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An Institute for Civil Services

PRELIMS 2025

ENVIRONMENT

PRACTICE TEST - 7

Environmental Concepts *and* Ecosystems

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GENERAL STUDIES

PRACTICE TEST - 7

(Environment: Environmental Concepts and Ecosystems)

Time Allowed: 40 Min. ***Maximum Marks: 50***

INSTRUCTIONS

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2. **Please note that it is the candidate's responsibility to encode and fill in the Roll Number carefully without any omission or discrepancy at the appropriate places in the OMR Answer Sheet. Any omission/discrepancy will render the Answer Sheet liable for rejection.**
3. You have to enter your Roll Number on the test booklet in the Box provided alongside. ***DO NOT*** write anything else on the Test Booklet.
4. This Test Booklet contains ***25*** items (questions). Each item is printed in English. Each item comprises four responses (answers). You will select the response which you want to mark on the Answer Sheet. In case you feel that there is more than one correct response, mark the response which you consider the best. In any case, choose ***ONLY ONE*** response for each item.
5. You have to mark all your responses ***ONLY*** on the separate Answer Sheet provided. See directions in the Answer Sheet.
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8. After you have completed filling in all your responses on the Answer Sheet and the examination has concluded, you should hand over to the Invigilator ***only the Answer Sheet***. You are permitted to take away with you the Test Booklet.
9. Sheets for rough work are appended in the Test Booklet at the end.
10. **Penalty for wrong answers:**

    THERE WILL BE PENALTY FOR WRONG ANSWERS MARKED BY A CANDIDATE IN THE OBJECTIVE TYPE QUESTION PAPERS.

    (i) There are four alternatives for the answer to every question. For each question for which a wrong answer has been given by the candidate, **one-third** of the marks assigned to that question will be deducted as penalty.

    (ii) If a candidate gives more than one answer, it will be treated as a **wrong answer** even if one of the given answers happens to be correct and there will be same penalty as above to that question.

    (iii) If a question is left blank, i.e., no answer is given by the candidate, there will be **no** penalty for that question.

1. Consider the following statements:

Statement-I:

Nutrients are continually recycled through ecosystems, and the balance of nutrients is critical to ecosystem health.

Statement-II:

The decomposition of organic matter plays a crucial role in the nutrient cycling, releasing nutrients back into the soil.

Which one of the following is correct in respect of the above statements?

(a) Both Statement-I and Statement-II are correct, and Statement-II is the correct explanation for Statement-I.

(b) Both Statement-I and Statement-II are correct, and Statement-II is not the correct explanation for Statement-I.

(c) Statement-I is correct, but Statement-II is incorrect.

(d) Statement-I is incorrect, but Statement-II is correct.

2. Consider the following statements:

1. An organism refers to a single living individual, while a population is a group of individuals of the same species living in a specific area.
2. A community includes all the different species living and interacting within a particular habitat.
3. The biosphere is a specific area of the Earth that contains all the ecosystems.
4. An ecosystem encompasses both the living organisms and their physical environment.

How many of the statements given above are ***incorrect*****?**

(a) Only one

(b) Only two

(c) Only three

(d) All four

3. Consider the following statements regarding Ecological Niches:

1. An ecological niche refers to the physical location where a species lives within an ecosystem.
2. Different species can share the same habitat but occupy different niches, reducing competition and promoting biodiversity.
3. A habitat with fewer ecological niches generally supports higher biodiversity than one with many niches.

How many of the statements given above are correct?

(a) Only one

(b) Only two

(c) All three

(d) None

4. Consider the following statements:

Statement-I:

Decomposers are essential in maintaining the balance of population interactions by directly influencing the cycling of nutrients in an ecosystem.

Statement-II:

Predation and mutualistic relationships are key drivers of nutrient availability, which in turn supports primary producers and higher trophic levels.

Which one of the following is correct in respect of the above statements?

(a) Both Statement-I and Statement-II are correct and Statement-II explains Statement-I

(b) Both Statement-I and Statement-II are correct and Statement-II does not explain Statement-I

(c) Statement-I is correct but Statement-II is incorrect

(d) Statement-I is incorrect but Statement-II is correct

5. Which of the following are the critically endangered species found in India?

1. Great Indian Bustard
2. Hawksbill Turtle
3. Sunda Pangolin
4. Kashmir Stag

Select the correct answer using the code given below:

(a) 1 and 2 only

(b) 2 and 3 only

(c) 3 and 4 only

(d) All of the above

6. Arrange the following regions according to the level of floral endemism seen in India:

1. Eastern Himalayas
2. Peninsular India
3. North-western Himalayas
4. Andaman and Nicobar Islands

Select the correct code from the options given below:

(a) 1-3-4-2

(b) 2-1-3-4

(c) 2-3-1-4

(d) 4-1-3-2

7. Consider the following statements:

1. It is situated along the international border between India and Myanmar.
2. It is encircled by the Patkai Hills to the south and southeast and the Himalayas to the north.
3. The Noa-Dehing River, which is a tributary of the Brahmaputra, runs through the centre of the National Park.

The above statements most appropriately are related to which of the following National Parks in India?

(a) Namdapha National Park

(b) Govind Pashu Vihar National Park

(c) Jim Corbett National Park

(d) Nanda Devi National Park

8. Match the following pairs of Ramsar Sites:

	Ramsar Sites	***States***
1.	Sultanpur National Park	– Uttar Pradesh
2.	Wadhvana Wetland	– Kerala
3.	Bhindawas Wildlife Sanctuary	– Haryana
4.	Thol Lake Wildlife Sanctuary	– Gujarat

How many of the above Pairs is/are correctly matched?

(a) Only one pair

(b) Only two pairs

(c) Only three pairs

(d) All fours pair

9. Which one of the following protected areas are within the Nilgiri Biosphere Reserve?

(a) Mudumalai Tiger Reserve, Bandipur National Park, Silent Valley National Park, and Sathyamangalam

(b) Mukurthi National Park, Wayanad Wildlife Sanctuary, Mudumalai Tiger reserve, and Srivilliputtur Megamalai

(c) Nagarhole National Park, Bandipur National Park, Silent Valley National Park, and Kalakkad - Mundanthurai

(d) Nagarhole National Park, Mukurthi National Park, Wayanad Wildlife Sanctuary, and Mudumalai Tiger reserve

10. Consider the following statements:

1. Snow Leopards leave scent marks to indicate their common territories and common travel routes.
2. For the first time Indian Snow Leopard Census was conducted by Wild Life Institute of India.
3. Unlike Cheetah, Snow Leopard can roar.

How many of the above statements are correct?

(a) Only one

(b) Only two

(c) All three

(d) None

11. How does thermal pollution specifically alter the biogeochemical cycling of nutrients in freshwater ecosystems?

(a) By enhancing nitrogen fixation and phosphorus uptake

(b) By increasing the rate of denitrification and reducing phosphorus availability

(c) By accelerating microbial decomposition and altering nutrient solubility

(d) By promoting the formation of organic complexes and increasing nutrient runoff

12. Consider the following:

1. Fabric Filters
2. Wet Scrubbers
3. Precipitators
4. Blast Furnace

How many of the above is/are instruments to control air pollution?

(a) Only one

(b) Only two

(c) Only three

(d) All four

13. Consider the following statements regarding Plastic Waste:

Statement-I:

Plastic waste exposure leads to soil and water pollution, harming ecosystems, and contributing to the accumulation of micro-plastics in the food chain.

Statement-II:

Burning plastic waste releases toxic gases like dioxins, which contribute to both air pollution and climate change.

Statement-III:

India's Plastic Waste Management Rules, 2016, mandate Extended Producer Responsibility (EPR) and emphasize banning single-use plastics to combat plastic pollution.

Which one of the following is correct in respect of the above statements?

(a) Both Statement-II and Statement-III are correct, and both of them explain Statement-I.

(b) Both Statement-II and Statement-III are correct, but only one of them explains Statement-I.

(c) Only one of the Statements-II and III is correct, and that explains Statement-I.

(d) Neither Statement-II nor Statement-III is correct.

14. Consider the following pairs:

	Technologies	*Used for*
1.	Gravitational settling	To control air pollution
2.	Phytoremediation	To control noise pollution
3.	Electrostatic precipitators	To control water pollution

Which of the above pairs are correctly matched?

(a) 1, 2 and 3

(b) 2 and 3 only

(c) 1 only

(d) 1 and 2 only

15. With reference to smog, consider the following statements:

1. Smog is a combination of various gases with water vapour and dust.
2. Photochemical is also called 'reducing smog'.
3. Classical smog is caused by high concentrations of sulphur oxides in the air due to use of sulphur-bearing fossil fuels like coal.
4. Photo-chemical smog requires neither smoke nor fog.

Which of the above statements are correct?

(a) 1 and 2 only

(b) 1 and 3 only

(c) 1, 3 and 4 only

(d) 2, 3 and 4 only

16. Which of the following statements is/are correct about the factors causing deforestation in different regions of the world?

1. In South-East Asia and South America, major deforestation is driven by the commercial needs, of certain forest commodities, such deforestations are generally permanent in nature.
2. In Africa, the new shift in agriculture is the major driving factor for deforestation which contributes to over 90 percent of the total deforestation.
3. Expansion of agricultural lands due to increasing food demand remains the biggest cause of deforestation in the world irrespective of region/continents.

Select the correct answer using the following code;

(a) 1 and 2 only

(b) 2 only

(c) 2 and 3 only

(d) 1, 2 and 3

17. Consider the following statements with respect to Carbon Dioxide Removal (CDR) , which of the following methods are used for CDR :

1. Afforestation and deforestation
2. Soil carbon sequestration

3. Blue carbon
4. Incineration
5. Algae cultivation

How many of the above statements are correct?

(a) Only two

(b) Only three

(c) Only four

(d) All five

18. Which of the following are the extra-terrestrial causes of climate change?

1. Fluctuation in the amount of energy irradiated from the photosphere.
2. Increase or decrease the number of sunspots.
3. Variations in the earth's orbital characteristics around the sun.
4. Changes in the earth's axial tilt.

Select the correct answer using the code given below:

(a) 1 and 2 only

(b) 3 and 4 only

(c) 1, 2 and 4 only

(d) 1, 2, 3 and 4

19. Select the most appropriate definition of 'Global Dimming' a phenomenon often seen in news:

(a) It refers to the collective efforts of G20 countries to reduce the global carbon footprint.

(b) It is an initiative of the UNEP aimed at reducing the urban heat island effect by propagating dim colours for high rises in urban areas.

(c) It is a drop in the amount of average solar energy reaching the earth's surface due to a shield created by suspended air particulate materials.

(d) An initiative of the UNFCCC, to reduce global burning of fossil fuels and shift to cleaner sources of energy.

20. Which of the following statements regarding the carbon sequestration in soils is ***incorrect***?

(a) Perennial crops store more carbon in soils than the cyclical (annual, biennial, etc.) crops.

(b) Continued increase in atmospheric CO_2 due to climate change helps in fixing more carbon through photosynthesis and thus beneficial in net carbon balance in the soils.

(c) Less intensive tilling releases less atmospheric CO_2.

(d) Inorganically Sequestered Carbon (carbonates) are slower to be formed but have the ability to store carbon for longer period than the organically sequestered carbon.

21. Consider the following statements with respect to loss and damage fund;

1. It was established for the first time during Paris agreement.
2. It provides financial support to both developed and developing countries to cope the challenges of climate change.
3. It refers to financial penalties for non-compliance with emission targets.

How many of the above statements are correct?

(a) Only one

(b) Only two

(c) All three

(d) None

22. Consider the following statements:

Statement-I:

Polar Regions are warming faster as compared to other regions of the world.

Statement-II:

Due to concentration of greenhouse gases there is more thermal change in poles as compared to other regions.

Which one of the following is correct in respect of the above statements?

(a) Both Statement-I and Statement-II are correct and Statement-II is the correct explanation for Statement-I

(b) Both Statement-I and Statement-II are correct and Statement-II is not the correct explanation for Statement-I

(c) Statement-I is incorrect but Statement-II is correct

(d) Statement-I is correct but Statement-II is incorrect

23. Consider the following statements:

Statement I:

Eutrophication can lead to ocean acidification.

Statement II:

Water pollution leads to eutrophication when excess nutrients, like nitrogen and phosphorus.

Which one of the following is correct in respect of the above statements?

(a) Both Statement-I and Statement-II are correct and Statement-II explains Statement-I

(b) Both Statement-I and Statement-II are correct and Statement-II does ***not*** explain Statement-I

(c) Statement-I is correct but Statement-II is incorrect.

(d) Statement-I is incorrect but Statement-II is correct.

24. With respect to the REDD+ framework to protect forests as part of the Paris Agreement, consider the following statements:

1. The '+' stands for additional forest-related activities that protect the climate.
2. Developing countries receive results-based payments for emission reductions when they reduce deforestation.

Which of the statements given above is/are ***incorrect***?

(a) 1 only

(b) 2 only

(c) Both 1 and 2

(d) Neither 1 nor 2

25. Consider the following statements:

Statement-I:

The World Wide Fund for Nature (WWF) supports small-scale fisheries and sustainable aquaculture.

Statement-II:

WWF and UNEP, via the Nairobi Convention, signed an MoU to implement marine and coastal programs in the Western Indian Ocean.

Which one of the following is correct in respect of the above statements?

(a) Both Statement-I and Statement-II are correct and Statement-II explains Statement-I

(b) Both Statement-I and Statement-II are correct and Statement-II does ***not*** explain Statement-I

(c) Statement-I is correct but Statement-II is incorrect.

(d) Statement-I is incorrect but Statement-II is correct.

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GENERAL STUDIES

PRACTICE TEST - 7

(Environment: Environmental Concepts and Ecosystems)

Answer Key

Q. 1 (a)	Q. 6 (b)	Q. 11 (c)	Q. 16 (a)	Q. 21 (d)
Q. 2 (a)	Q. 7 (a)	Q. 12 (c)	Q. 17 (b)	Q. 22 (a)
Q. 3 (b)	Q. 8 (b)	Q. 13 (a)	Q. 18 (d)	Q. 23 (a)
Q. 4 (a)	Q. 9 (d)	Q. 14 (c)	Q. 19 (c)	Q. 24 (d)
Q. 5 (d)	Q. 10 (b)	Q. 15 (c)	Q. 20 (b)	Q. 25 (b)

1. Correct Option: (a)

Both Statement-I and Statement-II are and Statement-II is the correct explanation for Statement-I.

Explanation:

Step 01: understanding statement 01

Nutrient recycling is a vital process where essential nutrients are transferred between living organisms (biotic components) and non-living elements (abiotic components) in an ecosystem. These cycles ensure the continuous availability of nutrients required for the growth and survival of organisms, supporting the health and productivity of ecosystems.

- **Process of Nutrient Cycling:**
  - **Carbon Cycle**: Plants absorb carbon dioxide, which is passed on to herbivores and decomposers, returning carbon to the atmosphere.
  - **Nitrogen Cycle**: Nitrogen is fixed by bacteria and passed through the food chain, with decomposers returning nitrogen to the soil.
  - **Phosphorus Cycle**: Phosphorus moves between soil, water, and living organisms, essential for energy transfer and growth.
- **Significance of Nutrient Balance:**
  - **Ecosystem Health**: A balanced nutrient cycle supports primary productivity, biodiversity, and soil fertility, ensuring ecosystem stability and resilience.
  - **Agriculture**: Proper nutrient cycling maintains soil fertility, essential for sustainable farming and food production.
- **Impact of Disruption:**
  - **Eutrophication**: Excess nutrients in water lead to algal blooms, oxygen depletion, and biodiversity loss.
  - **Soil Degradation**: Overuse of nutrients can lead to soil fertility loss, erosion, and desertification.
  - **Climate Change**: Disruptions in carbon and nitrogen cycles contribute to global warming.

Step 02: understanding statement 02

Decomposition is a natural process where dead organic material—such as plants, animals, and waste—is broken down by decomposers like bacteria, fungi, and certain animals. This process plays a vital role in the ***recycling of nutrients*** *within ecosystems.*

- **Key Aspects of Decomposition:**
  - **Breakdown of Organic Matter**:
    - When plants and animals die, decomposers begin breaking down their tissues into simpler organic and inorganic substances. This breakdown involves the conversion of complex organic molecules into simpler compounds such as carbon dioxide, water, and essential nutrients like nitrogen, phosphorus, and potassium.
  - **Nutrient Release**:
    - Through decomposition, essential nutrients are released back into the soil in a form that plants can absorb and utilize. This ensures the continuity of the nutrient cycle, allowing plants to grow and sustain herbivores, which are then consumed by higher trophic levels in the food chain.
  - **Contribution to Soil Fertility**:
    - The process of decomposition enriches the soil by adding valuable organic matter and nutrients. The result is improved soil structure and fertility, promoting better plant growth and overall ecosystem productivity.
  - **Impact on Ecosystem Stability**:
    - Decomposition helps maintain the balance of nutrients within ecosystems. Without this process, nutrients would become locked in dead material, leading to nutrient deficiencies in the soil. The continual recycling of nutrients through decomposition supports ecosystem stability, biodiversity, and resilience.

2. Correct Option: (a)

Only Statement 3 is incorrect: The biosphere is not a specific c area; it refers to the global sum of all ecosystems, including all living organisms and their interactions with the Earth's atmosphere, hydrosphere, and lithosphere. It is the broadest level of biological organisation, encompassing all ecosystems.

Step 01: understanding statement 01

- **Individual**

- An **individual** refers to a single, distinct organism that represents the most basic unit of life. It can be any living being, from a single-celled organism (like bacteria) to a complex multicellular organism (like a human or a tree). An individual organism exhibits all the characteristics of life, including metabolism, growth, reproduction, and response to stimuli.
  - **Example**: A single lion, a single oak tree, or a single bacterium is an individual.

Step 02: understanding statement 02

- **Population**
  - A **population** is a group of individuals of the same species living in a specific area at a given time. These individuals interact with each other, often competing for resources like food, water, and shelter. Populations can change over time due to factors like birth rates, death rates, immigration, and emigration. Members of a population can interbreed and produce fertile offspring, contributing to genetic diversity within the population.
- **Key Characteristics**:
  - Same species
  - Geographic area
  - Ability to interbreed
- **Example**: A population of deer in a forest or a population of bacteria in a petri dish.

Step 03: understanding statement 03

- **Community**
  - A **community** is a group of different populations of species living and interacting in the same area. These populations interact in various ways, such as predation, competition, mutualism, and symbiosis. A community includes all the living organisms (plants, animals, microorganisms, etc.) in a specific area, and the interactions among them shape the structure and dynamics of the community.
- **Key Characteristics**:
  - Multiple species
  - Interactions between species (competition, predation, mutualism, etc.)
- **Example**: The community in a coral reef includes fish, corals, algae, and microorganisms that all interact within the same habitat.

Step 04: understanding statement 04

- **Biosphere**
  - The **biosphere** refers to the global sum of all ecosystems. It is the part of Earth where life exists, encompassing all the living organisms (both on land and in water) and the environments they inhabit. The biosphere includes the atmosphere, hydrosphere, and lithosphere, and it extends from the highest mountain tops to the deepest ocean trenches. The biosphere is a dynamic, interconnected system where energy, nutrients, and matter are exchanged between living organisms and their physical environments.
- **Key Characteristics**:
  - Encompasses all ecosystems on Earth
  - Includes all forms of life, from microorganisms to large animals
  - Integrates with the atmosphere, hydrosphere, and lithosphere
- **Example**: The biosphere includes everything from the rainforests and deserts to the oceans and polar ice caps, where life exists in various forms.

Summary:

- **Individual**: A single organism.
- **Population**: A group of individuals of the same species in a given area.
- **Community**: A group of interacting populations of different species in the same area.
- **Biosphere**: The global ecosystem, encompassing all life on Earth and the environments that support it.

3. Correct Option: (b)

Answer b, statement 02 & 03 are correct

*An **ecological niche** refers to the role and function of a species within an ecosystem. It includes how a species interacts with both the biotic (living) and abiotic (non-living) components of its environment, such as its habitat, resource use, and relationships with other species.in other words* **an ecological niche defines how a species interacts with its environment and other species. It involves the species' resource use, habitat, and behaviour within the ecosystem, contributing to the balance and functioning of the ecosystem as a whole.**

Step 01: understanding statement 01

The statement is partially incorrect, An ecological niche does not refer solely to the physical location where a species lives (which is its habitat). An ecological niche refers to the role or function a species plays in its environment, including its interactions with other species, its use of resources, and how it contributes to energy and nutrient cycles. It includes both the physical habitat where the species lives and the functional role it plays within that habitat.

Example:

- **Lion**: Its niche includes being a predator in the savanna, hunting herbivores like zebras, and helping regulate prey populations.
- **Bee**: Its niche involves pollinating flowers to obtain nectar while aiding in plant reproduction.

Step 02: understanding statement 02

Yes, this statement is accurate. Different species can share the same habitat but occupy different ecological niches, which helps reduce direct competition for resources and promotes biodiversity within ecosystems. This concept is known as niche differentiation or niche partitioning. In other words Niche differentiation allows multiple species to share the same habitat without directly competing for the same resources, which enhances biodiversity and supports the functioning of ecosystems.

How It Works:

- **Niche Differentiation**: When species live in the same habitat but occupy different niches, they exploit different resources or occupy different roles in the ecosystem. This allows them to coexist without competing directly for the same resources.
    - **Example**: In a forest, **different bird species** may share the same trees but occupy different niches. Some birds may feed on insects on the tree trunks, while others may feed on insects in the leaves or flowers, thus reducing competition for food.
- **Temporal Niche Partitioning**: Species may use the same resources at different times to avoid competition.
    - **Example**: In a savanna ecosystem, **diurnal** (daytime) animals like **lions** and **herbivores** might feed during the day, while **nocturnal** species like **hyenas** and **bats** feed at night.
- **Spatial Niche Partitioning**: Species may use different parts of the same habitat, reducing competition.
    - **Example**: In a tree, one species of bird may live and nest in the upper branches, while another species might occupy the lower branches or tree trunk.

Benefits:

- **Reduced Competition**: By occupying different niches, species reduce direct competition for the same food, space, and other resources.
- **Biodiversity**: Niche partitioning promotes **species diversity** by allowing different species to coexist in the same ecosystem, enhancing the overall biodiversity.
- **Ecosystem Stability**: Coexistence of diverse species through niche differentiation contributes to ecosystem stability by ensuring various ecological functions are maintained.

Step 03: understanding statement 03

This statement is correct. Habitats with fewer niches tend to support lower biodiversity, while habitats with a variety of niches typically support higher biodiversity. The number and variety of niches in an ecosystem play a significant role in determining the species richness and diversity of that habitat.

Why Fewer Niches Lead to Lower Biodiversity:

- **Limited Resource Availability**:
    - A habitat with fewer niches typically has fewer types of resources and ecological roles available for species to exploit. This limits the number of species that can live in that habitat, as competition for the same resources becomes more intense.
    - **Example**: A desert ecosystem with few water sources and little vegetation has fewer niches available, which supports fewer species overall compared to a tropical forest.
- **High Competition**:
    - In habitats with fewer niches, there is greater overlap in the needs of species, leading to higher competition. This often results in fewer species being able to survive in the environment, thus reducing biodiversity.
    - **Example**: In a simple grassland, species might compete for the same food and

shelter, leading to a lower number of species compared to a more complex ecosystem like a rainforest.

In short, the niche is the species' "job" in the ecosystem, while the habitat is the place where it lives.

4. Correct Option: (a)

Decomposers play a unique and crucial role in ecosystems by acting as the "nature's recyclers", ensuring the continuous flow of nutrients and energy, and maintaining ecological balance. Their work directly impacts the health of ecosystems, influencing populations and nutrient cycles.

Step 01: understanding statement 01

Statement is accurate. Decomposers play a critical role in maintaining the balance of population interactions in ecosystems by recycling nutrients and ensuring the continual availability of essential elements for producers (such as plants) and consumers (such as herbivores and carnivores).

Key Roles and Examples:

- **Nutrient Recycling**:
  - Decomposers break down **dead organisms** and organic waste, converting them into simple nutrients such as **carbon**, **nitrogen**, and **phosphorus**. These nutrients are then reintroduced into the soil, enriching it for plants.
  - **Example**: In a forest, when a tree falls and decomposes, fungi and bacteria break down its organic matter, returning essential nutrients like nitrogen into the soil, which plants need to grow.
- **Supporting Plant Growth**:
  - By recycling organic material, decomposers provide essential nutrients for **primary producers** (plants), which form the foundation of the food web. Without this recycling process, plants would struggle to obtain the necessary nutrients.
  - **Example**: In grasslands, decomposers like earthworms break down plant material, enriching the soil and supporting the growth of grasses, which herbivores depend on for food.
- **Regulating Population Dynamics**:
  - Decomposers help regulate populations by preventing the accumulation of dead material. By breaking it down, they ensure that nutrients are recycled quickly, which maintains ecological balance and prevents overpopulation of any single species due to a lack of resources.
  - **Example**: In aquatic ecosystems, decomposers like bacteria decompose fish and plant debris, preventing the buildup of organic material that could suffocate the water and disrupt fish populations.
- **Energy Flow in Ecosystems**:
  - Decomposers ensure that **energy stored in dead organic matter** is released and made available for other organisms. This process is crucial in maintaining the flow of energy throughout the ecosystem.
  - **Example**: When a herbivore dies in a savanna, decomposers break down its body, releasing the energy stored in its tissues back into the ecosystem, where it can be absorbed by plants or consumed by smaller organisms.

Step 02: understanding statement 02

Predation and mutualistic relationships are fundamental to nutrient cycling in ecosystems, directly supporting the health and productivity of primary producers and higher trophic levels.

- **Predation** regulates herbivore populations, preventing overgrazing and promoting plant growth. When predators or prey decompose, they release vital nutrients back into the soil, enriching it for plants.
  - **Example**: In forests, wolves control deer populations, preventing overgrazing of vegetation, which maintains soil fertility and supports plant life.
- **Mutualistic relationships** enhance nutrient cycling by facilitating the exchange of resources between species. This boosts nutrient availability for plants, which supports herbivores and higher consumers.
  - **Example**: Bees pollinate flowers while collecting nectar, ensuring plant reproduction, which in turn supports herbivores and the entire food web.

Together, predation and mutualism maintain ecosystem balance, ensuring continuous nutrient flow that sustains biodiversity at all trophic levels.

5. Correct Option: (d)

*The **Critically Endangered Species of India** are at the brink of extinction and require urgent*

*conservation attention. India has made significant efforts to protect these species through the **Wildlife Protection Act of 1972**, the establishment of **Protected Areas** like national parks and sanctuaries, and **conservation programs** such as Project Tiger and Project Elephant. However, much more needs to be done, including better enforcement of laws, habitat restoration, and addressing human-wildlife conflicts.*

Step 01: understanding statements

Here is a list of Critically Endangered Species of India:

- Great Indian Bustard
- Hawksbill Turtle
- Sunda Pangolin
- Kashmir Stag (Hangul)
- Lion-tailed Macaque
- Asiatic Lion
- Snow Leopard
- Javan Rhino

Great Indian Bustard:

- **Status**: Critically Endangered
- **Habitat**: Arid grasslands and semi-desert regions of Rajasthan, Gujarat, and Maharashtra.
- **Threats**: Habitat loss, hunting, and disturbance from agricultural activities and infrastructure development.
- **Importance**: The Great Indian Bustard is one of the heaviest flying birds and is India's state bird of Rajasthan. Its decline is a significant loss to India's avian biodiversity.

Hawksbill Turtle:

- **Status**: Critically Endangered
- **Habitat**: Coastal waters and coral reefs.
- **Threats**: Illegal trade of their shells, loss of nesting sites, and accidental capture in fishing gear.
- **Importance**: Hawksbill turtles play a vital role in maintaining the health of coral reefs by controlling the growth of sponges that can otherwise overwhelm corals.

Sunda Pangolin:

- **Status**: Critically Endangered
- **Habitat**: Forests in the northeastern states of India, such as Assam and Manipur.
- **Threats**: Poaching for illegal wildlife trade, particularly for their scales and meat.
- **Importance**: Sunda Pangolins are insectivores that help in controlling insect populations, particularly ants and termites, which are beneficial for maintaining ecological balance.

Kashmir Stag (Hangul):

- **Status**: Critically Endangered
- **Habitat**: Dense forests in the Kashmir Valley. Dachigam national park, overa uru wild life sanctuary
- **Threats**: Habitat loss, poaching, and disease from domesticated animals.
- **Importance**: The Hangul is the only surviving species of red deer in India. It is a symbol of the Kashmiri wildlife and an important part of the region's biodiversity.

6. Correct Option: (b)

Floral endemism refers to the phenomenon where certain plant species are native to and restricted to a specific geographical area, meaning that they are not found naturally anywhere else in the world. Floral endemism in India is a rich and diverse phenomenon, as the country boasts a wide range of geographical features, climates, and ecosystems. This diversity has given rise to numerous plant species that are unique to specific regions.

Step 01: understanding statement 01

This phenomenon arises from several factors, including:

- **Geographical Isolation**: Natural barriers like mountains and oceans can separate plant populations over long periods, leading to the emergence of distinct species in those isolated areas.
- **Unique Climate and Soil Conditions**: Different regions possess varying climates and soil compositions, which may support specific species that have adapted to thrive in those environments.
- **Historical Events**: Geological occurrences, such as volcanic eruptions, glaciation, or tectonic shifts, can create new habitats and drive the evolution of endemic species.
- **Specialized Ecological Roles**: Endemic plants often occupy specific ecological niches, having evolved unique traits to adapt to the conditions and interactions of their local environment, including relationships with pollinators.

Key Regions of Floral Endemism

- **Western Ghats**:
  - The Western Ghats are one of the world's eight "hottest hotspots" of biological

diversity. This mountain range is home to a high number of endemic species, including various orchids, ferns, and flowering plants.

- Notable examples include **Neoregalia**, a genus of bromeliads, and many species of **Strobilanthes** (known locally as *kurinji*), which is famous for flowering once every twelve years.

- **Himalayas**:
  - The Himalayan region is also rich in endemic flora, with various climatic zones that support diverse vegetation.
  - Species such as the **Himalayan blue poppy** (*Meconopsis betonicifolia*) and numerous varieties of rhododendrons are endemic to this region.
- **Northeast India**:
  - The northeastern states, including Arunachal Pradesh, Nagaland, and Meghalaya, have a unique floral diversity due to their varied topography and climatic conditions.
  - Endemic species include several gymnosperms and orchids, such as **Dendrobium**, and many medicinal plants that are integral to local cultures.
- **Andaman and Nicobar Islands**:
  - These islands harbor a wealth of endemic species due to their isolation from the mainland.
  - Examples include various species of **Calophyllum** and native palms like **Nipa fruticans**.
- **Thar Desert**:
  - The arid conditions of the Thar Desert also support a unique set of flora, including drought-resistant plants.
  - Some of these endemic species include certain types of **calligonum** and other xerophytes adapted to survive in harsh condition.

7. Correct Option: (a) Namdapha National Park

Step 01: understanding statement 01

Namdapha National Park and Its Geographical Features

- **Location and Introduction:**
  - **Location:** Changlang district, Arunachal Pradesh, India.
  - **Latitude & Longitude:** 27°23' to 27°39' N and 96°15' to 96°58' E.
  - **Established:** Initially declared a wildlife sanctuary in 1972, it became a **National Park** and **Tiger Reserve** in 1983.
  - **Area:** Approximately **1,985 sq. km** (the **third-largest** national park in India).
  - **Protected Status:** Part of **Project Tiger (since 1983)** and included in the **UNESCO Biosphere Reserve Network**.
- **Geographical Features:**
  - **Topography:**
    - Characterized by **rugged mountains**, **deep valleys**, **dense forests**, and **rivers**.
    - **Altitude Range:** 200 meters to 4,571 meters (highest point: **Dapha Bum** peak).
    - **Varied Landscapes:** Low-lying plains, tropical rainforests, and alpine meadows.
  - **River System:**
    - The **Noa-Dihing River** flows through the park, a tributary of the Brahmaputra River.
    - Other rivers: Dibang, Tirap, and Namdapha.
  - **Climate:**
    - **Climate Zones:** From **tropical** in the lowlands to **alpine** in the high altitudes.
    - **Annual Rainfall:** 2,000 mm – 4,000 mm (heavy monsoonal rainfall).
    - **Temperature Range:** 5°C (winters) to 37°C (summers).
  - **Soil Types:**
    - **Alluvial Soil** (near river plains), **Laterite Soil** (lower hills), and **Podzolic Soil** (higher altitudes).
    - Fertile soils support rich vegetation.
- **Biodiversity:**
  - **Flora:**
    - **Forest Types:** Tropical, subtropical, temperate, and alpine.
    - Major species: Orchids, bamboo, pine, and rhododendron.
  - **Fauna:**
    - **Big Cat Species:** Bengal Tiger, Leopard, Snow Leopard, and Clouded

Leopard (**only park in India with all four**).

- Other Key Species: Red Panda, Hoolock Gibbon, Asiatic Black Bear, Musk Deer.
- **Birds:** Hornbills, White-winged Duck (endangered), Himalayan Vulture.

Key Facts:

- **Only National Park in India** with four big cat species.
- **Rare Species:** Red Panda, Arunachal Macaque.
- Part of the **Indo-Myanmar Biodiversity Hotspot**.
- **Significance:** One of the most biologically diverse areas in India, known as a **biodiversity hotspot**.

Step 02: understanding statement 02

Govind Pashu Vihar National Park and Wildlife Sanctuary

- **Location and Introduction:**
  - **Location:** Uttarkashi district, **Uttarakhand**, India.
  - **Latitude & Longitude:** 31°00′ N to 31°25′ N and 78°30′ E to 79°00′ E.
  - **Established:** Declared a **Wildlife Sanctuary** in 1955 and upgraded to a **National Park** in 1990.
  - **Area:** Approximately **958 sq. km**.
  - **Protected Status:** Part of **Govind Wildlife Sanctuary** and included under the **Project Snow Leopard**.
- Geographical Features:
  - **Topography:**
    - Rugged **Himalayan terrain** with steep slopes, deep valleys, and snow-capped peaks.
    - **Altitude Range:** 1,400 meters to **6,323 meters** (highest point: **Swargarohini Peak**).
    - **Diverse Landscapes:** Includes **glaciers**, **alpine meadows**, and **dense forests**.
  - **River System:**
    - The **Tons River** (a major tributary of the Yamuna River) flows through the park.
    - Origin of rivers like **Rupin** and **Supin**.
  - **Climate:**
    - **Summer:** Mild (15°C to 25°C).
    - **Winter:** Severe cold, with temperatures dropping to **-10°C** or lower.
    - **Annual Rainfall:** 1,500 mm – 2,000 mm (mostly during monsoon).
  - **Soil Types:**
    - **Alluvial Soil** (river valleys).
    - **Glacial Soil** (higher altitudes).
- **Biodiversity:**
  - **Flora:**
    - **Forest Types:** Alpine, sub-alpine, and temperate forests.
    - Major vegetation includes **oak**, **deodar**, **pine**, and **rhododendron**.
    - **Medicinal Plants:** The park is home to rare herbs like **yarsagumba** (caterpillar fungus).
  - **Fauna:**
    - **Flagship Species: Snow Leopard** (under Project Snow Leopard).
    - Other mammals: Himalayan Black Bear, Musk Deer, Bharal (Blue Sheep), Indian Porcupine.
    - **Bird Species:** Monal Pheasant (Uttarakhand's state bird), Western Tragopan, and Himalayan Snowcock.

Step 03: understanding statement 03

jim Corbett National Park

- **Location and Introduction:**
  - **Location:** Nainital and Pauri Garhwal districts, **Uttarakhand**, India.
  - **Latitude & Longitude:** 29°25′ N to 29°40′ N and 78°45′ E to 79°10′ E.
  - **Established: 1936** (originally named **Hailey National Park**—the **first national park** in India).
  - **Renamed:** In **1957**, it was renamed **Jim Corbett National Park** in honor of **Jim Corbett**, a conservationist and hunter who played a key role in its establishment.
  - **Area: 1,318 sq. km** (including the core area of 520 sq. km and a buffer zone).
  - **Protected Status:** First park under **Project Tiger** (launched in **1973**).

- **Geographical Features:**
  - **Topography:**
    - Diverse terrain comprising **hills**, **grasslands (chaur)**, **river belts**, and **dense Sal forests**.
    - **Altitude Range:** 385 meters to **1,100 meters** above sea level.
  - **River System:**
    - Key rivers: **Ramganga River** (main river), **Kosi River**, and several small streams.
    - Supports **wetlands** and **seasonal lakes**, vital for biodiversity.
  - **Climate:**
    - **Summer:** 30°C to 40°C (March to June).
    - **Winter:** 5°C to 25°C (November to February).
    - **Annual Rainfall:** 1,400 mm – 2,800 mm (mostly during monsoon from July to September).
  - **Soil Types:**
    - **Alluvial Soil** (near river plains—fertile and supports dense vegetation).
    - **Sandy and Clayey Soils** (along the riverbanks).
- **Biodiversity:**
  - **Flora:**
    - **Forest Types:** Moist deciduous forests dominate the park.
    - Major species: **Sal**, **Khair**, **Sheesham**, **Ber**, and **Bamboo**.
    - **Grasslands:** "Chaurs" are open grassy meadows that serve as crucial grazing grounds.
  - **Fauna:**
    - **Flagship Species: Royal Bengal Tiger** (key focus of **Project Tiger**).
    - **Other Mammals: Leopard**, **Elephant**, **Wild Boar**, **Sloth Bear**, **Otter**, and **Jackal**.
    - **Avifauna (Birds):** Over **650 species** including **Crested Serpent Eagle**, **Great Hornbill**, and **Kingfisher**.
    - **Aquatic Life: Mahseer Fish** and **Gharial (Indian Crocodile)** in the river systems.

Key Facts:

- **First** and **Oldest** national park in India.
- Divided into **6 zones** for tourism:
  - **Dhikala Zone** (famous for wildlife sightings).
  - **Bijrani Zone** (dense forests and open grasslands).
  - **Jhirna Zone** (open year-round).
  - **Dhela Zone** (rich biodiversity, open year-round).
  - **Durga Devi Zone** (bird watching).
  - **Pawalgarh Conservation Reserve** (newest eco-tourism site).

Step 04: understanding statement 04

Nanda Devi National Park

- **Location and Introduction:**
  - **Location:** Chamoli district, **Uttarakhand**, India.
  - **Latitude & Longitude:** 30°24′ N to 30°41′ N and 79°40′ E to 80°05′ E.
  - **Established:** Declared a **National Park** in **1982**.
  - **UNESCO Status:** Designated as a **UNESCO World Heritage Site** in **1988** as part of the **Nanda Devi and Valley of Flowers National Parks**.
  - **Area: 624.6 sq. km** (Core Zone).
  - **Protected Status:** Part of the **Nanda Devi Biosphere Reserve**, covering **5,148 sq. km**, and included under **Project Snow Leopard**.
- **Geographical Features:**
  - **Topography:**
    - Located in the **Garhwal Himalayas**, the park is characterized by **rugged mountains**, **deep valleys**, and **glacial basins**.
    - **Altitude Range:** 2,400 meters to **7,817 meters** (highest point: **Nanda Devi Peak**—the **second-highest mountain** in India).
    - The park is surrounded by **steep ridges** and **snow-clad peaks**, forming a **natural fortress**.
  - **River System:**
    - The **Rishi Ganga River** flows through the park, originating from **Nanda Devi Glacier**.
    - The **Dhauliganga River** is also a key watercourse in the region.

- **Climate:**
  - **Summer:** Cool, with temperatures ranging from **12°C to 20°C** (May to October).
  - **Winter:** Extremely cold, with temperatures dropping to **-20°C** (November to April).
  - **Annual Precipitation:** Approximately **1,500 mm**, mostly from **monsoon rains** and **snowfall**.
- **Soil Types:**
  - **Glacial Soil** (in the higher altitudes).
  - **Silty and Loamy Soil** (along river valleys).

- **Biodiversity:**
  - **Flora:**
    - **Forest Types:** Alpine and sub-alpine vegetation.
    - Dominant species include **birch**, **juniper**, **rhododendron**, and **Brahma Kamal** (state flower of Uttarakhand).
    - Home to many **medicinal plants** like **Aconitum** and **Picrorhiza kurroa**.
  - **Fauna:**
    - **Flagship Species: Snow Leopard** (endangered and a focus of conservation efforts).
    - Other Mammals:
      - ◊ Himalayan Musk Deer (endangered).
      - ◊ Bharal (Blue Sheep).
      - ◊ Asiatic Black Bear.
      - ◊ Himalayan Tahr.
    - **Avifauna (Birds):** Includes species like the **Golden Eagle**, **Himalayan Monal** (state bird of Uttarakhand), and **Snow Partridge**.

Key Facts:

- **Restricted Access:** Due to **ecological sensitivity**, the **core zone** of Nanda Devi National Park is **off-limits** to general tourists since **1983**.
- **Dual Heritage Status:** It is part of a combined **UNESCO World Heritage Site** along with the **Valley of Flowers National Park**.
- **Biosphere Reserve:** Recognized as part of the **UNESCO Man and the Biosphere (MAB) Programme** in **2004**.
- **Mythological Significance:** Named after **Goddess Nanda Devi**, revered in **Hindu mythology**.

8. Correct Option: (b)

Correct Pairing:

- **Sultanpur National Park – Haryana**
- **Wadhvana Wetland – Gujarat**
- **Bhindawas Wildlife Sanctuary – Haryana**
- **Thol Lake Wildlife Sanctuary – Gujarat**

Step 01: understanding statement 01

- **Sultanpur National Park – Haryana**
  - **Location:** Gurgaon district, Haryana (about 50 km from Delhi).
  - **Established:** Declared a **Bird Sanctuary** in **1972**, upgraded to a **National Park** in **1991**.
  - **Significance:** Designated as a **Ramsar Wetland Site** in **2021**.
  - **Biodiversity:**
    - Over **250 bird species**—including **Siberian Cranes**, **Greater Flamingos**, and **Painted Storks**.
    - Key habitat for **migratory** and **resident** birds.
  - **Ecological Importance:** Provides a crucial habitat for **winter migratory birds** from Europe, Central Asia, and Siberia.
- **Wadhvana Wetland – Gujarat**
  - **Location:** Vadodara district, Gujarat.
  - **Declared:** Recognized as a **Ramsar Site** in **2021**.
  - **Biodiversity:**
    - Home to **80+ species** of migratory birds, including **Common Pochard**, **Ferruginous Duck**, and **Greylag Goose**.
    - Supports **aquatic vegetation** and **fish species**.
  - **Ecological Importance:** Acts as an **irrigation reservoir** and supports local biodiversity and **agriculture**.

- **Bhindawas Wildlife Sanctuary – Haryana**
  - **Location:** Jhajjar district, Haryana (approximately **15 km** from **Sultanpur**).
  - **Established:** Declared a **Wildlife Sanctuary** in **2009**, **Ramsar Site** in **2021**.
  - **Biodiversity:**
    - Habitat for **320+ bird species**, including **Black-necked Storks**, **Indian Courser**, and **Bar-headed Geese**.
    - Supports **mammals** like **jackals** and **nilgai** (blue bull).
  - **Ecological Importance:** Functions as a **man-made wetland** that aids **groundwater recharge** and **biodiversity conservation**.
- **Thol Lake Wildlife Sanctuary – Gujarat**
  - **Location:** Mehsana district, Gujarat (near Ahmedabad).
  - **Established:** Declared a **Wildlife Sanctuary** in **1988**, **Ramsar Site** in **2021**.
  - **Biodiversity:**
    - Supports **150+ bird species**, including **Sarus Cranes**, **Dalmatian Pelicans**, and **Greater Flamingos**.
    - Rich **aquatic life** and **wetland vegetation**.
  - **Ecological Importance:** A **freshwater reservoir** supporting **migratory waterfowl** during the **winter season**.

Step 02: understanding statement 02

Ramsar Convention and India

- **Introduction to the Ramsar Convention**
  - **What is it?**
    - An **international treaty** for the **conservation** and **sustainable use** of **wetlands**.
  - **Adopted: 2 February 1971** in **Ramsar, Iran** (celebrated annually as **World Wetlands Day**).
  - **Came into Force: 1975**.
  - **Objective:**
    - **Conserve wetlands** of international importance.
    - Promote **wise use** and **sustainable management** of wetlands.
    - Foster **international cooperation** in wetland conservation.
  - **Importance of Wetlands:**
    - Vital for **biodiversity**, **climate regulation**, **water purification**, and **livelihoods**.
- **In India and the Ramsar Convention**
  - **Signatory:** India joined on **1 February 1982**.
  - **Number of Ramsar Sites (as of 2024): 80 wetlands** (covering approx. **1.33 million hectares**).
  - **First Designated Sites (1981): Keoladeo National Park** (Rajasthan) and **Chilika Lake** (Odisha).
  - **Most Recent Additions (2022):** 11 new sites, including **Tampara Lake** (Odisha) and **Sakhya Sagar** (Madhya Pradesh).
- **Key Ramsar Sites in India:**
  - **Largest Ramsar Site: Sundarbans Wetland** (West Bengal).
  - **Smallest Ramsar Site: Renuka Wetland** (Himachal Pradesh).
  - **High-Altitude Wetlands: Tso Kar** (Ladakh) and **Pangong Tso** (Ladakh).
  - **Notable Wetlands:**
    - **Loktak Lake** (Manipur) – famous for **phumdis** (floating vegetation).
    - **Wular Lake** (Jammu & Kashmir) – **largest freshwater lake** in India.
    - **Ashtamudi Lake** (Kerala) – **backwater** ecosystem.
    - **Sambhar Lake** (Rajasthan) – **largest inland saltwater lake**.
- **India's Wetland Conservation Initiatives:**
  - **National Plan for Conservation of Aquatic Ecosystems (NPCA):**
    - Merges **National Wetland Conservation Program (NWCP)** and **National Lake Conservation Plan (NLCP)**.
  - **Wetlands (Conservation and Management) Rules, 2017:**
    - Provides a **legal framework** for **wetland protection**.

- **Mission Amrit Sarovar (2022):**
  - Aims to **rejuvenate** 75 wetlands for **Azadi Ka Amrit Mahotsav**.

9. Correct Option: (d)

Step 01: understanding statement 01

- **Nilgiri Biosphere Reserve (NBR)**
  - **Introduction:**
    - **Established: 1986** (First **Biosphere Reserve** in India).
    - **UNESCO Status:** Recognized under the **Man and Biosphere (MAB) Programme** in **2000**.
    - **Location:** Spans across **Tamil Nadu**, **Kerala**, and **Karnataka** in the **Western Ghats**.
    - **Area: 5,520 sq. km** (Core zone: **1,240 sq. km**, Buffer zone: **4,280 sq. km**).
    - **Elevation Range:** From **80 m** to **2,637 m** (Doddabetta Peak – highest point)
- **Geographical Features:**
  - **Topography:**
    - A combination of **mountains**, **valleys**, **grasslands**, and **sholas (tropical montane forests)**.
    - Contains **river basins** of **Bhavani**, **Moyar**, and **Kabini**.
  - **Climate:**
    - **Tropical** and **subtropical** climate.
    - **Annual Rainfall:** 500 mm – 7,000 mm (varies with altitude).
    - Temperature ranges from **0°C** (high altitudes) to **35°C** (lowlands).
  - **Soil Types:**
    - **Lateritic soil** (lowland regions).
    - **Black soil** (plains).
    - **Red loamy soil** (forest areas)
- **Biodiversity:**
  - **Flora:**
    - **Forest Types:**
      - ◊ **Moist Deciduous Forests**
      - ◊ **Dry Deciduous Forests**
      - ◊ **Evergreen Forests**
      - ◊ **Montane Grasslands and Shola Forests**
    - **Key Species:**
      - ◊ **Teak**, **Rosewood**, **Sandalwood**.
      - ◊ Medicinal plants like **Gloriosa superba** and **Aconitum heterophyllum**.
  - **Fauna:**
    - **Mammals:**
    - **Asian Elephant**, **Bengal Tiger**, **Indian Leopard**, **Lion-tailed Macaque** (endemic).
    - **Nilgiri Tahr** (endemic and endangered).
  - **Birds:** Over **300 species**—including **Great Indian Hornbill** and **Malabar Pied Hornbill**.
  - **Reptiles and Amphibians:**
    - **King Cobra**, **Indian Rock Python**, **Nilgiri Frog** (endemic).
- **Protected Areas within NBR:**
  - **Mudumalai Tiger Reserve** (Tamil Nadu).
  - **Sathyamangalam Tiger Reserve** (Tamil Nadu).
  - **Bandipur National Park** (Karnataka).
  - **Nagarhole National Park** (Karnataka).
  - **Silent Valley National Park** (Kerala).
  - **Wayanad Wildlife Sanctuary** (Kerala).
- **Ecological & Socio-Cultural Importance:**
  - **Conservation Hotspot:** Part of the **Western Ghats**, a **UNESCO World Heritage Site**.
  - **Tribal Communities:** Home to **Toda**, **Kurumba**, and **Irula** tribes.
  - **Sustainable Development:** Promotes **eco-tourism** and **traditional knowledge preservation**.
- **Challenges & Conservation Efforts:**
  - **Threats:**
    - **Deforestation**, **Poaching**, and **Encroachment**.
    - **Human-Wildlife Conflict** (especially with elephants and leopards).

- **Conservation Programs:**
  - **Project Tiger** (Bandipur & Mudumalai Reserves).
  - **Project Elephant** (corridor protection).
  - **Community Participation** through **Joint Forest Management (JFM)**.

10. Correct Option: (b) Statement 3 is incorrect

Roaring Capability: Unlike some other big cats, snow leopards cannot roar. They are capable of making a variety of other sounds, including mewing, growling, yowling, and prusten (a unique chuffi ng sound)

Step 01: understanding statement 01

The Snow Leopard Population Assessment in India (SPAI), conducted from 2019 to 2023, represents the first comprehensive scientific survey of snow leopards across the Indian Himalayas. This extensive study estimated a total population of 718 snow leopards in India.

Regional Distribution:

- **Ladakh:** 477 individuals
- **Uttarakhand:** 124 individuals
- **Himachal Pradesh:** 51 individuals
- **Arunachal Pradesh:** 36 individuals
- **Sikkim:** 21 individuals
- **Jammu and Kashmir:** 9 individuals

The SPAI systematically covered over 70% of the potential snow leopard habitat across the trans-Himalayan region, including the Union Territories of Ladakh and Jammu and Kashmir, and states such as Himachal Pradesh, Uttarakhand, Sikkim, and Arunachal Pradesh.

The Wildlife Institute of India (WII) served as the National Coordinator for the SPAI, with support from snow leopard range states and conservation partners, including the Nature Conservation Foundation (NCF), Mysuru, and World Wildlife Fund (WWF)-India.

This assessment provides a crucial baseline for future conservation efforts, enabling targeted strategies to protect and preserve snow leopards and their habitats in India.

11. Correct Option: (c)

Thermal pollution significantly impacts the biogeochemical cycling of nutrients in freshwater ecosystems primarily by accelerating microbial decomposition. ***Thermal power plants*** *generate electricity by* ***burning fossil fuels*** *(coal, oil, natural gas) or through* ***nuclear reactions****. While they are a major source of energy, they also contribute significantly to* ***environmental pollution****.* ***Thermal pollution*** *occurs when industries (especially* ***thermal power plants****) discharge* ***heated water*** *into natural water bodies, raising their temperature. This temperature increase significantly* ***disrupts*** *the* ***biogeochemical cycling*** *of nutrients in freshwater ecosystems.*

Step 01: understanding statement 01

- **Environmental Regulations in India**
  - **Environment (Protection) Act, 1986** – Provides the framework for pollution control.
  - **Fly Ash Notification (1999, amended 2021)** – Mandates **100% fly ash utilization**.
  - **National Clean Air Programme (NCAP)** – Targets a **40% reduction** in **PM2.5 and PM10** by **2026**.
  - **Thermal Power Plant Emission Norms (2015)** – Sets limits for **SO2**, **NOx**, and **PM** emissions.
- **Effects of Thermal Pollution on Major Biogeochemical Cycles**
- **Nitrogen Cycle:** Thermal pollution alters **nitrification**, **denitrification**, and **ammonification** processes.
  - **Increased Temperature:** Accelerates the **decomposition** of organic matter, increasing **ammonia** (NH3) levels.
  - **Reduced Oxygen: Warm water** holds **less dissolved oxygen (DO)**, slowing **nitrification** (conversion of ammonia to nitrate).
  - **Eutrophication Risk:** Elevated nitrogen levels promote **algal blooms**, which deplete oxygen during decomposition.
- **Impact:**
  - Disruption of **ammonia** and **nitrate** balance.
  - Increased **toxicity** for aquatic organisms (ammonia poisoning).
  - **Dead zones** due to **hypoxia** (low oxygen levels).
- **Phosphorus Cycle:** Phosphorus is a **limiting nutrient** in freshwater ecosystems and is highly sensitive to thermal changes.

- **Increased Temperature:** Accelerates **organic matter decomposition**, releasing more **inorganic phosphorus**.
- **Sediment Release:** Thermal pollution disturbs sediments, releasing **phosphates** bound in the sediment.

- **Impact:**
  - **Eutrophication** due to excess **phosphates**.
  - Shift in **aquatic species composition**—favoring **algae** over **macrophytes**.
  - **Loss of biodiversity** as sensitive species decline.
- **Carbon Cycle:** Thermal pollution affects the **carbon balance** through its influence on **respiration** and **photosynthesis**.
  - **Enhanced Microbial Activity:** Warmer water increases **decomposition**, releasing **CO2** and **methane (CH4)**.
  - **Reduced Photosynthesis:** Excess heat and **low oxygen** reduce the photosynthetic efficiency of **aquatic plants**.
- **Impact:**
  - **Increased greenhouse gases** (CO2, CH4) in the aquatic environment.
  - Acidification of water due to higher **CO2** levels.
  - Disruption of **carbon sequestration** by aquatic vegetation.
- **Oxygen Cycle:** Thermal pollution directly impacts the **solubility** and **availability** of **dissolved oxygen (DO)**.
  - **Reduced DO Levels:** Warm water holds **less oxygen**, impairing critical biochemical processes.
  - **Increased Biological Oxygen Demand (BOD):** Faster decomposition consumes more oxygen.
- **Impact:**
  - **Hypoxia** or **anoxia** (oxygen depletion), leading to fish kills.
  - Altered **respiration rates** of aquatic organisms.
  - **Loss of keystone species**, disturbing ecosystem balance.

Long-Term Consequences of Thermal Pollution on Nutrient Cycling

- **Trophic Imbalance:** Excess nutrients disrupt food chains, increasing **primary productivity** and reducing biodiversity.
- **Altered Microbial Communities:** Temperature changes favor **thermophilic microbes**, disrupting natural **decomposer populations**.
- **Bioaccumulation and Toxicity:** Increased nutrient cycling releases **heavy metals** and **toxins** from sediments.
- **Permanent Ecosystem Shifts: Species migration** and **local extinctions** can cause irreversible changes in nutrient flow.

12. Correct Option: (c)

*Air pollution control devices are essential to reduce the emission of harmful pollutants (like **particulate matter (PM)**, **sulfur oxides (SO2)**, **nitrogen oxides (NOx)**, and **volatile organic compounds (VOCs)**) from industrial and vehicular sources. These instruments work through **filtration**, **chemical reactions**, **absorption**, and **electrostatic processes**.*

Step 01: understanding statement 01

- **Particulate Matter (PM) Control Devices**

Instrument	*Working Principle*	*Pollutants Controlled*
Electrostatic Precipitator (ESP)	Uses electrostatic charge to capture fine particles on collector plates.	PM2.5, PM10, smoke, and ash.
Baghouse Filters	Fabric filters trap particulate matter as gas flows through them.	PM, fly ash, and dust.
Cyclone Separator	Centrifugal force separates larger particulates from the air stream.	Coarse PM, dust, and solid particles.
Wet Scrubber	Uses a liquid spray to capture and neutralize pollutants.	PM, acid mists, and toxic gases.

Step 02: understanding statement 02

- **Gaseous Pollutant Control Devices**

Instrument	Working Principle	Pollutants Controlled
Flue Gas Desulfurization (FGD)	Chemical absorption **(lime/limestone slurry) to remove sulfur.**	Sulfur dioxide (SO2) **and acid gases.**
Selective Catalytic Reduction (SCR)	**Uses a** catalyst **(ammonia/urea) to convert NOx into nitrogen and water.**	Nitrogen oxides (NO2)**.**
Activated Carbon Adsorber	Adsorbs **gaseous pollutants onto porous carbon surfaces.**	VOCs**,** dioxins**, and heavy metals.**
Thermal Oxidizer	**Uses** high temperatures **to break down harmful gases.**	VOCs**,** hydrocarbons**, and organic gases.**

Step 03: understanding statement 03

- **Monitoring and Measurement Instruments**

Instrument	Function	Pollutants Monitored
Continuous Emission Monitoring System (CEMS)	**Real-time monitoring of emissions from industrial sources.**	SO2**,** NOx**,** CO2**,** PM**.**
Air Quality Monitoring Station (AQMS)	**Measures ambient air quality over a region.**	PM2.5**,** PM10**,** O2**,** SO2**,** NO2**.**
Opacity Monitor	**Measures** smoke density **from stacks.**	Particulate matter**.**
Gas Analyzers	**Detect specific gaseous pollutants.**	CO2**,** SO2**,** NOx**,** VOCs**.**

Step 04: understanding statement 04

- **Hybrid Technologies for Air Pollution Control**
  - **Dry Scrubber + ESP Combination:** Removes both **gaseous** and **particulate** pollutants.
  - **Bag Filter + SCR:** Captures PM and reduces **NOx** emissions in thermal power plants.
  - **Biofilters:** Use **microorganisms** to degrade **organic pollutants** (e.g., VOCs).
- **Global and Indian Standards for Air Pollution Control**
  - **Environment (Protection) Act, 1986** – Framework for pollution control.
  - **National Ambient Air Quality Standards (NAAQS)** – Sets permissible pollutant limits.
  - **Air (Prevention and Control of Pollution) Act, 1981** – Regulates air pollution in India.

13. Correct Option: (a) all statements are corrects

*Plastic waste refers to **discarded plastic materials** that are non-biodegradable and pose severe environmental hazards. With global plastic production exceeding **400 million tonnes annually**, plastic pollution has become a significant threat to ecosystems, human health, and biodiversity. Waste has become a major environmental issue due to its widespread use and non-biodegradable nature. Plastic does not decompose easily, and exposure to plastic waste has several harmful impacts on the environment.*

Step 01: understanding statement 01

Key Policies and Regulations on Plastic Waste in India

- **Plastic Waste Management (PWM) Rules, 2016 (Amended in 2018, 2022)**
  - **Objective:** Ensure the **systematic collection, segregation, recycling**, and **safe disposal** of plastic waste.
  - **Key Provisions:**
    - **Extended Producer Responsibility (EPR):** Producers, importers, and brand owners are responsible for collecting and managing plastic waste.
    - **Ban on Specific Single-Use Plastics (SUP):** Items like plastic cutlery, carry bags (<120 microns), and straws are prohibited.
    - **Phasing Out Multi-Layered Packaging:** Gradual reduction of non-recyclable plastic packaging.

- **Waste Collection System:** Municipal bodies must implement **door-to-door collection**, **segregation**, and **processing**.

- **Extended Producer Responsibility (EPR) Framework (2022)**
  - **Objective:** Hold manufacturers accountable for post-consumer plastic waste management.
  - **Key Provisions:**
    - **Plastic Categories:**
      - ◊ Rigid plastics (e.g., bottles)
      - ◊ Flexible plastics (e.g., pouches)
      - ◊ Multi-layered plastics (MLP)
    - **EPR Targets:** Producers must recycle a defined percentage of plastic annually.
    - **Plastic Credit System:** Companies that exceed targets can earn **credits** for plastic recycling.
    - **Monitoring Mechanism:** Central Pollution Control Board (CPCB) tracks compliance through a digital **EPR portal**.

- **Single-Use Plastic (SUP) Ban (2022)**
  - **Objective:** Eliminate plastic items with **low utility** and **high littering potential**.
  - **Key Provisions:**
    - **Prohibited Items:** Plastic straws, plates, cutlery, stirrers, and polystyrene packaging.
    - **Manufacturing & Import Ban:** Complete prohibition on the production and sale of specified SUP items.
    - **Penalties:** Non-compliance attracts fines under the **Environment Protection Act, 1986**.

- **Swachh Bharat Mission (Urban) 2.0 (2021-2026)**
  - **Objective:** Establish a **garbage-free** India with a focus on **plastic waste reduction**.
  - **Key Provisions:**
    - **Plastic-Free Cities:** Promote urban centers free from plastic waste.
    - **Material Recovery Facilities (MRFs):** Set up infrastructure for **plastic sorting** and **recycling**.
    - **Citizen Engagement:** Encourage public participation through awareness campaigns.

- **Environment Protection Act, 1986**
  - **Objective:** Empower the central government to regulate **hazardous waste**, including plastics.
  - **Key Provisions:**
    - Legal framework for imposing **penalties** on plastic waste violators.
    - **Polluter Pays Principle (PPP):** Liability for environmental damage caused by plastic pollution.

Step 02: understanding statement 02

- **International Commitments and Conventions**
  - **Basel Convention (1989, Amended 2019):** Regulates **transboundary movement** of plastic waste.
  - **UN Environment Assembly (UNEA):** India supports the **Global Plastic Treaty** to eliminate plastic pollution by **2040**.
  - **Ocean Plastic Charter (2018):** Commitment to reduce plastic leakage into marine ecosystems.

14. Correct Option: (c)

Only Pair 1 is correctly matched: Gravitational settling is used to control air pollution. It is used to remove large diameter suspended particles from a gas by using gravitational force.

Step 01: understanding pair 01

Gravitational Settling in Air Pollution Control

Gravitational settling is a simple and cost-effective method used to control air pollution by removing large, heavy particulate matter from industrial emissions. It relies on the natural force of gravity to separate particles from the air stream. This process typically occurs in settling chambers or gravity separators where the velocity of the polluted air is reduced, allowing suspended particles to settle at the bottom.

Step 02: understanding pair 02

Phytoremediation – Controlling Soil and Water Pollution

Phytoremediation is an eco-friendly and cost-effective technique that uses plants to remove, degrade, or stabilize pollutants from contaminated soil, water, and air. It

leverages the natural processes of specific plants (called hyperaccumulators) to absorb, break down, or contain harmful substances like heavy metals, pesticides, hydrocarbons, and other toxins.

Types of Phytoremediation Techniques:

- **Phytoextraction (Phytoaccumulation):**
  - **Process:** Plants absorb contaminants (especially heavy metals) from soil or water through their roots and store them in their stems and leaves.
  - **Example Plants:** Sunflower (Helianthus annuus), Indian mustard (Brassica juncea).
  - **Application:** Removing lead, arsenic, and cadmium from contaminated industrial sites.
- **Phytostabilization:**
  - **Process:** Plants limit the mobility of pollutants by immobilizing them in the soil, reducing the risk of leaching into groundwater.
  - **Example Plants:** Vetiver grass (Chrysopogon zizanioides), Willow (Salix spp.).
  - **Application:** Stabilizing mine tailings and heavy metal-contaminated lands.
- **Phytodegradation (Phytotransformation):**
  - **Process:** Plants and associated microbes break down organic pollutants into less toxic or non-toxic substances.
  - **Example Plants:** Poplar trees (Populus spp.), Alfalfa (Medicago sativa).
  - **Application:** Degrading petroleum hydrocarbons and pesticides.
- **Rhizofiltration:**
  - **Process:** Plant roots absorb, filter, and precipitate contaminants from water or wastewater.
  - **Example Plants:** Sunflowers, Water hyacinth (Eichhornia crassipes).
  - **Application:** Cleaning heavy metals like lead and uranium from industrial effluents.
- **Phytovolatilization:**
  - **Process:** Plants absorb pollutants, convert them into volatile forms, and release them into the atmosphere.
  - **Example Plants:** Poplars, Mustard plants.
  - **Application:** Removing volatile organic compounds (VOCs) and mercury.

Step 03: understanding pair 03

Electrostatic Precipitators (ESPs) – Used to Control Air Pollution

Electrostatic precipitators (ESPs) are highly efficient devices used to remove fine particulate matter (PM), such as dust, smoke, and soot, from industrial exhaust gases. They operate by using electrostatic forces to charge and collect airborne particles, thereby reducing air pollution.

15. Correct Option: (c)

Only Statement 2 is incorrect: Classical Smog/ Sulphurous Smog/London Smog is also called 'reducing smog'.

Smog *is a type of severe air pollution that results from the combination of* ***smoke***, ***fog***, *and other pollutants. It reduces visibility and can cause significant health and environmental problems. The term* ***"smog"*** *originated from the words* ***"smoke"*** *and* ***"fog"*** *and was first used to describe the air pollution in industrial cities.* **The term smog was first used in 1905 by Dr. H A Des Voeux to describe the conditions of fog that had soot or smoke in it.**

Step 01: understanding statement 01

- **Types of Smog:**
  - **Classical (London-Type) Smog:**
    - **Composition:** Mixture of **smoke**, **sulfur dioxide (SO2)**, and **fog**.
    - **Formation:** Occurs in **cold, damp climates** during winter due to the burning of **coal** or **fossil fuels**.
    - **Characteristics:**
      - ◊ Grayish in color.
      - ◊ High concentration of **sulfur compounds**.
    - **Example:** The **1952 Great London Smog** caused thousands of deaths.
  - **Photochemical (Los Angeles-Type) Smog:**
    - **Composition:** Formed by the reaction of **sunlight** with pollutants like **nitrogen oxides (NOx)** and **volatile organic compounds (VOCs)**.
    - **Formation:** Occurs in **warm, sunny climates** due to increased vehicle emissions.

- **Characteristics:**
  - ◊ Brownish or yellowish in color.
  - ◊ Contains **ozone (O3)**, **peroxyacetyl nitrate (PAN)**, and **aldehydes**.
- **Example:** Common in major cities like **Los Angeles**, **Delhi**, and **Beijing** during summer.

16. Correct Option: (a)

Statement 3 is incorrect: The shift and increase in agricultural land is a major cause of deforestation only in two regions e.g. Africa and South-East Asia and up to a certain extent in South America.

Loss of tree cover *refers to the reduction or disappearance of forests and vegetation due to human and natural causes. It impacts biodiversity, climate regulation, and local ecosystems. This phenomenon is occurring* ***globally*** *but is particularly severe in tropical regions and areas with rapid urbanization.*

Step 01: understanding statement 01

Where is Tree Cover Being Lost?

- **Amazon Rainforest (South America):**
  - **Countries Affected:** Brazil, Peru, Colombia, Bolivia.
  - **Reason:**
    - **Deforestation for agriculture** (soybean cultivation, cattle ranching).
    - **Illegal logging** and mining activities.
    - Infrastructure development (roads and dams).
- **Southeast Asia:**
  - **Countries Affected:** Indonesia, Malaysia, Myanmar, Thailand.
  - **Reason:**
    - **Palm oil plantations** and rubber cultivation.
    - Logging for timber exports.
    - Urban expansion and infrastructure projects.
- **Central Africa:**
  - **Countries Affected:** Democratic Republic of Congo, Cameroon, Gabon.
  - **Reason:**
    - **Logging and mining** operations.
    - Agricultural expansion (slash-and-burn practices).
    - Political instability leading to **unregulated deforestation**.
- **India:**
  - **Regions Affected:** Western Ghats, Northeast India, Central India.
  - **Reason:**
    - **Infrastructure projects** (dams, roads, mining).
    - **Shifting agriculture** and urban expansion.
    - Forest fires and illegal logging.
- **Australia:**
  - **Regions Affected:** Eastern Australia, Tasmania.
  - **Reason:**
    - **Land clearance** for agriculture and livestock.
    - **Bushfires** and climate change impacts.
- **Russia and Canada (Boreal Forests):**
  - **Reason:**
    - **Industrial logging** and mining.
    - Climate-driven **wildfires**.

Step 02: understanding statement 02

Major Locations of Tree Cover Loss in India:

- **Northeastern Region:**
  - **States Affected:** Assam, Arunachal Pradesh, Manipur, Meghalaya, Mizoram, Nagaland, Tripura.
  - **Reasons:**
    - **Shifting cultivation (Jhum farming)** – traditional slash-and-burn agriculture.
    - **Infrastructure development** – roads, hydropower projects.
    - **Illegal logging** and encroachment.
  - **Impact:** Loss of biodiversity (e.g., endangered species like the Hoolock Gibbon).
- **Western Ghats:**
  - **States Affected:** Kerala, Karnataka, Tamil Nadu, Goa, Maharashtra.

- **Reasons:**
  - **Plantation agriculture** – tea, coffee, and rubber.
  - **Mining activities** – iron ore and bauxite extraction.
  - **Urbanization** – tourism and road construction.
- **Impact:** Habitat loss for endemic species (e.g., Lion-tailed Macaque).

- **Central India:**
  - **States Affected:** Madhya Pradesh, Chhattisgarh, Jharkhand, Odisha.
  - **Reasons:**
    - **Mining and industrialization** – coal, bauxite, and mineral extraction.
    - **Infrastructure projects** – dams (e.g., Sardar Sarovar Dam).
    - **Agricultural expansion** – forest conversion for crops.
  - **Impact:** Depletion of dense forests and displacement of indigenous communities.

- **Himalayan Region:**
  - **States Affected:** Uttarakhand, Himachal Pradesh, Jammu & Kashmir, Ladakh.
  - **Reasons:**
    - **Infrastructure projects** – hydropower, highways (e.g., Char Dham Project).
    - **Forest fires** – caused by rising temperatures and human negligence.
    - **Tourism pressure** – increased construction in ecologically fragile zones.
  - **Impact:** Increased landslides and soil erosion due to deforestation.

- **Andaman and Nicobar Islands:**
  - **Reasons:**
    - **Coastal development** – ports, military infrastructure.
    - **Agricultural expansion** – conversion of mangroves and tropical forests.
  - **Impact:** Loss of **mangrove ecosystems** and damage to **coastal biodiversity**.

17. Correct Option: (b)

Only Statement 01 and 04 is incorrect

Step 01: understanding statement 01

Key Differences Between Afforestation and Reforestation:

Feature	*Afforestation*	*Reforestation*
Definition	Establishing forests on non-forest land.	Restoring forests on degraded/deforested land.
Objective	Create new forest ecosystems.	Recover lost forest cover.
Example	Planting trees in desert areas.	Replanting in deforested rainforests.
Purpose	Expand forest area for climate mitigation.	Restore natural habitats and ecosystem balance.
Impact	Prevents desertification, improves soil quality.	Reverses environmental degradation and climate change.

Afforestation and Reforestation in India: Major Initiatives

- **National Afforestation Programme (NAP):**
  - Objective: Restore **degraded forest lands** through community involvement.
- **Green India Mission (GIM):**
  - Part of **National Action Plan on Climate Change (NAPCC)** to increase **forest cover** and **ecosystem services**.
- **Compensatory Afforestation Fund (CAF) Act, 2016:**
  - Requires industries to plant trees when diverting forest land.
- **Aravalli Reforestation Project:**
  - Aim: Combat **desertification** and restore **ecological health**.

Step 02: understanding statement 02

Soil Carbon Sequestration: Definition, Process, and Importance

Soil carbon sequestration is the process of capturing and storing atmospheric carbon dioxide (CO_2) in soil organic matter through natural and human-induced processes. It is a key strategy to mitigate climate change, improve soil health, and enhance agricultural productivity.

What is Soil Carbon Sequestration?

It involves removing CO2 from the atmosphere and storing it in the soil in the form of:

- **Soil Organic Carbon (SOC):** Derived from **decomposed plants and microorganisms** (humus).
- **Soil Inorganic Carbon (SIC):** Includes **minerals** like calcium carbonate.

Carbon Pools in Soil:

- **Active Pool:** Rapid turnover (decomposed organic matter).
- **Slow Pool:** Partially decomposed material (decades).
- **Passive Pool:** Deep, stable carbon (centuries to millennia).

Methods of Soil Carbon Sequestration:

- **Conservation Agriculture:**
  - **No-till farming** – reduces soil disturbance.
  - **Crop rotation** – improves organic matter.
- **Agroforestry:**
  - Integrating **trees** with crops enhances **biomass** and **soil fertility**.
- **Cover Cropping:**
  - Growing **legumes** and **grasses** prevents soil erosion and adds organic carbon.
- **Organic Amendments:**
  - **Composting** and **biochar** enrich soil organic matter.
- **Grazing Management:**
  - **Rotational grazing** prevents overgrazing and promotes carbon storage.
- **Wetland Restoration:**
  - Preserving **peatlands** and **wetlands** enhances long-term carbon sinks.

Global and National Initiatives for Soil Carbon Sequestration:

- **4 per 1000 Initiative (Global):** Increase soil organic carbon by **0.4% annually**.
- **United Nations Land Degradation Neutrality (LDN):** Focus on **sustainable land management**.
- **India's National Mission for Sustainable Agriculture (NMSA):** Promotes **soil health cards** and **carbon-rich farming**.
- **Soil Health Management (SHM) Programme:** Supports **organic farming** and **carbon conservation**.

Step 03: understanding statement 03

Direct Air Capture (DAC): Definition, Process, and Importance

Direct Air Capture (DAC) is a technological method that removes carbon dioxide (CO2) directly from the atmosphere and stores it permanently or reuses it. It is a critical tool for climate change mitigation, helping to reduce greenhouse gas concentrations.

What is Direct Air Capture (DAC)?

DAC involves using chemical processes to extract CO2 from ambient air. Unlike point-source carbon capture (e.g., from industrial facilities), DAC targets carbon already present in the open atmosphere.

Key Goals of DAC:

- Reduce **atmospheric CO2** levels.
- Offset **hard-to-abate emissions** (e.g., aviation, agriculture).
- Support **negative emissions** targets (e.g., achieving **Net Zero**).

Global DAC Projects and Initiatives:

- **Climeworks (Switzerland):**
  - World's **largest DAC plant** (**Orca**) in Iceland, captures **4,000 tons of CO2/ year**.
- **Carbon Engineering (Canada):**
  - Plans to scale up to **1 million tons/year** of CO2 removal.
- **Global Initiatives:**
  - **Mission Innovation** – promotes **clean energy** and carbon removal.
  - **U.S. DAC Hubs Program** – invests **$3.5 billion** in DAC development.

Step 04: understanding statement 04

Ocean-Based Carbon Sequestration Methods: Definition, Types, and Importance

Ocean-based methods involve using the oceans to capture, store, or remove carbon dioxide (CO2) from the atmosphere. Since the oceans absorb ~30% of global CO2 emissions, these methods play a vital role in climate change mitigation and carbon cycle regulation.

Comparison of Ocean-Based Carbon Sequestration Methods:

Method	*Mechanism*	*Advantages*	*Challenges*
Ocean Fertilization	Stimulates phytoplankton growth	Scalable, low-cost	Ecosystem disruption, regulatory concerns
Ocean Alkalinity Enhancement	Adds alkaline minerals to neutralize CO2	Long-term storage, reduces acidification	Logistics-heavy, uncertain impacts
Blue Carbon Ecosystems	Protects and restores coastal vegetation	Biodiversity, coastal protection	Limited to coastal areas, sensitive ecosystems
Artificial Upwelling/ Downwelling	Manipulates ocean currents to store CO2	Boosts marine productivity	High energy needs, disrupts natural processes
Deep-Sea Carbon Storage	Injects CO2 into deep ocean formations	Permanent storage, large capacity	Leakage risk, monitoring challenges

Global Initiatives for Ocean-Based Carbon Sequestration:

- **UN Decade of Ocean Science (2021–2030):**
  - Supports ocean-based climate solutions.
- **Ocean Carbon Removal Partnership:**
  - International collaboration to **scale** ocean-based methods.
- **National Blue Carbon Policy (India):**
  - Focuses on **mangrove restoration** and **marine ecosystem protection**.

18. Correct Option: (d)

Step 01: understanding statement 01

Extra-Terrestrial Causes of Climate Change

Climate change is primarily driven by Earth-based factors, but extra-terrestrial (cosmic) influences also play a significant role in long-term climate variations. These causes originate outside Earth's atmosphere and affect the planet's energy balance, leading to temperature fluctuations and climatic shifts over geological time scales.

Key Extra-Terrestrial Causes of Climate Change:

- **Solar Variability**
  - **Definition:** Changes in the **Sun's energy output** affect the amount of **solar radiation** reaching Earth, influencing global temperatures.
  - **Mechanisms:**
    - **Solar Cycles (Sunspots):** The Sun experiences **11-year cycles** of increasing and decreasing sunspot activity, impacting **solar irradiance**.
    - **Solar Flares and Coronal Mass Ejections (CMEs):** High-energy **solar bursts** can temporarily affect Earth's atmosphere and climate.
  - **Impact on Climate:**
    - **Increased solar activity → Warming** (e.g., **Medieval Warm Period**).
    - **Decreased solar activity → Cooling** (e.g., **Little Ice Age** during the **Maunder Minimum**, 1645–1715).
  - **Example:**
    - **Maunder Minimum (1645–1715):** A period of **low sunspot activity** linked to **global cooling**.
- **Milankovitch Cycles**
  - **Definition:** Long-term changes in **Earth's orbit** around the Sun, affecting the distribution and intensity of **solar radiation** over thousands of years.
  - **Types of Milankovitch Cycles:**
    - **Eccentricity (100,000-year cycle):** Changes in the shape of Earth's orbit from **circular to elliptical**, influencing the distance from the Sun.
    - **Obliquity (41,000-year cycle):** Variation in the tilt of Earth's axis (from **22.1° to 24.5°**), affecting **seasonal contrasts**.
    - **Precession (23,000-year cycle):** The **wobble** of Earth's axis alters the **timing of seasons**.
  - **Impact on Climate:**
    - Triggers **glacial** (ice ages) and **interglacial** (warming) periods.
    - Responsible for **Quaternary Ice Age** cycles over the last **2.5 million years**.

- **Example:**
  - **Last Glacial Maximum (LGM):** Around **20,000 years ago**, caused by **Milankovitch-induced** low solar input.

- **Cosmic Rays**
  - **Definition:** High-energy **particles** from space (mainly from **supernovae**) that enter Earth's atmosphere, affecting **cloud formation** and the **climate**.
  - **Mechanisms:**
    - **Increased cosmic rays** → More cloud nucleation → Higher **albedo** (reflectivity) → **Cooling**.
    - **Decreased cosmic rays** → Less cloud cover → **Warming**.
  - **Impact on Climate:**
    - **Cooler climate** during **high cosmic ray periods**.
    - Affects **regional weather patterns** and **precipitation**.
  - **Example:**
    - **Cloud Formation Hypothesis (Svensmark Theory):** Suggests cosmic rays **increase cloud cover**, contributing to **climate cooling**.

- **Asteroid and Meteorite Impacts**
  - **Definition:** Large **asteroid** or **meteorite** impacts cause **rapid climate change** through the release of **dust**, **aerosols**, and **greenhouse gases**.
  - **Mechanisms:**
    - **Dust Clouds:** Block **sunlight**, causing **global cooling** (impact winter).
    - **Wildfires and Greenhouse Gases:** Increase **CO2** and **methane**, leading to **warming** after initial cooling.
  - **Impact on Climate:**
    - **Short-term cooling** from **blocked sunlight**.
    - **Long-term warming** from **greenhouse gases**.
  - **Example:**
    - **Chicxulub Impact (~66 million years ago):** Caused the **Cretaceous-Paleogene (K-Pg) extinction**, cooling Earth and wiping out **dinosaurs**.

- **Galactic Variations (Cosmic Motion)**
  - **Definition:** Earth's motion through the **Milky Way galaxy** exposes it to varying levels of **cosmic radiation** and **dust**.
  - **Mechanisms:**
    - As Earth moves through the **galactic spiral arms**, it encounters regions with **higher cosmic ray flux**.
    - Galactic position influences Earth's **climate cycles** over **200–250 million years**.
  - **Impact on Climate:**
    - Possible triggers for **mass extinctions** and **ice ages**.
    - May influence **cosmic ray-induced** cooling or warming.
  - **Example:**
    - **Ice Age Cycles:** May align with Earth's passage through **dense galactic regions**.

19. Correct Option: (c)

*The most appropriate definition of **'Global Dimming'** is: **"The gradual reduction in the amount of sunlight reaching the Earth's surface due to increased atmospheric pollutants such as aerosols and particulate matter."***

Step 01: understanding statement 01

- **Cause:** Air pollution from **fossil fuels**, **volcanic eruptions**, and **industrial activities** releases fine particles into the atmosphere.
- **Effect:** These particles reflect **solar radiation** back into space, reducing the sunlight that reaches Earth's surface.
- **Impact:** It can affect the **water cycle**, **reduce crop yields**, and **mask global warming** by cooling the Earth's surface.

Example: After the Mount Pinatubo eruption (1991), global temperatures temporarily dropped due to increased atmospheric aerosols.

20. Correct Option: (b)

***Carbon sequestration** refers to the process of **capturing and storing carbon dioxide (CO2)** from the atmosphere to mitigate **climate change**. This process reduces **greenhouse gas** concentrations, helping to **slow global warming**.*

Types of Carbon Sequestration:

- **Biological Carbon Sequestration**
  - **Definition:** Storing carbon in **natural ecosystems** through **photosynthesis** in plants and trees.
  - **Methods:**
    - **Forests:** Trees absorb CO2 and store carbon in **biomass** (trunks, leaves) and **soil**.
    - **Soil Carbon Sequestration:** Agricultural practices that enhance carbon storage in **topsoil**.
    - **Wetlands and Mangroves:** Coastal vegetation stores **"blue carbon"** in sediments.
  - **Examples:**
    - **Afforestation/Reforestation:** Planting trees to capture carbon.
    - **India's Green India Mission:** Aims to increase **forest cover** for carbon storage.
  - **Benefits:**
    - Improves **biodiversity** and **ecosystem health**.
    - **Cost-effective** and sustainable.
  - **Challenges:**
    - Land-use competition (e.g., **agriculture** vs. **forests**).
    - Vulnerable to **wildfires** and **climate change**.
- **Geological Carbon Sequestration**
  - **Definition:** Capturing CO2 from **industrial** or **power plant** emissions and storing it **underground** in **rock formations**.
  - **Methods:**
    - **Carbon Capture and Storage (CCS):** CO2 is captured, compressed, and injected into **deep geological reservoirs** (e.g., saline aquifers, depleted oil fields).
    - **Enhanced Oil Recovery (EOR):** Injecting CO2 into **oil fields** to increase oil extraction while trapping CO2 underground.
  - **Examples:**
    - **Sleipner Project (Norway):** Stores **1 million tons of CO2** annually under the **North Sea**.
  - **Benefits:**
    - **Long-term** and **stable** storage.
    - Reduces CO2 from **heavy industries** (e.g., **cement**, **steel**).
  - **Challenges:**
    - **Expensive** technology.
    - **Leakage risk** from underground storage.
- **Ocean Carbon Sequestration**
  - **Definition:** Using the **oceans** to absorb and store CO2 through natural or engineered processes.
  - **Methods:**
    - **Ocean Fertilization:** Adding **iron** to stimulate **phytoplankton** growth, which absorbs CO2.
    - **Ocean Alkalinity Enhancement:** Adding alkaline substances (e.g., **lime**) to increase the ocean's CO2 absorption.
  - **Examples:**
    - Experimental **iron fertilization** in the **Southern Ocean** to increase **carbon uptake**.
  - **Benefits:**
    - Potential for **large-scale** CO2 removal.
    - Utilizes the ocean's **natural carbon sink**.
  - **Challenges:**
    - **Ecological risks** (disrupting marine ecosystems).
    - Limited understanding of **long-term effects**.
- **Technological Carbon Sequestration**
  - **Definition:** Using advanced **technologies** to capture CO2 directly from the **atmosphere**.
  - **Methods:**
    - **Direct Air Capture (DAC):** Machines extract CO2 from ambient air, which is stored or reused.
    - **Bioenergy with Carbon Capture and Storage (BECCS):** Combines **biomass** energy with CO2 capture for **negative emissions**.
  - **Examples:**
    - **Climeworks (Switzerland):** Operates one of the largest **DAC** facilities.

- **Benefits:**
  - Removes CO2 from **diffuse sources** (e.g., **transport** emissions).
  - Can provide **permanent storage**.
- **Challenges:**
  - **Energy-intensive** and **high cost**.
  - Requires **scaling** for global impact.

Global Initiatives and Policies on Carbon Sequestration:

- **Paris Agreement (2015):** Encourages **carbon capture** as part of the effort to limit warming to **1.5°C**.
- **UN-REDD Programme:** Supports **reforestation** and **forest conservation** for carbon storage.
- **Carbon Markets:** Countries and industries trade **carbon credits** for sequestering emissions.

21. Correct Option: (d)

All statements are incorrect

*The **Loss and Damage Fund** is a **financial mechanism** established to **support developing countries** that are vulnerable to the **adverse effects of climate change**. It aims to provide **financial assistance** for **irreversible losses** (e.g., habitat destruction) and **damages** (e.g., infrastructure loss) caused by **climate-related disasters**.*

Step 01: understanding statement 01

- **Why is the Loss and Damage Fund Important?**
  - **Climate Justice:** Recognizes that **developed countries** (historically major polluters) should support **vulnerable nations** disproportionately affected by climate change.
  - **Financial Support:** Provides resources for **rebuilding** after climate disasters like **floods**, **cyclones**, and **sea-level rise**.
  - **Equity and Solidarity:** Helps **small island nations** and **least developed countries (LDCs)** cope with unavoidable climate impacts.

Timeline of Key Events:

Year	Milestone
1991	Vanuatu proposes an insurance mechanism for vulnerable countries.
2013	Warsaw International Mechanism (WIM) is established at COP19 to address loss and damage.
2022	COP27 (Egypt) formally agrees to create a Loss and Damage Fund.
2023	COP28 (UAE) operationalizes the Loss and Damage Fund, with initial pledges from developed nations.

Sources of Funding:

- **Developed Countries' Contributions:** High-income nations (historically responsible for most emissions).
- **Innovative Finance Mechanisms:**
  - **Carbon taxes** on high emitters.
  - **Airline levies** for international travel emissions.
- **Multilateral Institutions:** Contributions from the **World Bank** and **IMF**.

Examples:

- At **COP28**, countries like **Germany** and **UAE** pledged **$100 million** each.
- **EU** and **USA** made initial financial commitments.

22. Correct Option: (a)

Both Statement are correct

- Polar Regions, particularly the Arctic, are experiencing warming at a rate that is about twice as fast as the global average. This phenomenon is known as Arctic amplifi cation
- The thermal change or warming due to greenhouse gases is more pronounced in the poles compared to the equator.

Step 01: understanding statement 01

- Polar vs. Equatorial Warming: The poles, particularly the Arctic, are warming at a faster rate compared to the equator. This is due to feedback mechanisms like the albedo effect, which are more pronounced in Polar Regions.
- Arctic Amplifi cation: The process where warming in the Arctic occurs at a rate faster than the global average. Contributing factors include decreased sea ice extent and increased absorption of solar radiation by open water.
- Sea Ice Feedback: As sea ice melts, it exposes darker ocean water, which absorbs more heat, leading to further warming and more ice melt.

23. Correct Option: (a)

Both the statements are correct

Step 01: understanding statement 01

Eutrophication is the excessive enrichment of water bodies (lakes, rivers, reservoirs, and coastal areas) with nutrients—mainly nitrogen (N) and phosphorus (P)—leading to overgrowth of algae and aquatic plants. This disrupts the natural ecosystem and affects water quality.

Effects of Eutrophication:

- **Environmental Effects:**
  - **Algal Blooms:** Rapid algal growth blocks sunlight, harming aquatic plants.
    - *Example:* **Blue-green algae** (cyanobacteria) in **Lake Erie**, USA.
  - **Hypoxia (Oxygen Depletion):** Algae decay consumes oxygen, creating **"dead zones."**
    - *Example:* **Gulf of Mexico** has one of the world's largest dead zones.
  - **Loss of Biodiversity:** Oxygen depletion causes the **death** of fish and other aquatic life.
    - *Example:* Decline of **fish populations** in **Chilika Lake**, India.
  - **Disruption of Food Chains:** Reduces the survival of **fish**, **zooplankton**, and other species.

Solutions to Control Eutrophication:

- **Policy and Regulation:**
  - **Strengthen Pollution Laws:** Enforce **water quality standards** (e.g., the **Water (Prevention and Control of Pollution) Act, 1974** in India).
  - **Pollution Control Boards:** Monitor nutrient discharge into water bodies.
- **Sustainable Agricultural Practices:**
  - **Precision Farming:** Optimize **fertilizer use** to prevent runoff.
  - **Buffer Strips:** Plant **vegetative buffers** along water bodies.
- **Wastewater Treatment:**
  - **Advanced Sewage Treatment Plants (STPs):** Remove **phosphates** and **nitrates** before discharge.
  - **Decentralized Treatment Systems:** Promote **local wastewater** management.
- **Restoration Projects:**
  - **Bio-remediation:** Use **algae** and **wetlands** to absorb excess nutrients.
  - **Dredging:** Remove nutrient-rich **sediments** from lakes.
- **Community Action:**
  - **Public Awareness Campaigns:** Educate communities about **reducing nutrient waste**.
  - **Citizen Science Initiatives:** Involve locals in **monitoring** water quality

Step 02: understanding statement 02

Water pollution occurs when harmful substances—such as chemicals, waste, and microorganisms—contaminate water bodies (rivers, lakes, oceans, and groundwater), making the water unsafe for humans and ecosystems. It has far-reaching environmental, economic, and health consequences.

Effects of Water Pollution:

Category	*Effects*	*Examples*
Human Health	Waterborne diseases, toxicity, cancer	Arsenic poisoning in West Bengal
Ecosystems	Biodiversity loss, eutrophication, toxins	Oil spill in Gulf of Mexico
Agriculture	Soil contamination, unsafe crops	Heavy metal pollution in Punjab
Economy	Health costs, fisheries loss, tourism decline	Yamuna River fishing losses
Climate	Methane emissions, altered water cycle	Sewage methane from polluted lakes
Society & Culture	Water insecurity, loss of cultural sites	Ganga River pollution in Varanasi

24. Correct Option: (d)

Both the statements are correct

REDD+** is a global initiative under the **United Nations Framework Convention on Climate Change (UNFCCC)** aimed at reducing greenhouse gas emissions by protecting forests and promoting sustainable forest management. It also emphasizes the **conservation** and **enhancement** of **forest carbon stocks** in **developing countries.

Step 01: understanding statement 01

What Does REDD+ Stand For?

- **R** – Reducing
- **E** – Emissions from
- **D** – Deforestation and
- **D** – Forest Degradation

The + symbolizes additional activities:

- **Conservation of forest carbon stocks**
- **Sustainable forest management**
- **Enhancement of forest carbon stocks**

Evolution of REDD+ Framework: Key Milestones

Year	Event
2005	Proposal for REDD at COP11 by Papua New Guinea and Costa Rica.
2007	Bali Action Plan (COP13) formally introduces REDD.
2010	Cancún Agreements (COP16) expand REDD to REDD+.
2013	Warsaw Framework (COP19) establishes rules for REDD+ implementation.
2015	Paris Agreement (COP21) recognizes REDD+ as a climate mitigation tool.
2021	Glasgow Leaders' Declaration (COP26) reaffirms global commitment to forest protection.

Objectives of REDD+:

- **Mitigate Climate Change:** Reduce **carbon emissions** by curbing **deforestation** and **forest degradation**.
- **Conserve Biodiversity:** Protect forest ecosystems and their **biodiversity**.
- **Support Indigenous Communities:** Recognize and strengthen the role of **local and indigenous** communities in forest management.
- **Sustainable Development:** Promote **socio-economic benefits** while ensuring forest conservation.

How Does REDD+ Work?

- **Measurement and Monitoring:**
  - Countries measure and report **forest area** and **carbon stock** changes.
  - Use of advanced technologies like **satellite monitoring**.
- **Performance-Based Payments:**
  - Countries receive **financial incentives** based on verified **emission reductions**.
  - Funding from **Green Climate Fund (GCF)** and other international donors.
- **Safeguards Implementation:**
  - Ensures **transparency**, **equity**, and **biodiversity protection** while reducing risks.

Examples of REDD+ Projects:

- **Amazon Fund (Brazil):**
  - Largest REDD+ program globally, supported by **Norway** and **Germany**.
  - Focuses on **preserving the Amazon Rainforest**.
- **Indonesia's REDD+ Program:**
  - **Peatland restoration** and **forest conservation** supported by international funding.
- **India's Green India Mission (GIM):**
  - Aligns with REDD+ goals to **increase forest cover** and **enhance ecosystem services**.

25. Correct Option: (b)

Both Statement-I and Statement-II (a) are correct and Statement-II explains Statement-I

Step 01: understanding statement 01

The World Wide Fund for Nature (WWF) and Its Support for Small-Scale Fisheries and Sustainable Aquaculture

The World Wide Fund for Nature (WWF) is a leading international organization working to conserve nature and reduce human impact on the environment. One of its key areas of focus is promoting sustainable fisheries and responsible aquaculture to protect marine ecosystems and support coastal communities.

WWF's Goals for Small-Scale Fisheries and Sustainable Aquaculture:

- **Sustainable Resource Management:**
  - Promote **ecosystem-based management** to ensure **long-term fishery health**.
- **Community Livelihoods:**
  - Support **fisher communities** by improving **income stability** and **social equity**.
- **Biodiversity Conservation:**
  - Protect **marine habitats** and **endangered species** affected by unsustainable fishing.

- **Policy Advocacy:**
  - Advocate for **responsible fisheries policies** and **international regulations**.

WWF's Key Initiatives in Fisheries and Aquaculture:

- **Fishery Improvement Projects (FIPs):**
  - Collaborate with **local fishers**, **governments**, and **industry** to improve fishing practices.
  - *Example:* WWF works with **small-scale fisheries in India** to reduce **bycatch** and adopt **sustainable techniques**.
- **Aquaculture Stewardship Council (ASC):**
  - Co-founded by WWF to **certify sustainable aquaculture** practices.
  - Focus on minimizing environmental harm from **fish farms**.
- **Smart Fishing Initiative:**
  - Reduce **illegal, unreported, and unregulated (IUU)** fishing.
  - Promote **traceability** and **responsible seafood sourcing**.
- **Community-Based Coastal Management:**
  - Empower **local communities** to manage marine resources sustainably.
  - *Example:* WWF supports **coral reef** and **mangrove restoration** in Southeast Asia.

WWF plays a crucial role in promoting sustainable fisheries and aquaculture. Through collaboration, innovation, and advocacy, WWF supports small-scale fishers, protects marine ecosystems, and ensures a sustainable future for seafood production.

Step 02: understanding statement 02

WWF and UNEP's Collaboration under the Nairobi Convention

The World Wide Fund for Nature (WWF) and the United Nations Environment Programme (UNEP) have signed a Memorandum of Understanding (MoU) under the Nairobi Convention to enhance the conservation and sustainable management of marine and coastal ecosystems in the Western Indian Ocean (WIO) region.

What is the Nairobi Convention?

The Nairobi Convention is a regional treaty under UNEP that promotes the protection, management, and sustainable development of coastal and marine environments in the Western Indian Ocean (WIO).

Member States

The convention includes 10 countries: SC Seychelles | KE Kenya | TZ Tanzania | MZ Mozambique | SO Somalia | MG Madagascar | ZA South Africa | KM Comoros | MU Mauritius | FR France (Reunion)

Key Initiatives under the MoU

- **Western Indian Ocean Marine Protected Areas (MPAs)**
  - Expand **marine protected areas** to safeguard ecosystems.
  - Promote **community-based conservation**.
- **Sustainable Fisheries Management**
  - Reduce **illegal, unreported, and unregulated (IUU) fishing**.
  - Support **small-scale fisheries** through training and funding.
- **Blue Economy and Livelihoods**
  - Encourage **eco-tourism**, **seaweed farming**, and **sustainable aquaculture**.
  - Improve **coastal livelihoods** while protecting biodiversity.
- **Marine Pollution Control**
  - Implement policies to **reduce plastic pollution**.
  - Strengthen **waste management** in coastal cities.

The WWF-UNEP MoU under the Nairobi Convention is a major step toward safeguarding the Western Indian Ocean. By combining conservation, sustainable development, and climate action, this partnership will help protect marine biodiversity while supporting local economies.

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