MAH M Arch CET Environment

Sample Paper – 1

Duration: 12 Minutes **Maximum Marks: 20**

Instructions

- This paper contains **10** Multiple Choice Questions (Single Correct Answer), modelled on the Environment portion of **MAH M Arch CET** entrance.
- Each correct answer carries **+2 marks**. There is **no negative marking** for incorrect or unattempted answers.
- Only **one** option is correct. Choose carefully.
- Syllabus: Ecology & Landscape Design, Environmental Design Strategies, Environmental Laws & Regulations.
- Use of mobile phones, calculators, or electronic gadgets is strictly prohibited.

Q1. In the context of **passive solar heating** for buildings located in the Indian climate, which of the following statements about south-facing glazing is **correct**?

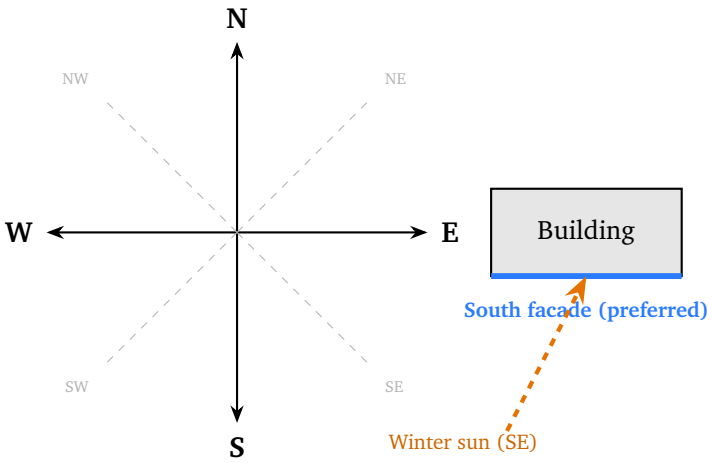
(A) North-facing glazing captures maximum winter sun in India because the sun rises in the north during the winter solstice and tracks along the northern sky.

(B) East-facing glazing is the preferred choice for passive solar heating as it receives the most intense and sustained afternoon radiation throughout the year.

(C) South-facing glazing in India receives maximum direct solar radiation during winter months when the sun is at its lowest altitude, making it optimal for passive solar heat gain; a properly designed horizontal overhang can simultaneously block high-angle summer sun, reducing unwanted gain.

(D) West-facing glazing is the standard recommendation of the National Building Code of India for passive solar design in tropical and composite climatic zones.

Q2. The figure below shows a simplified site plan with cardinal directions and the approximate winter sun-path direction. Which building orientation is **most suitable** for a climate-responsive office building in Mumbai (latitude $\approx 19^\circ$ N) to minimise unwanted heat gain while maximising beneficial natural daylighting?



(A) Orient the long axis of the building along the East–West direction so that the major facades face South and South-East; this minimises exposure of the short ends to the intense low-angle east and west sun while allowing effective shading of the south facade with horizontal overhangs.

(B) Orient the long axis along the North–South direction so the major facades face East and West, maximising sunlight intake throughout the day into the largest surface area of the building.

(C) Face all primary facades to the North to avoid any direct sunlight, relying entirely on diffuse sky illumination for uniform daylighting throughout the year in Mumbai's tropical climate.

(D) Orient the building primarily to the West to take full advantage of the prevailing south-west monsoon breezes, using wind as the dominant climate-responsive strategy.

Q3. Under the **LEED v4** (Leadership in Energy and Environmental Design, version 4) green building rating system published by the U.S. Green Building Council, the credit category that specifically addresses a building's **energy performance**—including optimising energy efficiency, commissioning, on-site renewable energy generation, demand response, and refrigerant management—is:

(A) Water Efficiency (WE)

(B) Indoor Environmental Quality (EQ)

(C) Sustainable Sites (SS)

(D) Energy and Atmosphere (EA)

Q4. A traditional **wind tower** (Persian: *Badgir*; Arabic: *Malqaf*), historically used in hot-arid climates across the Middle East and parts of Rajasthan, India, induces natural ventilation inside a building primarily by:

(A) Absorbing solar radiation on its blackened exterior surface to heat air inside the shaft, generating purely thermally-driven upward buoyancy independent of external wind direction.

(B) Capturing higher-velocity wind at the top of the tower, directing it downward into the building interior through wind-pressure and stack differentials, while warm stale air is expelled through low-level openings or the leeward face of the tower.

(C) Cascading water down wetted pads inside the tower to cool incoming air through direct evaporation, with cooled dense air sinking by gravity into the occupied spaces below.

(D) Routing external air through buried earth pipes to pre-cool it by conduction with the stable ground temperature before delivering it into the living spaces.

Q5. **Embodied energy** is defined as the total energy consumed across the entire life cycle of extracting, processing, manufacturing, and transporting a building material to the point of use. Which of the following common building materials has the **highest** embodied energy per kilogram?

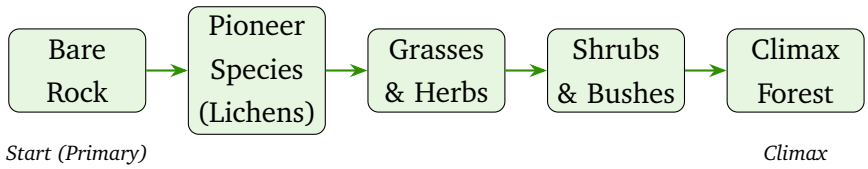
(A) Fired clay brick (≈ 3 MJ/kg)

(B) Structural timber (sawn) (≈ 10 MJ/kg)

(C) Primary (virgin) aluminium (≈ 155 MJ/kg)

(D) Ordinary Portland Cement concrete (≈ 1.4 MJ/kg)

Q6. The diagram below illustrates the sequential stages of **ecological succession** from a lifeless substrate to a stable climax community. Based on the figure and your knowledge of ecology, which statement **correctly** distinguishes **primary succession** from **secondary succession**?



(A) Primary succession begins on a substrate that has **never previously supported life** (e.g., bare rock, fresh lava field, newly exposed glacial till) with no pre-existing soil, whereas secondary succession occurs on land where a biological community **previously existed but was disturbed or destroyed** (e.g., by fire, flood, or agriculture), leaving existing soil and dormant seed banks intact.

(B) Primary succession is faster than secondary succession because pioneer organisms such as lichens grow very rapidly on bare surfaces and quickly build deep, nutrient-rich organic soil within a few decades.

(C) Secondary succession always begins on bare rock, while primary succession starts in areas that already contain some remnant organisms and soil from a previously disturbed community.

(D) Both primary and secondary succession follow identical ecological pathways, reach the same climax community in the same period, and differ only in the geographic location where they are initiated.

Q7. In the context of **urban landscape planning** and biodiversity conservation, **habitat corridors** are best described as:

(A) Designated no-build buffer zones established around listed heritage structures to preserve their visual and historic setting under statutory protection orders.

(B) Linear parks and tree-lined pedestrian paths designed exclusively for recreational use by urban residents, with no specific mandate for ecological connectivity.

(C) Underground utility ducts and service tunnels that protect soil biodiversity by keeping above-ground surfaces free from disturbance by heavy infrastructure.

(D) Linear strips of natural or semi-natural vegetation **connecting otherwise isolated habitat patches**, enabling safe movement of wildlife between them, facilitating gene flow between sub-populations, and enhancing the overall ecological resilience of fragmented urban landscapes.

Q8. In a freshwater lake ecosystem, a simplified food web is represented as follows:

Phytoplankton $\longrightarrow$ Zooplankton $\longrightarrow$ Small Fish $\longrightarrow$ Large Fish $\longrightarrow$ Osprey

Which organism in this food web is the **primary producer**?

(A) Zooplankton, because they are the first animals to consume and process organic matter, making energy available to all higher levels of the food chain.

(B) Phytoplankton, because they are photosynthetic autotrophs that fix solar energy into organic compounds through photosynthesis, forming the energy foundation of the entire food web.

(C) Small fish, because they occupy the third trophic level and convert zooplankton biomass into a form that is accessible to large fish and apex predators.

(D) Osprey, because as the apex predator they regulate the population sizes of all organisms at lower trophic levels and thus control primary production indirectly.

Q9. The **Environment (Protection) Act, 1986** is India's comprehensive umbrella environmental legislation enacted in the aftermath of the Bhopal gas tragedy of December 1984. It empowers the Central Government to take all measures necessary for protecting and improving environmental quality. This Act is currently **administered by**:

(A) Ministry of Housing and Urban Affairs (MoHUA)

(B) Ministry of Science and Technology

(C) Ministry of Environment, Forest and Climate Change (MoEFCC)

(D) Ministry of Health and Family Welfare

Q10. Under the **Environmental Impact Assessment (EIA) Notification, 2006** (S.O. 1533(E)) issued under the Environment (Protection) Act, 1986, which of the following **categories of projects** requires mandatory prior **Environmental Clearance** (EC) through the EIA process before any construction, expansion, or modernisation can commence?

(A) All projects and activities listed in **Schedule I** of the notification—such as thermal power plants above 25 MW, coal and non-coal mining above threshold capacities, river valley and hydro projects, large industrial estates, township and area development projects above 50 ha or 1,50,000 m^2 floor area, and airports with runways exceeding 2,500 m—require mandatory prior EC through Category A or Category B EIA appraisal.

(B) Only public-sector infrastructure projects with a capital investment exceeding Rs. 500 crore are required to conduct an EIA; private-sector projects of any scale are exempt provided they hold an ISO 14001 environmental management system certification.

(C) EIA is mandatory exclusively for coastal construction projects within the notified Coastal Regulation Zone (CRZ) and does not apply to any inland infrastructure projects, regardless of their scale or environmental sensitivity.

(D) All building projects exceeding five floors in municipal areas require a full EIA, while road and highway projects of any length or car-

riageway width are entirely excluded from the purview of the 2006 notification.

Detailed Solutions

Q1.

Solution

Concept: Passive solar heating exploits the geometric relationship between the sun's path and a building's facade orientation. In the northern hemisphere (India spans 8° N to 37° N), the sun transits the southern sky throughout the year, reaching its *lowest* noon altitude at the winter solstice (21 December) and its *highest* at the summer solstice (21 June).

Step 1 – Sun altitude in winter: At New Delhi (28° N), the noon sun altitude on the winter solstice is approximately $90^\circ - 28^\circ - 23.5^\circ = 38.5^\circ$. Low-angle winter sun penetrates deep into a vertical south-facing window, raising interior temperatures passively.

Step 2 – Summer shading by overhang: In summer, the noon sun altitude at Delhi rises to $\approx 85^\circ$. A correctly dimensioned horizontal overhang above a south-facing window can block this high-angle summer sun entirely while admitting the low winter sun—a dual benefit unique to south-facing glazing.

Why other options are wrong:

- **(A)** The sun never tracks the northern sky in India; it rises eastward and transits the south. North glazing receives only diffuse sky light and zero direct winter sun.
- **(B)** East glazing captures only morning sun, which is low-intensity in winter; afternoon, when peak heating is needed, it receives no direct radiation.
- **(D)** The NBC and ECBC do not recommend west glazing for passive solar heating; western facades receive intense low-angle afternoon sun causing summer overheating with no effective fixed shading solution.

Final Answer: Option (C) is correct. South-facing glazing maximises beneficial winter solar gain and is readily shaded in summer with a horizontal overhang.

Answer: (C) Go Back to Q1

Q2.

Solution

Concept: The fundamental rule of climate-responsive building orientation in tropical India is to orient the **long axis East–West**, placing the two large facades on the North and South sides. This strategy simultaneously minimises exposure of large wall areas to the harsh east and west sun, while allowing effective control of the south facade through horizontal shading devices.

Step 1 – East–West axis advantages:

- The **south facade** (large) receives beneficial low-angle winter sun and can be shaded in summer by a fixed horizontal overhang—a well-established architectural solution.
- The **north facade** (large) receives only diffuse sky light year-round—ideal for glare-free daylighting in offices without heat gain.
- The **east and west** ends (short) are exposed to difficult low-angle morning and afternoon sun, but because they are narrow faces, the total heat gain is minimised.

Step 2 – Why E–W sun is problematic: The east (morning) and west (afternoon) sun arrives at low angles ($15°$–$40°$) that no fixed horizontal overhang can effectively block. Vertical fins are required, but they obstruct views. Keeping these as short elevations limits the problem.

Why other options are wrong:

- **(B)** A N–S long axis creates large east- and west-facing facades—exactly what must be avoided; this is the worst orientation in tropical climates.
- **(C)** An all-north orientation denies useful winter solar warmth, reduces daylighting to the south half of the building, and ignores India's predominantly clear-sky winter solar resource.
- **(D)** Orienting primarily west for monsoon breezes sacrifices thermal performance for a minor ventilation gain; ventilation can be achieved through layout and openings without worsening the solar exposure.

Final Answer: Option (A) is correct. An East–West long axis with south and south-east major facades is the optimal orientation for climate-responsive design in Mumbai.

Answer: (A) Go Back to Q2

Q3.

Solution

Concept: LEED v4 organises its prerequisites and credits into distinct categories, each addressing a different aspect of building sustainability. Knowing which category covers which topic is essential for any green-building professional.

Step 1 – Energy and Atmosphere (EA) scope: The EA category is the largest and most points-weighted in LEED v4 for Building Design and Construction. It includes:

- *Prerequisites:* Fundamental Commissioning and Verification, Minimum Energy Performance, Building-Level Energy Metering, Fundamental Refrigerant Management.
- *Credits:* Enhanced Commissioning, Optimise Energy Performance (up to 18 points), Advanced Energy Metering, Demand Response, Renewable Energy Production, Enhanced Refrigerant Management, Green Power and Carbon Offsets.

Step 2 – Other categories distinguished:

- **(A) Water Efficiency (WE):** Covers outdoor water use, indoor water use, cooling tower water, and water metering.
- **(B) Indoor Environmental Quality (EQ):** Covers minimum IAQ performance, tobacco smoke control, enhanced IAQ, low-emitting materials, construction IAQ, thermal comfort, interior lighting, daylight, quality views, and acoustic performance.
- **(C) Sustainable Sites (SS):** Covers construction activity pollution prevention, site assessment, site development, open space, rainwater management, heat island reduction, and light pollution reduction.

Final Answer: Option (D) — **Energy and Atmosphere (EA)** — is the LEED v4 category that covers all aspects of a building's energy performance and related atmosphere/climate topics.

Answer: (D) Go Back to Q3

Q4.

Solution

Concept: A wind tower is one of the oldest passive cooling devices in vernacular architecture. Its fundamental mechanism relies on **wind pressure differences** (and, secondarily, thermal buoyancy) to drive air movement without any mechanical assistance.

Step 1 – Wind pressure mechanics: Wind blowing horizontally creates a **positive pressure zone** on the windward face of the tower opening and a **negative pressure (suction)** on the leeward face. Fresh, relatively cooler air at height is pushed down through the tower shaft by this positive pressure, emerging into the occupied rooms below. Stale, warm room air is simultaneously drawn out through low-level openings or through the leeward slot of the tower itself by the suction effect.

Step 2 – Stack effect contribution: Warm air in the occupied spaces is less dense and tends to rise. This thermal buoyancy supplements wind pressure, creating a continuous circuit: cool air in $\rightarrow$ absorbs heat from occupants and surfaces $\rightarrow$ rises and exits. Multi-directional towers (with openings on all four cardinal faces) can exploit wind from any direction.

Why other options are wrong:

- **(A)** Describes a **solar chimney**, a different device where a solar-heated glazed shaft drives upward convection to exhaust air from a building. A wind tower does not primarily depend on solar gain.
- **(C)** Wetted pads inside a tower for evaporative cooling are an *enhancement* found in some advanced Malqaf designs, but evaporation is not the primary working principle of a basic wind tower.
- **(D)** Describes an **earth-air heat exchanger** (ground pipe or earth tube), an entirely different passive cooling system that routes air through buried conduits.

Final Answer: Option (B) correctly describes the wind tower's primary mechanism: capturing high-velocity wind aloft and directing it downward via pressure and stack differentials.

Answer: (B) Go Back to Q4

Q5.

Solution

Concept: Embodied energy (EE) is a sustainability metric for building materials that quantifies the cumulative energy required to extract raw resources, refine them, manufacture the final product, and deliver it to site. High EE materials impose a larger "carbon debt" that must be repaid by operational efficiency savings over the building's life.

Step 1 – Why aluminium is the most energy-intensive: Primary (virgin) aluminium is produced via the **Bayer–Hall–Héroult process**: first, bauxite ore is refined to alumina (Al_2O_3) by the Bayer process, then alumina is reduced to metallic aluminium by electrolysis in a Hall–Héroult cell. This electrolytic step is extremely electricity-intensive, consuming approximately 13–15 kWh per kilogram of aluminium produced. The total embodied energy of primary aluminium is typically **155–200 MJ/kg**, making it the highest among all common construction materials by a large margin.

Step 2 – Comparative embodied energy values:

Material	EE (MJ/kg)
Ordinary Portland Cement concrete	≈ 1.4
Fired clay brick	≈ 3
Structural timber (sawn)	≈ 8–10
Virgin structural steel	≈ 32
Primary aluminium	$\approx$ **155**

Note: Recycled (secondary) aluminium has EE of only ≈ 8 MJ/kg, highlighting the enormous benefit of aluminium recycling in sustainable construction.

Final Answer: Option (C) — primary aluminium at ≈ 155 MJ/kg — carries the highest embodied energy of the four options listed.

Answer: (C) Go Back to Q5

Q6.

Solution

Concept: Ecological succession is the gradual, directional process by which the species composition and structure of a biological community change over time until a relatively stable *climax community* is reached. The two main types differ fundamentally in their **starting conditions**.

Step 1 – Primary succession: Begins on a **lifeless substrate with no prior soil formation**—examples include fresh volcanic lava flows, newly formed sand

dunes, bare glaciated rock, or land uplifted from the sea. Because there is no soil and no seed bank, colonisation must begin from scratch with hardy pioneer organisms (typically crustose lichens on rock) that can tolerate extreme conditions and begin the slow process of soil creation through physical weathering and organic matter accumulation. Primary succession may take **hundreds to thousands of years** to reach climax.

Step 2 – Secondary succession: Begins where a community **previously existed but was removed by disturbance** (fire, flood, storm, clear-cutting, field abandonment) while the **soil and seed bank remain intact**. Because nutrients, root stocks, and dormant seeds are already present, succession proceeds far more rapidly—typically **decades to a century**—through the intermediate stages (grasses, shrubs) to climax forest.

Why other options are wrong:

- **(B)** Exactly the opposite is true: primary succession is the *slower* of the two types; pioneers on bare rock grow very slowly, and soil formation is a bottleneck measured in centuries.
- **(C)** This completely reverses the definitions—secondary succession begins in a disturbed area *with existing soil*, while primary begins on *bare rock with no soil at all*.
- **(D)** The two types differ in rate, starting substrate, pioneer species, and sometimes final climax type; they are not identical in any practical sense.

Final Answer: Option (A) correctly defines primary succession (no prior life or soil) versus secondary succession (existing soil and seed banks after disturbance).

Answer: (A) Go Back to Q6

Q7.

Solution

Concept: Urban expansion and infrastructure development fragment continuous natural ecosystems into isolated "habitat islands." Species confined to small patches suffer reduced genetic diversity, increased inbreeding, and higher local extinction risk. Landscape ecology provides habitat corridors as the primary design intervention to restore connectivity.

Step 1 – Function of habitat corridors: A habitat corridor is a linear strip of natural or semi-natural habitat (riparian buffer, green belt, hedgerow, wildlife overpass, connected urban park network) linking two or more larger habitat patches.

Corridors serve three ecological functions:

- **Conduit function:** Provide safe passage for wildlife movement between patches for foraging, reproduction, and seasonal migration.
- **Genetic function:** Enable gene flow between isolated sub-populations, reducing inbreeding depression and maintaining adaptive diversity.
- **Recolonisation function:** Allow species to recolonise patches from which they were locally extirpated after disturbance events.

Step 2 – Urban design application: In cities, planners integrate corridors as blue–green networks: streams and their vegetated buffers, continuous tree canopy along streets, rooftop gardens connected to ground-level parks, and structural wildlife crossings over highways.

Why other options are wrong:

- **(A)** Heritage buffer zones are regulatory demarcations protecting built cultural character; they serve an architectural-heritage purpose, not an ecological connectivity function.
- **(B)** Pedestrian recreational paths serve human users; while incidental urban green space helps some species, a path designed for foot traffic is not a habitat corridor in the ecological definition.
- **(C)** Underground utility ducts are entirely subsurface infrastructure; they have no functional role in facilitating surface or aerial wildlife movement.

Final Answer: Option (D) is correct. Habitat corridors are linear connective vegetation strips enabling wildlife movement, gene flow, and ecological resilience in fragmented urban landscapes.

Answer: (D) Go Back to Q7

Q8.

Solution

Concept: Every food web is structured by **trophic levels**. The first trophic level always comprises **primary producers** (autotrophs)—organisms that synthesise their own organic matter from inorganic inputs using an external energy source (sunlight in photosynthesis, or chemical energy in chemosynthesis). All higher trophic levels (consumers, predators) depend entirely on primary producers for their energy supply.

Step 1 – Trophic level breakdown of the given food web:

Organism	Trophic Level	Role
Phytoplankton	1^{st}	**Primary Producer** (autotroph / photosynthetic)
Zooplankton	2^{nd}	Primary Consumer (herbivore)
Small Fish	3^{rd}	Secondary Consumer
Large Fish	4^{th}	Tertiary Consumer
Osprey	5^{th}	Apex Predator

Step 2 – Why phytoplankton are the primary producers: Phytoplankton (diatoms, cyanobacteria, dinoflagellates, green algae) are microscopic photosynthetic organisms that use dissolved CO_2, water, and sunlight to produce glucose and oxygen: $6\,CO_2 + 6\,H_2O \xrightarrow{h\nu} C_6H_{12}O_6 + 6\,O_2$. They account for roughly 50% of global net primary productivity.

Why other options are wrong:

- **(A)** Zooplankton are *primary consumers* (heterotrophs); they graze on phytoplankton and cannot fix solar energy.
- **(C)** Small fish are secondary consumers at trophic level 3; they cannot perform photosynthesis.
- **(D)** The osprey is the apex predator at trophic level 5; it is the furthest possible from primary production in this chain.

Final Answer: Option (B) is correct. Phytoplankton are the photosynthetic primary producers at the base of the freshwater lake food web.

Answer: (B) Go Back to Q8

Q9.

Solution

Concept: The Environment (Protection) Act, 1986 (EPA 1986) is India's most comprehensive environmental statute. Enacted on 23 May 1986 by Parliament under Article 253 of the Constitution (to give effect to the decisions of the 1972 Stockholm Conference on the Human Environment), it empowers the Central Government to coordinate activities of all regulatory agencies and take measures to protect and improve environmental quality.

Step 1 – Administering ministry: The Act vests executive authority in the **Central Government**, which exercises it through the **Ministry of Environment, Forest and Climate Change (MoEFCC)**, formerly known as the Ministry of Environ-

ment and Forests (MoEF) before its renaming in 2014. MoEFCC is responsible for framing rules, issuing notifications, setting environmental standards, and granting environmental clearances under this Act.

Step 2 – Key subordinate legislation under EPA 1986: All of the following are promulgated under EPA 1986 by MoEFCC:

- EIA Notification, 2006 (environmental clearances)
- Hazardous Waste (Management, Handling & Transboundary Movement) Rules, 2016
- Plastic Waste Management Rules, 2016
- E-Waste Management Rules, 2016
- Coastal Regulation Zone (CRZ) Notification, 2019

Why other options are wrong:

- **(A)** MoHUA handles town planning, RERA, smart cities, and the national urban mission—not environment regulation.
- **(B)** Ministry of Science and Technology oversees CSIR, DST, DBT, and research policy—no environmental regulatory role.
- **(D)** Ministry of Health and Family Welfare administers public health and medical services—it has no jurisdiction over the EPA 1986.

Final Answer: Option (C) — **Ministry of Environment, Forest and Climate Change (MoEFCC)** — is the correct administering ministry of the Environment (Protection) Act, 1986.

Answer: (C) Go Back to Q9

Q10.

Solution

Concept: The EIA Notification, 2006 (S.O. 1533(E), dated 14 September 2006) replaced the earlier EIA Notification of 1994 and established a structured, two-tier system for Environmental Clearance (EC) of development projects in India. It operates under the authority of EPA 1986.

Step 1 – Schedule I and its categories: The notification lists all project types requiring mandatory prior EC in **Schedule I**. These are divided into:

- **Category A:** Projects with potentially major or trans-boundary impacts, ap-

praised by the Expert Appraisal Committee (EAC) at the national level (MoEFCC). Examples: nuclear power plants, thermal power > 500 MW, major ports, national highways in sensitive zones.

- **Category B:** Projects with more localised impacts, appraised by State-level Expert Appraisal Committees (SEACs). Further split into B1 (full EIA required) and B2 (only Form I / Form IA required).
- **General Condition:** Any Category B project located within 10 km of a national park, sanctuary, or CRZ is automatically upgraded to Category A.

Step 2 – Typical Schedule I project triggers: Thermal power (> 25 MW), coal mining (> 5 MTPA), non-coal mining (> 50 ha), river valley hydro (> 25 MW), townships (> 50 ha or $> 1,50,000$ m^2 built-up), airports (runway $> 2,500$ m), national highways (> 100 km in sensitive areas).

Why other options are wrong:

- **(B)** The trigger is the *type and scale* of the project (as listed in the Schedule), not public vs. private ownership or ISO 14001 status. No such blanket private-sector exemption exists.
- **(C)** CRZ is governed by the separate CRZ Notification (2011/2019). The EIA Notification 2006 covers both coastal and inland projects; it is not restricted to CRZ areas.
- **(D)** The notification uses *floor area and plot area thresholds*, not floor count, for building projects. Highway projects (national highways, expressways) are explicitly included in Schedule I above certain length and width thresholds—they are not excluded.

Final Answer: Option (A) is correct. All projects listed in Schedule I of the EIA Notification 2006 require mandatory prior Environmental Clearance through the EIA process.

Answer: (A) Go Back to Q10

Answer Key

Q	Ans	Q	Ans	Q	Ans	Q	Ans	Q	Ans
1	C	2	A	3	D	4	B	5	C
6	A	7	D	8	B	9	C	10	A