MAH M Arch CET Environment

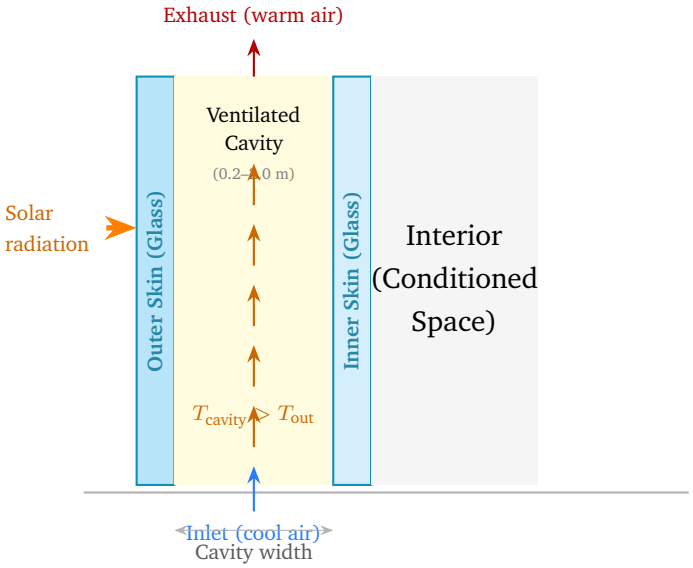
Sample Paper – 6

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 cross-section diagram below illustrates a **double-skin facade** system. Based on the figure and your knowledge of environmental building design, which statement **best describes** the primary thermal mechanism by which the ventilated cavity between the two skins improves the building's environmental performance?



(A) The outer glass skin acts as a photovoltaic panel, converting incident solar radiation directly into electricity that powers the building's cooling system, thereby eliminating the need for a separate air-conditioning unit.

(B) Solar radiation absorbed in the ventilated cavity heats the trapped air, which rises by natural convection and escapes at the top, continuously flushing heat away from the inner skin; this thermally decouples the interior from direct solar load and also attenuates outdoor noise through the air gap, delivering combined thermal and acoustic benefits.

(C) The double-skin system works entirely by radiative cooling: the cavity emits long-wave radiation skyward at night, chilling the inner skin below the dew point so that condensation on the inner surface cools the occupied floor below by cold-water trickle.

(D) Warm air trapped in the cavity creates a pressure seal that prevents any wind-driven rain or dust infiltration; no thermal benefit is achieved because both glass skins have identical thermal transmittance values.

Q2. In fenestration performance assessment for energy-efficient buildings, the **Solar Heat Gain Coefficient (SHGC)** is a critical parameter. Which of the following statements **correctly and completely** describes SHGC and the role of **low-emissivity (low-e) coatings** in improving glazing performance?

(A) SHGC is defined as the ratio of the U-value of a glazing assembly to its visible light transmittance; a low-e coating improves SHGC by increasing the U-value, thereby reducing thermal bridging across the glass pane.

(B) SHGC represents the fraction of incident ultraviolet radiation that passes through a glazing unit and reaches the interior; low-e coatings are applied to block only UV radiation above 380 nm, with no effect on infrared heat transfer or the visible spectrum.

(C) SHGC is the percentage of direct solar radiation reflected by the outer surface of the glass; a high SHGC value is always desirable in all climates because it indicates superior reflectance, reducing both cooling and heating loads simultaneously in every season.

(D) SHGC is the fraction of incident solar radiation—comprising both direct solar transmittance and the inward-flowing portion of absorbed radiation—that enters the building as heat; values range from 0 to 1, and a lower SHGC reduces unwanted solar heat gain in hot climates. Low-e coatings achieve this by depositing a microscopically thin metallic or metal-oxide layer on the glass surface that selectively reflects long-wave infrared radiation (heat) while transmitting visible light, thereby simultaneously lowering the SHGC and the U-value.

Q3. The **IGBC Green Homes** rating system is a voluntary, consensus-based national certification programme designed to evaluate the environmental performance of residential buildings in India across multiple categories including site selection, water efficiency, energy efficiency, indoor air quality, and innovation. This rating system is **developed and administered by**:

(A) The **Indian Green Building Council (IGBC)**, a part of the Confederation of Indian Industry (CII), which has its national headquarters at the CII–Sohrabji Godrej Green Business Centre in Hyderabad.

(B) The **Bureau of Energy Efficiency (BEE)**, functioning under the Ministry of Power, which also administers the Energy Conservation Building Code (ECBC) and the Star Labelling Programme for appliances.

(C) The **U.S. Green Building Council (USGBC)**, which licences its LEED rating framework to affiliated councils in South Asia, including a dedicated residential track adapted for Indian construction typologies.

(D) The **Ministry of Housing and Urban Affairs (MoHUA)**, through the Housing and Urban Development Corporation (HUDCO), as part of India's national green affordable housing mission.

Q4. A former industrial site is found to have soil heavily contaminated with heavy metals (cadmium, lead) and organic pollutants from decades of chemical discharge. An environmental consultant recommends **phytoremediation** as a low-cost, in-situ remediation strategy. Which of the following **correctly describes** phytoremediation and names plants that are **well-documented for use in this technique**?

(A) Phytoremediation is the use of specific fungal species introduced into contaminated soil to bio-degrade organic pollutants through enzymatic reactions; common species include *Phanerochaete chrysosporium* and *Trametes versicolor*, with no vascular plants involved.

(B) Phytoremediation refers to the installation of deep-rooted pioneer tree species such as *Eucalyptus* and *Acacia* solely to stabilise loose contaminated soil by mechanical root binding, preventing erosion and surface run-off without any chemical uptake of pollutants from the substrate.

(C) Phytoremediation is the use of living plants—and their associated root-zone microorganisms—to remove, degrade, contain, or immobilise contaminants from soil, sediment, surface water, or groundwater; plants such as **Vetiver grass** (*Chrysopogon zizanioides*), **Sunflower** (*Helianthus annuus*), and **Indian mustard** (*Brassica juncea*) are well-documented hyperaccumulators or rhizofiltration species used for this purpose.

(D) Phytoremediation is a chemical process in which synthetic plant-hormone analogues are injected into contaminated groundwater to precipitate heavy metals as insoluble hydroxides; the term "phyto" refers to the synthetic origin of these hormones rather than to any biological organism.

Q5. The **Millennium Ecosystem Assessment (MEA, 2005)** — a landmark global scientific appraisal commissioned by the United Nations — classified ecosystem services into four broad categories. Which of the following **correctly identifies all four categories** and provides an accurate example for each?

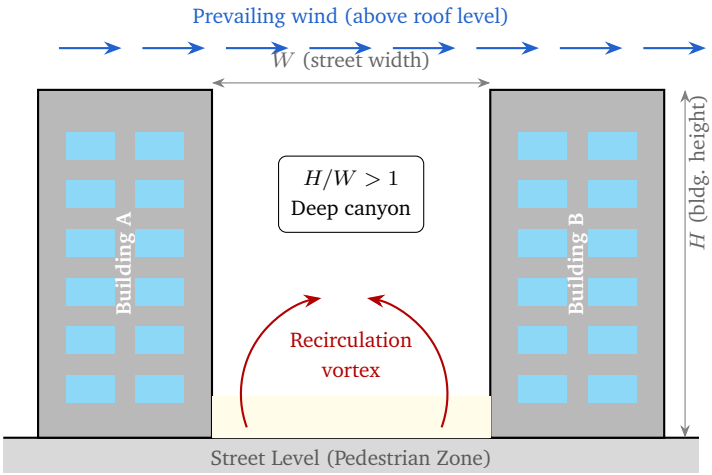
(A) **Extractive**, **Protective**, **Aesthetic**, and **Genetic** services; examples being mineral extraction, flood barriers, scenic views, and crop wild relatives respectively — these represent the four pillars of the MEA framework as adopted by the UNEP.

(B) **Provisioning** (food, fresh water, timber, fibre, genetic resources), **Regulating** (climate regulation, flood control, disease regulation, water purification), **Cultural** (spiritual, recreational, educational, aesthetic values), and **Supporting** (nutrient cycling, soil formation, primary production) services — these are the four categories defined by the MEA, where supporting services are foundational and enable the other three.

(C) **Economic**, **Ecological**, **Social**, and **Technological** services; this framework was adopted at the 1992 Earth Summit in Rio de Janeiro and has been operationalised through the TEEB (The Economics of Ecosystems and Biodiversity) initiative as the authoritative MEA classification.

(D) **Provisioning**, **Regulating**, **Cultural**, and **Restoration** services; the MEA replaced the older "supporting services" category with "restoration services" in a 2010 revision following findings from the IPBES Global Assessment on Biodiversity and Ecosystem Services.

Q6. The diagram below shows a simplified cross-section of an **urban street canyon** formed by tall buildings on both sides of a narrow street. Based on the figure and your knowledge of urban microclimate, which statement **correctly describes** the **street canyon effect** on pedestrian-level wind speed and urban thermal comfort?



(A) When the aspect ratio H/W (building height to street width) exceeds 1.0, buildings act as wind amplifiers, dramatically increasing pedestrian-level wind speeds to more than twice the free-stream velocity measured above the rooftops, thereby creating hazardous conditions for pedestrians and cyclists below.

(B) The street canyon effect exclusively refers to increased solar radiation levels at street level due to the multiple reflections of sunlight between parallel glass-clad building facades; it has no influence on wind patterns, pollutant dispersion, or street-level air temperature.

(C) In a deep urban street canyon (large H/W ratio), the undisturbed prevailing wind at rooftop height is channelled directly down to street level through a Venturi effect, maintaining the same wind speed as above the buildings with only a change in direction.

(D) In a deep urban street canyon with a large H/W aspect ratio, the prevailing wind above roof level is largely decoupled from the street below; reduced ventilation creates a **recirculation vortex** within the canyon, leading to significantly lower pedestrian-level wind speeds, accumulation of air pollutants and heat, elevated urban heat island intensity, and reduced thermal comfort for pedestrians.

Q7. In the context of **constructed wetlands** used for secondary and tertiary wastewater treatment, the two principal design typologies differ in how water flows relative to the substrate and vegetation. Which of the following **correctly distinguishes** a **Free Water Surface (FWS)** constructed

wetland from a **Subsurface Flow (SSF)** constructed wetland?

(A) In an **FWS** system, wastewater flows as a shallow open layer above the substrate surface, exposed to the atmosphere and sunlight, through emergent macrophytes such as *Phragmites australis* (common reed) or *Typha* (cattails); in an **SSF** system, wastewater flows horizontally or vertically *through* a porous medium (gravel, crushed rock) that supports the roots and rhizomes of the wetland plants, keeping the water surface below the substrate and greatly reducing mosquito breeding risk and odour.

(B) In an **FWS** system, all biological treatment is performed by aerobic bacteria living exclusively on the gravel bed beneath the water table; in an **SSF** system, treatment relies on anaerobic decomposition in completely sealed underground tanks with no plant involvement, making them suitable for high-rise buildings.

(C) Both FWS and SSF systems are hydraulically identical; the only difference is that FWS systems are used for industrial effluent and SSF systems for domestic sewage, as mandated by the Central Pollution Control Board (CPCB) guidelines for constructed wetland design in India.

(D) An **FWS** system requires water temperatures above 25 °C throughout the year and is therefore used exclusively in tropical and sub-tropical climates, while an **SSF** system relies on closed-cycle chemical dosing and has no temperature constraints, making it suitable for cold climates.

Q8. Indoor air quality in buildings is significantly affected by **Volatile Organic Compounds (VOCs)** emitted from interior finishes and furnishings. Which of the following statements **most accurately** describes VOCs in the context of building materials, their health effects, and the role of low-VOC products?

(A) VOCs are exclusively generated by industrial HVAC equipment—such as refrigerants and duct-cleaning chemicals—and are never present

in paints, adhesives, flooring, or furniture; the term is therefore inapplicable to assessment of interior finishing materials.

(B) VOCs are beneficial compounds intentionally added to interior paints and varnishes to accelerate drying time and improve adhesion; medical guidelines recommend high-VOC paints for newly occupied hospital wards and schools because of their antimicrobial properties.

(C) **VOCs** are a broad class of carbon-based chemicals—including formaldehyde, benzene, toluene, xylene, and acetaldehyde—emitted at room temperature from paints, adhesives, composite wood products (MDF, plywood), carpets, and sealants. Prolonged exposure causes headaches, nausea, respiratory irritation, and in severe cases liver and kidney damage or carcinogenicity; **low-VOC** and **zero-VOC paints** reduce these emissions by using water-based carriers, limiting solvent content, and substituting hazardous pigment binders with safer alternatives, thereby improving indoor air quality.

(D) VOCs in buildings are regulated solely by their flammability, not their toxicity; the National Building Code of India classifies low-VOC paints only under fire-safety provisions, with no mention of indoor air quality or occupant health implications.

Q9. The **Solid Waste Management (SWM) Rules, 2016** issued by the Ministry of Environment, Forest and Climate Change under the Environment (Protection) Act, 1986, introduced significant changes over the earlier Municipal Solid Wastes (Management and Handling) Rules, 2000. Which of the following statements **correctly describes** a key provision of the SWM Rules, 2016?

(A) The SWM Rules, 2016 abolished the requirement for door-to-door waste collection and instead mandated that all households deliver segregated waste to centralised community collection depots by 07:00 hrs every morning, with penalties for late delivery.

(B) The SWM Rules, 2016 introduced **Extended Producer Responsibility (EPR)**, making brand owners, importers, and retailers responsible for the collection of post-consumer packaging waste; they also

mandated **segregation of waste at source** into at least three streams—**wet (biodegradable)**, **dry (recyclable)**, and **domestic hazardous waste**—placing legal obligations on bulk waste generators (hotels, malls, residential complexes >50 units) to manage and process their waste within their premises.

(C) The SWM Rules, 2016 restricted the jurisdiction of the rules to Class-I cities (population above 1 lakh) and State capitals only; smaller urban local bodies and panchayats were explicitly excluded from compliance obligations until 2025.

(D) The SWM Rules, 2016 made incineration at municipal incinerators the only permissible method of solid waste disposal in India, banning all forms of composting, biomethanation, and mechanical-biological treatment (MBT) of mixed municipal solid waste.

Q10. The **Plastic Waste Management (PWM) Rules, 2016** (as amended in 2018 and 2021–22) issued under the Environment (Protection) Act, 1986, address the management of plastic waste in India. Which of the following statements **correctly describes** the categorisation of plastic waste and the phase-out provisions under these rules?

(A) The PWM Rules, 2016 apply exclusively to thermosetting plastics (bakelite, epoxy) and completely exempt thermoplastic materials such as PET, HDPE, PVC, and LDPE from any regulation, as these can be safely landfilled without environmental risk.

(B) Under the PWM Rules, 2016, all plastic carry bags are required to have a minimum thickness of **15 microns**; bags thicker than 100 microns are banned outright because they are more difficult to recycle than thin bags.

(C) The PWM Rules, 2016 prohibit the manufacture and use of all single-use plastic items with immediate effect from 1 January 2017, making India the first country globally to achieve a complete ban on all plastic packaging, including multi-layer plastic used in food and pharmaceutical industries.

(D) The PWM Rules, 2016 categorised plastic waste by thickness and application, mandating a minimum thickness of **50 microns** for plastic carry bags (raised to **75 microns** by the 2021 amendment) to make them thick enough for reuse and collection under EPR. The rules also notified a **phase-out schedule for specific single-use plastic (SUP) items**—such as plastic stirrers, straws, cutlery, polystyrene decoration, and earbuds with plastic sticks—prohibiting their manufacture, import, stocking, distribution, and sale from **1 July 2022**, under the broader framework of India's national commitment to eliminate problematic single-use plastics.

Detailed Solutions

Q1.

Solution

Concept: A double-skin facade (DSF) consists of two glass skins separated by a ventilated intermediate cavity (typically 0.2–2 m wide). The cavity serves as a thermal and acoustic buffer between the external environment and the conditioned interior. Its core working principle is **chimney effect (stack ventilation)**: air in the cavity heats up due to absorbed solar radiation, becomes less dense, rises by natural convection, and exits at the top through openings, continuously drawing cool fresh air in from the bottom.

Step 1 – Thermal decoupling: The inner skin "sees" the cavity air temperature (which is moderated by the chimney flush-out), not the outer glass surface temperature that receives direct solar irradiance. This significantly reduces the thermal load on the inner skin and the HVAC system serving the conditioned interior.

Step 2 – Acoustic attenuation: The air gap between the two glass layers—and the mass of the outer skin—acts as a secondary sound barrier, reducing transmission of external traffic, wind, and rain noise into the interior. Multi-skin facades with wider cavities can achieve sound reduction indices (R_w) 5–10 dB higher than single-skin glazing.

Step 3 – Additional benefits: The outer skin also provides weather protection for the inner skin and any integrated solar shading devices (blinds, louvres) placed inside the cavity, where they are shielded from wind and cleaning is facilitated.

Why other options are wrong:

- **(A)** A standard double-skin facade does not include photovoltaic cells; that is a distinct system (Building-Integrated Photovoltaics, BIPV). The DSF outer skin is transparent glass, not a PV panel.
- **(C)** Radiative night cooling is a separate passive strategy. Double-skin facades do not rely on condensation; in fact, condensation in the cavity is a design problem to be avoided.
- **(D)** The double-skin facade delivers very significant thermal benefits through the chimney effect. Both skins may have different U-values and coatings depending on the design intent.

Final Answer: Option (B) is correct. The ventilated cavity flushes absorbed heat by natural convection, thermally decoupling the interior from solar load, while also providing acoustic attenuation.

Answer: (B) Go Back to Q1

Q2.

Solution

Concept: The **Solar Heat Gain Coefficient (SHGC)** is a dimensionless ratio (0 to 1) that quantifies how much solar energy is admitted through a glazing assembly and converted to heat inside the building. It accounts for *both* directly transmitted solar radiation *and* the secondary heat emission of radiation absorbed by the glass itself. ASHRAE and ECBC both use SHGC as a primary metric for fenestration thermal performance.

Step 1 – SHGC formula:

$$\text{SHGC} = T_{\text{solar}} + N_i \cdot A_i$$

where T_{solar} is direct solar transmittance, N_i is the inward-flowing fraction of absorbed radiation, and A_i is absorptance. A single clear float glass has SHGC ≈ 0.86; a high-performance low-e triple-glazed unit can achieve SHGC < 0.25.

Step 2 – Low-e coatings: A low-emissivity coating deposits a metallic layer (typically silver, tin oxide, or indium tin oxide, 5–$20\,\text{nm}$ thick) on the glass surface. This layer:

- Reflects long-wave infrared (LW-IR, $> 3\,\mu$m) radiation—the re-emitted heat from warm interior surfaces—back into the room in winter ("soft-coat" hard-coat for cold climates).
- In solar-control low-e coatings for hot climates, the metallic layer also reflects a portion of near-infrared solar radiation (0.7–$2.5\,\mu$m) before it enters, reducing SHGC without heavily cutting visible light transmittance.

Why other options are wrong:

- **(A)** SHGC is not the ratio of U-value to visible transmittance; those are entirely separate properties. Low-e coatings reduce U-value, not increase it.
- **(B)** SHGC covers the full solar spectrum (UV + visible + near-IR, 0.3–2.5 μm), not UV alone. UV blocking is a separate consideration for interior fade protection.
- **(C)** SHGC is *transmittance-based*, not reflectance-based. A higher SHGC means *more* heat gain, which is desirable only in heating-dominated (cold) climates, not universally.

Final Answer: Option (D) is correct. SHGC is the total solar heat gain fraction (0–1); low-e coatings reduce both SHGC and U-value by selectively reflecting infrared radiation while preserving visible light transmittance.

Answer: (D) Go Back to Q2

Q3.

Solution

Concept: India has a well-established two-tier national green building rating landscape. The **Indian Green Building Council (IGBC)**, established in 2001, operates under the umbrella of the **Confederation of Indian Industry (CII)** with its Green Business Centre in Hyderabad. IGBC has developed a suite of green building rating programmes adapted to Indian contexts, of which **IGBC Green Homes** is the residential variant.

Key facts about IGBC Green Homes:

- Launched in 2007; India's first green rating system for residential buildings.
- Covers single-family homes, multi-family apartments, townships, and plotted developments.
- Categories: Sustainable Architecture & Design, Site Selection & Planning, Water Efficiency, Energy Efficiency, Indoor Environment Quality, Innovation & Design Process.
- Certification levels: Certified, Silver, Gold, Platinum.
- Distinct from **GRIHA** (Green Rating for Integrated Habitat Assessment), which is administered by TERI and promoted by MNRE/MoHUA.

Why other options are wrong:

- **(B)** The Bureau of Energy Efficiency (BEE) administers the Energy Conservation Building Code (ECBC) and Star Ratings for appliances and commercial buildings, not the IGBC Green Homes certification.
- **(C)** The USGBC administers LEED, a separate system. While IGBC has a memorandum of understanding with USGBC and IGBC Green Homes benchmarks were partly inspired by LEED for Homes, it is a fully independent Indian programme.
- **(D)** MoHUA/HUDCO promote GRIHA and green affordable housing policies but do not administer the IGBC Green Homes rating.

Final Answer: Option (A) is correct. IGBC Green Homes is developed and administered by the Indian Green Building Council (IGBC), a part of CII, headquartered at the CII–Sohrabji Godrej Green Business Centre, Hyderabad.

Answer: (A) Go Back to Q3

Q4.

Solution

Concept: Phytoremediation is a cost-effective, solar-energy-driven, in-situ environmental technology that uses living plants and their associated rhizosphere microorganisms to clean up contaminated environments. It covers several sub-mechanisms:

- **Phytoextraction**: Plants absorb contaminants (especially heavy metals) through roots into above-ground biomass, which is then harvested and disposed of safely.
- **Phytodegradation**: Plants metabolise and break down organic pollutants within root tissues or via root exudates.
- **Rhizofiltration**: Plant roots adsorb and absorb contaminants from water or aqueous waste streams.
- **Phytostabilisation**: Plants immobilise contaminants in the soil, reducing bioavailability and preventing leaching.

Well-documented hyperaccumulator plants:

- **Vetiver grass** (*Chrysopogon zizanioides*): Extensively used in India for phytoremediation of lead, cadmium, and arsenic-contaminated soils and constructed wetlands.
- **Sunflower** (*Helianthus annuus*): Used at Chernobyl to extract ^{137}Cs and ^{90}Sr from contaminated water; effective for uranium, lead, and zinc.
- **Indian mustard** (*Brassica juncea*): High accumulation rates for lead, chromium, cadmium, and copper.

Why other options are wrong:

- **(A)** This describes **mycoremediation** (use of fungi), which is a related but entirely separate bioremediation technique; phytoremediation specifically refers to vascular plants.
- **(B)** Mechanical root binding is one benefit of pioneer trees, but this describes **erosion control**, not phytoremediation. Phytoremediation specifically involves chemical uptake and transformation of pollutants.
- **(D)** This describes a chemical injection process, not a plant-based technology. The prefix "phyto-" derives from the Greek for plant ($\varphi\upsilon\tau\acute{o}\nu$), not from synthetic chemicals.

Final Answer: Option (C) is correct. Phytoremediation uses living plants (Vetiver, Sunflower, Indian mustard) and root-zone microorganisms to remove, degrade, or immobilise contaminants from soil and water.

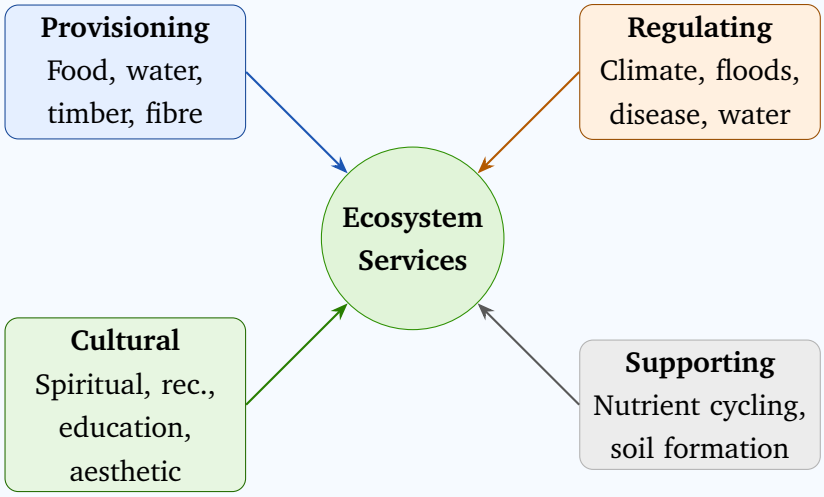
Answer: (C) Go Back to Q4

Q5.

Solution

Concept: The **Millennium Ecosystem Assessment (MEA)** was a major United Nations-commissioned scientific appraisal (2001–2005) that assessed the consequences of ecosystem change for human wellbeing. It established a framework of four categories of ecosystem services that has become the global standard in environmental science, urban planning, and landscape architecture.

The four MEA categories with examples:



Key distinctions:

- **Supporting services** are the foundational processes that underpin all others; they do not directly benefit humans but make the other three categories possible.
- **Regulating services** are indirect benefits humans receive from ecosystem processes (e.g., mangroves buffering cyclone storm surges).
- **Provisioning services** are tangible products obtained from ecosystems (e.g., rice paddy harvest, groundwater, medicinal plants).
- **Cultural services** are the non-material benefits that enrich human life (e.g., river Ganga's spiritual significance, urban parks for recreation).

Why other options are wrong:

- **(A)** "Extractive, Protective, Aesthetic, Genetic" is not the MEA framework; this list conflates industrial resource extraction with ecological services.
- **(C)** "Economic, Ecological, Social, Technological" is not the MEA classification; this resembles a generic sustainability framework, not the formal MEA categorisation.
- **(D)** The MEA was never revised to replace "Supporting" with "Restoration"; the 2005 four-category framework remains the authoritative MEA classification.

Final Answer: Option (B) is correct. The four MEA categories are Provisioning, Regulating, Cultural, and Supporting services, with Supporting services underpinning all the rest.

Answer: (B) Go Back to Q5

Q6.

Solution

Concept: An **urban street canyon** is formed when buildings on both sides of a street are tall relative to the street width, described by the aspect ratio H/W. When $H/W > 1$ (deep canyon), the buildings act as walls that **isolate the street-level air** from the faster prevailing wind above the rooftops. This has profound effects on urban microclimate, air quality, and pedestrian comfort.

Step 1 – Wind dynamics in deep canyons: The roof-level wind cannot penetrate freely into the narrow canyon. Instead, it creates a **recirculation vortex**: wind skims over the rooftops, exerts a drag on the canyon air, and generates a slow rotating vortex between the two building facades. Pedestrian-level wind speeds in deep canyons can be only 10–20% of the above-roof free-stream wind speed.

Step 2 – Consequences of reduced ventilation:

- **Pollutant accumulation**: Vehicle exhaust (NOx, $PM_{2.5}$, CO) cannot disperse and reaches concentrations 3–5$\times$ higher than in open urban settings.
- **Heat island intensification**: Reduced sky view factor (buildings obstruct long-wave radiative cooling to the sky), reduced wind cooling, and absorbed solar re-radiation from dark surfaces all trap heat.
- **Thermal discomfort**: Reduced air movement dramatically lowers the physiological equivalent temperature (PET) benefit that wind provides on warm days.

Step 3 – Design implications: Urban designers can mitigate canyon effects by

introducing **street trees** (shade and evapotranspiration), **cool pavements**, **increased H/W setbacks**, and **building gaps** at regular intervals to create wind corridors ("ventilation fingers").

Why other options are wrong:

- **(A)** Buildings do not amplify wind to twice the free-stream speed; the opposite occurs. Deep canyons significantly reduce pedestrian-level wind speed.
- **(B)** The street canyon effect is primarily a wind and thermal phenomenon; defining it as "only" a solar reflection issue is a fundamental mischaracterisation.
- **(C)** The Venturi effect would require a narrowing cross-section and relatively unobstructed flow path. In a blunt-ended street canyon, the geometry creates separation and recirculation, not acceleration.

Final Answer: Option (D) is correct. In a deep street canyon ($H/W > 1$), prevailing wind is decoupled from street level, creating recirculation vortices, low pedestrian-level wind speeds, pollutant and heat accumulation, and reduced thermal comfort.

Answer: (D) Go Back to Q6

Q7.

Solution

Concept: Constructed wetlands are engineered systems designed to replicate and optimise the natural water purification processes of natural wetlands for treating municipal, agricultural, and industrial wastewater. They use a combination of substrate, macrophyte plants, and associated microorganisms to remove BOD, TSS, nitrogen, phosphorus, and pathogens. The two primary typologies are:

Free Water Surface (FWS) Constructed Wetlands:

- Water flows as a shallow layer (5–40 cm) *above* the substrate surface, exposed to open air and sunlight.
- Emergent macrophytes (*Phragmites australis*, *Typha latifolia*, *Scirpus* spp.) grow with stems above water and roots in the substrate.
- Treatment mechanisms: sedimentation, algal photosynthesis, aerobic/anaerobic microbial activity.
- Limitation: open water surface allows mosquito breeding, some odour, and wildlife access.

Subsurface Flow (SSF) Constructed Wetlands:

- Wastewater flows *through* a porous medium (gravel bed), keeping the water surface **below the substrate** at all times.
- Can be horizontal flow (HF) or vertical flow (VF); VF systems alternate saturated/unsaturated cycles to promote nitrification.
- No open water surface: eliminates mosquito habitat, reduces odour, permits safe use in dense urban areas.
- Higher capital cost for gravel substrate but lower public health risk.

Why other options are wrong:

- **(B)** Both FWS and SSF systems involve plants; macrophyte roots are integral to biofilm formation in SSF. There are no sealed tanks without plants in the standard definitions.
- **(C)** The choice between FWS and SSF is not dictated by effluent type alone; both can treat domestic or industrial wastewater depending on design. CPCB guidelines recommend both typologies for Indian conditions.
- **(D)** Both types can be engineered for temperate to tropical climates; SSF systems perform well even in cooler climates due to insulation provided by the substrate. Neither requires closed-cycle chemical dosing.

Final Answer: Option (A) is correct. FWS systems have an open water surface above substrate; SSF systems convey wastewater through a buried porous medium, eliminating mosquito risk and significantly reducing odour.

Answer: (A) Go Back to Q7

Q8.

Solution

Concept: Volatile Organic Compounds (VOCs) are a large group of carbon-based chemical compounds that vaporise at room temperature (boiling point below $250\,^{\circ}\text{C}$ at atmospheric pressure, as per the WHO definition). They constitute a major source of **indoor air pollution (IAP)** in buildings and are responsible for what is colloquially called **Sick Building Syndrome (SBS)**.

Sources of VOCs in buildings:

- **Paints and varnishes**: Solvent-based formulations emit toluene, xylene,

ethylbenzene (BTEX compounds) during application and for months afterwards.

- **Adhesives and sealants**: Construction adhesives, carpet glues, and silicone sealants emit acetaldehyde, benzene, and chlorinated solvents.
- **Composite wood products**: MDF, particle board, and plywood bonded with urea-formaldehyde (UF) or melamine-formaldehyde (MF) resins continuously off-gas **formaldehyde** (IARC Group 1 carcinogen).
- **Flooring**: Vinyl (PVC) flooring, carpets, and their adhesive underlays emit plasticisers (phthalates) and residual solvents.

Health effects: Short-term: eye, nose, throat irritation; headaches; dizziness; nausea. Long-term: liver and kidney damage; central nervous system effects; carcinogenicity (benzene, formaldehyde).

Low-VOC and Zero-VOC paints:

- Use water as the primary carrier instead of organic solvents.
- LEED v4 and IGBC ratings require VOC content below defined limits (e.g., flat wall paints <50 g/L; non-flat <150 g/L).
- Zero-VOC paints achieve <5 g/L; plant-based natural paints (lime wash, clay paint) achieve near-zero.

Why other options are wrong:

- **(A)** VOCs are extensively documented in paints, adhesives, and furnishings—this is the primary context in which they are regulated for indoor air quality in buildings.
- **(B)** VOCs are toxic pollutants, not beneficial additives. High-VOC products are contraindicated for hospitals and schools.
- **(D)** NBC and ECBC address VOCs under Indoor Environment Quality provisions, not only fire safety; flammability is a separate classification (flash point-based).

Final Answer: Option (C) is correct. VOCs (formaldehyde, benzene, toluene, etc.) are emitted from paints, adhesives, composite wood, and carpets; prolonged exposure causes respiratory harm and carcinogenicity; low-VOC paints reduce emissions through water-based formulations.

Answer: (C) Go Back to Q8

Q9.

Solution

Concept: India generates approximately 62 million tonnes of solid waste annually (CPCB, 2019–20), of which less than 20% was being processed in the early 2010s. The **Solid Waste Management Rules, 2016** (G.S.R. 592(E), notified 8 April 2016) superseded the MSW Rules, 2000 and introduced several landmark provisions to address this crisis.

Key provisions of SWM Rules, 2016:

- **Segregation at source** (Rule 4): All households must segregate waste at home into at least three bins: **(1) Wet/biodegradable**, **(2) Dry/recyclable**, **(3) Domestic hazardous** (medicines, batteries, e-waste, used sanitary products).
- **Extended Producer Responsibility (EPR)** (Rule 17): Brand owners, importers, and retailers are legally responsible for establishing waste collection systems for their post-consumer packaging; they must file EPR plans with State Pollution Control Boards.
- **Bulk waste generators** (hotel, mall, market, residential complex $>$50 units, institutional premises $>5000\,m^2$): Must process/treat their own biodegradable waste within the premises (composting, biomethanation).
- **Widened jurisdiction**: Rules apply to urban local bodies (ULBs) of *all* sizes, including census towns and gram panchayats in peri-urban areas—a major expansion from the 2000 rules which focused on Class-I cities.
- **No mandatory incineration**: The rules permit composting, biomethanation, refuse-derived fuel (RDF), and waste-to-energy; incineration is not mandated.

Why other options are wrong:

- **(A)** The rules do not abolish door-to-door collection; they mandate it. Rule 15 requires ULBs to collect segregated waste from each household regularly.
- **(C)** The rules explicitly widened their scope to cover *all* ULBs; the Class-I city limitation is false.
- **(D)** The rules actively promote composting, biomethanation, and MBT as preferred waste processing methods; incineration is listed as one of the permissible options, not the only one.

Final Answer: Option (B) is correct. SWM Rules, 2016 mandated Extended Producer Responsibility and segregation at source into wet, dry, and domestic hazardous streams, with obligations on bulk generators to manage waste on-premises.

Answer: (B) Go Back to Q9

Q10.

Solution

Concept: The **Plastic Waste Management (PWM) Rules, 2016** (G.S.R. 320(E), notified 18 March 2016), amended in 2018 and again in 2021–22, form India's primary regulatory framework for managing plastic waste across its full lifecycle from manufacture to disposal.

Key provisions and the phase-out schedule:

1. Carry bag thickness mandate:

- Original 2016 rules: Minimum thickness raised to **50 microns** for plastic carry bags (from 40 microns under the earlier 2011 rules). Rationale: thicker bags are more easily collected and reused, supporting EPR collection systems.
- 2021 amendment: Thickness further raised to **75 microns** (effective 30 September 2021), and 120 microns by December 2022 for carry bags.

2. Single-Use Plastic (SUP) phase-out (Plastic Waste Management Amendment Rules, 2021): The following items were banned from **1 July 2022**:

- Plastic sticks for earbuds; ice cream sticks; balloon sticks
- Plastic cutlery (plates, cups, glasses, forks, spoons, knives, straws, trays)
- Wrapping or packing films around sweet boxes, invitation cards, cigarette packets
- Polystyrene (thermocol) for decoration
- PVC banners $<$100 microns

These items were identified on the basis of low utility, high littering potential, and ready availability of substitutes.

3. EPR for plastic packaging: PWM Rules require producers, importers, and brand owners to establish EPR systems for all categories of plastic packaging (rigid, flexible, multi-layer, compostable).

Why other options are wrong:

- **(A)** PWM Rules cover all plastics including thermoplastics such as PET, HDPE, LDPE, PVC, and PP; thermosetting plastics are a minor subset and the rules explicitly define five categories of plastic packaging.

- **(B)** The minimum thickness was set at 50 microns in 2016, raised to 75 microns in 2021; there is no 15-micron threshold and thick bags are *not* banned—the opposite is mandated.
- **(C)** India did not ban all single-use plastic from 1 January 2017; the selective SUP ban on specific items took effect from 1 July 2022. Multi-layer plastic for food and pharma is still permitted under EPR.

Final Answer: Option (D) is correct. PWM Rules mandated 50 microns minimum thickness (raised to 75 microns in 2021) for carry bags, and a phase-out of specific single-use plastic items from 1 July 2022 under the 2021 amendment.

Answer: (D) **Go Back to Q10**

Answer Key

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

Click any answer to jump to its detailed solution.