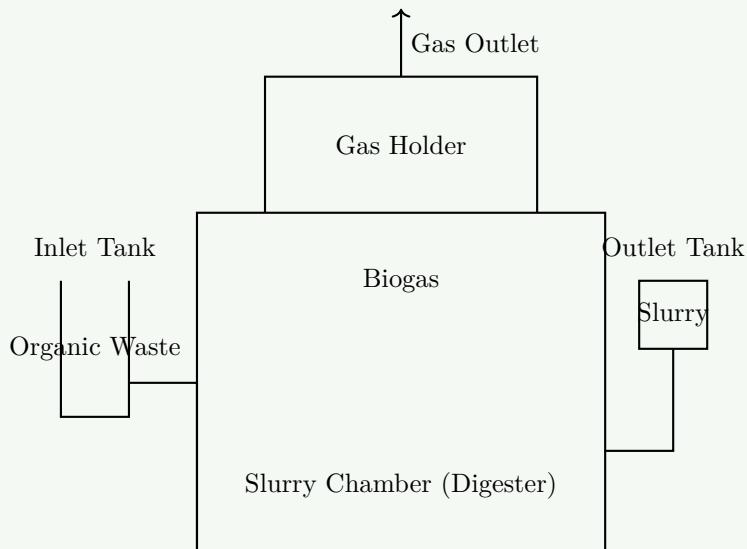
Kyoto, Paris, Montreal Protect Climate

## Question 4 [c marks]

7 Explain biogas plant with neat sketch.

## Solution

### Biogas Plant:



**Table 19.** Biogas Plant Components

Component	Function
<b>Inlet Tank</b>	Receives organic waste
<b>Digester</b>	Anaerobic decomposition occurs
<b>Gas Holder</b>	Stores produced biogas
<b>Outlet</b>	Removes spent slurry

### Working Process:

- **Loading:** Organic waste mixed with water
- **Digestion:** Bacteria decompose waste anaerobically
- **Gas Production:** Methane and CO<sub>2</sub> 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
<b>Carbon Dioxide</b>	Fossil fuels, deforestation	76%
<b>Methane</b>	Agriculture, landfills	16%
<b>Nitrous Oxide</b>	Fertilizers, combustion	6%
<b>Fluorinated Gases</b>	Industrial processes	2%

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

**Mnemonic**

CO<sub>2</sub>, CH<sub>4</sub>, N<sub>2</sub>O, 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

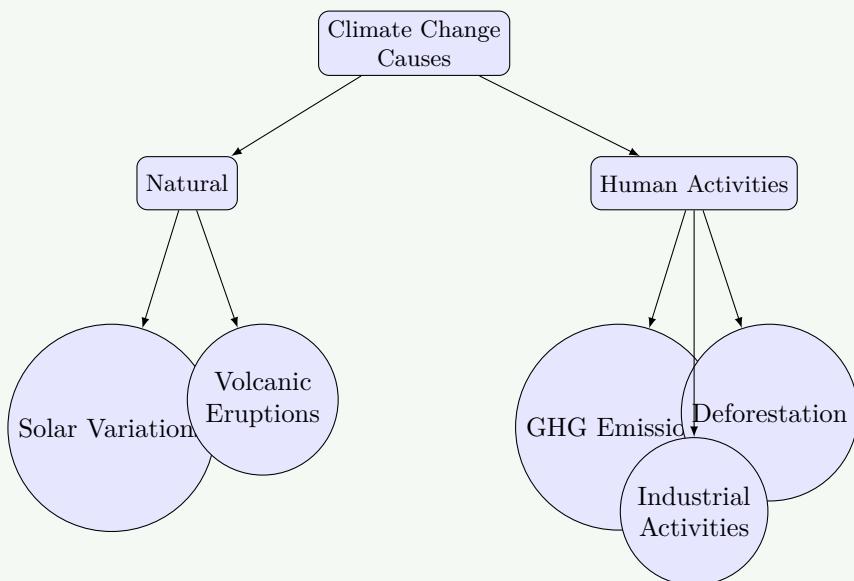
## Question 4 [c marks]

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 <sub>2</sub> 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
<b>Size</b>	20m x 20m x 3m depth
<b>Capacity</b>	1200 cubic meters
<b>Cost</b>	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
<b>Energy Efficiency</b>	Reduce energy consumption
<b>Water Conservation</b>	Minimize water usage
<b>Material Efficiency</b>	Use sustainable materials
<b>Indoor Environment</b>	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:**

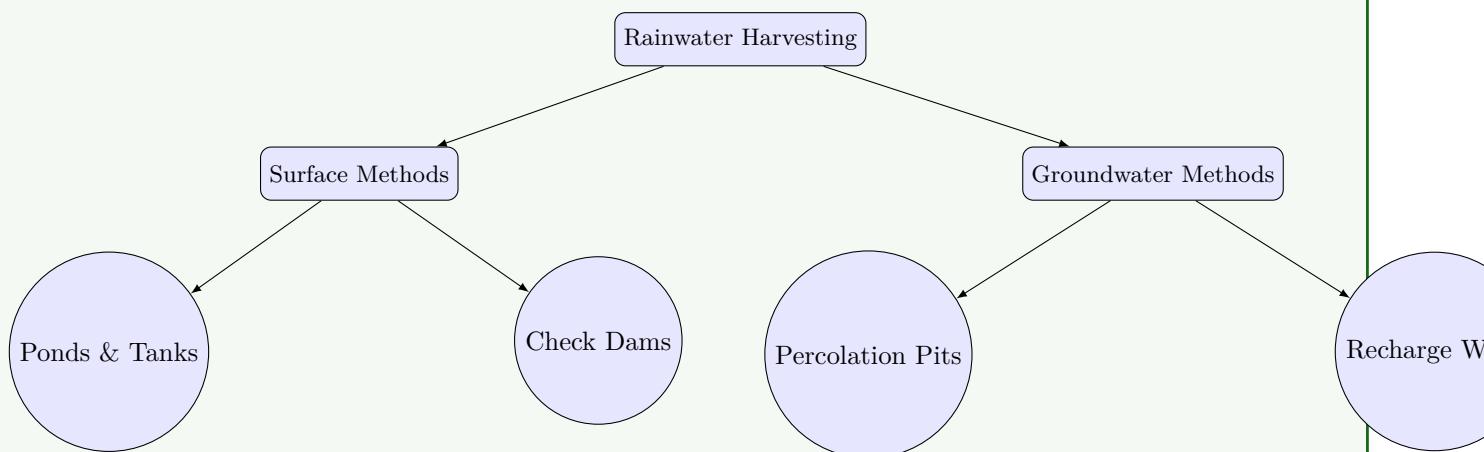
- **Solar Panels:** Renewable energy generation
- **Rainwater Harvesting:** Water conservation
- **Green Roofs:** Insulation and air purification

**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
<b>Rooftop Harvesting</b>	Collect water from building roofs	Urban areas
<b>Surface Runoff</b>	Capture water from ground surface	Rural areas
<b>Check Dams</b>	Small barriers across streams	Hilly regions
<b>Percolation Tanks</b>	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
<b>Raw Material</b>	Resource extraction
<b>Manufacturing</b>	Production processes
<b>Use Phase</b>	Product utilization
<b>End of Life</b>	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
<b>Three-tier Structure</b>	National, State, Local Biodiversity Boards
<b>Prior Approval</b>	Required for bio-resource access
<b>Benefit Sharing</b>	Equitable sharing with local communities
<b>Bio-piracy Prevention</b>	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

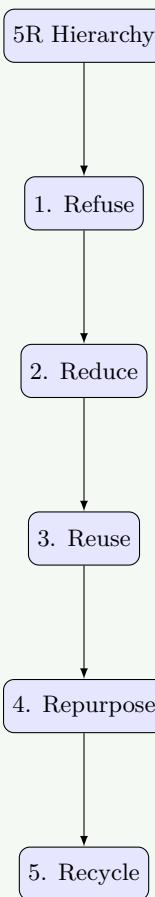
## Question 5 [c marks]

7 Explain 5R.

## Solution

**5R Concept:** Waste management hierarchy for environmental sustainability.

**The 5Rs:**

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

R	Definition	Examples	Benefits
<b>Refuse</b>	Avoid unnecessary items	Plastic bags, disposables	Prevent waste generation
<b>Reduce</b>	Minimize consumption	Energy, water, materials	Lower resource demand
<b>Reuse</b>	Use items multiple times	Containers, clothing	Extend product life
<b>Repurpose</b>	Find new uses for items	Tire planters, bottle crafts	Creative waste diversion
<b>Recycle</b>	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