

# Environment and Sustainability Solutions

4300003 – Summer 2022

Semester 1 Study Material

*Detailed Solutions and Explanations*

## Question 1(a) [3 marks]

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) [4 marks]

Describe global ecological overshoot.

### Solution

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

#### Key Components:

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) [7 marks]

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:

#### Mermaid Diagram (Code)

```
{Shaded}
{Highlighting}[]
graph LR
    A[Atmosphere CO2] --> B[Plants Photosynthesis]
    B --> C[Animals Respiration]
    C --> A
    B --> D[Decomposition]
    D --> A
    A --> E[Ocean Absorption]
    E --> A
{Highlighting}
{Shaded}
```

### Nitrogen Cycle:

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) OR [7 marks]

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

## Solution

### 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:**

Mermaid Diagram (Code)

```
{Shaded}
{Highlighting}[]
graph TD
    A[Deforestation] --> B[Climate Change]
    A --> C[Biodiversity Loss]
    A --> D[Soil Erosion]
    A --> E[Water Cycle Disruption]
{Highlighting}
{Shaded}
```

**Conservation Methods:**

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

**Effects of Deforestation:**

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**Mnemonic**

“Plant, Protect, Practice Sustainability”

**Mnemonic**

“Plant, Protect, Practice Sustainability”

Question 2(a) [3 marks]

**Write definition on pollution and pollutant.**

Solution	
Definitions:	
Term	Definition
<b>Pollution</b>	Addition of harmful substances to environment
<b>Pollutant</b>	Substance causing environmental contamination
<ul style="list-style-type: none"> <li><b>Sources:</b> Industrial, domestic, agricultural activities</li> <li><b>Types:</b> Air, water, soil, noise pollution</li> <li><b>Effects:</b> Health problems, ecosystem damage</li> </ul>	

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- | Solution                                                                                                                                                                                                                            |                                               |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------|
| Definitions:                                                                                                                                                                                                                        |                                               |
| Term                                                                                                                                                                                                                                | Definition                                    |
| <b>Pollution</b>                                                                                                                                                                                                                    | Addition of harmful substances to environment |
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**Mnemonic**

“Pollutants cause Pollution”

**Mnemonic**

“Pollutants cause Pollution”

Question 2(b) [4 marks]

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

**Solution**

**Gravity Settling Chamber:**

```
+{-}{-}{-}{-}{-}{-}{-}{-}{-}{-}{-}{-}{-}{-}{-}{-}{-}{-}{-}{-}+
| Dirty Air {-}{-} |}
|                               |
|   Particles                   |
|     ↓                         |
| Collection                     |
|   Chamber                      |
|                               |
| Clean Air {-}{-} |}
```

**Solution**

**Gravity Settling Chamber:**

```
+{-}{-}{-}{-}{-}{-}{-}{-}{-}{-}{-}{-}{-}{-}{-}{-}{-}{-}{-}{-}+
| Dirty Air {-}{-} |}
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|   ↓                         |
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**Solution**

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|                               |
|   Particles                   |
|     ↓                         |
| Collection                     |
|   Chamber                      |
|                               |
| Clean Air {-}{-} |}
```

### Working Principle:

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

## “Gravity Settles Heavy Particles”

**Describe solid waste management.**

### Solid Waste Management Hierarchy:

```
{Shaded}
{Highlighting}[]
graph LR
    A[Reduce] --{} B[Reuse]}
    B --{} C[Recycle]}
    C --{} D[Recovery]}
    D --{} E[Disposal]}
{Highlighting}
{Shaded}
```

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

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

“Collect, Transport, Treat, Monitor”

**Write effect on noise pollution.**

### Solution

#### 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) OR [4 marks]

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.

#### 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) OR [7 marks]

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:

#### Mermaid Diagram (Code)

```
{Shaded}
{Highlighting}[]
graph TD
    A[E{-waste}] --> B[Soil Contamination]
    A --> C[Water Pollution]
    A --> D[Air Pollution]
    A --> E[Resource Depletion]
{Highlighting}
{Shaded}
```

**Health Impact:**

Toxic Material	Health Effects
<b>Lead</b>	Nervous system damage
<b>Mercury</b>	Brain and kidney damage
<b>Cadmium</b>	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) [3 marks]**

What is BOD? Give a importance of BOD.

**Solution****BOD (Biochemical Oxygen Demand):**

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) [4 marks]**

Give a comparison of conventional and Non conventional energy sources.

**Solution****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) [7 marks]

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

#### Solution

##### Wind Turbine Classification:

##### Mermaid Diagram (Code)

```
{Shaded}
{Highlighting}[]
graph TD
    A[Wind Turbines] --> B[Horizontal Axis HAWT]
    A --> C[Vertical Axis VAWT]
    B --> D[Upwind]
    B --> E[Downwind]
    C --> F[Darrieus]
    C --> G[Savonius]
{Highlighting}
{Shaded}
```

##### Horizontal Axis Wind Turbine (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) OR [3 marks]

Explain need for renewable energy.

### Solution

#### 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) OR [4 marks]

Write a short note on Geo thermal energy.

### Solution

#### Geothermal Energy:

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

#### Types:

Type	Temperature	Application
<b>High Temperature</b>	>150°C	Power generation
<b>Medium Temperature</b>	90-150°C	Direct heating
<b>Low Temperature</b>	<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) OR [7 marks]

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:

#### Mermaid Diagram (Code)

```
{Shaded}
{Highlighting}[]
graph LR
    A[Sunlight] --> B[Silicon Cell]
    B --> C[Electron Movement]
    C --> D[Electric Current]
    D --> E[DC Power]
    E --> F[Inverter]
    F --> G[AC Power]
```



{Highlighting}  
{Shaded}

#### Cell Structure:

Layer	Material	Function
<b>Top Layer</b>	N-type silicon	Excess electrons
<b>Bottom Layer</b>	P-type silicon	Electron holes
<b>Junction</b>	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) [3 marks]

Explain Green house effect.

#### Solution

##### Greenhouse Effect:

Natural process where certain gases trap heat in Earth’s atmosphere.

##### Mechanism:

Step	Process
<b>Solar Radiation</b>	Sun’s energy reaches Earth
<b>Surface Absorption</b>	Earth absorbs and heats up
<b>Re-radiation</b>	Earth emits infrared radiation
<b>Gas Trapping</b>	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) [4 marks]

Write international protocol to prevent climate change management.

## Solution

### 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

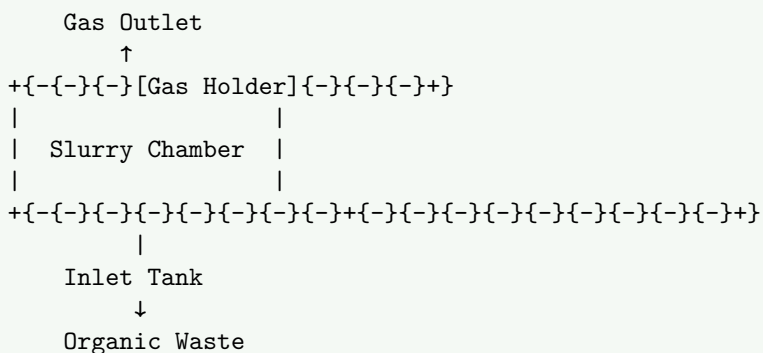
“Kyoto, Paris, Montreal Protect Climate”

## Question 4(c) [7 marks]

Explain biogas plant with neat sketch.

## Solution

### 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) OR [3 marks]**

Write short note on green house gases.

**Solution****Greenhouse Gases:**

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) OR [4 marks]**

Explain ozone layer depletion.

**Solution****Ozone Layer Depletion:**

Reduction of ozone concentration in stratosphere due to human activities.

**Causes:**

Substance	Source	Effect
<b>CFCs</b>	Refrigerants, aerosols	Break down ozone molecules
<b>Halons</b>	Fire extinguishers	Catalytic ozone destruction
<b>Methyl Bromide</b>	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) OR [7 marks]**

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:**

**Mermaid Diagram (Code)**

```
{Shaded}
{Highlighting}[]
graph TD
    A[Climate Change Causes] --> B[Natural]
    A --> C[Human Activities]
    B --> D[Solar Variations]
    B --> E[Volcanic Eruptions]
    C --> F[Greenhouse Gas Emissions]
    C --> G[Deforestation]
    C --> H[Industrial Activities]
{Highlighting}
{Shaded}
```

**Human Causes:**

Activity	Contribution
<b>Fossil Fuel Burning</b>	65% of CO2 emissions
<b>Deforestation</b>	15% of emissions
<b>Industrial Processes</b>	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) [3 marks]

Explain “Khet Talavadi”.

#### Solution

##### Khet Talavadi (Farm Pond):

Small water harvesting structure in agricultural fields for irrigation.

##### 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) [4 marks]

Give goal and advantage of green building.

#### Solution

##### 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) [7 marks]

Explain various methods of rain water harvesting.

## Solution

### Rainwater Harvesting Methods: Surface Methods:

#### Mermaid Diagram (Code)

```
{Shaded}
{Highlighting}[]
graph TD
    A[Rainwater Harvesting] --> B[Surface Methods]
    A --> C[Groundwater Methods]
    B --> D[Ponds and Tanks]
    B --> E[Check Dams]
    C --> F[Percolation Pits]
    C --> G[Recharge Wells]
{Highlighting}
{Shaded}
```

#### Detailed 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) OR [3 marks]

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:

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) OR [4 marks]

Give main features of the biological diversity Act, 2002

### Solution

#### Biological Diversity Act, 2002: 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) OR [7 marks]

Explain 5R.

### Solution

#### 5R Concept:

Waste management hierarchy for environmental sustainability.

#### The 5Rs:

#### Mermaid Diagram (Code)

```
{Shaded}
{Highlighting}[]
graph TD
    A[5R Hierarchy] --> B[1. Refuse]
    A --> C[2. Reduce]
    A --> D[3. Reuse]
    A --> E[4. Repurpose]
```

A {-}{ F[5. Recycle]}

{Highlighting}

{Shaded}

#### Detailed Explanation:

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”