

Code: 20CE2702A

IV B.Tech - I Semester – Regular / Supplementary Examinations
DECEMBER 2025

ENVIRONMENTAL MANAGEMENT AND AUDIT
(Common for ALL BRANCHES)

Duration: 3 hours

Max. Marks: 70

Note: 1. This paper contains questions from 5 units of Syllabus. Each unit carries 14 marks and have an internal choice of Questions.

2. All parts of Question must be answered in one place.

BL – Blooms Level

CO – Course Outcome

			BL	CO	Max. Marks
UNIT-I					
1	a)	What is meant by source reduction of solid wastes? Discuss its methods and importance. Also state the objectives of waste processing in solid waste management.	L3	CO1	8 M
	b)	Write the characteristics of solid waste.	L2	CO1	6 M
OR					
2		Enumerate and explain the essential elements of solid waste management. Discuss the role of the public in ensuring the success of solid waste management programs.	L2	CO1	14 M
UNIT-II					
3		Discuss the procedures for labeling, collection, and transportation of biomedical waste in a hospital setting.	L2	CO2	14 M

OR					
4	a)	Explain in detail the various methods of disposal of biomedical waste. Highlight their advantages and limitations.	L2	CO2	8 M
	b)	Classify the different categories of biomedical waste.	L2	CO2	6 M
UNIT-III					
5		Describe the collection process, segregation, and disposal methods of E-waste in detail.	L2	CO3	14 M
OR					
6		Discuss the effects of E-waste on air, water, and soil. Explain the associated health hazards.	L2	CO3	14 M
UNIT-IV					
7		Describe the different classifications of EIA. Explain the significance of Life Cycle Assessment in environmental management.	L2	CO4	14 M
OR					
8		What is meant by baseline data acquisition in EIA? Describe environmental inventory and rapid EIA with examples.	L2	CO4	14 M
UNIT-V					
9		Describe the essential elements of an Environmental Audit with suitable examples.	L2	CO5	14 M

OR					
10		Explain the process of Environmental Audit. Discuss the importance of the pre-audit activities in detail.	L2	CO5	14 M

IV B.Tech. - I Semester - Regular/Supplementary
Examinations.
December - 2025

Environmental Management & Audit – Marking Scheme (Pattern)

Subject Code: 20CE2702A

Total Marks: 70

Each Question: 14 Marks

Answer 1

(a) Source Reduction & Waste Processing - 8 Marks

Definition of Source Reduction - 1 Mark

Methods of Source Reduction (Any 3 points) - 3 Marks ($1 \times 3 = 3$)

Importance of Source Reduction (Any 2 points) - 2 Marks ($1 \times 2 = 2$)

Objectives of Waste Processing (Any 2 points) - 2 Marks ($1 \times 2 = 2$)

(b) Characteristics of Solid Waste - 6 Marks

Physical / Chemical / Biological characteristics (Any 6 points) - 6 Marks ($1 \times 6 = 6$)

Answer 2

Functional Elements of Solid Waste Management - 7 Marks [All elements required
(Generation → Disposal)]

Role of Public in SWM Programmes - 7 Marks [All points required]

Answer 3

Labelling of Biomedical Waste (Any 5 points) - 5 Marks ($1 \times 5 = 5$)

Collection of Biomedical Waste (Any 5 points) - 5 Marks ($1 \times 5 = 5$)

Transportation of Biomedical Waste (Any 4 points) - 4 Marks ($1 \times 4 = 4$)

Answer 4

(a) Disposal of Biomedical Waste (Any 4 methods) - 8 Marks ($2 \times 4 = 8$)

(b) Classification of Biomedical Waste (Any 6 categories) - 6 Marks ($1 \times 6 = 6$)

Answer 5

Collection of E-Waste - 4 Marks [All points required]

Segregation of E-Waste - 4 Marks [All points required]

Disposal Methods of E-Waste - 6 Marks [All points required]

Answer 6

Effects on Air - 3 Marks

Effects on Water - 3 Marks

Effects on Soil - 3 Marks

Associated Health Hazards - 5 Marks

(All points compulsory within each sub-section)

Answer 7

Classification of EIA (Any 6 types of EIA) - 12 Marks ($2 \times 6 = 12$)

Significance of LCA (Any 4 points) - 2 Marks ($0.5 \times 4 = 2$)

Answer 8

Definition of Baseline Data Acquisition - 4 Marks

Environmental Inventory - 5 Marks

Rapid EIA - 5 Marks

Answer 9

Essential Elements of Environmental Audit (Any 7 elements) - 14 Marks ($2 \times 7 = 14$)

Answer 10

Environmental Audit Process - 10 Marks

Importance of Pre-Audit Activities (Any 4 points) - 4 Marks ($1 \times 4 = 4$)

Answer Key and Marking Scheme for Environmental Management and Audit

Answer 1 (a)

[1 + 3 + 2 + 2 = 8 Marks]

Definition [1 Mark]

Source reduction (also called waste prevention) refers to the reduction of the quantity and toxicity of solid waste at the point of generation itself, before it enters the collection, processing or disposal system. It focuses on avoiding waste generation rather than managing waste after it is produced.

Methods of Source Reduction [Any 3 Points; 1 x 3 = 3 Marks]

- 1) Reduction in material use and toxicity
 - Minimizing the quantity of raw materials used in products and packaging
 - Reducing hazardous and toxic substances in products
 - Using lighter and simpler packaging materials to reduce waste generation
- 2) Product and packaging redesign
 - Designing products that require fewer materials
 - Developing packaging that reduces damage and spoilage
 - Avoiding unnecessary or excessive packaging
- 3) Increasing product durability and lifespan
 - Manufacturing long-lasting and durable products
 - Designing products that can be repaired and maintained easily
 - Reducing the frequency of product replacement and disposal
- 4) Reuse of products and materials
 - Promoting reusable items instead of disposable ones
 - Reusing containers, packaging, and materials multiple times
 - Encouraging refillable and returnable product systems
- 5) Material substitution
 - Replacing heavy or non-recyclable materials with lighter or reusable alternatives
 - Using materials that generate less waste during use and disposal
- 6) Changes in consumer purchasing and usage patterns
 - Buying products with minimal packaging
 - Purchasing goods in bulk to reduce packaging waste
 - Choosing products with longer useful life and lower toxicity
- 7) Residential source reduction practices
 - Grass cycling and home composting to reduce organic waste
 - Renting or sharing tools and equipment instead of owning them
 - Using reusable bags, containers, and household items
- 8) Commercial and institutional source reduction
 - Adopting procurement policies favouring durable and reusable products
 - Reducing paper use through double-sided printing and digital communication
 - Using reusable dining ware instead of disposables
- 9) Construction and demolition source reduction
 - Planning projects to minimize material waste
 - Reusing and salvaging construction materials such as doors, windows, and fixtures
 - Selecting building materials with longer service life
- 10) Waste prevention planning
 - Conducting waste audits to identify reduction opportunities
 - Setting measurable waste reduction goals
 - Encouraging participation of producers, consumers, and institutions in waste minimization

Importance of Source Reduction [Any 2 Points; 1 x 2 = 2 Marks]

- 1) Reduces the quantity of waste requiring collection, processing and disposal
- 2) Minimizes environmental pollution and health risks
- 3) Conserves natural resources and energy
- 4) Reduces landfill space requirements and operational costs
- 5) Lowers greenhouse gas emissions
- 6) Promotes sustainable consumption and circular economy practices

Objectives of Waste Processing in Solid Waste Management [Any 2 Points; 1 x 2 = 2 Marks]

The main objectives of waste processing are:

- 1) To reduce the volume and weight of solid waste
- 2) To recover valuable materials such as recyclables and compost
- 3) To stabilize organic waste and reduce putrescibility
- 4) To reduce environmental and health hazards
- 5) To improve handling, transportation, and disposal efficiency
- 6) To convert waste into useful products such as compost, fuel or energy

Answer 1 (b)

[Any 6 Points; 1 x 6 = 6 Marks]

Physical Characteristics

1) Density (specific weight)

- Mass per unit volume (kg/m^3) of solid waste
- Critical for the design of storage bins, collection vehicles, transfer stations, and sanitary landfills
- Influenced by compaction, moisture content, handling, and decomposition stage

2) Moisture content

- Ratio of water weight to total wet weight of waste
- Increases collection and transportation cost
- Reduces efficiency of incineration due to energy loss in water evaporation
- Plays a key role in composting and leachate generation

3) Particle size and size distribution

- Affects mechanical separation, shredding, screening, and material recovery
- Smaller particle size increases surface area and biodegradation rate but may reduce permeability

4) Shape of waste components

- Influences compaction and separation behavior
- Flaky materials behave differently from bulky or granular materials

5) Porosity and voids

- Represent the volume of air spaces within waste mass
- Control movement of air, water, and gases in landfills

6) Field capacity

- Maximum moisture retained by waste against gravity
- Excess moisture beyond field capacity results in leachate formation

7) Permeability

- Governs flow of liquids and landfill gases
- Depends on particle size, porosity, and degree of compaction

8) Compressibility

- Indicates settlement of waste under load
- Important for landfill stability, cover design, and long-term land use planning

Chemical Characteristics

9) Major organic constituents

- Carbohydrates (food and yard waste)

- Proteins (food and garden waste, responsible for odors)
- Lipids (fats and oils with high heating value)
- Natural fibres (paper, wood, cellulose, lignin)
- Synthetic organics (plastics with high calorific value)

10) Proximate analysis

- Determines moisture content, volatile matter, fixed carbon, and ash
- Useful for evaluating combustion and refuse-derived fuel potential

11) Ultimate analysis

- Determines elemental composition (C, H, O, N, S, and ash)
- Used for mass balance calculations and biological process design

12) Calorific (heating) value

- Indicates energy recovery potential
- Reduced by high moisture and ash content

13) Ash content and fusing point of ash

- Ash reduces usable energy during combustion
- Fusing point determines clinker formation in incinerators

Biological Characteristics

14) Biodegradability

- Ability of organic fraction to decompose biologically into gases and stable residues
- Depends on composition and lignin content

15) Putrescibility

- Rapid decomposition of organic matter producing odours and attracting vectors

16) Gas generation potential

- Formation of methane and carbon dioxide during anaerobic decomposition

17) Odour and vector problems

- Result from exposed biodegradable organic waste
- Major concern in collection, storage, and disposal operations

18) Lignin content

- High lignin reduces the biodegradation rate
- Used to estimate the biodegradable fraction of solid waste

Answer 2 [7 + 7 = 14 Marks]

Functional Elements of Solid Waste Management

[All points are required; 7 Marks]

Solid waste management consists of a sequence of functional elements that together ensure the safe, hygienic, and efficient handling of waste from its generation to final disposal. The essential elements are as follows:

1) Waste Generation

- Refers to activities in which materials are identified as no longer useful and are discarded.
- Waste is generated from residential, commercial, industrial, institutional, and agricultural sources.
- The quantity and composition of waste depend on population, lifestyle, economic status, and consumption patterns.

2) Waste Handling and Storage

- Includes activities associated with the handling of waste at the source until it is collected.
- Involves segregation, on-site storage, and movement of waste to collection points.
- Proper containers (stationary or haul containers) help prevent littering, odour, and vector problems.

3) Collection of Solid Waste

Collection involves gathering waste from storage points and transporting it to processing or disposal sites. It is divided into:

a) Primary Collection

- Includes door-to-door collection or community-level collection from waste generators.
- Ensures removal of waste from households, shops, and institutions.

b) Secondary Collection

- Involves transportation of waste from community bins or dustbin areas to disposal or processing facilities.
- Usually carried out using collection vehicles or container hauling systems.

4) Processing and Transformation of Solid Waste

- Includes operations to reduce the volume, weight, or toxicity of waste.
- Methods include segregation, recycling, composting, shredding, and energy recovery.
- Improves efficiency of disposal and enables recovery of useful materials or energy.

5) Transfer and Transport

- Consists of transferring waste from small collection vehicles to larger transport equipment.
- Transfer stations are used to reduce transportation cost and improve operational efficiency.
- Waste is then transported to processing plants or disposal sites over longer distances.

6) Disposal

- Final stage of solid waste management.
- Involves disposal of waste in landfills or dumpsites after all possible recovery and processing.
- Sanitary landfilling is the preferred method to minimize environmental and public health impacts.

Role of the Public in Ensuring the Success of Solid Waste Management Programmes

[All points are required; 7 Marks]

Effective solid waste management (SWM) cannot be achieved by municipal authorities alone; active participation of the public is essential for its success. Individuals and households play a key role in minimizing waste generation, improving segregation efficiency, and supporting sustainable disposal practices. The role of the public can be discussed as follows:

- 1) Waste reduction at source:** The public can reduce the quantity of waste generated by adopting responsible consumption habits, avoiding unnecessary purchases, and preferring durable and eco-friendly products. This directly lowers the burden on collection, processing, and disposal systems.
- 2) Segregation of waste at source:** Proper segregation of biodegradable, recyclable, and hazardous waste at the household level is crucial. Public participation in segregation improves recycling efficiency, enhances composting outcomes, and reduces contamination of waste streams.
- 3) Adoption of the 7 R's principles:** By practicing rethink, refuse, reduce, reuse, repair, repurpose, and rot (composting), individuals contribute significantly to waste minimization, resource conservation, and circular economy practices.
- 4) Participation in recycling and composting:** The public can actively support recycling by properly cleaning and separating recyclables and by composting organic waste at home or through community composting systems, thereby reducing landfill dependency.
- 5) Cooperation with municipal systems:** Timely disposal of waste, adherence to collection schedules, and correct use of designated bins help improve the efficiency and hygiene of SWM services.
- 6) Public awareness and behavioural change:** Awareness, education, and positive attitudes toward cleanliness and environmental protection encourage long-term behavioural change, which is essential for sustainable SWM programmes.
- 7) Community involvement and monitoring:** Participation in community initiatives, cleanliness drives, resident welfare associations, and reporting of illegal dumping strengthens local waste management efforts and accountability.

Answer 3 [5 + 5 + 4 = 14 Marks]

Labelling of Biomedical Waste [Any 5 points; 1 x 5 = 5 Marks]

Proper labelling of biomedical waste is an essential requirement to ensure safe handling, transportation, treatment, and disposal. The labelling procedure helps in identifying the nature of waste, minimizing health risks, and ensuring compliance with biomedical waste management rules. The key procedures for labelling biomedical waste are as follows:

1) Affixing the biohazard symbol:

Every biomedical waste container or bag must carry a clearly visible biohazard symbol. This symbol warns handlers and transport personnel about the potential health risks associated with the waste.

2) Indicating the type of waste:

The label should clearly mention the category of biomedical waste, such as infectious waste, pathological waste, sharps, pharmaceutical waste, or chemical waste. Proper identification ensures that correct treatment and disposal methods are followed.

3) Following colour-coding standards:

Labels must correspond to the prescribed colour-coded containers or bags (e.g., yellow, red, white, blue). Colour coding allows quick visual identification and reduces the chances of mixing different waste categories.

4) Providing generator details:

The name and address of the healthcare facility, laboratory, or department generating the waste should be clearly mentioned on the label. This helps in accountability and traceability of waste.

5) Mentioning the date of generation:

The date of waste generation must be included to monitor storage duration and ensure timely collection and disposal, thereby reducing risks of infection and contamination.

6) Including handling instructions:

Labels should contain basic handling precautions such as “handle with care”, “do not open”, or “use protective equipment”. These instructions protect workers involved in collection, transport, and treatment.



Collection of Biomedical Waste [Any 5 points; 1 x 5 = 5 Marks]

Biomedical waste poses serious health and environmental risks due to its infectious and hazardous nature. Therefore, healthcare facilities must follow well-defined procedures for the safe and efficient collection of biomedical waste to protect healthcare workers, patients, and the environment. The key procedures involved in the collection of biomedical waste are discussed below:

1) Identification and Segregation

- Biomedical waste is segregated at the point of generation to prevent mixing of different waste categories.

- Colour-coded containers and bags are used for segregation, such as red, yellow, white, and blue, based on the type of waste.
- Proper segregation ensures safe handling, treatment, and disposal.

2) Use of Appropriate Containers

- Waste is collected in leak-proof, non-chlorinated, and puncture-resistant containers.
- Sharps are always collected in rigid, puncture-proof containers to prevent needle-stick injuries.
- Containers are placed strategically to ensure 100% waste collection.

3) Training and Awareness

- Healthcare personnel involved in waste collection receive regular training on biomedical waste management rules and safety practices.
- Training emphasizes correct segregation, handling methods, and emergency procedures.

4) Use of Personal Protective Equipment (PPE)

- Personnel handling biomedical waste must wear appropriate PPE such as gloves, masks, gowns, and eye protection.
- PPE reduces the risk of exposure to infectious agents and hazardous substances.

5) Safe Collection and Handling Practices

- Waste is collected without manual sorting or direct contact.
- Containers are not overfilled and are securely closed before removal.
- Waste handling is done carefully to avoid spills, splashes, or injuries.

6) Proper Labelling

- Each biomedical waste container is clearly labelled with the biohazard symbol, type of waste, and date of generation.
- Proper labelling ensures easy identification and safe downstream handling.

7) Transportation within Healthcare Facility

- Waste is transported using dedicated trolleys or carts that are easy to clean and disinfect.
- Transportation routes are designed to minimize exposure to patients and visitors.

8) Temporary Storage

- Biomedical waste is stored in designated, secure, and ventilated areas with restricted access.
- Storage duration is minimized to prevent decomposition, odour, and infection risk.

9) Documentation and Record-Keeping

- Records of waste generation, collection, and handover are maintained.
- Proper documentation ensures regulatory compliance and traceability.

10) Emergency Preparedness

- Healthcare facilities maintain emergency response plans for spills, accidents, or exposure incidents.
- Staff are trained to handle emergencies promptly and safely.

Transportation of Biomedical Waste [Any 4 points; 1 x 4 = 4 Marks]

Transportation of biomedical waste is a critical step in biomedical waste management, as improper transport can lead to spillage, infection, and environmental contamination. Strict procedures must be followed to ensure safety of workers, the public, and the environment.

1) Use of dedicated transport equipment:

Biomedical waste should be transported using trolleys, carts, or enclosed wheelbarrows specifically designed for this purpose. Manual loading should be avoided as far as possible to reduce direct contact and occupational hazards.

2) Proper closure of containers:

Bags and containers containing biomedical waste must be securely tied, sealed, or lidded before transportation. This prevents leakage, spillage, and accidental exposure during movement.

3) Enclosed and leak-proof transport:

All containers must be properly enclosed during transportation. Transport vehicles and trolleys should be leak-proof and designed to prevent any release of waste into the surroundings.

4) Prevention of public exposure:

Vehicles used for transporting biomedical waste should be specially designated and should avoid direct contact with operators, scavengers, patients, and the general public. Routes should be planned to minimize public exposure.

5) Training of personnel and drivers:

Drivers and handlers involved in transportation must be trained in safe handling practices and emergency response procedures. They should be aware of actions to be taken in case of accidents or accidental spillage.

6) Accident and spill management:

The design of transport systems should consider possible traffic accidents. Emergency kits and clear instructions must be available, and drivers should be trained to manage spills safely and effectively.

7) Cleaning and disinfection:

The interior surfaces of transport containers, trolleys, and vehicles must be rinsed and disinfected thoroughly after each trip to prevent cross-contamination and infection spread.

8) Use of appropriate transfer tools:

Wheelbarrows and trolleys are used to transfer waste from the point of generation to collection or treatment centers. These tools help in controlled and systematic movement of waste.

9) Proper use and maintenance of dustbins:

Dustbins should be of adequate capacity based on waste generation rates to prevent overflow. They should be lined with chlorine-free, colour-coded plastic bags as per regulations and cleaned with disinfectants after every collection cycle.

Answer 4(a)

Disposal of Biomedical Waste [Any 4 Points; 2 x 4 = 8 Marks]

Biomedical waste (BMW) contains infectious, hazardous, and sometimes toxic materials; hence, its disposal requires specialized methods to ensure complete disinfection and environmental safety. The major methods of biomedical waste disposal are discussed below.

1) Deep Burial

- A pit or trench about 2 m deep is dug.
- Waste is placed up to half the depth, covered with lime within about 50 cm of the surface, and then filled with soil.
- The site is secured using wire mesh or covers to prevent access by animals.

Advantages:

- Simple and low-cost method
- Suitable for rural or remote areas
- Requires minimal infrastructure

Limitations:

- Risk of groundwater contamination if not properly designed
- Not suitable for large quantities of waste
- Requires land availability and proper site selection

2) Incineration

- Incineration is a high-temperature dry oxidation process.
- Organic and combustible waste is converted into inorganic, incombustible ash.
- Used for wastes that cannot be recycled or safely landfilled.

Advantages:

- Significant reduction in waste volume and weight
- Effective destruction of pathogens
- Saves landfill space

Limitations:

- High capital and operational cost
- Emission of toxic gases if not properly controlled
- Not suitable for chemical wastes, mercury- or cadmium-containing waste, pressurized containers, photographic waste, and PVC plastics

3) Autoclaving

- A low-heat thermal treatment using steam for disinfection.
- Operates typically between 93-177°C.
- Includes gravity-flow and vacuum autoclaves.

Advantages:

- Effective sterilization of infectious waste
- Environmentally safer than incineration
- Lower air pollution

Limitations:

- Does not significantly reduce waste volume
- Not suitable for anatomical waste, chemical waste, or pharmaceutical waste
- Requires segregation before treatment

4) Microwave Treatment

- Uses microwave radiation (2450 MHz, wavelength 12.24 cm).
- Waste is heated uniformly to about 97-100°C, destroying microorganisms by moist heat.
- Can be carried out at the source of generation.

Advantages:

- Effective disinfection of infectious waste
- No need for shredding
- Lower emissions compared to incineration

Limitations:

- Not suitable for body parts, human organs, animal carcasses, or metal objects
- Requires skilled operators
- Initial setup cost is high

5) Chemical Disinfection

- Uses chemical disinfectants such as bleaching powder or chlorine compounds.
- Commonly applied to liquid waste, sharps, and infected plastics.
- Syringes are cut using hub cutters and disinfected before disposal.

Advantages:

- Simple and effective for liquid waste
- Suitable for on-site treatment
- Low capital cost

Limitations:

- Handling chemicals poses occupational hazards
- Incomplete disinfection if concentration is inadequate
- Chemical residues may affect sewage systems

6) Disposal of Biomedical Liquid Waste

- Liquid waste is treated chemically or physically before discharge.
- Pathological and infectious liquids are disinfected and then discharged into the sewer system.
- Chemical waste is neutralized before disposal.

Advantages:

- Prevents direct discharge of infectious liquids
- Compatible with sewage treatment systems
- Effective for large volumes of liquid waste

Limitations:

- Requires skilled operators
- Must strictly comply with discharge standards
- Risk of sewer contamination if improperly treated

7) Recycling After Disinfection

- Infected plastics are disinfected or autoclaved, shredded, and recycled.
- Residual waste is disposed of in municipal dumps.

Advantages:

- Reduces waste volume
- Promotes resource recovery
- Cost-effective in the long term

Limitations:

- Requires strict segregation
- Risk of infection if disinfection is incomplete
- Needs regulatory oversight

Answer 4(b)

Classification of Biomedical Waste [Any 6 Points; 1 x 6 = 6 Marks]

Biomedical waste is classified based on its source of generation, characteristics, and level of hazard to human health and the environment. According to the provided material, biomedical waste is broadly classified into two major categories.

1) Non-Hazardous Biomedical Waste

- Constitutes about 75-90% of the total biomedical waste.
- Similar in nature to domestic waste and non-infectious.
- Generated mainly from hospital administration, housekeeping, and maintenance activities.
- Examples include: Paper, cardboard, Food waste, Packaging materials, Office and kitchen waste

2) Hazardous Biomedical Waste

- Accounts for about 10-25% of total biomedical waste.
- Poses infectious, toxic, or radioactive risks.
- Further classified into the following categories:

a) Infectious Waste

- Contains pathogens that can cause disease.
- Examples: Human excreta, Laboratory cultures, Waste from isolation wards, Swabs, bandages, and materials contaminated with blood or body fluids

b) Pathological Waste

- Consists of human tissues, organs, and body fluids.
- Examples: Human body parts, Blood and body fluids, Fetuses

c) Pharmaceutical Waste

- Contains expired, unused, or contaminated pharmaceutical products.
- Examples: Expired medicines, Discarded drug containers, bottles, and boxes

d) Genotoxic Waste

- Waste containing cytotoxic or genotoxic substances.
- Examples: Cytostatic drugs used in cancer therapy, Genotoxic chemicals

e) Chemical Waste

- Contains discarded chemical substances.
- Examples: Laboratory reagents, Disinfectants, Solvents, Film developers

f) Waste with High Heavy Metal Content

- Contains metals that are toxic even at low concentrations.
- Examples: Batteries, Broken thermometers, Blood pressure gauges, Pressurized containers and aerosol cans

g) Radioactive Waste

- Generated from diagnostic and therapeutic medical procedures.
- Examples: Radioactive liquids from laboratories, Contaminated glassware and absorbent materials, Urine and excreta from patients treated with radionuclides

Answer 5

[4 + 4 + 6 = 14 Marks]

E-Waste Management

Electronic waste (E-waste) includes discarded electrical and electronic equipment such as computers, mobile phones, televisions, refrigerators, and printers. E-waste contains valuable materials as well as hazardous substances like lead, mercury, cadmium, and brominated flame retardants. Therefore, scientific collection, segregation, and disposal are essential to minimize environmental and health risks.

Collection Process of E-Waste [All points are required; 4 Marks]

- 1) E-waste is collected from households, offices, industries, institutions, and commercial establishments.
- 2) Authorized collection centers and municipal drop-off points are provided for public disposal.
- 3) Door-to-door collection systems are used for large electronic items.
- 4) Take-back and buy-back programs implemented by manufacturers under Extended Producer Responsibility (EPR) help recover end-of-life electronics.
- 5) Special collection drives and awareness campaigns encourage safe disposal practices.

Segregation of E-Waste [All points are required; 4 Marks]

- 1) E-waste is segregated based on type of equipment, such as IT equipment, household appliances, and consumer electronics.
- 2) Hazardous components like batteries, cathode ray tubes (CRTs), mercury lamps, and capacitors are removed separately.
- 3) Devices are manually or mechanically dismantled into circuit boards, plastics, metals, and glass.
- 4) Material-wise segregation is carried out to separate ferrous metals, non-ferrous metals, plastics, and precious metals.
- 5) Proper labeling and use of PPE ensure worker safety during segregation.

Disposal Methods of E-Waste [All points are required; 6 Marks]

a) Recycling

- Metals such as copper, aluminium, gold, and silver are recovered through mechanical separation and chemical processes.
- Recycling is conducted only in authorized and environmentally sound facilities.

Advantages: Resource recovery, reduced pollution

Limitations: High cost and technological requirements

b) Reuse and Refurbishment

- Usable electronics are repaired and reused.
- Extends product lifespan and reduces waste generation.

Limitation: Eventually contributes to future e-waste

c) Acid Bath (Chemical Leaching)

- Circuit boards and electronic components are treated with strong acids such as nitric acid, hydrochloric acid, or aqua regia to dissolve and recover precious metals like gold, silver, and copper.
- This method is commonly used in informal recycling sectors but must be strictly controlled in authorized facilities.

Advantages:

- Efficient recovery of precious metals
- High economic value

Limitations:

- Generates toxic acidic effluents
- Risk of air, water, and soil pollution
- Serious health hazards if improperly handled

d) Take-Back Programs

- Manufacturers collect and manage e-waste under EPR policies.

Advantage: Environmentally responsible disposal

Limitation: Limited awareness and participation

e) Secure Landfilling

- Non-recyclable residues are disposed of in engineered landfills with liners and leachate control.

Limitation: Loss of valuable materials and long-term environmental risk

Answer 6

[3 + 3 + 3 + 5 = 14 Marks]

Electronic waste (E-waste) contains a wide range of toxic substances such as heavy metals, flame retardants, and persistent organic pollutants. Improper disposal, open dumping, and informal recycling of e-waste lead to serious environmental pollution and health hazards.

Effects of E-Waste on Air [All points are required; 3 Marks]

- Open burning and incineration of e-waste release toxic fumes into the atmosphere.
- Plastics and flame retardants present in electronic devices emit dioxins and furans, which are highly toxic and carcinogenic.
- Heavy metals like lead and mercury can vaporize during burning and contaminate the air.
- Airborne pollutants can travel long distances, affecting regional air quality and exposing large populations.

Impact:

- Degradation of air quality
- Increased respiratory illnesses
- Long-term environmental damage

Effects of E-Waste on Water [All points are required; 3 Marks]

- E-waste contains hazardous substances such as lead, mercury, cadmium, and brominated flame retardants.
- When dumped in landfills, these substances leach into groundwater and surface water due to rainwater percolation.
- Polluted water bodies adversely affect aquatic ecosystems and contaminate fish, entering the human food chain.
- Runoff from illegal dumping sites causes widespread water contamination.

Impact:

- Unsafe drinking water
- Bioaccumulation of toxins
- Threat to aquatic life

Effects of E-Waste on Soil [All points are required; 3 Marks]

- Improper disposal leads to accumulation of heavy metals such as lead and cadmium in soil.
- Contaminated soil becomes unsuitable for agriculture, affecting crop productivity.
- Toxic substances are absorbed by plants and transferred to animals and humans through food consumption.

Impact:

- Loss of soil fertility
- Contaminated crops
- Long-term land degradation

Associated Health Hazards of E-Waste [All points are required; 5 Marks]**1) Heavy Metal Exposure**

- Lead: Causes neurological damage and developmental disorders, especially in children.
- Mercury: Affects the nervous system and leads to behavioural and developmental problems.
- Cadmium: Damages kidneys and may cause lung and prostate cancer.
- Chromium (VI): Causes respiratory problems and lung cancer.

2) Toxic Organic Compounds

- Brominated Flame Retardants (BFRs): Disrupt hormonal balance and cause reproductive and developmental issues.
- Polychlorinated Biphenyls (PCBs): Lead to immune system suppression, reproductive problems, and cancer.
- Dioxins and Furans: Cause skin disorders, endocrine disruption, and long-term toxicity.

3) Respiratory and Skin Problems

- Inhalation of toxic fumes causes lung irritation, asthma, and chronic respiratory diseases.
- Direct contact with e-waste dust results in dermatitis and skin allergies.

4) Neurological and Developmental Effects

- Exposure to heavy metals leads to cognitive impairment, developmental delays, and behavioural disorders.

5) Cancer and Reproductive Risks

- Long-term exposure increases the risk of cancer.
- Certain chemicals affect fertility and fetal development.
- Endocrine-disrupting chemicals cause hormonal imbalance.

Answer 7 [12 + 2 = 14 Marks]**Classification of EIA [2 + 2 + 2 + 2 + 2 + 2 = 12 Marks]**

EIA can be categorized according to the purpose and development theme. EIA encompasses various types, including climate impact assessment, demographic impact assessment, development impact assessment, ecological impact assessment, economic and fiscal impact assessment, health impact assessment, risk assessment, social impact assessment, strategic impact assessment, and technology assessment.

In addition to this list, EIA is also categorised based on systematic analysis of environmental parameters, geographical region, carrying capacity limitations and sectoral planning. They are strategic EIA, program level EIA, regional EIA, sectoral EIA, project level EIA, and life cycle assessment.

1) Strategic EIA (SEIA) [2 Marks]

Strategic EIA involves a systematic examination of the environmental implications associated with development policies, plans, programs, and other strategic initiatives. Going beyond the conventional project-focused EIA, SEIA extends its reach to the early stages of decision-making, especially when significant alternatives are under consideration. By adopting a proactive stance, SEIA aims to integrate environmental considerations into the broader decision-making processes, offering a comprehensive analysis that helps policymakers and stakeholders understand and address potential environmental impacts at a strategic level. This approach ensures that environmental concerns are factored into decision-making before commitments are made, promoting sustainable and environmentally conscious development at the higher echelons of planning and policy formulation.

2) Program level EIA [2 Marks]

Program-level EIA is a strategic and comprehensive approach to assessing the potential environmental impacts of a series of related projects or activities within a broader program. Unlike project-level EIA that focuses on individual ventures, PEIA considers the cumulative and synergistic effects of multiple projects undertaken as part of a program. This approach allows for a more integrated and holistic understanding of the environmental implications associated with the entire program, providing decision-makers with valuable insights into the combined effects of various activities. PEIA typically involves screening, scoping, baseline data collection, impact assessment, and the development of a program-wide Environmental Management Plan (EMP) that outlines mitigation measures. By addressing environmental considerations at the program level, PEIA facilitates more effective decision-making, promoting sustainable development practices and minimizing the overall environmental footprint of the entire program.

3) Regional EIA [2 Marks]

EIA in the context of regional planning integrates environmental concerns into development planning for a geographic region, normally at the sub-country level. Such an approach is referred to as the economic-cum-environmental (EcE) development planning. This approach facilitates adequate integration of economic development with management of renewable natural resources within the carrying capacity limitation to achieve sustainable development.

It fulfils the need for macro-level environmental integration, which the project-oriented EIA is unable to address effectively. Regional EIA addresses the environmental impacts of regional development plans and thus, the context for project-level EIA of the subsequent projects, within the region. In addition, if environmental effects are considered at regional level, then cumulative environmental effects of all the projects within the region can be accounted.

4) Project level EIA [2 Marks]

Project-level EIA is a process that evaluates the environmental implications of a specific development project carried out in isolation. It focuses on understanding and mitigating the impacts that the project might have on the surrounding environment. However, the limitation of project-level EIA is that it tends to overlook or inadequately address the cumulative effects of various developmental activities within a region. By considering each project in isolation, it may fail to capture the broader environmental impact that arises from the combined effects of multiple projects operating in the same area.

5) Sectoral EIA [2 Marks]

In contrast to project-level EIA, Sectoral EIA takes a more comprehensive approach by considering regional and sectoral level planning. Rather than focusing solely on individual projects, sectoral EIA addresses the broader context of development within a specific sector or region. This approach involves integrating environmental considerations into sectoral development plans, allowing for a more holistic assessment of environmental impacts. Once sectoral-level development plans incorporate measures to address environmental concerns, the need for project-level EIA becomes more specific and narrowed in scope. Sectoral EIA becomes instrumental in identifying and addressing environmental challenges associated with the planning and implementation of development projects within a particular sector. By doing so, it ensures a more effective and integrated management of environmental issues at a larger scale, contributing to sustainable and balanced development.

6) Life Cycle Assessment [2 Marks]

Life Cycle Assessment (LCA) is a systematic approach that involves a set of procedures for gathering and analyzing the inputs and outputs of materials and energy associated with a product or service system. This comprehensive assessment spans the entire life cycle of the product or service, encompassing raw material extraction, production, distribution, use, and end-of-life disposal. LCA goes beyond the immediate production phase to evaluate the environmental impacts directly linked to the functioning of the product or service. By considering all stages of the life cycle, LCA provides a holistic understanding of the environmental footprint, helping identify opportunities for improvement and sustainable practices. It serves as a valuable tool for decision-makers, businesses, and policymakers to make informed choices that contribute to environmental conservation and resource efficiency.

Significance of LCA in Environmental Management [Any 4 Points; 0.5 x 4 = 2 Marks]

- Provides a comprehensive assessment of environmental impacts over the entire life cycle
- Helps identify major sources of pollution (hotspots) in a product or process
- Supports informed and scientific decision-making
- Quantifies resource use and emissions to air, water, and soil
- Highlights environmental trade-offs between alternatives
- Promotes eco-design and sustainable product development
- Aids in policy formulation and regulatory compliance
- Enhances stakeholder communication and transparency
- Encourages sustainable consumption and production

Answer 8

[4 + 5 + 5 = 14 Marks]

Definition of Baseline Data Acquisition [All points are required; 4 Marks]

Baseline data acquisition refers to the systematic collection of existing information on biophysical, biological, social, cultural, and economic aspects of the environment in the project area before the implementation of a proposed project. It represents the existing environmental status against which future changes due to the project can be assessed.

Objectives of Baseline Data Acquisition

- To assess the present environmental quality of air, water, soil, noise, ecology, and socio-economic conditions
- To identify and quantify potential environmental impacts of project activities
- To develop an effective Environmental Management Plan (EMP)
- To establish a reference for future monitoring and comparison after project commissioning

- Baseline data are usually collected within a 10 km radius of the proposed project site

Environmental Inventory [All points are required; 5 Marks]

Definition - Environmental inventory is a complete description of environmental conditions in an area where a proposed activity is planned. It forms the foundation of EIA and is included in the Environmental Impact Statement (EIS)

Components of Environmental Inventory

1) Physical-Chemical Environment

Includes:

- Soil characteristics
- Geology and topography
- Surface and groundwater resources
- Water quality
- Air quality
- Noise levels
- Meteorology and climatology

Example: Measurement of ambient air quality (PM₁₀, PM_{2.5}, SO₂, NO_x) around a proposed thermal power plant.

2) Biological Environment

Includes:

- Flora and fauna
- Terrestrial and aquatic ecosystems
- Species diversity and abundance
- Presence of endangered or threatened species

Example: Assessment of mangrove vegetation and fish diversity for a coastal port project.

3) Socio-Economic Environment

Includes:

- Population distribution and density
- Livelihood patterns
- Infrastructure facilities (water supply, sanitation, transport)
- Health and education services

Example: Study of employment patterns and income levels near an industrial estate.

4) Cultural Environment

Includes:

- Historical and archaeological sites
- Religious and heritage structures
- Aesthetic and visual quality

Example: Identification of protected monuments near a highway project.

Rapid Environmental Impact Assessment (Rapid EIA) [All points are required; 5 Marks]

Definition - Rapid EIA (REIA) is a quick, qualitative assessment technique used to identify, prioritize, and rank potential environmental impacts within a short time frame, especially when time or data availability is limited.

Key Features of Rapid EIA

- Uses short-term primary data and existing secondary data
- Focuses only on critical environmental components likely to be affected
- Employs checklists, matrices, rating scales, and expert judgment

- Does not replace detailed EIA but acts as an initial screening tool

Applications of Rapid EIA

- Disaster situations (floods, earthquakes, industrial accidents)
- Emergency development projects
- Preliminary project appraisal and feasibility studies

Areas Covered in Rapid EIA

- General disaster or project context
- Immediate environmental impacts
- Environmental risks due to relief or construction activities
- Unmet basic needs that may lead to environmental degradation

Examples of Rapid EIA

- Rapid assessment of environmental damage after a chemical spill
- Preliminary environmental screening for road widening projects
- Quick evaluation of environmental impacts of temporary relief camps

Answer 9 [14 Marks]

Essential Elements of an Environmental Audit

[Any 7 Points; 2 x 7 = 14 Marks]

1) Audit Planning and Scope Definition

- Defines the objectives, scope, criteria, and boundaries of the audit.
- Identifies applicable environmental laws, standards, and company policies.

Example: Defining whether the audit will cover air emissions, wastewater discharge, hazardous waste handling, or all environmental aspects of a chemical plant.

2) Review of Environmental Management System (EMS)

- Evaluates the effectiveness of the organization's Environmental Management System.
- Assesses policies, procedures, responsibilities, and documentation.

Example: Reviewing ISO 14001 implementation in an automobile manufacturing unit.

3) Legal and Regulatory Compliance Assessment

- Verifies compliance with environmental laws, rules, and permits.
- Identifies instances of non-compliance.

Example: Checking adherence to Air (Prevention and Control of Pollution) Act and Water Act discharge standards.

4) Site Inspection and Process Walkthrough

- Physical inspection of facilities, equipment, storage areas, and waste disposal sites.
- Helps identify pollution sources and unsafe practices.

Example: Inspecting hazardous waste storage areas for leakage, labeling, and secondary containment.

5) Risk Identification and Impact Assessment

- Identifies environmental risks associated with operations and processes.
- Evaluates probability and severity of impacts on air, water, soil, and human health.

Example: Assessing risks from improper handling of biomedical or chemical waste.

6) Data Collection and Analysis

- Collection of monitoring data related to emissions, effluents, waste generation, and energy use.
- Data is analyzed to identify trends and deviations.

Example: Analyzing stack emission data to verify compliance with permissible limits.

7) Audit Reporting

- Preparation of a detailed audit report summarizing findings, non-compliances, and observations.

- Includes recommendations for corrective and preventive actions.

Example: Audit report recommending installation of effluent treatment upgrades.

8) Corrective Action and Follow-Up

- Ensures implementation of recommended corrective measures.
- Follow-up audits verify improvements and compliance.

Example: Follow-up audit confirming improved waste segregation and disposal practices.

9) Management Review and Continuous Improvement

- Audit findings are reviewed by top management.
- Supports continuous environmental performance improvement.

Example: Management allocating funds for cleaner technologies based on audit outcomes.

Answer 10 [10 + 4 = 14 Marks]

Environmental Audit Processes [All points are required; 10 Marks]

An environmental audit is a systematic, documented, and objective evaluation of an organization's activities to assess compliance with environmental laws, standards, and environmental management practices.

The process of an environmental audit is generally carried out in three main phases:

1) Pre-Audit Phase

This is the planning and preparation stage, which lays the foundation for a successful audit.

- **Defining audit objectives and scope**
The auditor determines whether the audit is for legal compliance, environmental management system evaluation, or performance improvement.
- **Identification of applicable laws and standards**
Relevant environmental laws, rules, permits, consent conditions, and company policies are identified.
- **Formation of the audit team**
A qualified audit team with technical and regulatory expertise is selected.
- **Collection and review of background information**
Previous audit reports, environmental permits, process flow diagrams, waste records, emission data, and monitoring reports are reviewed.
- **Preparation of audit plan and checklist**
A detailed audit plan and checklist are prepared to guide on-site activities.

2) Audit (On-Site) Phase

This phase involves actual assessment of environmental performance at the site.

- **Opening meeting**
The audit team explains objectives, scope, and methodology to management and staff.
- **Site inspection and walkthrough**
Physical inspection of facilities, pollution control systems, waste storage areas, and treatment units is conducted.
- **Interviews and discussions**
Discussions are held with employees to assess awareness, training, and implementation of environmental practices.
- **Verification of records and data**
Monitoring records, logbooks, compliance reports, and emergency preparedness documents are verified.
- **Identification of non-compliance and risks**
Gaps, violations, and environmental risks are documented.

3) Post-Audit Phase

This phase focuses on reporting and follow-up.

- **Preparation of audit report**
The report highlights compliance status, observations, non-conformities, and good practices.
- **Recommendations and corrective actions**
Practical recommendations are suggested to improve environmental performance and compliance.
- **Closing meeting**
Findings are discussed with management and timelines for corrective actions are agreed upon.
- **Follow-up and monitoring**
Implementation of corrective actions is monitored to ensure continual improvement.

Importance of Pre-Audit Activities [Any 4 Points; 1 x 4 = 4 Marks]

Pre-audit activities are crucial for the effectiveness and credibility of an environmental audit.

- 1) **Ensures clear objectives and scope**
Prevents ambiguity and ensures the audit focuses on relevant environmental issues.
- 2) **Improves audit efficiency**
Proper planning reduces time wastage during on-site inspections.
- 3) **Identifies regulatory requirements in advance**
Helps auditors evaluate compliance accurately with applicable laws and standards.
- 4) **Reduces operational disruptions**
Advance coordination with the auditee minimizes interference with normal operations.
- 5) **Enhances accuracy of findings**
Reviewing historical data and records helps in identifying trends and recurring issues.
- 6) **Builds cooperation and transparency**
Early communication reduces fear and resistance among employees.
- 7) **Facilitates risk-based auditing**
High-risk areas can be prioritized, leading to better environmental risk management.