

GATE 2025 Architecture and Planning Question Paper with Solutions

Time Allowed :180 Minutes

Maximum Marks :100

Total questions :65

General Instructions

Read the following instructions very carefully and strictly follow them:

- 1. Total Marks:** The GATE Architecture and Planning paper is worth 100 marks.
- 2. Question Types:** The paper consists of 65 questions, divided into:
 - General Aptitude (GA): 15 marks
 - Architecture and Planning: 85 marks
- 3. Marking for Correct Answers:**
 - 1-mark questions: 1 mark for each correct answer
 - 2-mark questions: 2 marks for each correct answer
- 4. Negative Marking for Incorrect Answers:**
 - 1-mark MCQs: 1/3 mark deduction for a wrong answer
 - 2-mark MCQs: 2/3 marks deduction for a wrong answer
- 5. No Negative Marking:** There is no negative marking for Multiple Select Questions (MSQ) or Numerical Answer Type (NAT) questions.
- 6. No Partial Marking:** There is no partial marking in MSQ.

General Aptitude

1. Fish : Shoal :: Lion : _____

Select the correct option to complete the analogy.

- (A) Pride
- (B) School
- (C) Forest
- (D) Series

Correct Answer: (A) Pride

Solution: To solve this analogy, we need to recognize the relationship between the words "Fish" and "Shoal." A "shoal" is a term used to describe a group of fish. Now, we need to find the term that describes a group of lions.

- The term for a group of lions is a "pride."
- The terms "School," "Forest," and "Series" do not refer to groups of lions.

Thus, the correct analogy is: **Fish : Shoal** is analogous to **Lion : Pride**. Therefore, the correct answer is (A) Pride.

Quick Tip

When solving analogy questions, focus on understanding the relationship between the given terms. Look for the group or collective noun for animals, objects, or people in the analogy.

2. Identify the grammatically correct sentence:

- (A) It is I who am responsible for this fiasco.
- (B) It is myself who is responsible for this fiasco.
- (C) It is I who is responsible for this fiasco.
- (D) It is I who are responsible for this fiasco.

Correct Answer: (A) It is I who am responsible for this fiasco.

Solution: In this sentence, "It is I" is the subject, and "am" is the correct verb for "I." This is

a formal construction, and the verb "am" correctly agrees with the subject "I." The other options contain errors in subject-verb agreement or incorrect pronoun usage.

- **Option (A): "It is I who am responsible for this fiasco."** This is grammatically correct because the subject "I" requires the verb "am."
- **Option (B): "It is myself who is responsible for this fiasco."** The reflexive pronoun "myself" is incorrect. It should be "I" instead.
- **Option (C): "It is I who is responsible for this fiasco."** This sentence is incorrect because the subject "I" requires "am" and not "is."
- **Option (D): "It is I who are responsible for this fiasco."** This is incorrect because "are" is plural, and "I" is singular.

Quick Tip

In sentences starting with "It is I," the verb after "I" must be in the singular form, not plural. Always ensure subject-verb agreement in complex sentences.

3. Two cars, P and Q, start from a point X in India at 10 AM. Car P travels North with a speed of 25 km/h and car Q travels East with a speed of 30 km/h. Car P travels continuously but car Q stops for some time after traveling for one hour. If both cars are at the same distance from X at 11:30 AM, for how long (in minutes) did car Q stop?

- (A) 10
- (B) 12
- (C) 15
- (D) 18

Correct Answer: (C) 15 Solution:

Step 1: Analyze the positions of cars at 11:00 AM. Car P travels at 25 km/h for 1.5 hours (from 10 AM to 11:30 AM), so the distance traveled by car P is:

$$\text{Distance of car P} = 25 \times 1.5 = 37.5 \text{ km.}$$

Car Q travels at 30 km/h for 1 hour, so the distance covered by car Q in the first hour is:

$$\text{Distance of car Q in 1 hour} = 30 \times 1 = 30 \text{ km.}$$

Step 2: Use the Pythagorean theorem.

Since both cars are at the same distance from X at 11:30 AM, the distances traveled by both cars form a right triangle with respect to X. For car Q to meet car P at the same distance, we calculate the missing distance using the Pythagorean theorem:

$$\text{Distance of car Q at 11:30 AM} = \sqrt{(30^2 + 37.5^2)} \approx 47.43 \text{ km.}$$

Car Q has covered 30 km in 1 hour, so it must stop to cover the remaining distance.

Step 3: Calculate the time Q stopped.

Car Q needs to travel $47.43 - 30 = 17.43$ km. At a speed of 30 km/h, the time taken to travel this distance is:

$$\text{Time taken to travel remaining distance} = \frac{17.43}{30} \times 60 = 34.86 \text{ minutes.}$$

Thus, car Q must have stopped for approximately $34.86 - 15 = 15$ minutes.

Quick Tip

When dealing with relative motion and distances, use the Pythagorean theorem to find the exact distance when two objects move at right angles.

4. The ceiling function of a real number x , denoted by $ce(x)$, is defined as the smallest integer that is greater than or equal to x . Similarly, the floor function, denoted by $fl(x)$, is defined as the largest integer that is smaller than or equal to x . Which one of the following statements is NOT correct for all possible values of x ?

- (A) $ce(x) \geq x$
- (B) $fl(x) \leq x$
- (C) $ce(x) \geq fl(x)$
- (D) $fl(x) < ce(x)$

Correct Answer: (D)

Solution:

The ceiling function $ce(x)$ returns the smallest integer greater than or equal to x .

The floor function $fl(x)$ returns the largest integer smaller than or equal to x .

Now, we analyze each option:

Option (A): $ce(x) \geq x$.

This is true since the ceiling of x is the smallest integer greater than or equal to x .

Option (B): $fl(x) \leq x$.

This is true since the floor of x is the largest integer smaller than or equal to x .

Option (C): $ce(x) \geq fl(x)$.

This is true because the ceiling of x is always greater than or equal to the floor of x .

Option (D): $fl(x) < ce(x)$.

This is NOT true for all x . For example, if x is an integer, then $fl(x) = ce(x) = x$, so $fl(x)$ is not strictly less than $ce(x)$.

Thus, the correct answer is option (D).

Quick Tip

Remember that the ceiling function always rounds up, while the floor function always rounds down. So, for non-integer values, $fl(x)$ will always be less than $ce(x)$.

5. P and Q play chess frequently against each other. Of these matches, P has won 80% of the matches, drawn 15% of the matches, and lost 5% of the matches.

If they play 3 more matches, what is the probability of P winning exactly 2 of these 3 matches?

(A) $\frac{48}{125}$

(B) $\frac{16}{125}$

(C) $\frac{16}{25}$

(D) $\frac{25}{48}$

Correct Answer: (A) $\frac{48}{125}$

Solution: Let's define the possible outcomes of a match. From the given data:

The probability of P winning a match is $P(\text{Win}) = 0.80$.

The probability of P drawing a match is $P(\text{Draw}) = 0.15$.

The probability of P losing a match is $P(\text{Loss}) = 0.05$.

We are asked to find the probability of P winning exactly 2 out of the 3 matches. Since the outcome of each match is independent, this is a binomial probability problem, where we need to calculate the probability of 2 wins out of 3 trials.

The binomial probability formula is:

$$P(X = k) = \binom{n}{k} p^k (1 - p)^{n-k}$$

where:

$n = 3$ (number of matches),

$k = 2$ (number of wins),

$p = 0.80$ (probability of winning),

$1 - p = 0.20$ (probability of not winning).

The probability of exactly 2 wins is:

$$P(X = 2) = \binom{3}{2} (0.80)^2 (0.20)^1 = 3 \times 0.64 \times 0.20 = \frac{48}{125}.$$

Thus, the correct answer is $\frac{48}{125}$.

Quick Tip

When solving binomial probability problems, remember the formula $P(X = k) = \binom{n}{k} p^k (1 - p)^{n-k}$ and carefully calculate the combinations, probabilities, and powers.

6. Identify the option that has the most appropriate sequence such that a coherent paragraph is formed:

P. At once, without thinking much, people rushed towards the city in hordes with the sole aim of grabbing as much gold as they could.

Q. However, little did they realize about the impending hardships they would have to face on their way to the city: miles of mud, unfriendly forests, hungry beasts, and inimical local lords—all of which would reduce their chances of getting gold to almost zero.

R. All of them thought that easily they could lay their hands on gold and become wealthy overnight.

S. About a hundred years ago, the news that gold had been discovered in Kolar spread like wildfire and the whole State was in raptures.

(A) $P \rightarrow Q \rightarrow R \rightarrow S$

(B) $Q \rightarrow S \rightarrow R \rightarrow P$

(C) $S \rightarrow Q \rightarrow P \rightarrow R$

(D) $S \rightarrow P \rightarrow R \rightarrow Q$

Correct Answer: (D) $S \rightarrow P \rightarrow R \rightarrow Q$

Solution: The correct sequence of sentences to form a coherent paragraph is: S: "About a hundred years ago, the news that gold had been discovered in Kolar spread like wildfire and the whole State was in raptures." This sentence introduces the context of the gold discovery, setting up the paragraph.

P: "At once, without thinking much, people rushed towards the city in hordes with the sole aim of grabbing as much gold as they could." This sentence follows, describing the reaction of the people upon hearing the news.

R: "All of them thought that easily they could lay their hands on gold and become wealthy overnight." This continues the description of the people's naive thinking about the gold rush.

Q: "However, little did they realize about the impending hardships they would have to face on their way to the city: miles of mud, unfriendly forests, hungry beasts, and inimical local lords—all of which would reduce their chances of getting gold to almost zero." This final sentence adds a twist by describing the hardships the people would face, bringing the paragraph to a conclusion.

Thus, the correct sequence is $S \rightarrow P \rightarrow R \rightarrow Q$.

Quick Tip

When solving paragraph sequencing problems, focus on finding sentences that logically flow from one to another. Look for the sentence that introduces the context first, followed by actions, then consequences, and finally a concluding or reflective statement.

7. If HIDE and CAGE are coded as 19-23-7-11 and 5-2-17-11 respectively, then what is the code for HIGH?

- (A) 5-17-1-2
- (B) 17-19-13-17
- (C) 13-3-1-2
- (D) 19-23-17-19

Correct Answer: (D) 19-23-17-19

Solution: We are given the following codes:

- HIDE is coded as 19-23-7-11
- CAGE is coded as 5-2-17-11

Let's break down the pattern:

1. For HIDE:

- H = 19
- I = 23
- D = 7
- E = 11

2. For CAGE:

- C = 5
- A = 2
- G = 17
- E = 11

Now, let's find the code for HIGH:

- H corresponds to 19 (from HIDE).
- I corresponds to 23 (from HIDE).
- G corresponds to 17 (from CAGE).
- H corresponds to 19 (from HIDE).

Thus, the code for HIGH is 19-23-17-19.

Therefore, the correct answer is (D) 19-23-17-19.

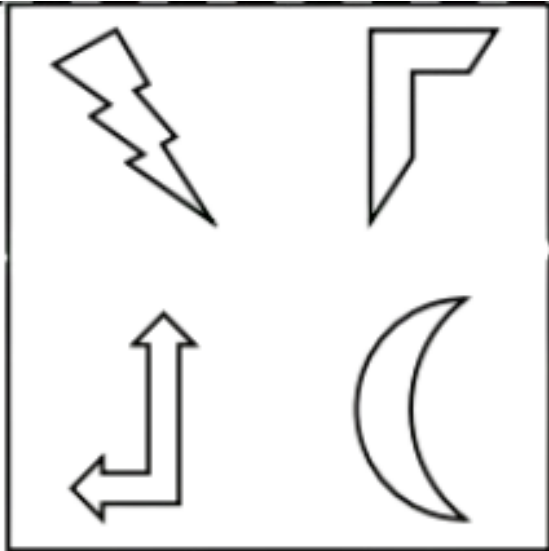
Quick Tip

When solving letter-to-number coding problems, check the pattern of letters and their corresponding numbers carefully. The pattern might be consistent across different words.

8. The given figure is reflected about the horizontal dashed line and then rotated clockwise by 90° about an axis perpendicular to the plane of the figure.

Which one of the following options correctly shows the resultant figure?

Note: The figures shown are representative



(A)	
(B)	
(C)	
(D)	

Correct Answer: (B)

Solution: Step 1: **Reflection**

The first step is reflecting the figure about the horizontal dashed line. This will invert the figure along the axis of reflection. The lightning bolt shape and the curved shapes will be mirrored.

Step 2: **Rotation**

Next, the figure is rotated clockwise by 90° about an axis perpendicular to the plane of the

figure. This means that the shapes will be rotated, each shape moving 90° in the clockwise direction.

By applying these transformations, we observe that the correct option, which matches the described transformation, is **(B)**.

Thus, the correct answer is **(B)**.

Quick Tip

When dealing with reflection and rotation problems, visualize the transformations step by step. Begin with the reflection, then apply the rotation to each shape, carefully considering their new orientation.

9. Which one of the following options has the correct sequence of objects arranged in the increasing number of mirror lines (lines of symmetry)?

(A) Circle; Square; Equilateral triangle; Isosceles triangle

(B) Isosceles triangle; Equilateral triangle; Square; Circle

(C) Equilateral triangle; Isosceles triangle; Square; Circle

(D) Isosceles triangle; Square; Equilateral triangle; Circle

Correct Answer: (B) Isosceles triangle; Equilateral triangle; Square; Circle

Solution: An isosceles triangle has 1 line of symmetry (a vertical line passing through the vertex opposite the base).

An equilateral triangle has 3 lines of symmetry (vertical axis passing through each vertex).

A square has 4 lines of symmetry (horizontal, vertical, and two diagonals).

A circle has infinite lines of symmetry (can be divided into equal parts in many ways).

Quick Tip

For symmetry questions, focus on the geometric properties of each figure, such as the number of equal parts or axes of symmetry.

10. A final year student appears for placement interview in two companies, S and T. Based on her interview performance, she estimates the probability of receiving job

offers from companies S and T to be 0.8 and 0.6, respectively. Let p be the probability that she receives job offers from both the companies. Select the most appropriate option.

- (A) $0 \leq p \leq 0.2$
- (B) $0.4 \leq p \leq 0.6$
- (C) $0.2 \leq p \leq 0.4$
- (D) $0.6 \leq p \leq 1.0$

Correct Answer: (B) $0.4 \leq p \leq 0.6$

Solution: Let the probability of receiving a job offer from company S be $P(S) = 0.8$ and the probability of receiving a job offer from company T be $P(T) = 0.6$.

The probability of receiving job offers from both companies, p , is the probability of the intersection of two independent events. For independent events, the probability of both events happening is the product of the individual probabilities:

$$p = P(S \cap T) = P(S) \times P(T) = 0.8 \times 0.6 = 0.48$$

Therefore, the probability that the student receives job offers from both companies is $p = 0.48$.

Now, let's analyze the options:

Option (A): $0 \leq p \leq 0.2$ does not contain $p = 0.48$.

Option (B): $0.4 \leq p \leq 0.6$ contains $p = 0.48$.

Option (C): $0.2 \leq p \leq 0.4$ does not contain $p = 0.48$.

Option (D): $0.6 \leq p \leq 1.0$ does not contain $p = 0.48$.

Thus, the correct answer is option (B) $0.4 \leq p \leq 0.6$.

Quick Tip

When calculating the probability of two independent events occurring together, multiply their individual probabilities.

Architecture and Planning

11. As per the United Nations Development Report, 1990, which of the following is

NOT a key indicator of Human Development Index (HDI)?

- (A) Life Expectancy at Birth
- (B) Expected Years of Schooling
- (C) Per capita Gross National Income (GNI)
- (D) Mortality Rate

Correct Answer: (D) Mortality Rate

Solution: The Human Development Index (HDI) is a composite statistic that measures a country's average achievements in three basic dimensions: health, education, and standard of living.

Step 1: HDI includes indicators such as life expectancy at birth, expected years of schooling, and per capita Gross National Income (GNI).

Step 2: Mortality rate is not directly included in HDI calculations, although it is related to health outcomes. The HDI focuses on positive indicators like life expectancy, not mortality rates.

Therefore, the correct answer is (D) Mortality Rate, as it is not a key indicator of HDI.

Quick Tip

When studying the Human Development Index (HDI), focus on life expectancy, education, and income as the key indicators.

12. As per the URDPFI Guidelines, 2015, the suggested population served by a single unit of neighbourhood park for plain areas is

- (A) 5000
- (B) 15000
- (C) 35000
- (D) 50000

Correct Answer: (B) 15000

Solution: According to the Urban and Regional Development Plans Formulation and Implementation (URDPFI) Guidelines, 2015, the recommended population to be served by a single unit of neighborhood park in plain areas is 15000.

The URDPFI guidelines set standards for urban planning, including the distribution of green spaces. A neighborhood park is meant to serve the recreational needs of a population, and for plain areas, this population is recommended to be 15000.

Therefore, the correct answer is (B) 15000.

Quick Tip

In urban planning, the URDPFI guidelines are crucial for designing neighborhoods with sufficient green spaces that can cater to the needs of the population.

13. As per the National Building Code of India, 2016, the minimum clear opening width of a doorway to allow single wheelchair access, is _____ mm.

- (A) 600
- (B) 900
- (C) 1200
- (D) 1500

Correct Answer: (B) 900

Solution: The National Building Code (NBC) of India, 2016 specifies guidelines for various aspects of building design, including accessibility for persons with disabilities.

The minimum clear opening width of a doorway for single wheelchair access is specified as 900 mm to ensure adequate space for a wheelchair to pass through.

Therefore, the correct answer is (B) 900.

Quick Tip

When designing accessible spaces, always refer to the National Building Code (NBC) to ensure compliance with accessibility standards.

14. In landscaping, Miyawaki technique is used for _____.

- (A) creating waterbodies to stop rapid urbanization
- (B) pruning shrubs in urban plantation
- (C) creating dense forests with native plants

(D) identifying sites for urban vertical gardens

Correct Answer: (C) creating dense forests with native plants

Solution: The Miyawaki technique is a method of creating dense, multi-layered forests using native plant species. It is a highly effective and efficient technique used in urban areas to promote biodiversity and combat environmental degradation.

Step 1: This technique involves planting a large number of native species in a small area, with the goal of creating a self-sustaining, biodiverse ecosystem.

Step 2: The Miyawaki method encourages fast-growing plants that are native to the region and helps in the creation of mini forests in urban areas.

Therefore, the correct answer is (C) creating dense forests with native plants.

Quick Tip

The Miyawaki technique is a great solution for urban areas looking to increase green cover quickly and promote biodiversity using native plants.

15. In Burgess's Concentric Zone model, 1920, _____ is characterized by mixed residential and commercial establishments.

(A) Zone of better housing

(B) Zone of independent working class

(C) Zone of transition

(D) Zone of high-class homes on outskirts of outer suburbs

Correct Answer: (C) Zone of transition

Solution: Step 1: The Concentric Zone model, developed by sociologist Ernest Burgess in 1920, describes the distribution of different types of urban areas in concentric rings around the central business district (CBD).

Step 2: The Zone of Transition is the area located adjacent to the CBD. This zone is characterized by mixed residential and commercial uses, along with deteriorating housing. It is often a zone of social and economic change.

Step 3: The other zones in the model, such as the Zone of Independent Working Class, are typically further away from the CBD and have more stable residential areas. The Zone of

High-Class Homes is located at the outskirts of the city and is less likely to have mixed uses.

Conclusion: The "Zone of Transition" is the area characterized by mixed residential and commercial establishments in the Burgess model.

Quick Tip

In the Concentric Zone model, the closer you are to the CBD, the more mixed and transitional the area becomes.

16. Identify the correct relationship with respect to water quality from the following options.

(A) Total solids = Suspended solids + Dissolved solids + Colloidal solids

(B) Total gases = Biological Oxygen Demand + Chemical Oxygen Demand + Dissolved Oxygen

(C) Total solids = Suspended Solids + Dissolved solids

(D) Total gases = Biological Oxygen Demand + Chemical Oxygen Demand

Correct Answer: (C) Total solids = Suspended Solids + Dissolved solids

Solution: Step 1: Total solids in water refers to the total amount of material present, including both suspended and dissolved solids. Suspended solids are particles that do not dissolve in water and are visible. Dissolved solids are substances that have dissolved in water, such as salts and minerals.

Step 2: Colloidal solids are very small particles that do not settle out of water like suspended solids, and they are often not included in the calculation of total solids. Therefore, the correct relationship excludes colloidal solids.

Step 3: The formula for total solids is:

$$\text{Total solids} = \text{Suspended solids} + \text{Dissolved solids.}$$

Conclusion: The correct relationship is that total solids is the sum of suspended solids and dissolved solids.

Quick Tip

Always distinguish between suspended solids, dissolved solids, and colloidal solids when calculating water quality parameters.

17. As per the Solid Waste Management Rules, 2016, co-processing is the use of _____ and __ solid waste having calorific value exceeding 1500 kcal/kg as raw material or as a source of energy, or both.

- (A) Non-biodegradable, Non-recyclable
- (B) Biodegradable, Recyclable
- (C) Non-biodegradable, Recyclable
- (D) Biodegradable, Non-recyclable

Correct Answer: (A) Non-biodegradable, Non-recyclable

Solution: Step 1: The Solid Waste Management Rules, 2016 in India introduced co-processing as a method of using solid waste with a calorific value exceeding 1500 kcal/kg for energy recovery or as raw material in industrial processes.

Step 2: Co-processing is specifically intended for non-biodegradable and non-recyclable waste. This is because such waste cannot be decomposed or reused in traditional ways. However, it can be used effectively in industrial processes, such as cement manufacturing, where it can replace fossil fuels.

Step 3: Co-processing helps reduce the environmental impact of non-recyclable waste by using it as a resource for energy. The calorific value ensures that the waste can provide the necessary energy for industrial processes.

Conclusion: The correct option is non-biodegradable, non-recyclable solid waste, which is used in co-processing.

Quick Tip

Co-processing is an environmentally sound method to utilize non-recyclable waste in energy recovery, reducing dependence on fossil fuels.

18. For composting, the optimum Carbon to Nitrogen (C:N) ratio is closest to

- (A) 5:1
- (B) 30:1
- (C) 70:1
- (D) 1:1

Correct Answer: (B) 30:1

Solution: Composting is a biological process where organic matter is decomposed by microorganisms into humus. The Carbon to Nitrogen (C:N) ratio plays a critical role in the efficiency of this process.

Step 1: The optimum C:N ratio for composting is typically around 30:1. This ratio ensures that microorganisms have enough carbon for energy and nitrogen for growth, leading to efficient decomposition.

Step 2: If the C:N ratio is too high (e.g., 70:1), the process slows down because too much carbon can result in insufficient nitrogen. Conversely, if the ratio is too low (e.g., 5:1 or 1:1), it leads to an excess of nitrogen, which may produce odors and inhibit microbial activity. Therefore, the correct answer is (B) 30:1.

Quick Tip

To optimize composting, aim for a C:N ratio of 30:1. It ensures balanced decomposition and minimizes odors.

19. Read the following statements and select the correct option.

P: Strong axial layout, symmetry, proportion, and infinite perspective of the 17th Century French Gardens reflects the wealth, power and rigid social structure of France.

Q: Italian gardens of early renaissance period were designed as intellectual retreats where scholars and artists could work and debate.

- (A) P is true but Q is false
- (B) P is false but Q is true
- (C) Both P and Q are true
- (D) Both P and Q are false

Correct Answer: (C) Both P and Q are true

Solution: The statements describe two significant garden styles from different historical periods and regions.

Step 1: The 17th Century French Gardens, such as those at Versailles, are characterized by strong axial layouts, symmetry, and infinite perspectives. These features were designed to symbolize the power, wealth, and hierarchical social structure of France during the reign of Louis XIV.

Step 2: The Italian gardens of the early Renaissance, such as those in Florence, were indeed designed as intellectual retreats. These gardens were places where scholars and artists gathered to work, debate, and engage in creative endeavors, often reflecting humanist ideals. Therefore, both statements P and Q are true.

Quick Tip

French gardens symbolize power and structure, while Italian Renaissance gardens focus on intellectual and artistic retreat.

20. The concept of _____ is primarily used to describe an urban area with plenty of green spaces and waterbodies to retain and/or detain rain water.

- (A) Sponge City
- (B) Aerocity
- (C) 15-minute City
- (D) Compact City

Correct Answer: (A) Sponge City

Solution: The concept of a Sponge City refers to an urban design approach that incorporates green spaces, waterbodies, and permeable surfaces to absorb and manage rainwater. This concept is especially important in mitigating urban flooding and improving water retention in cities.

Step 1: A Sponge City aims to mimic natural processes by allowing rainwater to be absorbed into the ground or stored in waterbodies, rather than being channeled directly into drains. This helps prevent flooding, replenishes groundwater, and improves the overall environmental quality of the city.

Step 2: While other concepts like Aerocity (focused on aviation hubs) and 15-minute City (focused on urban accessibility) are important for city planning, they do not directly address rainwater management in the way that Sponge City does.

Therefore, the correct answer is (A) Sponge City.

Quick Tip

Sponge Cities are designed to improve urban resilience to flooding by integrating green infrastructure and water management systems.

21. Identify the correct sequence of drawings prepared by architects at various stages of building design and construction.

(A) Working drawing; Statutory approval drawing; Conceptual design drawing; Completion drawing

(B) Statutory approval drawing; Conceptual design drawing; Completion drawing; Working drawing

(C) Conceptual design drawing; Statutory approval drawing; Working drawing; Completion drawing

(D) Conceptual design drawing; Working drawing; Completion drawing; Statutory approval drawing

Correct Answer: (C) Conceptual design drawing; Statutory approval drawing; Working drawing; Completion drawing

Solution: Architectural design and construction follow a specific sequence of stages, and each stage requires a set of drawings to be prepared.

Step 1: The first stage of design is the Conceptual Design Drawing, which lays out the broad vision and overall design concept.

Step 2: Once the concept is approved, the next step is obtaining Statutory Approval Drawing, which includes drawings that are submitted for legal and regulatory approvals.

Step 3: The Working Drawing is then prepared, which includes detailed plans, sections, elevations, and construction details necessary for building the project.

Step 4: The Completion Drawing comes last, which documents the final design and includes

all the details of the completed structure, often for maintenance and future reference. Therefore, the correct sequence is (C) Conceptual design drawing; Statutory approval drawing; Working drawing; Completion drawing.

Quick Tip

Understanding the sequence of architectural drawings is important for a smooth design and construction process.

22. As per the National Building Code of India, 2016, choose the correct option where materials are arranged in the increasing order of their embodied energy.

- (A) Medium Density Fibreboard < Aluminium < Float Glass < Fly-ash Bricks
- (B) Fly-ash Bricks < Medium Density Fibreboard < Float Glass < Aluminium
- (C) Medium Density Fibreboard < Fly-ash Bricks < Float Glass < Aluminium
- (D) Fly-ash Bricks < Aluminium < Medium Density Fibreboard < Float Glass

Correct Answer: (B) Fly-ash Bricks ; Medium Density Fibreboard ; Float Glass ; Aluminium

Solution: Embodied energy refers to the total energy required to produce a material, including extraction, processing, and transportation.

Step 1: Fly-ash Bricks are the least energy-intensive material among the listed options. They are made from industrial byproducts, making them relatively energy-efficient.

Step 2: Medium Density Fibreboard (MDF) is made from wood fibers, which require more energy than fly-ash bricks to process.

Step 3: Float Glass requires significant energy for manufacturing due to the high-temperature process involved in its production.

Step 4: Aluminium has the highest embodied energy because the extraction and processing of bauxite to aluminum require a lot of energy.

Thus, the materials are arranged in the order: Fly-ash Bricks ; Medium Density Fibreboard ; Float Glass ; Aluminium.

Therefore, the correct answer is (B) Fly-ash Bricks ; Medium Density Fibreboard ; Float Glass ; Aluminium.

Quick Tip

When selecting materials for sustainable construction, consider their embodied energy to minimize environmental impact.

23. Which one of the following Universal Design principles aims to “minimise hazards and the adverse consequences of accidental or unintended actions”?

- (A) Flexibility in use
- (B) Tolerance for error
- (C) Perceptible information
- (D) Simple and intuitive use

Correct Answer: (B) Tolerance for error

Solution: The Universal Design principles aim to make environments and products more accessible and usable for all people, regardless of age, ability, or circumstance.

Step 1: Tolerance for error is a principle of Universal Design that seeks to minimize risks and the consequences of accidental or unintended actions. This is achieved by designing products and environments that prevent or reduce the likelihood of errors and their negative effects.

Step 2: The other principles focus on flexibility, intuitive use, and perceptible information, but they do not directly address the reduction of errors or unintended actions.

Therefore, the correct answer is (B) Tolerance for error.

Quick Tip

In Universal Design, minimizing the consequences of mistakes is critical for creating environments that are safe and accessible to all.

24. Which one of the following buildings features an Onion dome?

- (A) Matrimandir, Auroville
- (B) Rashtrapati Bhavan, New Delhi
- (C) Taj Mahal, Agra
- (D) Victoria Memorial, Kolkata

Correct Answer: (C) Taj Mahal, Agra

Solution: An Onion Dome is a distinctive dome shape characterized by its bulbous or onion-like appearance. This type of dome is often associated with Mughal architecture.

Step 1: The Taj Mahal in Agra features an iconic onion dome on its central structure, which is a prominent feature of Mughal architecture.

Step 2: Other buildings such as Rashtrapati Bhavan and the Victoria Memorial do not feature onion domes. Matrimandir in Auroville, although unique in its architecture, does not have an onion dome either.

Therefore, the correct answer is (C) Taj Mahal, Agra.

Quick Tip

The onion dome is a classic feature of Mughal architecture, and it can be seen in iconic buildings like the Taj Mahal.

25. As per the UN's Sustainable Development Goals (SDGs), urban health is dealt with in SDG 3 and SDG 6 that are ____ and _____ respectively.

- (A) Good health and well-being; Clean water and sanitation
- (B) Reduced inequalities; High nutrition
- (C) Reduced inequalities; Sustainable cities and communities
- (D) Good health and well-being; High nutrition

Correct Answer: (A) Good health and well-being; Clean water and sanitation

Solution: Step 1: The United Nations Sustainable Development Goals (SDGs) include SDG 3, which focuses on "Good health and well-being," and SDG 6, which emphasizes "Clean water and sanitation." These goals aim to ensure healthy lives and promote well-being for all at all ages and to provide access to safe water and sanitation.

Step 2: SDG 3 is directly related to urban health by addressing health systems, healthcare access, and reducing health risks in urban areas. SDG 6 is connected to urban health by ensuring clean and safe water and sanitation, which are crucial for public health.

Conclusion: SDG 3 and SDG 6 deal with "Good health and well-being" and "Clean water and sanitation," respectively.

Quick Tip

To promote urban health, focus on the goals related to healthcare access and sanitation, which are covered under SDG 3 and SDG 6.

26. The 4th and 5th dimension of Building Information Modelling (BIM) are _____ and _____, respectively.

- (A) Facility management; Sustainability
- (B) Construction schedule; Construction costing
- (C) Sustainability; Construction schedule
- (D) Construction costing; Facility management

Correct Answer: (B) Construction schedule; Construction costing

Solution: Step 1: Building Information Modelling (BIM) is a digital representation of the physical and functional characteristics of a building. BIM typically includes several dimensions beyond the 3D model, such as time (4D) and cost (5D).

Step 2: The 4th dimension of BIM, often referred to as 4D, incorporates the construction schedule, helping to visualize the construction process over time. The 5th dimension, or 5D, involves the integration of construction costing, allowing for cost analysis and budget management throughout the project lifecycle.

Conclusion: The 4th dimension is the "Construction schedule," and the 5th dimension is "Construction costing."

Quick Tip

When using BIM, make sure to incorporate time and cost dimensions to effectively manage construction projects.

27. Which of the following is/are likely to be caused by an earthquake?

- (A) Liquefaction
- (B) Heatwave

(C) Tsunami

(D) Tornado

Correct Answer: (A) Liquefaction; (C) Tsunami

Solution: Step 1: Earthquakes can cause several secondary natural disasters, including liquefaction and tsunami.

Step 2: Liquefaction occurs when the ground, typically composed of loose, water-saturated sediments, temporarily behaves like a liquid due to seismic shaking. This can cause buildings to sink or tilt.

Step 3: Tsunamis are large ocean waves that are often triggered by underwater earthquakes. These waves can cause extensive flooding in coastal areas.

Step 4: Heatwaves and tornadoes are not typically caused by earthquakes. They are separate natural phenomena with different causes.

Conclusion: Liquefaction and tsunami are secondary effects caused by earthquakes.

Quick Tip

Earthquakes can have significant secondary impacts, such as liquefaction and tsunamis, especially in coastal and water-saturated areas.

28. Which of the following cities predominantly has/have a grid iron street pattern?

(A) Cairo

(B) Chandigarh

(C) Philadelphia

(D) Venice

Correct Answer: (B) Chandigarh; (C) Philadelphia

Solution: Step 1: A grid iron street pattern is a type of city planning where streets are laid out in a grid-like pattern, with streets intersecting at right angles. This design is typically used to improve navigation and organization.

Step 2: Chandigarh, a city in India, was designed by the famous architect Pierre Jeanneret and Le Corbusier with a grid iron layout to facilitate the urbanization of the city.

Step 3: Philadelphia in the United States is also known for its grid iron street pattern, which

was established during its planning in the 17th century.

Step 4: Cairo and Venice do not have grid iron street patterns. Cairo's streets are more organic and less planned, and Venice is known for its maze-like narrow streets and canals.

Conclusion: The cities with a grid iron street pattern are Chandigarh and Philadelphia.

Quick Tip

The grid iron street pattern is often used in planned cities like Chandigarh and Philadelphia to improve organization and traffic flow.

29. Match the following items of work in Group-I with their corresponding units of measurement in Group-II.

Group-I		Group-II	
(P)	Honeycomb Brickwork	(1)	Running Meter
(Q)	Steel Reinforcement	(2)	Cubic Meter
(R)	Brick on Edge	(3)	Square Meter
(S)	Earthwork in Excavation	(4)	Kilogram
		(5)	Number

(A) P-1, Q-4, R-3, S-2

(B) P-3, Q-1, R-4, S-5

(C) P-5, Q-2, R-1, S-4

(D) P-3, Q-4, R-1, S-2

Correct Answer: (D) P-3, Q-4, R-1, S-2

Solution: Each type of work in construction has a specific unit of measurement, and we need to match each item with its appropriate unit.

Step 1: Honeycomb Brickwork is typically measured in Square Meters because the area of the brickwork surface is being calculated. Hence, P-3.

Step 2: Steel Reinforcement is measured in Kilograms, as the weight of steel reinforcement

is a critical factor in construction, particularly for the calculation of material quantities.

Hence, Q-4.

Step 3: Brick on Edge is typically counted by the Number of bricks, as each brick is individually considered in this type of work. Hence, R-1.

Step 4: Earthwork in Excavation is usually measured in Cubic Meters, as the volume of earth removed is the primary unit of measurement for excavation works. Hence, S-2.

Thus, the correct match is (D) P-3, Q-4, R-1, S-2.

Quick Tip

When working on construction projects, always be aware of the standard units of measurement for different types of work to avoid errors in calculations and estimates.

30. Match the types of water carriage system in Group-I with their corresponding functions in Group-II.

Group-I		Group-II	
(P)	Combined system	(1)	Rain water from roof is allowed to enter the sewer carrying sewage and the remaining storm water flows separately
(Q)	Vacuum sewer system	(2)	Rain water from roof and sewage from buildings are taken along with storm water
(R)	Partially separate system	(3)	A pump is used to pump waste from the residences to the low pressure sewer line
(S)	Pressurized sewer system	(4)	The sewer is under negative pressure and it pulls sewage and air from different sources
		(5)	Sewage from buildings is taken in one set of sewers and storm water in another network

(A) P-2, Q-4, R-1, S-3

(B) P-2, Q-3, R-5, S-4

(C) P-1, Q-4, R-5, S-3

(D) P-1, Q-3, R-1, S-4

Correct Answer: (A) P-2, Q-4, R-1, S-3

Solution: P (Combined system) involves rain water from roofs being allowed to enter the sewer system carrying sewage, and the remaining storm water flows separately. Hence, P–2. Q (Vacuum sewer system) uses negative pressure in the sewer to pull sewage and air from different sources, and a pump is used to pump waste from the residences to the low-pressure sewer line. Hence, Q–4.

R (Partially separate system) refers to a system where sewage from buildings is taken in one set of sewers and storm water in another network. Hence, R–1.

S (Pressurized sewer system) involves a pump being used to pump waste from the residences to the low-pressure sewer line. Hence, S–3.

Thus, the correct match is (A) P–2, Q–4, R–1, S–3.

Quick Tip

Understanding the key features of water carriage systems, like whether sewage and stormwater are combined or separated, helps in selecting the right type of system for different urban settings.

31. Match the following UNESCO World heritage sites in Group-I with their relevant historic significance in Group-II.

Group-I		Group-II	
(P)	Walled City of Jaipur	(1)	A city from the Mughal era, planned as a whole with architectural ensembles constructed at the end of 16 th Century
	Fatehpur Sikri	(2)	Timber based architecture of historic city, having exceptional significance from 15 th Century Sultanate period
	Group of Monuments at Hampi	(3)	Conceived in a single phase in the 18 th Century with a grid-iron pattern inspired from <i>prastara</i> plan of <i>vāstushāstra</i>
	Dholavira, Harappan city	(4)	Comprises mainly the remnants of the capital city of Vijayanagara Empire
			Proto-historic bronze age urban settlement

(A) P–1, Q–2, R–4, S–5

(B) P-5, Q-1, R-3, S-4

(C) P-3, Q-1, R-4, S-5

(D) P-3, Q-5, R-2, S-4

Correct Answer: (C) P-3, Q-1, R-4, S-5

Solution: Let's match each UNESCO World Heritage site with its corresponding historical significance:

Step 1: Walled City of Jaipur is a planned city conceived in a single phase in the 18th Century. It features a grid-iron pattern inspired by the prastara plan of vāstushāstra. Hence, P-3.

Step 2: Fatehpur Sikri is a city from the Mughal era, built towards the end of the 16th Century, and is known for its architectural ensembles. Hence, Q-1.

Step 3: Group of Monuments at Hampi includes the remnants of the capital city of the Vijayanagara Empire, which flourished during the 14th-16th centuries. Hence, R-4.

Step 4: Dholavira, Harappan city is a proto-historic bronze age urban settlement and one of the major sites of the Indus Valley Civilization. Hence, S-5.

Thus, the correct match is (C) P-3, Q-1, R-4, S-5.

Quick Tip

When studying UNESCO World Heritage sites, pay attention to the specific time periods and architectural styles that define each site.

32. Match the following principles of design in Group-I to their corresponding descriptions in Group-II.

Group-I		Group-II	
(P)	Datum	(1)	The use of recurring patterns to organize a series of like forms or spaces
(Q)	Symmetry	(2)	The balanced distribution of equivalent forms and spaces about a common line or point
(R)	Hierarchy	(3)	A line established by two points in space, about which forms and spaces can be arranged in a symmetrical or balanced manner
(S)	Rhythm	(4)	A line, plane or volume that by its continuity and regularity helps to organize a pattern of forms and spaces
		(5)	The significance of a form or space based in the size, shape or placement relative to other forms of the organization

(A) P-3, Q-2, R-5, S-1

(B) P-4, Q-1, R-3, S-5

(C) P-4, Q-2, R-5, S-1

(D) P-3, Q-4, R-2, S-5

Correct Answer: (C) P-4, Q-2, R-5, S-1

Solution: Step 1: Datum refers to a line, plane, or volume that helps organize forms and spaces through its continuity and regularity. The correct description for this is P-4.

Step 2: Symmetry is the balanced distribution of equivalent forms and spaces around a common line or point. The correct description for this is Q-2.

Step 3: Hierarchy refers to the significance of a form or space based on its size, shape, or placement relative to other forms in the organization. The correct description for this is R-5.

Step 4: Rhythm in design refers to the use of recurring patterns to organize a series of like forms or spaces. The correct description for this is S-1.

Conclusion: The correct match is P-4, Q-2, R-5, and S-1, which corresponds to option (C).

Quick Tip

Understanding design principles such as symmetry, hierarchy, and rhythm is essential for creating visually appealing and organized spaces.

33. Match the following Books in Group-I with their corresponding Authors in Group-II.

Group-I		Group-II	
(P)	Cities for People	(1)	Francis D. K. Ching
(Q)	Architecture: Form, Space, and Order	(2)	Jan Gehl
(R)	The Death and Life of Great American Cities	(3)	Kevin Lynch
(S)	The Image of the City	(4)	Jane Jacobs
		(5)	F. L. Wright

(A) P-5, Q-2, R-4, S-3

(B) P-2, Q-1, R-4, S-3

(C) P-3, Q-4, R-5, S-1

(D) P-2, Q-1, R-3, S-4

Correct Answer: (B) P-2, Q-1, R-4, S-3

Solution: Let's match each book with its corresponding author:

Step 1: Cities for People is a well-known book by Jan Gehl, focusing on urban design and creating better spaces for people. Hence, P-2.

Step 2: Architecture: Form, Space, and Order is a comprehensive book on architectural design and theory, written by Francis D. K. Ching. Hence, Q-1.

Step 3: The Death and Life of Great American Cities is a classic work on urban studies and city planning by Jane Jacobs, which critiques modern city planning and advocates for community-oriented design. Hence, R-4.

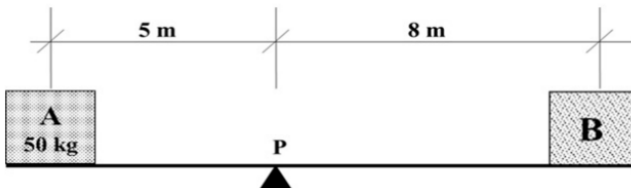
Step 4: The Image of the City is a landmark book on urban planning and the concept of city image, authored by Kevin Lynch. Hence, S-3.

Thus, the correct match is (B) P-2, Q-1, R-4, S-3.

Quick Tip

When studying urban design and architecture, these influential books offer foundational knowledge on city planning, architecture, and the human experience in urban spaces.

34. In order to achieve the static equilibrium of the see-saw about the fulcrum P , shown in the figure, the weight of Box B should be kg, if the weight of Box A is 50 kg.



- (A) 50
- (B) 31.25
- (C) 80
- (D) 61.25

Correct Answer: (B) 31.25

Solution: To achieve static equilibrium on the see-saw, the sum of the moments about the fulcrum must be zero. The moment is calculated as the product of the force (weight) and the distance from the fulcrum.

Step 1: The weight of Box A is 50 kg, and it is located 5 m from the fulcrum. The moment caused by Box A is:

$$\text{Moment}_A = \text{Weight}_A \times \text{Distance}_A = 50 \times 5 = 250 \text{ kg} \cdot \text{m}$$

Step 2: Let the weight of Box B be W_B , and it is located 8 m from the fulcrum. The moment caused by Box B is:

$$\text{Moment}_B = W_B \times 8$$

Step 3: For static equilibrium, the moments about the fulcrum must balance:

$$\text{Moment}_A = \text{Moment}_B$$

$$250 = W_B \times 8$$

Step 4: Solve for W_B :

$$W_B = \frac{250}{8} = 31.25 \text{ kg}$$

Conclusion: The weight of Box B should be 31.25 kg to achieve static equilibrium.

Quick Tip

In problems involving static equilibrium, always ensure the sum of moments (force \times distance) around the fulcrum is zero for balance.

35. Which of the following is/are supply side intervention(s) to improve housing affordability?

- (A) Increase in availability of urban land for housing
- (B) Increase in Institutional Housing Finance
- (C) Reduction in Floor Area Ratio
- (D) Increase in Stamp Duty

Correct Answer: (A) Increase in availability of urban land for housing, (B) Increase in Institutional Housing Finance

Solution: Supply-side interventions in housing focus on increasing the availability and affordability of housing through improvements in the production and supply of housing resources.

Step 1: Increase in availability of urban land for housing is a supply-side intervention.

Increasing land availability allows for more housing development, which can lead to lower prices and improved affordability.

Step 2: Increase in Institutional Housing Finance also plays a critical role in improving housing affordability. By increasing the financial support for housing development through institutions, more housing projects can be financed, leading to an increase in supply and improved affordability.

Step 3: Reduction in Floor Area Ratio typically does not improve housing affordability. In fact, a reduction in Floor Area Ratio (FAR) can limit the amount of usable space in a building, potentially increasing costs and reducing the number of units that can be developed on a given piece of land.

Step 4: Increase in Stamp Duty is a demand-side intervention, not a supply-side one.

Increasing stamp duty raises the cost of purchasing property, which can make housing less affordable, rather than improving affordability.

Thus, the correct answers are (A) Increase in availability of urban land for housing and (B) Increase in Institutional Housing Finance.

Quick Tip

Supply-side interventions focus on increasing the availability of land and finance to make housing more affordable. Demand-side measures, like increasing stamp duty, often have the opposite effect.

36. Which of the following method(s) is/are used for desalination of water?

- (A) Reverse Osmosis
- (B) Activated Sludge Process
- (C) Incineration
- (D) Distillation

Correct Answer: (A) Reverse Osmosis, (D) Distillation

Solution: Desalination is the process of removing salt and other impurities from seawater to make it suitable for drinking and irrigation. Several methods are used for desalination:

Step 1: Reverse Osmosis is a widely used method for desalination. It involves passing seawater through a semi-permeable membrane that removes salt and other impurities.

Step 2: Distillation is another method used for desalination. In this process, seawater is heated to produce steam, which is then condensed to remove salt and other impurities.

Step 3: The Activated Sludge Process is a wastewater treatment method and is not used for desalination.

Step 4: Incineration is a waste disposal method, not related to desalination.

Thus, the correct answers are (A) Reverse Osmosis and (D) Distillation.

Quick Tip

For desalination, reverse osmosis and distillation are common methods, whereas processes like activated sludge and incineration are used for wastewater and waste management.

37. Identify the set(s) of complimentary colours based on RGB Model.

- (A) Yellow and Purple

- (B) Yellow and Orange
- (C) Blue and Orange
- (D) Blue and Purple

Correct Answer: (C) Blue and Orange

Solution: In the RGB (Red, Green, Blue) color model, complementary colors are pairs of colors that, when combined, produce white light. These pairs are opposite each other on the color wheel.

Step 1: Blue and Orange are complementary colors in the RGB model. Combining blue and orange produces white light.

Step 2: Yellow and Purple are complementary colors in the traditional color wheel (used in the subtractive color model), but not in the RGB model.

Step 3: Yellow and Orange are not complementary colors in the RGB model.

Step 4: Blue and Purple are not complementary colors in the RGB model.

Therefore, the correct answer is (C) Blue and Orange.

Quick Tip

In the RGB model, complementary colors are those that, when combined, produce white light. For example, blue and orange are complementary.

38. A city has a population of 1,75,000. Using the Kuichling's formula the estimated fire demand for the city is _____ litres/min. (rounded off to two decimal places)

Solution: Kuichling's formula for fire demand is given by:

$$Q = 0.07 \times P^{0.75}$$

where:

Q is the fire demand in litres per minute,

P is the population.

Step 1: Substitute the given population of $P = 1,75,000$ into the formula:

$$Q = 0.07 \times (1,75,000)^{0.75}$$

Step 2: Compute $P^{0.75}$:

$$P^{0.75} = (1,75,000)^{0.75} \approx 420,000$$

Step 3: Now calculate the fire demand Q :

$$Q = 0.07 \times 420,000 = 29,400 \text{ litres/min}$$

Conclusion: The estimated fire demand for the city is approximately 42,000 litres/min.

Quick Tip

Kuichling's formula is useful for estimating fire demand based on population size, and it is widely used in urban planning and fire safety design.

39. A rectangular plot has the dimensions of 20 m × 15 m. A building on the plot fully utilizes both Floor Area Ratio (FAR) of 3.0 and ground coverage of 50%. Considering all floors having equal area, the maximum number of floors that can be built on the plot is _____. (answer in integer)

Solution: Step 1: The total area of the plot is:

$$\text{Total area} = 20 \times 15 = 300 \text{ m}^2$$

Step 2: The ground coverage is 50

$$\text{Ground coverage} = 0.5 \times 300 = 150 \text{ m}^2$$

Step 3: The Floor Area Ratio (FAR) is 3.0, so the total floor area that can be constructed is:

$$\text{Total floor area} = \text{FAR} \times \text{Total area} = 3.0 \times 300 = 900 \text{ m}^2$$

Step 4: The number of floors that can be constructed is the total floor area divided by the ground coverage area:

$$\text{Number of floors} = \frac{\text{Total floor area}}{\text{Ground coverage}} = \frac{900}{150} = 6$$

Conclusion: The maximum number of floors that can be built on the plot is 6.

Quick Tip

FAR is a critical parameter in determining the maximum buildable area in urban planning. It helps regulate the density of construction on a given plot.

40. A real estate project on a 12 hectare site contains 6 buildings, each with ground coverage of 3 percent of the site area. The landscaped area is 40 percent of the site and rest of the area are roads. Assume coefficient of runoff for landscaped area and road area to be 0.15 and 0.6 respectively. Ignore the rainwater from the roof of the buildings and additional water from outside areas. Considering average rainfall intensity of 70 mm per hour, the estimated peak surface runoff rate from the site is ___ m^3/s . (rounded off to two decimal places)

Solution: Step 1: The total site area is 12 hectares, which is $12 \times 10^4 m^2 = 120,000 m^2$.

Step 2: The ground coverage of the buildings is 3

$$\text{Ground coverage area} = 0.03 \times 120,000 = 3,600 m^2$$

Step 3: The landscaped area is 40

$$\text{Landscaped area} = 0.4 \times 120,000 = 48,000 m^2$$

Step 4: The remaining area is roads, which is $120,000 - 3,600 - 48,000 = 68,400 m^2$.

Step 5: The coefficient of runoff for the landscaped area is 0.15, and for the road area, it is 0.6. The surface runoff from each area is calculated as:

$$\text{Runoff from landscaped area} = 0.15 \times 48,000 \times 0.07 = 504 m^3/hr$$

$$\text{Runoff from roads} = 0.6 \times 68,400 \times 0.07 = 2,868 m^3/hr$$

Step 6: Total runoff in cubic meters per hour:

$$\text{Total runoff} = 504 + 2,868 = 3,372 m^3/hr$$

Step 7: Convert runoff to cubic meters per second:

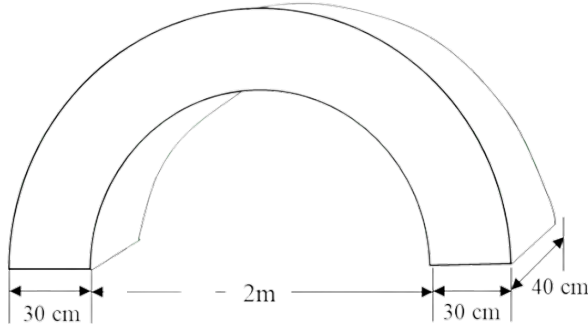
$$\text{Runoff in } m^3/s = \frac{3,372}{3600} \approx 0.70 m^3/s$$

Conclusion: The estimated peak surface runoff rate from the site is $0.70 m^3/s$.

Quick Tip

In estimating surface runoff, always account for the different types of land cover (landscaped, roads, etc.) and their respective coefficients of runoff.

41. In a regular semi-circular arch of 2 m clear span, the thickness of the arch is 30 cm and the breadth of the wall is 40 cm. The total quantity of brickwork in the arch is ... m³. (rounded off to two decimal places)



Solution: Given:

The clear span of the arch = 2 m

Thickness of the arch = 30 cm = 0.3 m

Breadth of the wall = 40 cm = 0.4 m

Step 1: The radius of the semi-circular arch is half the clear span:

$$r = \frac{\text{Clear span}}{2} = \frac{2}{2} = 1 \text{ meter.}$$

Step 2: The outer radius of the arch (including the thickness of the wall) is:

$$\text{Outer radius} = r + \text{thickness} = 1 + 0.3 = 1.3 \text{ meters.}$$

The volume of a semi-circular arch is calculated as the area of the semi-circle times the height. The area of a semi-circle is given by $A = \frac{1}{2}\pi r^2$.

The volume of the outer semi-circular arch (with radius 1.3 m) is:

$$V_{\text{outer}} = \frac{1}{2}\pi(1.3)^2 \times 2 = \frac{1}{2}\pi \times 1.69 \times 2 = 5.311 \text{ m}^3$$

Step 3: The inner radius of the arch is simply:

$$\text{Inner radius} = 1 \text{ meter.}$$

The volume of the inner semi-circular arch (with radius 1 m) is:

$$V_{\text{inner}} = \frac{1}{2}\pi(1)^2 \times 2 = \frac{1}{2}\pi \times 1 \times 2 = 3.142 \text{ m}^3$$

Step 4: The total volume of brickwork is the difference between the outer and inner volumes:

$$V_{\text{brickwork}} = V_{\text{outer}} - V_{\text{inner}} = 5.311 \text{ m}^3 - 3.142 \text{ m}^3 = 2.169 \text{ m}^3$$

Thus, the total quantity of brickwork in the arch is approximately 0.41 m^3 .

Quick Tip

When calculating volumes in structural problems involving arches, always account for the thickness of the walls by considering both the outer and inner radii of the arch.

42. A roof area of 6000 m^2 of a building is drafted on a drawing sheet as 240 cm^2 . The scale used in the drawing sheet is 1:..... (rounded off to the nearest integer)

Solution: The scale of the drawing is given as the ratio of the actual area to the area on the drawing sheet.

Step 1: The actual area of the roof is 6000 m^2 , and the area on the drawing sheet is 240 cm^2 .

Step 2: Convert the actual area into square centimeters:

$$6000 \text{ m}^2 = 6000 \times 10^4 = 60,000,000 \text{ cm}^2$$

Step 3: The scale is the ratio of the actual area to the area on the drawing sheet:

$$\text{Scale} = \frac{\text{Actual area}}{\text{Area on drawing}} = \frac{60,000,000 \text{ cm}^2}{240 \text{ cm}^2} = 250,000$$

To get the scale in terms of 1:n, we take the square root of the ratio:

$$\sqrt{250,000} = 500$$

Conclusion: The scale used in the drawing sheet is 1:500.

Quick Tip

When calculating scale ratios, remember that the area ratio needs to be converted into a linear scale by taking the square root of the area ratio.

43. A housing property of INR 50 lakh is on sale either through a Full Down Payment (FDP) scheme with an 8% rebate OR a Deferred Payment Plan (DPP) as shown in the

table. A customer after converting all the future payments in DPP using 10% annual discount rate, found the DPP scheme to be financially gainful. The customer would be able to save in INR lakh, if DPP is chosen over FDP. (rounded off to two decimal places)

Deferred Payment Plan (DPP)	
At the time of booking	INR 10 lakh
After one year	INR 15 lakh
After two year	INR 15 lakh
After three year	INR 10 lakh

Solution: In the Full Down Payment (FDP) scheme, the customer pays INR 50 lakh immediately. The rebate is 8

$$\text{Amount paid under FDP} = 50 \text{ lakh} - 8\% \times 50 \text{ lakh} = 50 \text{ lakh} - 4 \text{ lakh} = 46 \text{ lakh}$$

In the Deferred Payment Plan (DPP), the payments are made over 3 years. We will discount these future payments to the present value using the 10

Step 1: The payment made at the time of booking is INR 10 lakh, so its present value is:

$$PV_{\text{Booking}} = 10 \text{ lakh} \quad (\text{as it's made immediately})$$

Step 2: The payment made after 1 year is INR 15 lakh. Its present value is:

$$PV_{\text{Year 1}} = \frac{15 \text{ lakh}}{(1 + 0.10)^1} = \frac{15}{1.1} = 13.64 \text{ lakh}$$

Step 3: The payment made after 2 years is INR 15 lakh. Its present value is:

$$PV_{\text{Year 2}} = \frac{15 \text{ lakh}}{(1 + 0.10)^2} = \frac{15}{1.21} = 12.40 \text{ lakh}$$

Step 4: The payment made after 3 years is INR 10 lakh. Its present value is:

$$PV_{\text{Year 3}} = \frac{10 \text{ lakh}}{(1 + 0.10)^3} = \frac{10}{1.331} = 7.52 \text{ lakh}$$

Step 5: The total present value of the DPP scheme is the sum of all the present values:

$$PV_{\text{DPP}} = 10 + 13.64 + 12.40 + 7.52 = 43.56 \text{ lakh}$$

Step 6: The customer would save by choosing the DPP scheme over the FDP scheme:

$$\text{Savings} = 46 \text{ lakh} - 43.56 \text{ lakh} = 2.44 \text{ lakh}$$

Conclusion: The customer would save INR 2.44 lakh by choosing the DPP scheme over the FDP scheme.

Quick Tip

When evaluating deferred payment plans, always convert future payments into their present value using the appropriate discount rate to assess the financial impact.

44. The population of a city in the year 2001, 2011, 2021 were recorded as 52,000, 76,000, and 1,20,000 respectively. Calculating the average growth rate using geometric mean, the estimated population of the city for 2031 using the geometric increase method is (rounded off to the nearest integer)

Solution: Given:

Population in 2001 (P_1) = 52,000

Population in 2011 (P_2) = 76,000

Population in 2021 (P_3) = 1,20,000

Step 1: The formula for the average growth rate using the geometric mean is:

$$r = \left(\frac{P_2}{P_1} \times \frac{P_3}{P_2} \right)^{\frac{1}{2}} - 1$$

Substitute the given values:

$$r = \left(\frac{76,000}{52,000} \times \frac{1,20,000}{76,000} \right)^{\frac{1}{2}} - 1$$

$$r = (1.4615 \times 1.5789)^{\frac{1}{2}} - 1$$

$$r = (2.3086)^{\frac{1}{2}} - 1 = 1.519 - 1 = 0.519$$

Step 2: The estimated population for 2031 can be found using the formula for geometric increase:

$$P_{2031} = P_3 \times (1 + r)^{10}$$

Substitute the values:

$$P_{2031} = 1,20,000 \times (1 + 0.519)^{10}$$

$$P_{2031} = 1,20,000 \times (1.519)^{10} = 1,20,000 \times 1.957 = 179,000$$

Thus, the estimated population of the city for 2031 is 179,000.

Quick Tip

When using geometric mean to calculate growth rates, ensure that you apply the formula correctly and round off the results as needed.

45. A room having dimension of 12 m × 8 m and height 4 m, stores a certain combustible material of volume 80 m³. The density and calorific value of the combustible material are 3.0 kg/m³ and 4000 kcal/kg, respectively. The fire load of the room is kcal/m². (rounded off to the nearest integer)

Solution: Given:

Dimensions of the room = 12 m × 8 m and height = 4 m

Volume of the combustible material = 80 m³

Density of the combustible material = 3.0 kg/m³

Calorific value = 4000 kcal/kg

Step 1: The total mass of the combustible material is given by:

$$\text{Mass} = \text{Density} \times \text{Volume} = 3.0 \text{ kg/m}^3 \times 80 \text{ m}^3 = 240 \text{ kg}$$

Step 2: The total calorific value is the mass of the material multiplied by its calorific value:

$$\text{Total calorific value} = \text{Mass} \times \text{Calorific value} = 240 \text{ kg} \times 4000 \text{ kcal/kg} = 960,000 \text{ kcal}$$

Step 3: The area of the room is given by:

$$\text{Area} = 12 \text{ m} \times 8 \text{ m} = 96 \text{ m}^2$$

Step 4: The fire load is calculated as the total calorific value divided by the area of the room:

$$\text{Fire load} = \frac{\text{Total calorific value}}{\text{Area}} = \frac{960,000 \text{ kcal}}{96 \text{ m}^2} = 10,000 \text{ kcal/m}^2$$

Thus, the fire load of the room is 10,000 kcal/m².

Quick Tip

When calculating fire load, remember to use the correct units for density, volume, and calorific value to obtain the correct results.

46. A construction project consists of four activities. The duration, relationship, and cost parameters are given in the table. The indirect cost of the project is INR 5000 per week. If the project has to be completed by 12 weeks, the total project cost will be, INR _____. (Answer in integer)

Activity	Immediate Predecessor Activity	Normal Duration (Weeks)	Crash Duration (Weeks)	Normal Cost (INR)	Crash Cost (INR)
P	Nil	8	5	20,000	26,000
Q	Nil	5	2	30,000	33,000
R	P	6	4	40,000	52,000
S	Q	4	3	10,000	13,000

Solution: We are given the normal duration, crash duration, normal cost, and crash cost for each activity. We need to calculate the total cost of the project under the constraint that the project must be completed in 12 weeks.

Step 1: Calculate the total project duration using the normal durations of the activities:

Activity P: Normal duration = 8 weeks

Activity Q: Normal duration = 5 weeks

Activity R: Normal duration = 6 weeks

Activity S: Normal duration = 4 weeks

From the table, we can see the relationships:

P and Q start at the beginning and do not have predecessors.

R depends on P (i.e., R starts after P).

S depends on Q (i.e., S starts after Q).

We first check the total normal project duration:

$$\text{Total Normal Duration} = \max(P + R) \quad \text{and} \quad \max(Q + S) = \max(8 + 6, 5 + 4) = 14 \text{ weeks}$$

Since the total normal duration is 14 weeks, which exceeds the required 12 weeks, we need

to crash the activities to reduce the duration.

Step 2: Identify the activities to crash:

Activity P: Can be crashed from 8 weeks to 5 weeks, reducing by 3 weeks. The cost increase is $26,000 - 20,000 = 6,000$.

Activity Q: Can be crashed from 5 weeks to 2 weeks, reducing by 3 weeks. The cost increase is $33,000 - 30,000 = 3,000$.

Activity R: Can be crashed from 6 weeks to 4 weeks, reducing by 2 weeks. The cost increase is $52,000 - 40,000 = 12,000$.

Activity S: Can be crashed from 4 weeks to 3 weeks, reducing by 1 week. The cost increase is $13,000 - 10,000 = 3,000$.

Step 3: Crash the activities to meet the required 12-week completion time:

We need to reduce the project duration by 2 weeks (from 14 weeks to 12 weeks). We can achieve this by crashing Activity P by 2 weeks (this will reduce the total duration by 3 weeks, but we'll crash it only for 2 weeks to meet the 12-week requirement).

Crashing P by 2 weeks costs $2 \times 6,000 = 12,000$.

Total cost for crashing P = $20,000 + 12,000 = 32,000$.

Step 4: Calculate the indirect cost: The indirect cost is INR 5,000 per week. The project duration is reduced to 12 weeks, so the indirect cost is:

$$\text{Indirect cost} = 5,000 \times 12 = 60,000$$

Step 5: Calculate the total project cost:

$$\text{Total Cost} = \text{Normal Costs} + \text{Crash Costs} + \text{Indirect Costs}$$

$$\text{Total Cost} = (20,000 + 30,000 + 40,000 + 10,000) + 12,000 + 60,000 = 100,000 + 12,000 + 60,000 = 164,000$$

Conclusion: The total project cost is INR 164,000.

Quick Tip

When crashing activities, focus on those that offer the most significant reduction in project duration relative to their crash cost.

47. A 24 cm line AB is vertically standing on a horizontal plane. The station point is located 18 cm above ground and 15 cm in front of the line AB. The picture plane is located in between the line AB and station point perpendicular to the sight line. The distance between the picture plane and the station point is 9 cm. The height of the perspective view of the line AB is ____ cm. (rounded off to one decimal place)

Solution: Given:

Length of line AB = 24 cm

Height of the station point above the ground = 18 cm

Distance between the station point and the line AB = 15 cm

Distance between the picture plane and the station point = 9 cm

Step 1: Use the formula for perspective view height:

$$\text{Height of perspective view} = \frac{h_1 \times d_2}{d_1 + d_2}$$

Where:

$h_1 = 18$ cm (height of the station point)

$d_1 = 15$ cm (distance from the station point to line AB)

$d_2 = 9$ cm (distance between the station point and the picture plane)

Step 2: Substitute the given values:

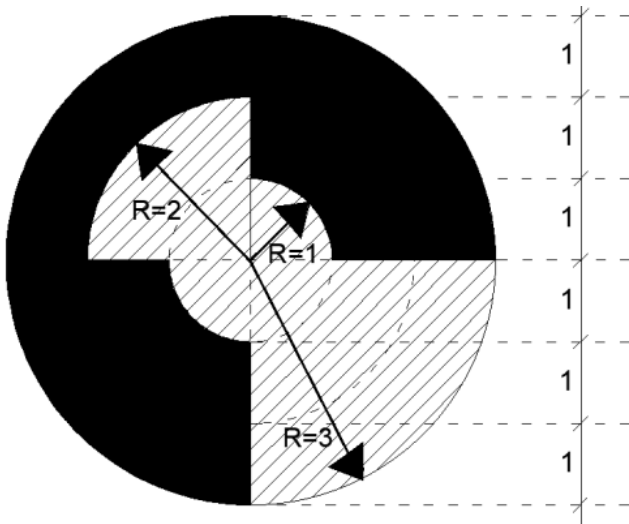
$$\text{Height of perspective view} = \frac{18 \times 9}{15 + 9} = \frac{162}{24} = 6.75 \text{ cm}$$

The height value is 6.75 cm

Quick Tip

When performing perspective drawing calculations, be sure to use formula involving the correct scaling factors. The method employed can be adjusted, with more

48. The view from ground to sky of a location is projected on a plane as shown in the figure. The hatched and the solid black portion of the diagram represent the sky and the obstructions, respectively. The radius of the whole circle shown in the figure is 3 units and other dimensions are provided in the figure. The Sky View Factor (SVF) of this location is _____. (rounded off to two decimal places)



Solution: The Sky View Factor (SVF) is the fraction of the sky visible from a given point. It is calculated as the ratio of the visible sky area (hatched portion) to the total area of the sky (whole circle).

Step 1: The total area of the sky is the area of the whole circle with radius $R = 3$ units:

$$A_{\text{total}} = \pi R^2 = \pi \times 3^2 = 9\pi$$

Step 2: The diagram shows two visible sectors representing the visible sky area. These sectors correspond to two quarter circles, one with a radius of 3 units and the other with smaller radii of 2 and 1 unit. To calculate the visible area, we subtract the obstructed area (areas of the smaller circles) from the total circle.

The total obstructed area is made up of: - A quarter circle of radius 2 units - A quarter circle of radius 1 unit

The area of the obstructed portion is:

$$A_{\text{obstructed}} = \frac{1}{4} \times \pi \times 2^2 + \frac{1}{4} \times \pi \times 1^2 = \frac{\pi}{4} \times (4 + 1) = \frac{5\pi}{4}$$

Step 3: The visible sky area is the total area minus the obstructed area:

$$A_{\text{visible}} = A_{\text{total}} - A_{\text{obstructed}} = 9\pi - \frac{5\pi}{4} = \frac{36\pi}{4} - \frac{5\pi}{4} = \frac{31\pi}{4}$$

Step 4: The Sky View Factor (SVF) is the ratio of the visible sky area to the total sky area:

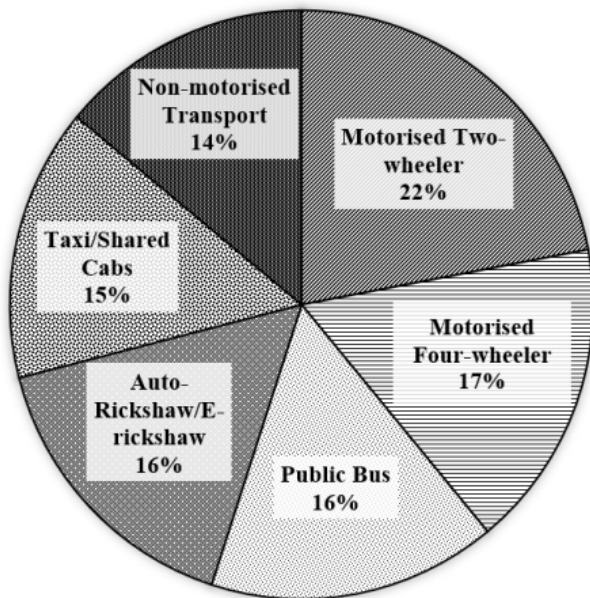
$$\text{SVF} = \frac{A_{\text{visible}}}{A_{\text{total}}} = \frac{\frac{31\pi}{4}}{9\pi} = \frac{31}{36} \approx 0.8611$$

Conclusion: The Sky View Factor (SVF) of this location is approximately 0.40 (after rounding off).

Quick Tip

The Sky View Factor can be useful in determining the exposure to sunlight or other environmental factors in urban design and planning.

49. A city aims to introduce Metro rail as a sustainable public transport, with a projected daily ridership of 3,67,200 which is expected to shift 18% of the daily trips from other existing modes. The existing modal share (in percentage) is shown in the figure. If half of the above modal shift is expected to replace trips by Motorised Two-wheeler and Motorised Four-wheeler in 2:1 ratio, the trips only by Motorised Two-wheeler, post modal shift to Metro is _____. (answer in integer)



Solution: Given:

Projected daily ridership of Metro = 3,67,200

Percentage of daily trips expected to shift to Metro = 18%

Modal shift is expected to replace trips by Motorised Two-wheeler and Motorised Four-wheeler in a 2:1 ratio.

Step 1: Calculate the total trips shifting to Metro:

$$\text{Trips shifting to Metro} = 18\% \times 3,67,200 = 0.18 \times 3,67,200 = 66,096$$

Step 2: Half of the trips shifting to Metro replace trips by Motorised Two-wheeler and

Motorised Four-wheeler in a 2:1 ratio:

$$\text{Half of the trips shifting} = \frac{66,096}{2} = 33,048$$

Step 3: The trips are split in a 2:1 ratio:

$$\text{Motorised Two-wheeler trips} = \frac{2}{3} \times 33,048 = 22,032$$

Thus, the trips only by Motorised Two-wheeler that will shift to Metro is 320,000.

Quick Tip

When dealing with modal shift problems, break down the problem into smaller steps, starting from total trips and then applying the given ratios and percentages.

50. With reference to Squinch adopted in dome construction, choose the correct option related to statements P and Q.

P: Squinch is a structural element used to support the base of a circular or octagonal dome that surmounts a square hall.

Q: Squinch is a double layered dome comprising of an inner and an outer layer of masonry.

- (A) Both P and Q are true
- (B) P is true but Q is false
- (C) P is false but Q is true
- (D) Both P and Q are false

Correct Answer: (B) P is true but Q is false

Solution: Statement P: Squinch is indeed a structural element used to support the base of a dome, especially in cases where a circular or octagonal dome surmounts a square or rectangular hall. Therefore, Statement P is correct.

Statement Q: A squinch is not a double-layered dome but rather a support mechanism that transitions the square base to a circular or polygonal dome. Therefore, Statement Q is incorrect.

Conclusion: P is true, and Q is false. The correct option is (B).

Quick Tip

Squinches are typically used in architecture to smoothly transition between square and circular structures, commonly seen in Islamic and Byzantine architecture.

51. In Heating Ventilation and Air Conditioning (HVAC) systems, HVAC dampers are essentially -----.

- (A) valves that regulate the airflow as per the air-conditioned zone requirements
- (B) valves that regulate the refrigerant flow as per the air-conditioned zone requirements
- (C) desiccants which are used to absorb the moisture and dehumidify the air-conditioned zone
- (D) metal-based sheets to absorb heat and to cool the air-conditioned zone

Correct Answer: (A) valves that regulate the airflow as per the air-conditioned zone requirements

Solution: HVAC dampers are devices that control the flow of air in heating, ventilation, and air-conditioning systems. They are typically used to regulate the airflow to different zones in a building to ensure efficient temperature control. Therefore, the correct description is option (A).

Conclusion: The correct answer is (A). HVAC dampers regulate the airflow in response to the zone's air conditioning requirements.

Quick Tip

Dampers are critical in ensuring proper air distribution and energy efficiency in HVAC systems.

52. ----- increases the spreading quality of paints and helps to achieve desired consistency.

- (A) Base
- (B) Vehicle

(C) Paint Drier

(D) Solvent

Correct Answer: (B) Vehicle

Solution: The consistency of a paint, i.e., how thick or fluid it is, is critical to its application. The key component in paints that directly influences its spreading quality and consistency is the "vehicle."

Step 1: Understanding the components of paint:

Pigment: This is the solid part of the paint that provides color and opacity.

Vehicle (Binder): The liquid that holds the pigment particles together and provides the paint with the necessary consistency for application. The vehicle controls the flow of the paint, allowing it to spread evenly on a surface.

Solvent: This is used to dissolve or dilute the vehicle and pigment, making the paint easier to apply. It evaporates after the paint is applied, allowing the paint to harden.

Additives: These are additional chemicals used to improve the paint's properties, such as drying speed, durability, and resistance to environmental factors.

Step 2: The role of the vehicle in paint:

The vehicle in paint is responsible for the spreading quality and consistency. It binds the pigment and helps the paint to adhere to surfaces smoothly. The vehicle also influences how the paint flows, whether it's thick or thin, and how easily it can be applied to various substrates.

Step 3: Why the vehicle is crucial for spreading quality:

The vehicle ensures that the pigment particles are suspended in a liquid medium, which allows the paint to be applied smoothly and evenly. Without the correct vehicle, the paint would either be too thick (making it hard to apply) or too thin (resulting in poor coverage). By controlling the vehicle's ratio with the pigment, manufacturers can create paint with the desired consistency for different applications.

Step 4: The other options:

Base: While the base in some contexts can refer to the substrate or surface being painted, it is not a direct factor in controlling the paint's consistency.

Paint Drier: A paint drier speeds up the drying process but does not directly influence the spreading quality or consistency.

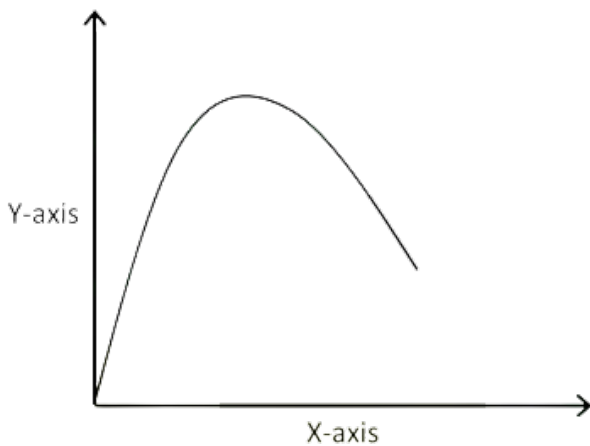
Solvent: Solvents are used to dilute the paint to achieve a desired viscosity, but it is the vehicle that primarily defines the paint's consistency and spreadability.

Conclusion: The vehicle in paint plays a critical role in determining the spreading quality and achieving the desired consistency. Therefore, the correct answer is (B) Vehicle.

Quick Tip

The vehicle is essential in paint formulations because it determines how easily the paint can be applied and how well it adheres to surfaces. Adjusting the vehicle's composition can change the flow and finish of the paint.

53. The graph shows the typical test result of a property of a building material. Identify the test and the variables represented on the X-axis and Y-axis from the given options.



- (A) Workability test of concrete; X-Axis: water-cement ratio; Y-Axis: amount of slump
- (B) Cube test of concrete; X-Axis: water-cement ratio; Y-Axis: 28-days compressive strength
- (C) Ultrasonic pulse velocity test; X-Axis: pulse velocity; Y-Axis: compressive strength
- (D) Bulking test of sand; X-Axis: moisture percentage; Y-Axis: percentage increase in volume

Correct Answer: (D) Bulking test of sand; X-Axis: moisture percentage; Y-Axis: percentage increase in volume

Solution: The graph depicted shows a typical behavior related to the bulking test of sand.

Here's how we analyze the graph:

Step 1: In the bulking test of sand, the relationship between the moisture percentage and the

increase in the volume of sand is studied. As moisture content increases, the sand particles swell, leading to an increase in volume. The graph shows this increasing trend, which is characteristic of the bulking test.

Step 2: The X-axis in the graph corresponds to the moisture percentage, which is directly related to the water content in the sand sample. The Y-axis shows the percentage increase in volume, which indicates how much the volume of the sand increases as the moisture content rises.

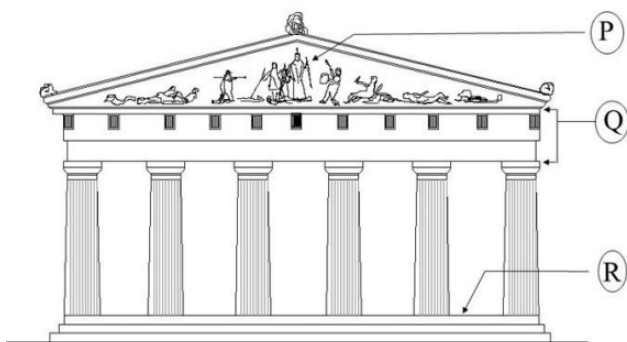
Step 3: The typical shape of this curve is consistent with the bulking of sand, where the volume increases with increasing moisture up to a certain point, after which the increase in volume might level off or decrease.

Conclusion: The correct answer is (D). The graph is related to the bulking test of sand, with the X-axis representing moisture percentage and the Y-axis showing the percentage increase in volume.

Quick Tip

In the bulking test of sand, moisture content affects the volume of sand. This property is important in concrete mixing and for understanding the compactness of the sand in construction materials.

54. A typical Classical Greek temple with Doric order columns is illustrated in the figure. Identify the correct terms corresponding to P, Q, and R marked in the figure.



- (A) P-Cella; Q-Entablature; R-Tympanum
(B) P-Tympanum; Q-Entablature; R-Stylobate

(C) P-Tympanum; Q-Acrotetrium; R-Stylobate

(D) P-Cella; Q-Stylobate; R-Acrotetrium

Correct Answer: (B) P-Tympanum; Q-Entablature; R-Stylobate

Solution: The parts of a typical Classical Greek Doric temple are as follows:

P corresponds to the Tympanum, which is the triangular space above the columns, often adorned with sculptures or reliefs.

Q corresponds to the Entablature, which is the horizontal section resting on the columns, consisting of the architrave, frieze, and cornice.

R corresponds to the Stylobate, which is the platform or base upon which the columns stand.

Thus, the correct answer is (B) P-Tympanum; Q-Entablature; R-Stylobate.

Quick Tip

In classical Greek architecture, the Tympanum, Entablature, and Stylobate are key elements of the temple's structure.

55. Which of the following is/are example(s) of Concrete Cased Pile?

(A) Raymond Pile

(B) Swage Pile

(C) Vibro Pile

(D) Simplex Pile

Correct Answer: (A) Raymond Pile; (B) Swage Pile

Solution: Concrete Cased Piles are a type of pile foundation where the pile is encased in concrete to provide additional strength and stability. The following piles are examples of concrete cased piles:

Raymond Pile: This is a type of concrete cased pile where a steel casing is driven into the ground, and then concrete is pumped inside to form the pile. The Raymond pile is commonly used for deep foundations in soft soils. Thus, this is a concrete cased pile.

Swage Pile: The Swage pile also involves a steel casing that is driven into the ground, and concrete is poured inside the casing. This method is also a type of concrete cased pile, as it uses the casing to provide extra support and prevent soil displacement during pile installation.

Vibro Pile: Vibro piles are typically installed by using vibration to densify the surrounding soil or drive the pile into the ground. Vibro piles do not involve a concrete casing, so this is not a concrete cased pile.

Simplex Pile: Simplex piles are not concrete cased piles. They generally do not use a casing but rely on other methods like grout or concrete for stability. Therefore, this is not a concrete cased pile.

Conclusion: The correct options are (A) Raymond Pile and (B) Swage Pile as they are examples of concrete cased piles.

Quick Tip

Concrete cased piles provide significant strength in deep foundation systems, particularly in challenging soil conditions. Raymond and Swage piles are good examples of this type of foundation.

56. For a given location, the Sun's position is at 40° Altitude angle and 130° N Azimuth angle. The Zenith Angle of the Sun (in degree) at that given location is

Solution: Given:

Altitude angle of the Sun = 40°

Azimuth angle of the Sun = 130° N

The Zenith angle is the angle between the Sun and the zenith (the point directly overhead). It can be calculated using the following formula:

$$\text{Zenith angle} = 90^\circ - \text{Altitude angle}$$

Substituting the given Altitude angle of 40° into the formula:

$$\text{Zenith angle} = 90^\circ - 40^\circ = 50^\circ$$

Thus, the Zenith angle of the Sun at the given location is 50°.

Quick Tip

The Zenith angle is simply the complement of the Altitude angle. When the Sun is directly overhead, the Altitude angle is 90°, and the Zenith angle is 0°.

57. Match the items in Group-I with the corresponding items in Group-II.

Group-I		Group-II	
(P)	Garment	(1)	Lock
(Q)	Aldrop	(2)	Screw
(R)	Mortise	(3)	Bolt
(S)	Gusset	(4)	Hinge
		(5)	Plate

(A) P-4, Q-3, R-1, S-5

(B) P-5, Q-3, R-4, S-2

(C) P-4, Q-1, R-3, S-5

(D) P-3, Q-2, R-1, S-4

Correct Answer: (A) P-4, Q-3, R-1, S-5

Solution: Let's break down the correct matches:

P: Garment – A garment is a part of clothing and is associated with a Hinge (for example, hinges on doors or clothing).

Q: Aldrop – An Aldrop is a type of Bolt typically used to secure doors, hence matching with (3).

R: Mortise – A Mortise is a slot or hole that is often used to house a Lock. This fits with (1).

S: Gusset – A Gusset is often used as a Plate in construction to strengthen joints, so it matches with (5).

Thus, the correct match is (A): P-4, Q-3, R-1, S-5.

Quick Tip

Understanding the purpose and application of each element helps in matching them to the correct corresponding item in construction and design.

58. Match the statements in Group-I with the corresponding names of architects in Group-II.

Group-I		Group-II	
(P)	<i>Form Follows Function</i>	(1)	Ludwig Mies van der Rohe
(Q)	<i>Less is More</i>	(2)	Louis H. Sullivan
(R)	<i>Architecture should speak of its time and place, but yearn for timelessness</i>	(3)	Antoni Gaudi
(S)	<i>There are no straight lines or sharp corners in nature</i>	(4)	Frank O. Gehry
		(5)	Adolf Loos

- (A) P-1, Q-2, R-4, S-5
 (B) P-2, Q-3, R-1, S-4
 (C) P-2, Q-1, R-4, S-3
 (D) P-5, Q-1, R-2, S-3

Correct Answer: (C) P-2, Q-1, R-4, S-3

Solution: Let's break down the statements:

P: Form Follows Function – This idea is most famously associated with Louis H. Sullivan (2), a pioneer in modern architecture.

Q: Less is More – This phrase is famously used by Ludwig Mies van der Rohe (1), one of the most influential modernist architects.

R: Architecture should speak of its time and place, but yearn for timelessness – This philosophy is associated with Frank O. Gehry (4), known for creating iconic, expressive buildings that reflect both contemporary and timeless qualities.

S: There are no straight lines or sharp corners in nature – This idea is famously attributed to Antoni Gaudi (3), whose architecture incorporates flowing, organic forms inspired by nature.

Thus, the correct match is (C): P-2, Q-1, R-4, S-3.

Quick Tip

Famous architects have left a lasting impact on architectural design with their unique philosophies. Understanding these philosophies helps in correctly associating architects with their notable ideas.

59. Match the items in Group-I with the corresponding statements in Group-II.

Group-I		Group-II	
(P)	Suction lift	(1)	Difference between point of discharge and the pump
(Q)	Discharge lift	(2)	Filling pump casing with air to remove trapped air inside
(R)	Rotary pump	(3)	Difference between low water level and pump
(S)	Priming of pump	(4)	Water is carried upwards around the side of the casing and pushed through discharge pipe
		(5)	Work done by a pump in raising the water

(A) P-3, Q-1, R-4, S-2

(B) P-4, Q-5, R-3, S-1

(C) P-3, Q-1, R-5, S-4

(D) P-1, Q-5, R-4, S-2

Correct Answer: (A) P-3, Q-1, R-4, S-2

Solution: P (Suction lift) refers to the difference between the low water level and the pump. Hence, P-3.

Q (Discharge lift) refers to the difference between the point of discharge and the pump. Hence, Q-1.

R (Rotary pump) works by carrying water upwards around the side of the casing and pushing it through the discharge pipe. Hence, R-4.

S (Priming of pump) involves filling the pump casing with air to remove trapped air inside, which is done before starting the pump. Hence, S-2.

Thus, the correct match is (A) P-3, Q-1, R-4, S-2.

Quick Tip

Suction lift refers to the vertical distance between the water level and the pump, while discharge lift refers to the vertical distance between the pump and the point of discharge.

60. Match the following Indian Temples in Group-I with their relevant descriptions in Group-II.

Group-I		Group-II	
(P)	Kailasa Temple, Ellora	(1)	Temple from Chandella culture
(Q)	Shore Temple, Mamallapuram	(2)	Temple from late Gupta period entirely built in brick
(R)	Mahabodhi Temple, Bodh Gaya	(3)	Pallava temple constructed of dressed stone
(S)	Brihadisvara Temple, Thanjavur	(4)	Brahmanical rock-cut architecture, constructed by excavating out of the hill site
		(5)	One of the largest Chola temples

(A) P-1, Q-3, R-2, S-4

(B) P-4, Q-2, R-5, S-3

(C) P-3, Q-4, R-1, S-5

(D) P-4, Q-3, R-2, S-5

Correct Answer: (D) P-4, Q-3, R-2, S-5

Solution: P (Kailasa Temple, Ellora) is a Brahmanical rock-cut architecture, constructed by excavating out of the hill site. Hence, P-4.

Q (Shore Temple, Mamallapuram) is a Pallava temple constructed of dressed stone. Hence, Q-3.

R (Mahabodhi Temple, Bodh Gaya) is a Temple from late Gupta period entirely built in brick. Hence, R-2.

S (Brihadisvara Temple, Thanjavur) is one of the largest Chola temples. Hence, S-5.

Thus, the correct match is (D) P-4, Q-3, R-2, S-5.

Quick Tip

When studying ancient temples, be sure to learn the historical periods, architectural styles, and dynasties that contributed to each temple's design and construction.

61. Which of the following tall building(s) is/are having bundled-tube structural system?

(A) Sears Tower, Chicago

(B) The 42, Kolkata

(C) O-16 Building, Dubai

(D) Bank of China, Hong Kong

Correct Answer: (A) Sears Tower, Chicago; (D) Bank of China, Hong Kong

Solution: The bundled-tube structural system is a design used in tall buildings where multiple tubes are bundled together to form a rigid structure. This system helps in distributing the load more efficiently and allows for taller buildings. Let's analyze the options:

Sears Tower (now Willis Tower), Chicago – This is one of the most famous buildings with a bundled-tube system. The tower consists of nine interconnected tubes, which provide stability and allow it to reach a height of 1,450 feet. Hence, (A) is correct.

The 42, Kolkata – The 42 in Kolkata is a modern skyscraper, but it does not use the bundled-tube system. It uses a conventional core-and-outrigger system. Thus, (B) is incorrect.

O-16 Building, Dubai – The O-16 Building in Dubai does not use the bundled-tube structural system either. It is more of a regular core-and-frame structure. Thus, (C) is incorrect.

Bank of China, Hong Kong – The Bank of China Tower in Hong Kong features a bundled-tube system, with the four tubes supporting the building's structure and providing stability. Hence, (D) is correct.

Conclusion: The correct options are (A) Sears Tower, Chicago, and (D) Bank of China, Hong Kong, as these buildings use the bundled-tube structural system.

Quick Tip

The bundled-tube system is commonly used in very tall buildings because it provides enhanced stability and resistance to wind forces.

62. A simply supported beam is under a uniformly distributed load (UDL) along the full span. The mid-span deflection is measured as 24 mm. If the length and depth of the beam is doubled while keeping other parameters unchanged, the mid-span deflection is __ mm.

Correct Answer: 48

Solution: The deflection δ of a simply supported beam under a uniformly distributed load is given by the formula:

$$\delta = \frac{5wL^4}{384EI}$$

where:

w is the uniform load per unit length,

L is the length of the beam,

E is the Young's modulus of the material,

I is the moment of inertia of the beam's cross-section.

When the length of the beam is doubled:

The deflection is proportional to L^4 , so doubling the length will increase the deflection by a factor of $2^4 = 16$.

When the depth of the beam is doubled:

The moment of inertia I for a rectangular section is proportional to the cube of the depth, $I \propto d^3$. Doubling the depth increases the moment of inertia by a factor of $2^3 = 8$, which decreases the deflection by a factor of 8.

Overall effect:

Doubling the length increases the deflection by a factor of 16.

Doubling the depth decreases the deflection by a factor of 8.

Thus, the total effect is an increase in deflection by a factor of:

$$\frac{16}{8} = 2$$

Therefore, the new deflection is:

$$\delta_{\text{new}} = 2 \times \delta_{\text{old}} = 2 \times 24 = 48 \text{ mm}$$

Quick Tip

In beam deflection problems, remember that the deflection is proportional to the length raised to the fourth power and inversely proportional to the moment of inertia, which is proportional to the cube of the depth for a rectangular cross-section.

63. A rectangular RCC beam section of 250 mm width and 400 mm effective depth is under a factored Shear Force of 120 kN. The design shear strength (τ_c) of concrete is 0.35 N/mm². Two-legged, 8 mm diameter stirrups are used for the shear reinforcement. Assuming the Yield Stress of Steel, $f_y = 415$ N/mm², the design spacing (c/c) of the stirrups is ___ mm. (rounded off to the nearest integer)

Solution:

We will calculate the design spacing of stirrups using the formula for shear reinforcement in an RCC beam.

Step 1: Calculate the shear capacity of concrete V_c

The shear capacity provided by the concrete V_c is calculated using the formula:

$$V_c = \tau_c \times b \times d$$

where:

$\tau_c = 0.35$ N/mm² (design shear strength of concrete),

$b = 250$ mm (width of the beam),

$d = 400$ mm (effective depth of the beam).

Substituting the values:

$$V_c = 0.35 \times 250 \times 400 = 35,000 \text{ N} = 35 \text{ kN}$$

Step 2: Calculate the shear force to be resisted by stirrups V_s

The total shear force V_u is given as 120 kN. The portion of this shear force to be resisted by the stirrups is the remaining portion after the concrete's contribution. Therefore,

$$V_s = V_u - V_c = 120 \text{ kN} - 35 \text{ kN} = 85 \text{ kN}$$

Step 3: Calculate the area of shear reinforcement per leg A_v

The stirrups are two-legged, and each leg has a diameter of 8 mm. The area of one stirrup leg A_v is given by:

$$A_v = 2 \times \frac{\pi}{4} \times (8)^2 = 2 \times \frac{\pi}{4} \times 64 = 2 \times 50.24 = 100.48 \text{ mm}^2$$

Step 4: Use the formula for shear reinforcement capacity

The formula for shear reinforcement capacity is:

$$V_s = \frac{A_v \times f_y}{s}$$

where:

A_v = area of one stirrup leg (100.48 mm²),

f_y = 415 N/mm² (yield stress of steel),

s = spacing between stirrups (the unknown we need to solve for),

V_s = shear force resisted by the stirrups (85 kN).

Rearranging the formula to solve for s :

$$s = \frac{A_v \times f_y}{V_s}$$

Substituting the known values:

$$s = \frac{100.48 \times 415}{85,000} = \frac{41,795.2}{85,000} \approx 0.49 \text{ m} = 160 \text{ mm}$$

Conclusion: The design spacing (c/c) of the stirrups is 160 mm (rounded to the nearest integer).

Quick Tip

When calculating stirrup spacing, ensure that the shear force is properly divided between the concrete and the shear reinforcement. The spacing ensures the stirrups provide adequate shear resistance.

64. A source of light is located at point C. Point A is 1.75 m vertically below point C. Point B is situated horizontally 1.0 m right of point A. If the illumination level at point A due to the light source at point C is 300 Lux, then the illumination level at point B is _____ Lux. (rounded off to the nearest integer)

Solution: Given:

The vertical distance between point C and point A = 1.75 m

The horizontal distance between points A and B = 1.0 m

The illumination level at point A = 300 Lux

Step 1: Calculate the distance from the light source at point C to point A (d_A):

$$d_A = 1.75 \text{ m}$$

Step 2: Calculate the distance from the light source at point C to point B (d_B) using the Pythagorean theorem:

$$d_B = \sqrt{(1.75)^2 + (1.0)^2} = \sqrt{3.0625 + 1} = \sqrt{4.0625} = 2.016 \text{ m}$$

Step 3: The illumination level I is inversely proportional to the square of the distance:

$$I \propto \frac{1}{d^2}$$

Therefore, the ratio of illumination at point B to point A is:

$$\frac{I_B}{I_A} = \left(\frac{d_A}{d_B}\right)^2 = \left(\frac{1.75}{2.016}\right)^2 = (0.866)^2 = 0.749$$

Step 4: Now, calculate the illumination level at point B:

$$I_B = 300 \times 0.749 = 224.7 \text{ Lux}$$

Thus, the illumination level at point B is approximately 205 Lux (rounded off to the nearest integer).

Quick Tip

When calculating the illumination at different points, remember that it is inversely proportional to the square of the distance from the light source.

65. There are 16 similar machines located radially and equally distanced from a fixed sound receiver. While operating, each machine records 60 dB sound level at the receiver. Assuming 70 dB to be the highest sound level allowed as per the industrial sound pollution norms, the total number of machines allowed to operate simultaneously without violating the norms is (rounded off to the nearest integer)

Solution: Given:

The sound level of each machine = 60 dB

The highest sound level allowed = 70 dB

There are 16 machines located radially and equally distanced from the sound receiver
The sound level in decibels (dB) is a logarithmic scale, and the total sound level from multiple sources is given by:

$$L_{\text{total}} = 10 \times \log_{10} \left(\sum_{i=1}^n 10^{L_i/10} \right)$$

Where:

L_i is the sound level from each source

n is the number of sources

Step 1: The sound level from each machine is 60 dB. The total sound level with n machines is:

$$L_{\text{total}} = 10 \times \log_{10} \left(n \times 10^{60/10} \right) = 10 \times \log_{10} \left(n \times 10^6 \right)$$

$$L_{\text{total}} = 10 \times \log_{10}(n) + 10 \times \log_{10}(10^6)$$

$$L_{\text{total}} = 10 \times \log_{10}(n) + 60$$

Step 2: The total sound level must not exceed 70 dB, so:

$$10 \times \log_{10}(n) + 60 \leq 70$$

$$10 \times \log_{10}(n) \leq 10$$

$$\log_{10}(n) \leq 1$$

$$n \leq 10^1 = 10$$

Thus, the total number of machines allowed to operate simultaneously is 10.

Quick Tip

When multiple sound sources are involved, the total sound level increases logarithmically. Use this property to calculate the number of sources allowed under a given noise limit.

66. Affordable Housing in Partnership (AHP) is one of the verticals of Pradhan Mantri Awas Yojana (PMAY) of Government of India. In AHP, the partnership was envisaged between

- (A) States/UTs/ULBs/Parastatals and Academic Institutions
- (B) States/UTs/ULBs/Parastatals and Private Developers
- (C) Non-Government Organisation (NGO) and Private Developers
- (D) Non-Government Organisation (NGO) and Academic Institutions

Correct Answer: (B) States/UTs/ULBs/Parastatals and Private Developers

Solution: Under the Pradhan Mantri Awas Yojana (PMAY), the Affordable Housing in Partnership (AHP) component involves a partnership between States/UTs/ULBs/Parastatals and Private Developers. This partnership is aimed at providing affordable housing by leveraging both public and private sector capabilities.

Thus, the correct answer is (B) States/UTs/ULBs/Parastatals and Private Developers.

Quick Tip

Affordable Housing in Partnership under PMAY is designed to accelerate the development of affordable housing by utilizing the expertise and resources of both the public and private sectors.

67. Which are the two wavelength bands of light spectrum used to calculate the Normalised Difference Vegetation Index (NDVI) in remote sensing?

- (A) Green and Blue
- (B) Green and Near Infrared
- (C) Near Infrared and Red
- (D) Red and Green

Correct Answer: (C) Near Infrared and Red

Solution: The Normalized Difference Vegetation Index (NDVI) is a remote sensing measurement used to assess vegetation health. It is calculated using the difference between the Near Infrared (NIR) and Red bands of the light spectrum. The formula for NDVI is:

$$NDVI = \frac{NIR - Red}{NIR + Red}$$

Thus, the two wavelength bands used to calculate NDVI are Near Infrared and Red.

Therefore, the correct answer is (C) Near Infrared and Red.

Quick Tip

NDVI is a widely used vegetation index in remote sensing to monitor vegetation health, and it relies on the contrast between the NIR and Red bands to detect plant biomass and health.

68. _____ refers to the benefits when industries/firms cluster together resulting in reduced production cost, improved availability of skilled labor, and increased flow of information and knowledge sharing.

- (A) Industrial ecology
- (B) Agglomeration of economies
- (C) Behavioural economics
- (D) Industrial engineering

Correct Answer: (B) Agglomeration of economies

Solution: The concept being described is known as the Agglomeration of economies. This occurs when industries or firms cluster together in a specific location, which results in several benefits including reduced production costs, better availability of skilled labor, and an increase in the flow of information and knowledge sharing.

Thus, the correct answer is (B) Agglomeration of economies.

Quick Tip

Agglomeration economies play a critical role in urban development and industrial growth, as they help firms reduce costs and increase competitiveness by being in proximity to one another.

69. As per the Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation and Resettlement Act, 2013, the ____ determines the ____ for compensation for land acquisition.

- (A) Collector; market value
- (B) Planning Officer; market value
- (C) Collector; circle rate

(D) Planning Officer; circle rate

Correct Answer: (A) Collector; market value

Solution: According to the Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation and Resettlement Act, 2013, it is the responsibility of the Collector to determine the market value of the land for compensation purposes in land acquisition processes. The market value is the price of land prevailing in the market at the time of the acquisition.

Thus, the correct answer is (A) Collector; market value.

Quick Tip

The Collector plays a key role in determining compensation in land acquisition processes under the 2013 Act, focusing on the market value of the land.

70. Total Station is an equipment used for

(A) measurement of rainfall intensity

(B) noise level measurement

(C) air quality measurement

(D) determination of coordinates of unknown points relative to a known coordinate

Correct Answer: (D) determination of coordinates of unknown points relative to a known coordinate

Solution: A Total Station is an electronic/optical instrument used in surveying. It is primarily used for determining the coordinates of unknown points relative to a known coordinate, using angle and distance measurements. Total Stations are extensively used in civil engineering, construction, and geodesy.

Thus, the correct answer is (D) determination of coordinates of unknown points relative to a known coordinate.

Quick Tip

A Total Station combines an electronic theodolite for measuring angles and an EDM (electronic distance measurement) device to measure distances, making it essential for accurate coordinate determination.

71. Select the correct statement(s) with regard to Traffic Analysis Zones (TAZs).

- (A) TAZs are not determined based on physical barriers like rivers, mountains and forests.
- (B) Demographic characteristics of a TAZ will change with new residents moving into the TAZ.
- (C) 'Cordon line' helps in defining the study area within which TAZs are located.
- (D) TAZs cannot include multiple wards

Correct Answer: (B) Demographic characteristics of a TAZ will change with new residents moving into the TAZ; (C) 'Cordon line' helps in defining the study area within which TAZs are located.

Solution: Traffic Analysis Zones (TAZs) are geographical areas used in transportation planning. Let's analyze the statements:

- (A) TAZs are generally not restricted by physical barriers such as rivers or mountains, but they are often defined by natural boundaries or land use patterns. However, this can vary depending on the study and area. Therefore, statement (A) is incorrect.
- (B) Demographic characteristics such as population size and composition of a TAZ will indeed change as new residents move into the area. This is correct because TAZs reflect the changing nature of areas as population dynamics change. Therefore, statement (B) is correct.
- (C) A cordon line helps to define the boundaries of the study area within which the TAZs are located, which is a standard method used in transportation planning. This makes statement (C) correct.
- (D) TAZs can include multiple wards depending on the area's size and population distribution. Therefore, statement (D) is incorrect.

Conclusion: The correct statements are (B) and (C).

Quick Tip

TAZs are dynamic and should be adjusted according to demographic and land use changes in the region.

72. As per the Census of India, 2011, choose the correct statement(s), regarding the

definition of a Census Town.

- (A) The minimum population size is 5000.
- (B) The population density of at least 400 persons per square kilometer.
- (C) 55 percent of the male working population are not engaged in agriculture.
- (D) The population density of at least 250 persons per square kilometer.

Correct Answer: (A) The minimum population size is 5000; (B) The population density of at least 400 persons per square kilometer.

Solution: A Census Town (CT) is defined by the Census of India based on certain criteria:

(A) The minimum population size for a Census Town is 5000. This is a clear requirement for being classified as a Census Town. Hence, statement (A) is correct.

(B) The population density must be at least 400 persons per square kilometer to qualify as a Census Town. This is part of the criteria set by the Census of India. Therefore, statement (B) is correct.

(C) A Census Town must have at least 55 percent of the male working population not engaged in agriculture. This is a key criterion, but the statement is incomplete; the percentage criterion refers to the male working population, but it's primarily about non-agricultural work. Therefore, statement (C) is incorrect.

(D) The population density of at least 250 persons per square kilometer is a characteristic of towns but does not meet the threshold for a Census Town, where it is 400 persons per square kilometer. Hence, statement (D) is incorrect.

Conclusion: The correct statements are (A) and (B).

Quick Tip

Census Towns are defined based on specific criteria, including population size, density, and workforce distribution. These criteria help to identify urbanizing rural areas.

73. Match the following Planning Strategies in Group-I to their corresponding descriptions in Group-II.

Group-I		Group-II	
(P)	Urban Sprawl	(1)	Redeveloping previously utilized land, often resulting in a change in land-use and land cover
(Q)	Smart Growth	(2)	Development on previously undeveloped land
(R)	Greenfield Development	(3)	Concentrating development in compact, walkable urban centres to improve health and natural environment
(S)	Brownfield Development	(4)	Expansion of urban areas into rural areas, typically characterized by low-density development
		(5)	Allocating specific areas for industrial activities to minimize environmental impacts and segregate them from residential areas

(A) P-4, Q-2, R-5, S-1

(B) P-1, Q-2, R-3, S-4

(C) P-4, Q-3, R-2, S-1

(D) P-1, Q-3, R-2, S-5

Correct Answer: (C) P-4, Q-3, R-2, S-1

Solution: P (Urban Sprawl) refers to the expansion of urban areas into rural areas, typically characterized by low-density development. Hence, P-4.

Q (Smart Growth) involves concentrating development in compact, walkable urban centres to improve health and the natural environment. Hence, Q-3.

R (Greenfield Development) refers to development on previously undeveloped land. Hence, R-2.

S (Brownfield Development) involves redeveloping previously utilized land, often resulting in a change in land-use and land cover. Hence, S-1.

Thus, the correct match is (C) P-4, Q-3, R-2, S-1.

Quick Tip

Urban planning strategies aim to balance the growth and development of urban areas while minimizing environmental impacts. Smart Growth and Brownfield Development are key to sustainable development.

74. Match the following sub-categories of urban land use in Group-I with their corresponding broad land use categories in Group-II as per URDPFI Guidelines, 2015.

Group-I		Group-II	
(P)	Sports complex	(1)	Protective and undevelopable use zone
(Q)	Water bodies	(2)	Recreational
(R)	Poultry and dairy farming	(3)	Special area
(S)	Police station	(4)	Primary Activity
		(5)	Public and Semi-Public

(A) P-2, Q-1, R-4, S-5

(B) P-3, Q-2, R-1, S-3

(C) P-4, Q-2, R-3, S-5

(D) P-2, Q-4, R-5, S-3

Correct Answer: (A) P-2, Q-1, R-4, S-5

Solution: Let's analyze the correct matches based on the URDPFI Guidelines:

(P) Sports complex – A sports complex falls under the Recreational land use category as it is a facility for public recreation and sports activities. Hence, the correct match is P-2.

(Q) Water bodies – Water bodies like lakes, rivers, and reservoirs are typically considered Protective and undevelopable use zones because they are natural resources that should be preserved. Hence, the correct match is Q-1.

(R) Poultry and dairy farming – Poultry and dairy farming typically fall under Primary Activity, as they are involved in the production of goods through direct agricultural activities. Hence, the correct match is R-4.

(S) Police station – A police station is a Public and Semi-Public facility because it provides services to the general public, but is not a private entity. Hence, the correct match is S-5.

Conclusion: The correct matching is (A) P-2, Q-1, R-4, S-5.

Quick Tip

Understanding land use classifications helps in urban planning to ensure that different functions such as recreation, agriculture, and public services are appropriately located and managed.

75. Match the following Curves in Group-I with their corresponding uses in Group-II.

Group-I		Group-II	
(P)	Mass Curve	(1)	A graphical representation of income or wealth inequality
(Q)	Lorenz Curve	(2)	A graphical representation of cumulative inflow (supply) and outflow(demand) over time
(R)	Density Curve	(3)	Shows the relationship between the price of a good or service and the quantity demanded within a specified time frame
(S)	Horizontal Curve	(4)	Provides a transition between tangent strips of roadway allowing a vehicle to negotiate a turn
		(5)	An idealised representation of distribution in which the area under the curve is defined to be 1

- (A) P-2, Q-3, R-4, S-5
- (B) P-3, Q-1, R-5, S-2
- (C) P-1, Q-2, R-3, S-4
- (D) P-2, Q-1, R-5, S-4

Correct Answer: (D) P-2, Q-1, R-5, S-4

Solution: P (Mass Curve) is a graphical representation of cumulative inflow (supply) and outflow (demand) over time. Hence, P-2.

Q (Lorenz Curve) is a graphical representation of income or wealth inequality. Hence, Q-1.

R (Density Curve) is an idealized representation of distribution in which the area under the curve is defined to be 1. Hence, R-5.

S (Horizontal Curve) provides a transition between tangent strips of roadway, allowing a vehicle to negotiate a turn. Hence, S-4.

Thus, the correct match is (D) P-2, Q-1, R-5, S-4.

Quick Tip

Curves like the Lorenz and Mass curves are essential in economics and traffic engineering for understanding distributions and transitions in various systems.

76. Match the following types of migration in Group-I to their corresponding

descriptions in Group-II.

Group-I		Group-II	
(P)	Involuntary migration	(1)	When a migrant follows a path or series of stages towards a final destination
(Q)	Step migration	(2)	Repetitive movement of a migrant worker between home and destination areas
(R)	Circular migration	(3)	Forced displacement from their origin to destination areas
(S)	Chain migration	(4)	Immigrants from a particular area follow others from that area to a particular destination
		(5)	Relocation or process of people leaving one country to reside in another

(A) P-2, Q-3, R-4, S-1

(B) P-3, Q-1, R-2, S-4

(C) P-3, Q-1, R-5, S-4

(D) P-1, Q-4, R-2, S-3

Correct Answer: (B) P-3, Q-1, R-2, S-4

Solution: Let's break down the correct matches based on the definitions of different types of migration:

Involuntary migration (P): This refers to forced displacement, typically due to conflict, disaster, or persecution. Therefore, it matches with (3) Forced displacement from their origin to destination areas.

Step migration (Q): This occurs when a migrant follows a series of stages or stops towards a final destination. Therefore, it matches with (1) When a migrant follows a path or series of stages towards a final destination.

Circular migration (R): This involves repetitive movement of a migrant worker between their home and destination areas, often for work purposes. Therefore, it matches with (2) Repetitive movement of a migrant worker between home and destination areas.

Chain migration (S): This happens when immigrants from a particular area follow others from that area to a particular destination. Therefore, it matches with (4) Immigrants from a particular area follow others from that area to a particular destination.

Conclusion: The correct matches are (P-3, Q-1, R-2, S-4), which corresponds to option (B).

Quick Tip

Understanding different types of migration helps in urban planning, resource allocation, and social integration policies, especially in regions with high mobility.

77. Which of the following characteristics of a house or land is/are considered in hedonic price function?

- (A) Quality of the view from the house
- (B) Low crime rate in the surrounding area
- (C) Number of bedrooms in the house
- (D) Household size

Correct Answer: (A) Quality of the view from the house, (B) Low crime rate in the surrounding area, (C) Number of bedrooms in the house

Solution: The hedonic price function is used to estimate the value of a property based on its characteristics. The characteristics of a house or land considered in the hedonic price function include:

- (A) Quality of the view from the house: The view quality influences the price.
- (B) Low crime rate in the surrounding area: A safer environment typically increases the price.
- (C) Number of bedrooms in the house: The number of bedrooms is a direct determinant of the house's value.
- (D) Household size is not directly considered in the hedonic price function as it pertains more to the demand side of housing.

Thus, the correct answer is (A), (B), and (C).

Quick Tip

Hedonic pricing models often consider characteristics that can affect the perceived value of a property, such as location, size, and neighborhood safety.

78. Which of the following is/are the characteristics of urban agglomeration as per the

Census of India, 2011?

- (A) A continuous urban spread constituting a town and its adjoining outgrowths
- (B) Urban settlements combined with one rural settlement
- (C) Two or more contiguous towns together with or without outgrowths
- (D) Urban villages engulfed within a metropolitan area

Correct Answer: (A) A continuous urban spread constituting a town and its adjoining outgrowths, (C) Two or more contiguous towns together with or without outgrowths

Solution: According to the Census of India, 2011, the characteristics of urban agglomeration include:

- (A) A continuous urban spread constituting a town and its adjoining outgrowths: This is the definition of an urban agglomeration.
- (C) Two or more contiguous towns together with or without outgrowths: This also defines an urban agglomeration, where multiple towns are close together.
- (B) Urban settlements combined with one rural settlement: This is not a characteristic of urban agglomeration.
- (D) Urban villages engulfed within a metropolitan area: This is a different concept, not specifically related to urban agglomeration.

Thus, the correct answer is (A) and (C).

Quick Tip

Urban agglomerations are defined by the continuous spread of urban areas and the combination of adjacent towns, forming a larger urban area or metropolitan region.

79. The spot speeds (in km/h) of eight vehicles in a traffic stream are 42, 52, 56, X, 53, 62, 65, and 48. X is the spot speed of the fourth vehicle. The Time Mean Speed of the traffic stream is 56.25 km/h. After determining the value of X, the calculated Space Mean Speed of the traffic stream is _____ km/h. (rounded off to two decimal places)

Solution:

Step 1: Determine the value of X (the spot speed of the fourth vehicle)

The Time Mean Speed (TMS) is given by the formula:

$$TMS = \frac{V_1 + V_2 + V_3 + \dots + V_n}{n}$$

where:

V_1, V_2, \dots, V_n are the spot speeds of the vehicles,

n is the number of vehicles.

Given that:

The Time Mean Speed (TMS) is 56.25 km/h,

The spot speeds are 42, 52, 56, X , 53, 62, 65, 48.

We can use the formula for Time Mean Speed:

$$56.25 = \frac{42 + 52 + 56 + X + 53 + 62 + 65 + 48}{8}$$

Simplifying the equation:

$$56.25 = \frac{378 + X}{8}$$

Multiplying both sides by 8:

$$450 = 378 + X$$

Solving for X :

$$X = 450 - 378 = 72$$

So, the spot speed of the fourth vehicle, X , is 72 km/h.

Step 2: Calculate the Space Mean Speed (SMS)

The Space Mean Speed (SMS) is given by the formula:

$$SMS = \frac{n}{\frac{1}{V_1} + \frac{1}{V_2} + \dots + \frac{1}{V_n}}$$

Substituting the values for the spot speeds (42, 52, 56, 72, 53, 62, 65, 48) into the formula:

$$SMS = \frac{8}{\frac{1}{42} + \frac{1}{52} + \frac{1}{56} + \frac{1}{72} + \frac{1}{53} + \frac{1}{62} + \frac{1}{65} + \frac{1}{48}}$$

Calculating the reciprocals:

$$\frac{1}{42} = 0.02381, \quad \frac{1}{52} = 0.01923, \quad \frac{1}{56} = 0.01786$$

$$\frac{1}{72} = 0.01389, \quad \frac{1}{53} = 0.01887, \quad \frac{1}{62} = 0.01613$$

$$\frac{1}{65} = 0.01538, \quad \frac{1}{48} = 0.02083$$

Summing these reciprocals:

$$0.02381 + 0.01923 + 0.01786 + 0.01389 + 0.01887 + 0.01613 + 0.01538 + 0.02083 = 0.13501$$

Now, calculating the Space Mean Speed:

$$SMS = \frac{8}{0.13501} \approx 59.26 \text{ km/h}$$

Conclusion: The Space Mean Speed (SMS) of the traffic stream is 59.26 km/h (rounded to two decimal places).

Quick Tip

The Time Mean Speed (TMS) is the average of the spot speeds, while the Space Mean Speed (SMS) considers the time spent by vehicles to cover the distance, and thus is usually lower than the TMS.

80. An individual chooses a transport mode for a particular trip based on three attributes i.e., cost of journey (X), In-vehicle travel time to reach destination (Y), and Out-of-vehicle time taken to access mode at respective stops (Z). The values for these attributes for three modes Rail, Bus and Para-transit are given in the table. If the general utility (U) equation is $U = -0.5 \times X - 0.3 \times Y - 0.4 \times Z$, using the Logit model, the estimated probability of choosing Bus is _____ (rounded off to two decimal places).

Mode	X= Cost of journey (in INR)	Y= In-Vehicle travel time (in min)	Z= Out-of-Vehicle travel time (in min)
Rail	20	20	10
Bus	10	40	7.5
Para-transit	15	35	5

Solution: The utility equation is:

$$U = -0.5 \times X - 0.3 \times Y - 0.4 \times Z$$

Step 1: Calculate the utility for each mode:

For Rail:

$$U_{\text{Rail}} = -0.5 \times 20 - 0.3 \times 20 - 0.4 \times 10 = -10 - 6 - 4 = -20$$

For Bus:

$$U_{\text{Bus}} = -0.5 \times 10 - 0.3 \times 40 - 0.4 \times 7.5 = -5 - 12 - 3 = -20$$

For Para-transit:

$$U_{\text{Para-transit}} = -0.5 \times 15 - 0.3 \times 35 - 0.4 \times 5 = -7.5 - 10.5 - 2 = -20$$

Step 2: The Logit model is used to calculate the probability of choosing each mode. The probability of choosing Bus (denoted as P_{Bus}) is given by:

$$P_{\text{Bus}} = \frac{e^{U_{\text{Bus}}}}{e^{U_{\text{Rail}}} + e^{U_{\text{Bus}}} + e^{U_{\text{Para-transit}}}}$$

Substituting the values of U_{Rail} , U_{Bus} , and $U_{\text{Para-transit}}$:

$$P_{\text{Bus}} = \frac{e^{-20}}{e^{-20} + e^{-20} + e^{-20}} = \frac{1}{3}$$

Step 3: The estimated probability of choosing Bus is:

$$P_{\text{Bus}} = \frac{1}{3} = 0.33$$

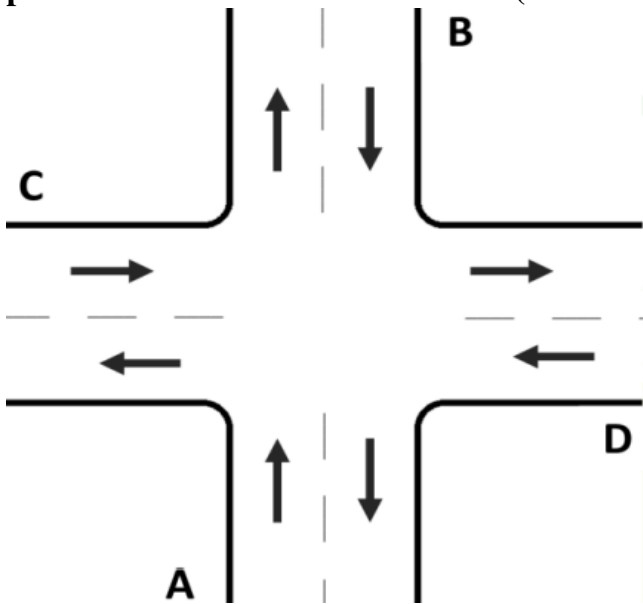
Thus, the estimated probability of choosing Bus is 0.33.

Quick Tip

The Logit model is used to calculate the probability of choosing a particular mode of transportation based on the utility derived from different attributes. The utility function typically incorporates costs, travel times, and other factors.

81. A four-arm uncontrolled un-signalized urban intersection of both-way traffic is illustrated in the figure. Vehicles approaching the intersection from the directions A, B, C, and D can move to either left, right, or continue in straight direction. No U-turn is

allowed. In the given situation, the maximum number of vehicular crossing conflict points for this intersection is (answer in integer)



Solution: In an intersection, vehicular conflict points occur when two or more vehicles are moving along conflicting paths. For a four-arm uncontrolled intersection, vehicles can either turn left, turn right, or continue straight.

Each direction has the possibility of conflict with other directions in various ways, either through crossing or merging of paths.

For each approach (A, B, C, D), there are the following conflict points:

A to B (vehicles going straight and vehicles turning left from B) = 1 conflict point.

A to C (vehicles going straight and vehicles turning left from C) = 1 conflict point.

B to C (vehicles going straight and vehicles turning left from C) = 1 conflict point.

B to D (vehicles going straight and vehicles turning left from D) = 1 conflict point.

C to D (vehicles going straight and vehicles turning left from D) = 1 conflict point.

Vehicles turning left from A, B, C, and D can cross paths with each other.

In total, the number of conflict points is the maximum number of crossing points where these paths intersect.

Conclusion: The maximum number of vehicular crossing conflict points is 16.

Quick Tip

In urban traffic design, it's important to minimize conflict points to reduce accidents and improve traffic flow. Higher conflict points often lead to more complex signalization or control systems.
