MAH M Arch CET Environment

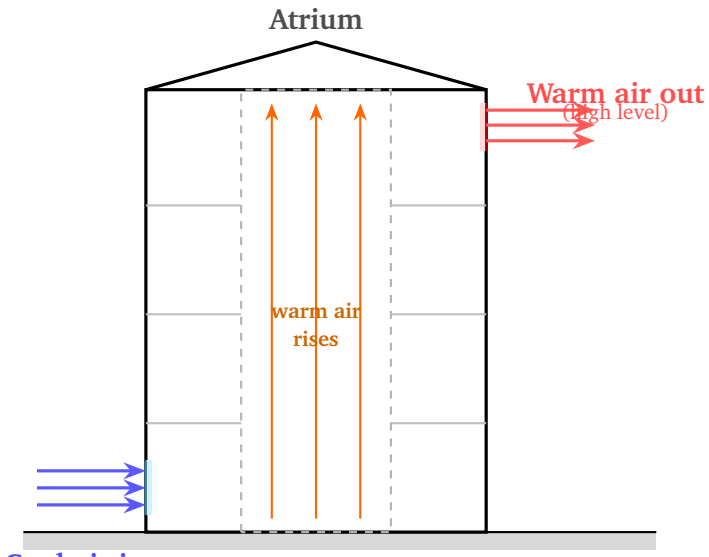
Sample Paper – 4

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. The **stack effect** (thermal buoyancy-driven ventilation) relies on the density difference between warm and cool air to drive natural airflow through a building. The diagram below illustrates the operating principle. In which building type is the stack effect **most effectively exploited** for passive natural ventilation?



Stack effect: buoyancy-driven natural ventilation in a tall atrium building

(A) Tall atrium buildings with low-level air inlets and high-level air outlets

(B) Single-storey detached bungalows with no significant internal height variation

(C) Below-grade basement parking structures fitted with mechanical exhaust fans

(D) Single-storey warehouses with a uniform, low ceiling height throughout

Q2. **Building-Integrated Photovoltaics (BIPV)** describes solar PV modules that replace or supplement conventional building envelope materials — such as roofing sheets, cladding panels, or glazing — rather than being mounted as external add-on structures. Which building element is **most commonly** used for BIPV integration in order to maximise annual solar energy capture?

(A) A north-facing vertical glass facade (in the northern hemisphere)

(B) A below-ground basement floor slab

(C) A south-facing roof slope or flat rooftop surface

(D) An interior non-load-bearing partition wall

Q3. The **Construction and Demolition (C&D) Waste Management Rules, 2016** notified by the Ministry of Environment, Forest and Climate Change (MoEFCC) prescribe clear responsibilities for the segregation, storage, transportation, and processing of construction debris in India. According to these Rules, who bears the **primary legal responsibility** for processing or delivering C&D waste to authorised facilities?

(A) The Municipal Corporation, which must collect and process all C&D waste free of charge

(B) Bulk generators — projects generating ≥ 20 tonnes per day of C&D waste — who must self-process or deliver to authorised processing facilities

(C) The Central Pollution Control Board (CPCB), which operates dedicated C&D processing plants

(D) Individual households generating any quantity of C&D waste from minor home repairs

Q4. The concept of a **Net Zero Energy Building (NZEB)** provides a clear and measurable performance target for sustainable architecture. Which of the following metrics **most accurately defines** an NZEB?

(A) The building uses no fossil fuels for space heating or cooling at any time

(B) The building generates zero embodied carbon during its entire construction phase

(C) The building's annual operational energy deficit is offset solely by purchasing Renewable Energy Certificates (RECs) sourced from off-site generators

(D) Annual on-site renewable energy generation equals or exceeds the building's total annual energy consumption

Q5. **Thermal mass** is a key passive design strategy used to moderate indoor temperature swings: a high-thermal-mass building element absorbs heat

during the day and releases it slowly at night. Which combination of material properties **best defines** high thermal mass?

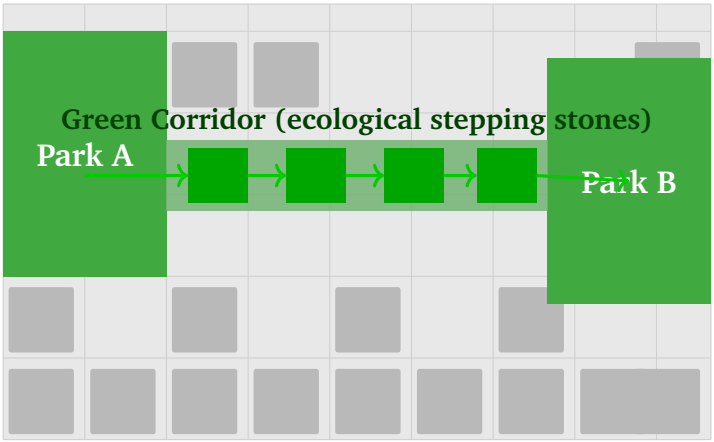
(A) High specific heat capacity combined with high material density

(B) Low thermal conductivity combined with high surface reflectivity

(C) High thermal conductivity combined with high surface emissivity

(D) Low moisture absorption combined with high vapour permeability

Q6. Urban green spaces — parks, street tree rows, roadside verges, and community gardens — can function as critical ecological assets beyond their recreational value. The schematic city plan below shows two large parks connected through smaller green patches. Which ecological concept **best describes** the role of urban green spaces as **ecological stepping stones** linking larger habitat patches?



Schematic: urban ecological network connecting two large habitat patches

(A) Urban farming corridor network for food-system localisation

(B) Biophilic design matrix integrating nature into the built fabric

(C) Ecological network / green infrastructure connectivity

(D) Permaculture zoning system organised around human-use intensity

Q7. Ecological succession is the sequential process by which communities of organisms colonise and transform an environment over time. In a **newly created urban pond** containing clear, nutrient-poor water with no established vegetation or sediment layer, which group of organisms would be among the **first ecological colonisers** (pioneer species)?

(A) Aquatic macrophytes such as water lilies (*Nymphaea* spp.) and emergent reeds

(B) Phytoplankton and microscopic algae

(C) Dragonflies, water beetles, and other aquatic macroinvertebrates

(D) Frogs, newts, and semi-aquatic reptiles

Q8. Conventional impermeable hard surfaces — concrete pavements, asphalt roads, and paved plazas — increase the volume and speed of stormwater runoff, raising the risk of downstream flooding. Which of the following **site design strategies** most directly reduces peak stormwater runoff by **increasing on-site infiltration** of rainwater into the ground?

(A) Installing large underground reinforced concrete stormwater detention tanks

(B) Raising the finished floor level of all buildings above the flood-plain datum

(C) Installing conventional cast-iron catch basins at low-lying points of the site

(D) Replacing impermeable surfaces with permeable paving or porous surface treatment across parking areas and pedestrian paths

Q9. The **Wildlife Protection Act, 1972** provides legal protection to both fauna and flora through its numbered Schedules, with each Schedule prescribing a specific level of protection and associated penalties. Plant species that are threatened by over-collection and illegal trade receive special legal protection. Under which Schedule of the Wildlife Protection Act, 1972 are **plant species** protected from collection, uprooting, possession, and trade?

(A) Schedule VI of the Wildlife Protection Act, 1972

(B) Schedule I of the Wildlife Protection Act, 1972

(C) Schedule III of the Wildlife Protection Act, 1972

(D) Schedule V of the Wildlife Protection Act, 1972

Q10. The **EIA Notification, 2006** classifies development projects into categories based on their scale and potential environmental impact, and mandates different Environmental Clearance procedures accordingly. A **public hearing** — in which local communities and affected persons may voice concerns about a proposed project — is a mandatory stage of the clearance process. Under the EIA Notification 2006, for which category of projects is a public hearing **compulsorily required**?

(A) Category B2 projects that have been screened out from preparing a full EIA report

(B) Category B1 projects appraised by the State Expert Appraisal Committee (SEAC)

(C) Category A projects appraised at the central level by the Expert Appraisal Committee (EAC)

(D) All projects with a capital investment above Rs. 1 crore, irrespective of their category

Detailed Solutions

Q1.

Solution

Concept — Stack Effect (Thermal Buoyancy Ventilation): The stack effect is driven by the fact that warm air is less dense than cool air and therefore rises. In a building with a large internal vertical height, warm air accumulates at the top and escapes through high-level openings, creating a pressure differential that draws cool fresh air in through low-level inlets. The driving pressure is: $\Delta P \propto H \times \Delta T$, where H is the vertical height between inlet and outlet, and ΔT is the indoor-outdoor temperature difference. A greater H produces a stronger stack effect.

Step 1 — Identify the key parameter: For the stack effect to be a powerful ventilation strategy, the building must provide a large height differential (H) between low-level inlets and high-level outlets, combined with a continuous open air path for buoyant warm air to rise through.

Step 2 — Match building type to maximum H: A **tall atrium building** provides several storeys of unobstructed vertical space (the atrium void), with dedicated low-level inlets at ground floor and high-level clerestory windows or roof outlets at the apex. This combination delivers the largest H and the strongest stack-effect pressure, making it the building type where this strategy is most effectively exploited.

Why other options are wrong:

- Option B: Single-storey bungalows have a ceiling height of only 2.7–3.0 m, giving a negligible H and near-zero stack pressure.
- Option C: Basement parking structures are below grade and rely on mechanical exhaust; there is no useful vertical height for natural buoyancy-driven flow.
- Option D: Single-storey warehouses have a uniform low ceiling and no dedicated high-level outlet positioned above a tall open void.

Final Answer: Tall atrium buildings maximise the height differential that drives stack-effect ventilation $\Rightarrow$ A

Answer: (A) Go Back to Q1

Q2.

Solution

Concept — Building-Integrated Photovoltaics (BIPV): BIPV replaces conventional building envelope components (roof tiles, facade panels, skylight glazing) with PV-active elements that simultaneously protect the building from weather and generate electricity. The primary design objective is to maximise incident solar radiation on the PV surface across the year.

Step 1 — Optimum solar geometry in the northern hemisphere: The sun tracks across the *southern* sky throughout the year in the northern hemisphere (India included). A surface facing south and tilted at an angle close to the site latitude receives the maximum annual global solar irradiance. The roof is also largely unobstructed by building elements that might cast shadows.

Step 2 — Match to most common BIPV element: The **south-facing roof slope** or **flat rooftop** (with south-tilted module arrays) consistently receives the highest annual solar irradiance and is the most widely adopted, cost-effective location for BIPV installations globally and in India.

Why other options are wrong:

- Option A: A north-facing facade faces *away* from the sun in the northern hemisphere and receives only diffuse radiation — severely limiting PV output.
- Option B: A below-ground floor slab receives no direct or diffuse sunlight; it cannot function as a solar energy collector.
- Option D: Interior partition walls are shielded from exterior sunlight by the building envelope and are entirely unsuitable for photovoltaic integration.

Final Answer: South-facing roof slope / rooftop maximises annual solar yield for BIPV $\Rightarrow$ $\boxed{\text{C}}$

Answer: (C) Go Back to Q2

Q3.

Solution

Concept — C&D Waste Management Rules, 2016 (India): The Construction and Demolition Waste Management Rules, 2016 were notified by MoEFCC under the Environment (Protection) Act, 1986. They apply the "polluter pays" principle: those who generate large quantities of C&D waste bear direct legal responsibility for its proper management rather than passing that burden to local bodies.

Step 1 — Definition of "bulk generator" (Rule 3(c)): A **bulk generator** is any project or site that generates **20 tonnes or more per day** of C&D waste. Large construction, infrastructure, and demolition projects typically fall into this category.

Step 2 — Obligations of bulk generators (Rule 4): Bulk generators must: (i) segregate waste at source into concrete, bricks/masonry, wood, metal, glass, etc.; (ii) transport it only in covered vehicles to authorised sites; (iii) either *self-process* the waste on site or *deliver* it to facilities designated by the local authority. They are prohibited from mixing C&D waste with municipal solid waste or burning it.

Why other options are wrong:

- Option A: Municipal Corporations are responsible for *setting up* processing facilities and managing waste from *small* generators, not for collecting from bulk generators free of charge.
- Option C: CPCB issues guidelines and oversees compliance but does not operate C&D processing plants.
- Option D: Individual households generating small quantities follow a simpler registration procedure; the bulk-generator obligations do not apply to them.

Final Answer: Bulk generators (≥ 20 t/day) bear primary C&D waste processing responsibility $\Rightarrow$ $\boxed{\text{B}}$

Answer: (B) Go Back to Q3

Q4.

Solution

Concept — Net Zero Energy Building (NZEB): An NZEB is defined by its *annual energy balance*. The definition is used by ASHRAE Standard 228, the US Department of Energy, and is embedded in India's Energy Conservation Building Code (ECBC) 2017. The core idea is that the building itself generates enough renewable energy to cover its own consumption over a full calendar year.

Step 1 — Distinguish NZEBs from related but different concepts:

- A *fossil-fuel-free building* avoids combustion fuels but may still import large amounts of grid electricity.
- A *net zero carbon building* targets greenhouse-gas emissions (including embodied carbon), not the energy balance specifically.
- Purchasing RECs is a carbon-accounting tool, not an on-site generation measure.

Step 2 — Identify the correct metric: The defining metric is:

$$\underbrace{\text{Annual on-site renewable energy generation (kWh/yr)}}_{\text{e.g., rooftop PV, wind turbine}} \geq \underbrace{\text{Total annual building energy consur}}_{\text{HVAC, lighting, plug loads, etc}}$$

Any surplus may be exported to the utility grid.

Why other options are wrong:

- Option A: Eliminating fossil fuels for heating is necessary but not sufficient; it does not guarantee that on-site renewables cover all other electricity loads.
- Option B: Zero embodied carbon in construction is a separate objective addressing material production and construction-phase emissions, not operational energy balance.
- Option C: Purchasing off-site RECs is a financial offset mechanism; it does not require on-site renewable generation and is not accepted as NZEB compliance by most codes.

Final Answer: Annual on-site renewable generation $\geq$ total annual energy consumption defines NZEB $\Rightarrow$ $\boxed{\text{D}}$

Answer: (D) Go Back to Q4

Q5.

Solution

Concept — Thermal Mass in Passive Design: Thermal mass describes a material's capacity to absorb, store, and later release heat energy. In passive building design, high-thermal-mass elements (concrete floors, brick walls, stone) act as thermal batteries: they absorb solar and internal heat gains during the day, moderating peak indoor temperatures, and release stored heat at night when outdoor temperatures drop.

Step 1 — Governing formula: The heat energy Q stored by a material is:

$$Q = m \cdot c_p \cdot \Delta T \;=\; (\rho \cdot V) \cdot c_p \cdot \Delta T$$

where m is mass, c_p is specific heat capacity, ΔT is the temperature swing, ρ is density, and V is volume. For a given volume, thermal mass increases with **high ρ (density)** and **high c_p (specific heat capacity)**.

Step 2 — Common high-thermal-mass materials:

- Concrete: $\rho \approx 2300$ kg/m^3, $c_p \approx 0.88$ kJ/(kg·K)
- Brick: $\rho \approx 1800$ kg/m^3, $c_p \approx 0.84$ kJ/(kg·K)
- Water: $\rho \approx 1000$ kg/m^3, $c_p \approx 4.18$ kJ/(kg·K) (highest c_p)

Why other options are wrong:

- Option B: Low thermal conductivity characterises *insulation* (e.g., mineral wool, EPS), not thermal mass; reflectivity relates to solar gain control, not heat storage.
- Option C: High thermal conductivity means heat passes through the material quickly and is not retained; high surface emissivity aids radiative cooling rather than heat storage.
- Option D: Low moisture absorption is a durability property; vapour permeability is relevant to moisture transport, not thermal energy storage.

Final Answer: High specific heat capacity combined with high density defines thermal mass $\Rightarrow$ A

Answer: (A) Go Back to Q5

Q6.

Solution

Concept — Ecological Networks and Green Infrastructure Connectivity: Urban development fragments natural habitats, isolating wildlife populations in disconnected "islands" of green space. When a population cannot move between patches, it loses genetic diversity and faces local extinction. The concept of an **ecological network** addresses this by deliberately designing a system of habitat patches, corridors, and stepping stones that allow species to disperse, forage, and migrate across a fragmented urban landscape.

Step 1 — Key ecological vocabulary:

- *Habitat patch*: a discrete area of suitable habitat (e.g., a large urban park).
- *Corridor*: a continuous linear linkage of vegetation connecting two patches.
- *Stepping stone*: a small discrete patch positioned between larger patches to facilitate species movement when a continuous corridor is not feasible.
- *Ecological network / green infrastructure connectivity*: the integrated system of patches, corridors, and stepping stones planned at the landscape scale.

Step 2 — Apply to the diagram: The schematic shows Park A and Park B (large habitat patches) connected by a linear green corridor containing smaller stepping-stone patches, with arrows indicating species movement. This precisely illustrates an **ecological network / green infrastructure connectivity**.

Why other options are wrong:

- Option A: Urban farming corridors are food-production networks focused on horticulture, not wildlife movement between habitat patches.
- Option B: Biophilic design matrix is an architectural design approach that incorporates natural elements into buildings and interiors, not a landscape-scale habitat-connectivity concept.
- Option D: Permaculture zoning organises land use around a central habitation based on frequency of human access; it is not about inter-patch wildlife movement.

Final Answer: Ecological network / green infrastructure connectivity $\Rightarrow$ C

Answer: (C) Go Back to Q6

Q7.

Solution

Concept — Aquatic Ecological Succession and Pioneer Species: Ecological succession in aquatic systems follows a predictable sequence from simple autotrophic colonisers to complex, species-rich communities. Pioneer species are those that can establish themselves in a bare, nutrient-poor environment with no pre-existing biological infrastructure.

Step 1 — Sequence of aquatic succession in a new pond:

1. **Phytoplankton and microscopic algae** — arrive via wind-dispersed spores and cells; require only water, dissolved minerals, light, and CO_2; begin photosynthesis and oxygenation immediately.
2. **Zooplankton and small aquatic invertebrates** — colonise once phytoplankton provide a food source.
3. **Aquatic macrophytes** (submerged, then floating-leaved, then emergent) — become established once a sediment layer and nutrient pool have developed.
4. **Macroinvertebrates** (dragonfly larvae, water beetles, snails).
5. **Fish, amphibians, and semi-aquatic vertebrates** — the last arrivals, depending on established invertebrate prey and vegetation.

Step 2 — Confirm pioneer group: Phytoplankton and microscopic algae are the true pioneers: their propagules are ubiquitous in the air and arrive immediately; they need only the abiotic environment (sunlight, water, dissolved ions) and can tolerate extreme conditions including high UV exposure and low nutrients.

Why other options are wrong:

- Option A: Water lilies and emergent macrophytes require a sediment layer and an established nutrient pool — they appear *after* phytoplankton has been photosynthesising and enriching the pond for some time.
- Option C: Dragonflies and water beetles are secondary colonisers that depend on invertebrate prey and algal food sources already present.
- Option D: Frogs, newts, and semi-aquatic reptiles are higher-order colonisers dependent on invertebrate prey and suitable vegetation for shelter and breeding.

Final Answer: Phytoplankton and microscopic algae are the pioneer species in a new urban pond $\Rightarrow$ B

Answer: (B) Go Back to Q7

Q8.

Solution

Concept — Stormwater Management and On-Site Infiltration: In a natural landscape, a significant fraction of rainfall infiltrates the soil, recharging groundwater and attenuating peak flows. Urbanisation replaces permeable surfaces with impermeable hard cover, drastically reducing infiltration and creating rapid, high-volume runoff events. Sustainable Urban Drainage Systems (SUDS) / Low Impact Development (LID) aim to restore the pre-development hydrological cycle by re-introducing infiltration on site.

Step 1 — Evaluate each strategy:

- *Underground detention tanks* hold water temporarily, releasing it slowly into drains — they delay runoff but do not add infiltration into the soil.
- *Raising floor levels* is a flood-protection measure for buildings; it does not reduce total runoff volume or increase soil infiltration.
- *Catch basins* collect surface runoff and channel it into the stormwater network; they accelerate, rather than reduce, discharge rates.
- *Permeable paving / porous surface treatment* replaces impermeable surfaces with materials that allow water to pass through to the underlying sub-base and soil, directly increasing infiltration and reducing surface runoff.

Step 2 — Confirm the correct strategy: Permeable paving (permeable concrete, porous asphalt, interlocking grass pavers, gravel surfaces) is the only option that directly replaces impermeable area with infiltration capacity, reducing peak runoff volumes and recharging groundwater simultaneously.

Why other options are wrong:

- Option A: Detention tanks store runoff above or below ground but do not increase soil infiltration.
- Option B: Raising floor levels protects buildings from inundation; it has no effect on the volume or rate of surface runoff across the site.
- Option C: Catch basins accelerate surface drainage to the pipe network; they do not promote infiltration.

Final Answer: Permeable paving / porous surface treatment increases on-site infiltration $\Rightarrow$ $\boxed{\text{D}}$

Answer: (D) Go Back to Q8

Q9.

Solution

Concept — Wildlife Protection Act, 1972 — Schedules for Flora: The Wildlife Protection Act, 1972 (WPA) organises protected species into numbered Schedules that determine the degree of legal protection and associated penalties. Different Schedules apply to different taxonomic groups and threat levels.

Step 1 — Summary of key Schedules under the WPA 1972:

- **Schedule I**: Most critically endangered animals (tiger, elephant, great Indian rhinoceros, lion, snow leopard, etc.); highest penalties; absolutely prohibited from hunting/trade.
- **Schedule II**: Endangered animals; high penalties; strictly protected.
- **Schedule III & IV**: Less threatened animals; lower penalty levels.
- **Schedule V**: "Vermin" — animals the government permits to be hunted (e.g., common crow, fruit bats, rats); the *opposite* of protection.
- **Schedule VI**: **Plant species** protected from uprooting, collection, possession, sale, and trade. Examples include Blue Vanda (*Vanda coerulea*), Red Vanda, Ladies' Slipper Orchid (*Paphiopedilum* spp.), Pitcher Plant (*Nepenthes khasiana*), Cycas beddomei, and Mahogany (*Swietenia mahagoni*).

Step 2 — Confirm the answer: Schedule VI is the *only* Schedule of the WPA, 1972 that specifically addresses **plant species**, protecting them from collection, uprooting, possession, and commercial trade.

Why other options are wrong:

- Option B: Schedule I protects the most endangered *animal* species, not plants.
- Option C: Schedule III lists lesser-protected *animal* species (e.g., porcupines, hyenas, nilgai); it does not cover plants.
- Option D: Schedule V is the "vermin" list — it permits hunting of certain animals; it provides no protection and covers no plant species.

Final Answer: Schedule VI of the Wildlife Protection Act, 1972 protects plant species $\Rightarrow$ A

Answer: (A) Go Back to Q9

Q10.

Solution

Concept — EIA Notification 2006: Project Categories and Public Hearing: The Environmental Impact Assessment (EIA) Notification, 2006 issued under the Environment (Protection) Act, 1986 classifies projects into two categories based on potential environmental impact and appraisal authority:

- **Category A**: Large-scale projects with significant national or inter-state environmental impacts; appraised by the *Expert Appraisal Committee (EAC)* at the *central level* (MoEFCC). Examples: thermal power plants > 500 MW, large highways, major airports, large river valley projects, large mining leases.
- **Category B**: Projects with more localised impacts; appraised at the *state level*. Further sub-divided into:
  - **B1**: Require a full EIA report and, generally, a public hearing.
  - **B2**: Exempted from preparing a full EIA and from conducting a public hearing.

Step 1 — Public hearing requirement: Schedule I, Clause 7 of the EIA Notification, 2006 mandates that a **public hearing** must be conducted as part of the Environmental Clearance process for projects that undergo a full EIA. For **Category A** projects this is unconditionally mandatory.

Step 2 — Confirm the answer: Category A projects, being the largest and most impactful, always require a full EIA and a compulsory public hearing before the EAC can grant Environmental Clearance.

Why other options are wrong:

- Option A: Category B2 projects are *explicitly exempt* from conducting a public hearing under the EIA Notification, 2006.
- Option B: Category B1 projects generally require a public hearing as part of their full EIA, but the *unambiguous* mandatory requirement applies to Category A projects; B1 state-level appraisal may have procedural variations by state.
- Option D: The EIA Notification categorises projects by their nature, scale, and environmental sensitivity, not by a simple capital-investment threshold alone.

Final Answer: Category A projects (central appraisal) require a mandatory public hearing $\Rightarrow$ $\boxed{\text{C}}$

Answer: (C) Go Back to Q10

Answer Key

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