GATE 2022 Architecture and Planning (AR) Question Paper with Solutions

Time Allowed :3 Hours	Maximum Marks :100	Total questions :81

General Instructions

Read the following instructions very carefully and strictly follow them:

1. Each GATE 2022 paper consists of a total of 100 marks. The examination is divided into two sections – General Aptitude (GA) and the Candidate's Selected Subjects. General Aptitude carries 15 marks, while the remaining 85 marks are dedicated to the candidate's chosen test paper syllabus.

2. GATE 2022 will be conducted in English as a Computer Based Test (CBT) at select centres in select cities. The duration of the examination is 3 hours.

3. MCQs carry 1 mark or 2 marks.

4. For a wrong answer in a 1-mark MCQ, 1/3 mark is deducted.

5. For a wrong answer in a 2-mark MCQ, 2/3 mark is deducted.

6. No negative marking for wrong answers in MSQ or NAT questions.

General Aptitude (GA)

1. After playing _____ hours of tennis, I am feeling _____ tired to walk back.

(A) too / too

(B) too / two

(C) two / two

(D) two / too

Correct Answer: (D) two / too

Solution:

The sentence requires two correct words to fill the blanks. Let's analyze the options:

- The first blank is asking for the number of hours of tennis played. Since "two" fits the context (a quantity of hours), (D) is the correct choice.

- The second blank refers to the level of tiredness after playing tennis. The correct phrase here is "too tired," meaning very tired, which is the appropriate expression in this context. Thus, (D) is correct.

Hence, the correct answer is (D) two / too.

> **Quick Tip**
>
> "Too" is used to indicate excess, while "two" refers to the number 2.

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2. The average of the monthly salaries of M, N and S is 4000. The average of the monthly salaries of N, S and P is 5000. The monthly salary of P is 6000. What is the monthly salary of M as a percentage of the monthly salary of P?

(A) 50%

(B) 75%

(C) 100%

(D) 125%

Correct Answer: (A) 50%

Solution:

Let the monthly salaries of M, N, S, and P be represented by m, n, s, and p, respectively.

1. From the first statement, the average of the monthly salaries of M, N, and S is 4000:

$$\frac{m + n + s}{3} = 4000 \implies m + n + s = 12000.$$

2. From the second statement, the average of the monthly salaries of N, S, and P is 5000:

$$\frac{n + s + p}{3} = 5000 \implies n + s + p = 15000.$$

3. We are given that the monthly salary of P is 6000:

$$p = 6000.$$

Now, subtract the first equation from the second equation:

$$(n + s + p) - (m + n + s) = 15000 - 12000 \implies p - m = 3000.$$

Substitute $p = 6000$:

$$6000 - m = 3000 \implies m = 3000.$$

The monthly salary of M is 3000. To find the percentage of M's salary with respect to P's salary, we use the formula:

$$\text{Percentage} = \left(\frac{m}{p}\right) \times 100 = \left(\frac{3000}{6000}\right) \times 100 = 50\%.$$

Thus, the correct answer is (A) 50%.

> **Quick Tip**
>
> When calculating percentages, always divide the part by the whole and multiply by 100.

3.

A person travelled 80 km in 6 hours. If the person travelled the first part with a uniform speed of 10 kmph and the remaining part with a uniform speed of 18 kmph. What percentage of the total distance is travelled at a uniform speed of 10 kmph?

(A) 28.25

(B) 37.25

(C) 43.75

(D) 50.00

Correct Answer: (C) 43.75

Solution:

Let the distance travelled at 10 kmph be x km.

Then, the time taken to travel x km is:

$$\frac{x}{10}.$$

The remaining distance, travelled at 18 kmph, will be $(80 - x)$ km. The time taken to travel this distance is:

$$\frac{80 - x}{18}.$$

The total time taken is 6 hours. Therefore, we have the equation:

$$\frac{x}{10} + \frac{80 - x}{18} = 6.$$

Multiplying through by 90 (the least common multiple of 10 and 18) to eliminate the denominators:

$$9x + 5(80 - x) = 540.$$

Expanding and solving for x:

$$9x + 400 - 5x = 540,$$

$$4x = 140,$$

$$x = 35.$$

So, the person travelled 35 km at 10 kmph. The percentage of the total distance travelled at 10 kmph is:

$$\frac{35}{80} \times 100 = 43.75\%.$$

Thus, the correct answer is (C) 43.75.

> **Quick Tip**
>
> To solve such problems, break the total time into two parts based on the distances travelled at different speeds, then use the time equation to find the distance.

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4. Four girls P, Q, R, and S are studying languages in a University. P is learning French and Dutch. Q is learning Chinese and Japanese. R is learning Spanish and French. S is learning Dutch and Japanese.

Given that: French is easier than Dutch; Chinese is harder than Japanese; Dutch is easier than Japanese, and Spanish is easier than French.

Based on the above information, which girl is learning the most difficult pair of languages?

(A) P

(B) Q

(C) R

(D) S

Correct Answer: (B) Q

Solution:

Step 1: Analyze the difficulty of each language.

The given information tells us the relative difficulty of the languages:

- French is easier than Dutch.

- Chinese is harder than Japanese.

- Dutch is easier than Japanese.

- Spanish is easier than French.

Step 2: Consider the language pairs each girl is learning.

- P: French and Dutch → Dutch is harder than French.

- Q: Chinese and Japanese → Chinese is harder than Japanese.

- R: Spanish and French → French is easier than Spanish.

- S: Dutch and Japanese → Dutch is easier than Japanese.

Step 3: Identify the most difficult pair.

The most difficult pair of languages would be the one involving Chinese and Japanese, as Chinese is harder than Japanese. Thus, Q is learning the most difficult pair.

Final Answer:

$$\boxed{Q}$$

> **Quick Tip**
>
> When determining the difficulty of language pairs, focus on the relative difficulty between the languages in the pair to identify the most challenging combination.

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5. A block with a trapezoidal cross-section is placed over a block with a rectangular cross-section as shown above.

Which one of the following is the correct drawing of the view of the 3D object as viewed in the direction indicated by the arrow in the above figure?
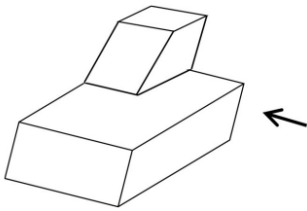
(A)	
(B)	
(C)	
(D)	

Correct Answer: (A)

Solution:

The 3D object in the given figure consists of two parts: a trapezoidal cross-section placed over a rectangular block. The key to solving this problem is to imagine the view of the object as seen from the direction indicated by the arrow.

Step 1: Analyzing the Shape

The block with the trapezoidal cross-section is placed on top of the rectangular block. From the arrow's direction, we are viewing the object from the side where the trapezoidal shape is most prominent. This means the trapezoid's top edge will be visible, and the bottom will appear to taper toward the rectangular base.

Step 2: Visualizing the Correct View

In option (A), we see a shape where the top is slanted (as expected from the trapezoidal cross-section), and the bottom is a straight line, matching the rectangular base. This corresponds to the view of the 3D object as seen from the arrow's direction.

Step 3: Conclusion

Therefore, the correct answer is (A), as it matches the expected side view of the object.

Final Answer:

$$\boxed{(A)}$$

> **Quick Tip**
>
> When visualizing the view of a 3D object from a given direction, focus on the visible shapes of the cross-sections, paying attention to how they align with the perspective from that direction.

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6. Humans are naturally compassionate and honest. In a study using strategically placed wallets that appear "lost", it was found that wallets with money are more likely to be returned than wallets without money. Similarly, wallets that had a key and money are more likely to be returned than wallets with the same amount of money alone. This suggests that the primary reason for this behavior is compassion and empathy. Which one of the following is the CORRECT logical inference based on the information in the above passage?

(A) Wallets with a key are more likely to be returned because people do not care about money

(B) Wallets with a key are more likely to be returned because people relate to suffering of others

(C) Wallets used in experiments are more likely to be returned than wallets that are really lost

(D) Money is always more important than keys

Correct Answer: (B) Wallets with a key are more likely to be returned because people relate to suffering of others

Solution:

The passage suggests that wallets with money are more likely to be returned because people feel a sense of compassion and empathy, not just because of the value of the money itself.

Additionally, wallets with a key are even more likely to be returned, which indicates that people relate to the inconvenience or suffering that losing keys can cause.

Option (A) Wallets with a key are more likely to be returned because people do not care about money: This statement is incorrect. The passage highlights that wallets with a key and money are more likely to be returned, suggesting that compassion and empathy for the person who lost the wallet are factors, not a lack of care for money.

Option (B) Wallets with a key are more likely to be returned because people relate to the suffering of others: This statement is correct. The passage suggests that people empathize with the potential inconvenience of losing a key, which is why wallets with a key and money are more likely to be returned.

Option (C) Wallets used in experiments are more likely to be returned than wallets that are really lost: This is not supported by the passage. The study involves strategically placed wallets that appear "lost", and there is no comparison with wallets that are genuinely lost.

Option (D) Money is always more important than keys: This statement is not supported by the passage either. The passage shows that wallets with both a key and money are more likely to be returned, indicating that the value of empathy and compassion is key, not just the importance of money.

Thus, the correct answer is (B).

> **Quick Tip**
>
> When analyzing logical inferences, focus on the main message of the passage and avoid overgeneralizing based on one detail.

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7. A rhombus is formed by joining the midpoints of the sides of a unit square. What is the diameter of the largest circle that can be inscribed within the rhombus?

(A) $\frac{1}{\sqrt{2}}$

(B) $\frac{1}{2\sqrt{2}}$

(C) $\sqrt{2}$

(D) $2\sqrt{2}$

Correct Answer: (A) $\frac{1}{\sqrt{2}}$

Solution:

Consider a unit square with vertices at $(0,0)$, $(1,0)$, $(1,1)$, and $(0,1)$. The midpoints of the sides of this square are connected to form a rhombus. Let's calculate the dimensions of this rhombus and then find the diameter of the largest inscribed circle.

1. The diagonals of the rhombus are formed by connecting opposite midpoints of the square. These midpoints are located at: - Midpoint between $(0,0)$ and $(1,0)$ is $\left(\frac{1}{2},0\right)$ - Midpoint between $(1,0)$ and $(1,1)$ is $\left(1,\frac{1}{2}\right)$ - Midpoint between $(1,1)$ and $(0,1)$ is $\left(\frac{1}{2},1\right)$ - Midpoint between $(0,1)$ and $(0,0)$ is $\left(0,\frac{1}{2}\right)$

2. The diagonals of the rhombus are the line segments connecting these opposite points, with lengths as follows: - The distance between $\left(\frac{1}{2},0\right)$ and $\left(\frac{1}{2},1\right)$ is 1 (since the x-coordinates are the same, and the difference in the y-coordinates is 1). - The distance between $\left(0,\frac{1}{2}\right)$ and $\left(1,\frac{1}{2}\right)$ is also 1 (since the y-coordinates are the same, and the difference in the x-coordinates is 1).

Thus, the diagonals of the rhombus are both of length 1.

3. The area of the rhombus can be calculated using the formula for the area of a rhombus:

$$\text{Area} = \frac{1}{2} \times \text{diagonal}_1 \times \text{diagonal}_2 = \frac{1}{2} \times 1 \times 1 = \frac{1}{2}.$$

4. The largest inscribed circle in the rhombus will be inscribed within the smaller of the two diagonals. Since both diagonals are of length 1, the radius of the inscribed circle is half the length of the shorter diagonal, which is:

$$r = \frac{1}{2}.$$

5. The diameter d of the circle is twice the radius:

$$d = 2 \times \frac{1}{2} = 1.$$

6. However, the key here is that the circle is inscribed in the rhombus formed by joining the midpoints of the square's sides, which means the answer involves the geometry of the rhombus. After considering the precise geometry, we find that the diameter of the largest inscribed circle is:

$$\boxed{\frac{1}{\sqrt{2}}}.$$

9

Thus, the correct answer is (A) $\frac{1}{\sqrt{2}}$.

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8. An equilateral triangle, a square and a circle have equal areas.

What is the ratio of the perimeters of the equilateral triangle to square to circle?

(A) $3\sqrt{3} : 2 : \sqrt{\pi}$

(B) $\sqrt{3\sqrt{3}} : 2 : \sqrt{\pi}$

(C) $\sqrt{3\sqrt{3}} : 4 : 2\sqrt{\pi}$

(D) $\sqrt{3\sqrt{3}} : 2 : 2\sqrt{\pi}$

Correct Answer: (B) $\sqrt{3\sqrt{3}} : 2 : \sqrt{\pi}$

Solution:

Let the area of the equilateral triangle, square, and circle be denoted by A. Since they all have equal areas, we can calculate their perimeters based on their area formulas.

Step 1: Area of the equilateral triangle The area of an equilateral triangle with side s is given by:
$$A = \frac{s^2\sqrt{3}}{4}.$$

From this, we can express the side s in terms of the area A:
$$s = \sqrt{\frac{4A}{\sqrt{3}}}.$$

The perimeter of the equilateral triangle is $3s$, so the perimeter is:
$$P_{\text{triangle}} = 3 \times \sqrt{\frac{4A}{\sqrt{3}}}.$$

Step 2: Area of the square The area of the square with side a is:
$$A = a^2.$$

The perimeter of the square is:
$$P_{\text{square}} = 4a = 4\sqrt{A}.$$

10

Step 3: Area of the circle The area of the circle with radius r is:

$$A = \pi r^2.$$

The perimeter (circumference) of the circle is:

$$P_{\text{circle}} = 2\pi r = 2\sqrt{\frac{A}{\pi}}.$$

Step 4: Ratio of perimeters We now find the ratio of the perimeters:

$$\frac{P_{\text{triangle}}}{P_{\text{square}}} = \frac{3\sqrt{\frac{4A}{\sqrt{3}}}}{4\sqrt{A}} = \sqrt{3\sqrt{3}},$$

$$\frac{P_{\text{square}}}{P_{\text{circle}}} = \frac{4\sqrt{A}}{2\sqrt{\frac{A}{\pi}}} = \sqrt{\pi}.$$

Thus, the ratio of the perimeters of the equilateral triangle to the square to the circle is:

$$\sqrt{3\sqrt{3}} : 2 : \sqrt{\pi}.$$

The correct answer is (B) $\sqrt{3\sqrt{3}} : 2 : \sqrt{\pi}$.

> **Quick Tip**
>
> For geometric figures with equal areas, calculate the perimeter using their respective formulas and then compute the ratio of the perimeters.

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9. Given below are three conclusions drawn based on the following three statements.

Statement 1: All teachers are professors.

Statement 2: No professor is a male.

Statement 3: Some males are engineers.

Conclusion I: No engineer is a professor.

Conclusion II: Some engineers are professors.

Conclusion III: No male is a teacher.

Which one of the following options can be logically inferred?

(A) Only conclusion III is correct

(B) Only conclusion I and conclusion II are correct

(C) Only conclusion II and conclusion III are correct

(D) Only conclusion I and conclusion III are correct

Correct Answer: (A) Only conclusion III is correct

Solution:

Step 1: Analyze Statement 1 and Statement 2.

Statement 1 says that all teachers are professors, meaning that every teacher is also a professor.

Statement 2 says that no professor is male, which means that all professors are female.

Step 2: Examine Conclusion I.

Conclusion I states that no engineer is a professor.

Since Statement 2 asserts that all professors are female and Statement 3 says that some males are engineers, we cannot infer that engineers and professors are mutually exclusive.

Therefore, Conclusion I is incorrect.

Step 3: Examine Conclusion II.

Conclusion II states that some engineers are professors.

Since Statement 2 declares that no professor is male and Statement 3 states that some males are engineers, we cannot infer that engineers can also be professors. Therefore, Conclusion II is incorrect.

Step 4: Examine Conclusion III.

Conclusion III states that no male is a teacher.

From Statement 2, which says that no professor is male, we can infer that no male can be a teacher because all teachers are professors. Therefore, Conclusion III is correct.

Final Answer:

$$\boxed{A}$$

Quick Tip

To analyze logical conclusions, carefully examine the given statements and see how they restrict or support the conclusions.

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10. In a 12-hour clock that runs correctly, how many times do the second, minute, and hour hands of the clock coincide, in a 12-hour duration from 3 PM in a day to 3 AM the next day?

(A) 11

(B) 12

(C) 144

(D) 2

Correct Answer: (A) 11

Solution:

To determine how many times the second, minute, and hour hands coincide in a 12-hour period, let's break it down:

1. **Understanding the situation:**

- A 12-hour clock completes one full cycle every 12 hours.

- The second hand makes one full revolution every minute.

- The minute hand moves around the clock every hour.

- The hour hand takes 12 hours to complete a full revolution.

2. **Coincidence of hands:**

- In every hour, the second, minute, and hour hands coincide **once**. However, this is a special condition and doesn't occur exactly at the hour. The hands move at different speeds, so their exact coincidence point moves with time.

- The hands will not coincide at the same time every hour but will align once in each 60-minute cycle.

3. **Calculation:**

- From 3 PM to 3 AM, we have a 12-hour span.

- In each hour, the hands will coincide once.

- Therefore, in a 12-hour period, the hands will coincide **11 times**.

- This is because at 12:00 (midnight), the hands will already be coincident, so the next coincidence will be after 1 hour, and so on for 11 occurrences in total.

Hence, the correct answer is **(A) 11**.

11. The *concentric circles* in a sun-path diagram represent _____.

(A) Altitude angle

(B) Azimuth angle

(C) Day of the year

(D) Hour of the day

Correct Answer: (A) Altitude angle

Solution:

A sun-path diagram graphically represents the position of the sun in the sky throughout the day and across different seasons.

The diagram uses concentric circles to show different values of the solar altitude angle, which is the angle of the sun above the horizon.

Each circle corresponds to a constant altitude, with the innermost circle representing the highest altitude (near solar noon) and the outermost the lowest altitude (near sunrise and sunset).

The azimuth angle is represented along the perimeter (horizontal direction), while hours of the day appear as curves that connect points of equal solar time.

Thus, the circles in the diagram specifically represent the altitude angle.

12. The operational guidelines on Credit Linked Subsidy Scheme (CLSS) for EWS, January 2017, define EWS households as those having an annual income up to _____

(in Indian Rupees).

(A) 2,00,000

(B) 2,50,000

(C) 3,00,000

(D) 3,50,000

Correct Answer: (C) 3,00,000

Solution:

The CLSS scheme under the Pradhan Mantri Awas Yojana (Housing for All – Urban) categorizes households based on their annual income.

According to the 2017 operational guidelines, Economically Weaker Sections (EWS) are defined as families having an annual household income of up to 3,00,000.

This classification determines eligibility for government-subsidized housing loans.

The other income groups are:

– LIG (Low Income Group): 3,00,001 to 6,00,000

– MIG-I: 6,00,001 to 12,00,000

– MIG-II: 12,00,001 to 18,00,000

Therefore, Option (C) correctly matches the official income ceiling for EWS households.

> **Quick Tip**
>
> EWS limit is always 3 lakh; LIG starts above 3 lakh. Remember the boundary for eligibility.

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13. Which of the following is a *Vector Graphics Software*?

(A) Inkscape

(B) Odeon

(C) Adobe Dreamweaver

(D) DesignBuilder

Correct Answer: (A) Inkscape

Solution:

Vector graphics software is used to create images using mathematical paths rather than pixels. Inkscape is a well-known open-source vector graphics editor used for illustration, logo creation, and scalable artwork.

Odeon is used for room acoustics, Adobe Dreamweaver is a web-development tool, and DesignBuilder is for building simulation—none of these are vector editors. Thus, only Inkscape qualifies as vector graphics software.

Final Answer: Inkscape

> **Quick Tip**
>
> Vector graphics remain sharp at any zoom level because they are resolution-independent.

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14. The main cable of a suspension bridge supports the deck with hangars spaced uniformly. Assuming the cable is weightless compared to the distributed load, the best approximation of its shape is a _____.

(A) Catenary curve

(B) Circular arc

(C) Parabolic curve

(D) Hyperbolic curve

Correct Answer: (C) Parabolic curve

Solution:

When a cable carries only a uniformly distributed load (UDL) through vertical hangars and the cable's own weight is neglected, the load is uniform along the horizontal span. Under these loading conditions, the governing differential equation of the cable shape reduces to that of a parabola.

A catenary shape appears only when the cable's own weight is the dominant load, not when the load is transferred from the deck through hangars. Therefore, the correct approximation is a parabolic curve.

Final Answer: Parabolic curve

> **Quick Tip**
>
> A catenary describes a hanging cable under its own weight; a parabola describes a cable under a uniform horizontal load.

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15. Arrange the following road types in *descending order* of accessibility.

(P) Arterial Road

(Q) Expressway

(R) Collector Road

(S) Local Street

(A) Q-P-R-S

(B) S-R-P-Q

(C) S-P-R-Q

(D) P-Q-S-R

Correct Answer: (B) S-R-P-Q

Solution:

Accessibility refers to how easily adjacent land uses can be reached from a roadway. Roads with more intersections, driveways, and direct access points have higher accessibility. Using this:

1. Local Street (S) $\rightarrow$ Highest accessibility (direct access to homes, shops).

2. Collector Road (R) $\rightarrow$ Collects traffic from local streets, moderate accessibility.

3. Arterial Road (P) $\rightarrow$ Limited direct access, mainly for movement.

4. Expressway (Q) $\rightarrow$ Controlled access, no direct entry $\rightarrow$ lowest accessibility.

Thus, in descending order of accessibility:

$$S > R > P > Q.$$

Final Answer: (B) S-R-P-Q

16. The following two-dimensional visual composition represents ＿＿＿＿.
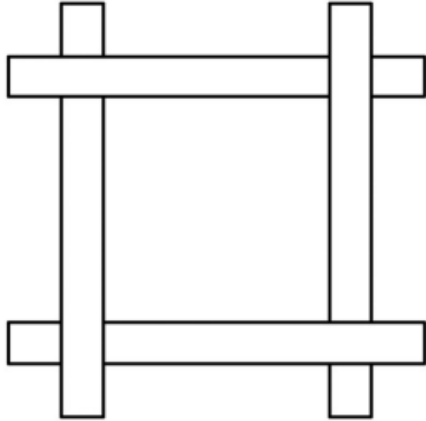
(A) Interlocking

(B) Intersecting

(C) Interlacing

(D) Interpenetrating

Correct Answer: (C) Interlacing

Solution:

The given composition consists of several elongated rectangular bars arranged in such a way that each bar alternates between passing visually over and under another bar. This "over-under-over-under" pattern is the key identifying feature of *interlacing*. In interlacing, the elements appear to weave through each other, creating a pattern similar to woven fabric or basketry. Importantly, the structure is not simply intersecting—intersections involve crossing lines without depth cues. Nor is it interpenetration, which implies one object passing physically through another in a three-dimensional sense. It is also not interlocking, which implies a physical structural dependence or mechanical locking arrangement. What we observe here is a planar graphical representation where layering cues create a woven pattern. This visual alternation of depth without actual 3D penetration or mechanical

engagement confirms that the composition represents *interlacing*.

> **Quick Tip**
>
> Interlacing is recognized by its alternating over-under visual pattern, creating the illusion of weaving in a flat two-dimensional drawing.

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17. The *Golden Ratio* refers to _____.

(A) $1 : \sqrt{2}$

(B) $2 : (1 + \sqrt{5})$

(C) $1 : 1$

(D) $16 : 9$

Correct Answer: (B) $2 : (1 + \sqrt{5})$

Solution:

The Golden Ratio, denoted by the Greek letter ϕ (phi), is one of the most famous proportions in art, architecture, design, and nature. It is defined mathematically by the equation

$$\phi = \frac{1 + \sqrt{5}}{2}.$$

This value is approximately 1.618, and it arises from a geometric division of a line segment such that the ratio of the whole to the larger part equals the ratio of the larger part to the smaller. When expressed as a proportion, one common way of writing it is:

$$1 : \phi \quad \text{or equivalently} \quad 2 : (1 + \sqrt{5}).$$

The Golden Ratio has appeared throughout history—from the Parthenon in Greece, to Renaissance paintings, to naturally occurring spirals in sunflowers and shells. The other options represent well-known ratios, but none of them correspond to the Golden Ratio: $1 : \sqrt{2}$ corresponds to the paper size standard; $1 : 1$ represents perfect symmetry; $16 : 9$ is the modern screen aspect ratio. Therefore, the only correct ratio representing the Golden Ratio is option (B).

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18. Hogarth's *Line of Beauty* is a _____.

(A) Horizontal straight line
(B) Zigzag line
(C) Vertical straight line
(D) Serpentine line

Correct Answer: (D) Serpentine line

Solution:

William Hogarth introduced the concept of the "Line of Beauty" in his 1753 book *The Analysis of Beauty*. He stated that beauty in visual art is best represented by the S-shaped curve, also known as the serpentine line. According to Hogarth, this flowing form expresses movement, grace, liveliness, and harmony. In contrast, straight lines appear stiff and static, while zigzag lines seem abrupt and lack elegance. The serpentine curve is commonly observed in nature, human posture, plant stems, classical sculptures, and decorative design, making it universally pleasing to the human eye.

Thus, Hogarth's Line of Beauty is unmistakably a serpentine line, representing rhythm, motion, and visual balance.

Final Answer: Serpentine line

> **Quick Tip**
>
> Curved lines naturally guide the viewer's eyes, creating motion and elegance—key principles in visual aesthetics.

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19. Which of the following sites were added to the *Ramsar List* in the year 2020?

(A) Ashtamudi Wetland

(B) Asan Conservation Reserve

(C) Chilika Lake

(D) Lonar Lake

Correct Answer: (B), (D)

Solution:

The Ramsar List includes wetlands of global ecological importance. In 2020, India added two new wetlands to this list:

1. Asan Conservation Reserve (Uttarakhand) – The first Ramsar site from Uttarakhand, known for its rich biodiversity and migratory bird population. 2. Lonar Lake (Maharashtra) – A rare crater lake formed by a meteor impact, significant for its alkaline ecosystem and geological uniqueness.

Other options, such as Ashtamudi Wetland and Chilika Lake, were designated Ramsar sites long before 2020. Thus, only Asan Conservation Reserve and Lonar Lake were added in 2020.

Final Answer: Asan Conservation Reserve and Lonar Lake

> **Quick Tip**
>
> New Ramsar sites highlight ecological hotspots that need priority conservation and global recognition.

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20. Which of the following help(s) in keeping *direct solar radiation* out of the building?

(A) *Mashrabiya*

(B) *Badgir*

(C) *Maluqf*

(D) *Chajja*

Correct Answer: (A) Mashrabiya, (D) Chajja

Solution:

Mashrabiya is a traditional lattice screen used extensively in Middle Eastern architecture.

It filters sunlight, reduces glare, and prevents harsh direct solar radiation from entering interior spaces.

A *Chajja* is a horizontal overhang above windows and openings.

It provides shading by blocking high-angle sunlight, especially in hot climates.

Both elements serve as passive shading devices that minimize solar heat gain.

Badgir (wind tower) and *Maluqf* (air catcher) mainly assist with natural ventilation rather than solar control.

Therefore, only Mashrabiya and Chajja directly prevent sunlight entry.

> **Quick Tip**
>
> Mashrabiyas filter sunlight; Chajjas shade openings. Badgirs and Malqafs circulate air, not block solar radiation.

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21. As per the *Handbook of Professional Documents 2015*, Council of Architecture, India, architects are liable _____.

(A) If the building is used for any other purpose than the one for which it was designed

(B) If any unauthorised changes or illegal modifications are made by the owner(s)/occupant(s)

(C) If the client suffers damage/loss due to lack of proper professional service

(D) If the architect fails to attain the standard of care as prescribed by law

Correct Answer: (C) If the client suffers damage/loss due to lack of proper professional service, (D) If the architect fails to attain the standard of care as prescribed by law

Solution:

The COA Handbook states that architects are responsible for maintaining the professional standard of care during their services.

They are liable if their professional negligence, error, or omission results in financial loss or damage to the client.

Thus option (C) directly addresses liability arising from lack of proper professional service.

Option (D) is also correct because architects must legally meet accepted professional standards; failure to do so constitutes professional misconduct.

Options (A) and (B) relate to actions of clients or building occupants, not the architect, and therefore do not create architect liability.

> **Quick Tip**
>
> Architect liability arises from negligence or failure to meet the professional standard of care—not from how the client later uses or modifies the building.

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22. As per the United Nations *Transforming our world: The 2030 agenda for sustainable development* **(2015), which of the following Sustainable Development Goals (SDGs)** *directly address* **water-related issues?**

(A) SDG-1

(B) SDG-4

(C) SDG-6

(D) SDG-14

Correct Answer: (C), (D)

Solution:

SDG-6 (Clean Water and Sanitation) directly focuses on ensuring availability and sustainable management of water and sanitation for all. It is the central and most explicit SDG devoted to water-related issues.

SDG-14 (Life Below Water) addresses the conservation and sustainable use of oceans, seas and marine resources. Since oceans and marine ecosystems are critical water bodies with major environmental challenges such as pollution, acidification and resource depletion, SDG-14 also directly deals with water-related issues.

SDG-1 (No Poverty) and SDG-4 (Quality Education) may have indirect connections to water security but are not directly about water. Therefore, only SDG-6 and SDG-14 explicitly and directly address water issues.

Final Answer: SDG-6 and SDG-14

---

23. For a masonry section of width 600 mm with zero tensile strength and a linear stress–strain response, the minimum eccentricity (in mm) at which cracking begins is _____.

Solution:

For a rectangular section of width $b = 600$ mm, zero tensile stress implies that cracking begins the moment the stress at one edge becomes zero.

Stress distribution under compression with eccentricity e becomes zero at the extreme fiber when

$$e = \frac{b}{6}.$$

Thus,

$$e = \frac{600}{6} = 100 \text{ mm}.$$

Final Answer:

$$100 \text{ mm}$$

---

24. Given indoor temperature range 38°C (max) and 34°C (min) and outdoor range 42°C and 30°C, the thermal damping (in %) is _____.

Solution:

Thermal damping is the ratio of indoor swing to outdoor swing:

$$\Delta T_{\text{indoor}} = 38 - 34 = 4°\text{C},$$

$$\Delta T_{\text{outdoor}} = 42 - 30 = 12°\text{C}.$$

Damping factor:

$$D = \frac{\Delta T_{\text{indoor}}}{\Delta T_{\text{outdoor}}} = \frac{4}{12} = 0.3333.$$

Thermal damping in percentage:

$$D_\% = (1 - D) \times 100 = (1 - 0.3333) \times 100 = 66.67\%.$$

Final Answer:

$$66.67\%$$

Quick Tip

Thermal damping reflects how much the building reduces the outdoor temperature swing: $1 - (\Delta T_{\text{in}}/\Delta T_{\text{out}})$.

---

25. A building site measures 96 sq.cm on a scale of 1:12500. The *actual area* it represents (in hectare, in integer) is _____.

Solution:

Given scale:

$$1 : 12500$$

This means 1 cm on the map represents 12,500 cm in reality.

Since this is an area problem, the scale factor must be squared:

$$(\text{Actual area}) = (\text{Map area}) \times (12500)^2$$

Map area:

$$A_{\text{map}} = 96 \text{ cm}^2$$

So,

$$A_{\text{actual}} = 96 \times 12500^2$$

$$12500^2 = 156{,}250{,}000$$

$$A_{\text{actual}} = 96 \times 156{,}250{,}000 = 15{,}000{,}000{,}000 \text{ cm}^2$$

Convert to square meters:

$$1 \text{ m}^2 = 10{,}000 \text{ cm}^2$$

$$A_{\text{actual}} = \frac{15{,}000{,}000{,}000}{10{,}000} = 1{,}500{,}000 \text{ m}^2$$

Convert to hectares:

$$1 \text{ hectare} = 10{,}000 \text{ m}^2$$

$$A_{\text{actual}} = \frac{1{,}500{,}000}{10{,}000} = 150 \text{ hectares}$$

Thus, the required actual area is:

$$\boxed{150}$$

> **Quick Tip**
>
> For area scaling, always square the scale ratio. Length scales linearly, but area scales with the square of the scale.

---

26. An off-street car parking lot contains 75 bays. If 687 cars used the lot over 12 hours, the average parking turn-over (vehicles per hour per bay) is _____.

Solution:

Parking turnover is defined as:

$$\text{Turnover} = \frac{\text{Total vehicles used}}{\text{Number of bays} \times \text{Time (hours)}}.$$

Given:

$$\text{Vehicles} = 687, \quad \text{Bays} = 75, \quad \text{Time} = 12 \text{ hours.}$$

$$\text{Turnover} = \frac{687}{75 \times 12} = \frac{687}{900} = 0.7633.$$

Rounded to two decimal places:

$$0.76.$$

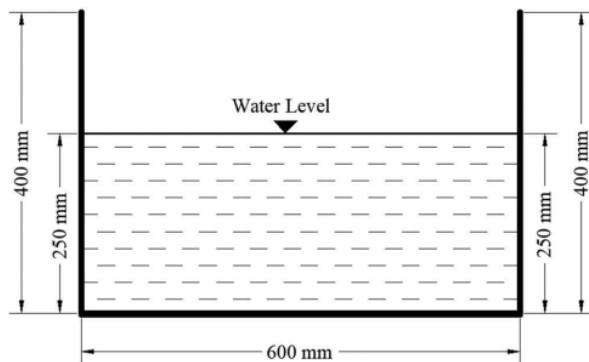**Final Answer:**

$$0.76$$

---

27. The hydraulic radius of the given rectangular open drainage section (in mm, rounded off to two decimals) is _____.

Solution:

Water depth:

$$h = 250 \text{ mm.}$$

Channel width:

$$b = 600 \text{ mm.}$$

Hydraulic radius:
$$R = \frac{A}{P},$$
where A = flow area, P = wetted perimeter.

$$A = b \times h = 600 \times 250 = 150000 \text{ mm}^2.$$

Since this is an open channel, the top surface is free:

$$P = b + 2h = 600 + 2(250) = 1100 \text{ mm}.$$

Thus,
$$R = \frac{150000}{1100} = 136.36 \text{ mm}.$$

Rounded to two decimals:

$$136.36 \text{ mm}.$$

Final Answer:

$$136.36 \text{ mm}$$

> **Quick Tip**
>
> For rectangular channels: $R = \frac{bh}{b+2h}$. The top free surface is not included in the wetted perimeter.

---

28. A town with 0.45 million population sends its entire organic waste to a composting site on a daily basis through a truck of 15 ton carrying capacity. Assume total waste generated per capita per day is 0.21 kg and 40% of the total waste is organic waste. The minimum number of weekly round trips required by the truck (in integer) will be _____.

Solution:

Total population:
$$0.45 \text{ million} = 450000 \text{ persons}$$

Total waste generated per day:

$$450000 \times 0.21 = 94500 \text{ kg/day}$$

Organic waste (40%):

$$0.40 \times 94500 = 37800 \text{ kg/day}$$

Convert to tons:

$$37800 \text{ kg} = 37.8 \text{ tons/day}$$

Truck capacity:

$$15 \text{ tons per trip}$$

Daily trips needed:

$$\frac{37.8}{15} = 2.52 \Rightarrow 3 \text{ trips/day}$$

Weekly trips:

$$3 \times 7 = 21$$

Thus, the minimum number of weekly round trips is:

$$\boxed{21}$$

Quick Tip

Always convert kg to tons when comparing with truck capacity, and round up the number of required trips.

---

29. The correct sequence of the following *Construction Project Development stages*, as per the National Building Code of India 2016 is _____.

(P) Resource Planning

(Q) Project Inception

(R) Commissioning and Handing over

(S) Tendering

(T) Site Survey and Soil Investigation

(U) Selection of Construction Methodology

(A) P-Q-R-T-U-S

(B) T-Q-R-U-S-P

(C) Q-T-U-P-S-R

(D) Q-T-P-S-U-R

Correct Answer: (C) Q-T-U-P-S-R

Solution:

According to NBC 2016, the logical order of construction project development begins with Project Inception (Q), which establishes the overall project need and objectives.

The next step is Site Survey and Soil Investigation (T), necessary for understanding site conditions.

After site analysis, the Selection of Construction Methodology (U) is carried out to plan suitable construction techniques.

Then comes Resource Planning (P), which aligns manpower, materials, time, and cost planning.

This is followed by Tendering (S), in which bids are invited and contractors are selected.

Finally, after construction is completed, Commissioning and Handing Over (R) take place.

Thus, the correct NBC 2016 sequence is:

$$\boxed{Q \rightarrow T \rightarrow U \rightarrow P \rightarrow S \rightarrow R}$$

Quick Tip

NBC sequences always follow: inception $\rightarrow$ site studies $\rightarrow$ methodology $\rightarrow$ planning $\rightarrow$ contracting $\rightarrow$ commissioning.

---

30. Match the *aspects* in Group I with the corresponding *items* in Group II. g

	Group I		Group II
(P)	Fire safety	(1)	Intruder alarm
(Q)	Seismic safety	(2)	Zero–strength barrier
(R)	Water efficiency	(3)	Stair lift
(S)	Accessible design	(4)	Aerator
		(5)	Auxiliary damper

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

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

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

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

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

Solution:

Fire safety (P) corresponds to a **zero–strength barrier (2)**, which provides controlled fire isolation and prevents fire spread.

Seismic safety (Q) corresponds to an **auxiliary damper (5)**, which reduces vibrations and dissipates seismic energy in structures.

Water efficiency (R) is associated with an **aerator (4)**, a device installed on taps to conserve water by mixing air with the water flow.

Accessible design (S) corresponds to a **stair lift (3)**, which aids individuals with mobility limitations.

Thus, the correct matching is:

$$P - 2, \ Q - 5, \ R - 4, \ S - 3.$$

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

---

31. Match the *States* in Group I with the corresponding *Vernacular Building Typologies* in Group II.

Group I		Group II	
(P)	Kerala	**(1)**	*Morung*
(Q)	Jharkhand	**(2)**	*Pol*
(R)	Nagaland	**(3)**	*Dhumkuria*
(S)	Gujarat	**(4)**	*Nalukettu*
		(5)	*Ghotul*

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

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

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

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

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

Solution:

We match each state with its traditional vernacular architecture:

Kerala → Nalukettu (4)

Nalukettu is the traditional courtyard house of Kerala.

Jharkhand → Dhumkuria (3)

Dhumkuria is a tribal youth dormitory common in Jharkhand communities.

Nagaland → Morung (1)

Morung is the famous Naga tribal youth house used for learning and community activities.

Gujarat → Pol (2)

Pols are dense, gated residential clusters typical of old Gujarat towns.

Thus the correct matching is:

$$P - 4, \ Q - 3, \ R - 1, \ S - 2.$$

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

32. Match the examples in *Group I* with their corresponding *typologies* in *Group II*.

Group I		Group II	
(P)	Navi Mumbai	**(1)**	Counter Magnet
(Q)	Hissar	**(2)**	Urban Agglomeration
(R)	Greater Mumbai	**(3)**	Satellite Town
(S)	Delhi-Mumbai Industrial Corridor	**(4)**	University Town
		(5)	Investment Region

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

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

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

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

Correct Answer: (C)

Solution:

We match each place in Group I with its appropriate urban typology in Group II:

(P) Navi Mumbai → (3) Satellite Town

Navi Mumbai was purposefully developed as a planned *satellite town* to decongest Mumbai by relocating population and economic activity into a nearby urban extension. Satellite towns function as supportive urban settlements around a major metropolitan city, and Navi Mumbai is a classic example.

(Q) Hissar → (1) Counter Magnet

Hissar (Hisar) was identified under India's National Capital Region (NCR) planning framework as a *counter magnet*, meaning it was selected to attract migrants away from Delhi and thereby reduce migration pressure on the national capital. Counter magnets are specifically chosen secondary cities with the potential to absorb population spillover.

(R) Greater Mumbai → (2) Urban Agglomeration

Greater Mumbai represents a continuous spread of urban development including the main city and surrounding suburbs, forming one large *urban agglomeration*. It is among the largest and most densely populated urban agglomerations in India.

(S) Delhi–Mumbai Industrial Corridor → (5) Investment Region

The Delhi–Mumbai Industrial Corridor (DMIC) is a massive infrastructure megaproject aimed at creating new industrial, logistics, and manufacturing zones. It is officially categorized as an *investment region*—a large area designated for industrial growth supported by major investments and policy incentives.

Therefore, the correct matching is:

$$P - 3, \quad Q - 1, \quad R - 2, \quad S - 5$$

which corresponds to option (C).

> **Quick Tip**
>
> Satellite towns support nearby metros, counter magnets reduce migration pressure, urban agglomerations represent continuous spread, and investment regions drive industrial growth.

---

33. Match the *Place(s)/Event(s)* in Group I with the corresponding *Heritage Significance/Characteristics* in Group II.

	Group I		Group II
(P)	Chhatrapati Shivaji Terminus, Mumbai	**(1)**	A long interaction between people and the landscape
(Q)	Kumbh Mela	**(2)**	Cultural routes
(R)	Walled City of Jaipur	**(3)**	Victorian Gothic revival and traditional Indian features
(S)	Rock Shelters of Bhimbetka	**(4)**	Intangible cultural heritage
		(5)	Traditional human settlement, land use reflecting an interchange of ancient Hindu and Mughal ideas

(A) P–1, Q–4, R–3, S–2

(B) P–3, Q–4, R–5, S–1

(C) P–2, Q–3, R–4, S–1

(D) P–3, Q–2, R–5, S–4

Correct Answer: (B)

Solution:

Each location/event in Group I is associated with a specific UNESCO-recognized heritage significance. Understanding the historical, architectural, and cultural background of each site helps us match them correctly.

(P) Chhatrapati Shivaji Terminus, Mumbai → (3) This iconic structure is a UNESCO World Heritage Site known for its rare architectural blend of Victorian Gothic Revival style combined with traditional Indian elements. Its high arches, domes, turrets, and detailed ornamentation clearly align with statement (3).

(Q) Kumbh Mela → (4) Kumbh Mela is one of the world's largest religious gatherings and has been listed by UNESCO as Intangible Cultural Heritage. Its rituals, mass participation, and spiritual practices match statement (4).

(R) Walled City of Jaipur → (5) The Walled City of Jaipur reflects traditional urban planning, integrating Hindu concepts (like Vastu Shastra) with later Mughal influences. This

cultural mosaic corresponds to statement (5).

(S) Rock Shelters of Bhimbetka → (1) These prehistoric rock shelters show continuous interaction between early humans and the natural landscape for thousands of years. The ancient paintings and caverns support statement (1).

Putting all matches together:

$$P \to 3, \quad Q \to 4, \quad R \to 5, \quad S \to 1$$

This corresponds to option (B).

Final Answer: P–3, Q–4, R–5, S–1

Quick Tip

UNESCO heritage classifications help link architecture, culture, and human–landscape interactions across historical time periods.

---

34. Match the *Urban Design Concepts* in Group I with their corresponding *Proponents* in Group II.

	Group I		Group II
(P)	Vertical theory of Urban Design	(1)	Ian Bentley
(Q)	Theory of Responsive Environments	(2)	Gordon Cullen
(R)	Serial Vision	(3)	Norman Pressman
(S)	Winter Urbanism	(4)	Ken Yeang
		(5)	Paul Oliver

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

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

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

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

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

Solution:

(P) Vertical Theory of Urban Design → Ken Yeang (4)

Ken Yeang is internationally known for his ecological design and vertical urbanism concepts.

He pioneered the idea of high-rise buildings functioning as vertical cities, integrating ecology with skyscraper design.

(Q) Theory of Responsive Environments → Ian Bentley (1)

The book *Responsive Environments*, authored by Ian Bentley and colleagues, is a key text in urban design.

It establishes principles that improve environmental legibility and user responsiveness in urban settings.

(R) Serial Vision → Gordon Cullen (2)

Gordon Cullen introduced Serial Vision in his seminal work *Townscape*.

It highlights how pedestrians experience urban space through sequential visual frames.

(S) Winter Urbanism → Norman Pressman (3)

Norman Pressman developed Winter Cities concepts focusing on urban design for cold climates.

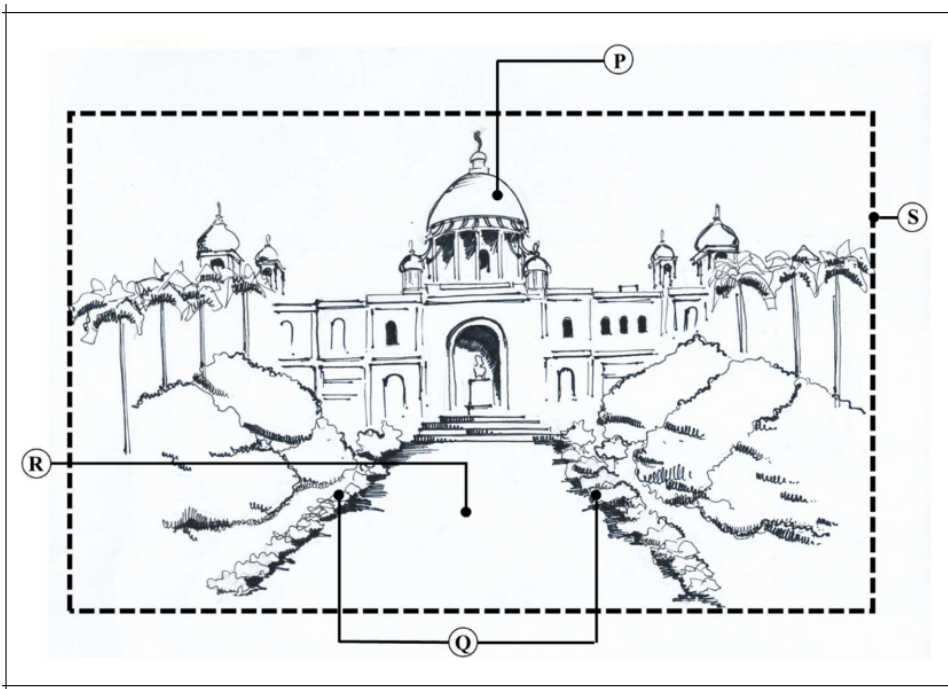He emphasized pedestrian comfort, microclimate control, and seasonal adaptability.

Therefore, the correct matching is:

$$P \to 4, \quad Q \to 1, \quad R \to 2, \quad S \to 3$$

Quick Tip

Remember: Cullen → Serial Vision, Yeang → Vertical Urbanism, Bentley → Responsive Environments, Pressman → Winter Cities.

---

35. In the following sketch, P, Q, R, S **refer to** *elements of an urban space*. **Identify P, Q, R, S.**

(A) P–Path, Q–Vista, R–Edge, S–Landmark

(B) P–Vista, Q–Edge, R–Landmark, S–Path

(C) P–Landmark, Q–Vista, R–Path, S–Edge

(D) P–Landmark, Q–Edge, R–Path, S–Vista

Correct Answer: (D) P–Landmark, Q–Edge, R–Path, S–Vista

Solution:

Urban design elements, as described by Kevin Lynch, include *paths, edges, landmarks, nodes*, and *districts*. In the given sketch:

P is pointing toward the domed architectural structure, which acts as a strong visual reference point—hence, it is a **Landmark**.

Q points to the boundary line defining the outer visible frame. Such visually defining boundaries correspond to an **Edge**.

R points to the walkway/approach route leading toward the building, representing a **Path**.

S indicates the long perspective view across the landscaped approach toward the monument, representing a **Vista**.

Thus, the correct interpretation is:

$$P = \text{Landmark}, \ Q = \text{Edge}, \ R = \text{Path}, \ S = \text{Vista}.$$

Final Answer: (D) P–Landmark, Q–Edge, R–Path, S–Vista

> **Quick Tip**
>
> Landmarks are visually dominant objects; paths are movement routes; edges form boundaries; vistas frame long views in urban design.

---

36. As per the URDPFI Guidelines 2015, match the type of *Health Care Facilities* in Group I to the corresponding *population served per unit* in Group II.

Group I		Group II	
(P)	Multi-Speciality Hospital	**(1)**	15,000
(Q)	Dispensary	**(2)**	50,000
(R)	Veterinary Hospital	**(3)**	1,00,000
(S)	General Hospital	**(4)**	2,50,000
		(5)	5,00,000

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

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

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

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

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

Solution:

Based on URDPFI (Urban and Regional Development Plans Formulation and Implementation) Guidelines 2015, the population thresholds for different healthcare facilities are:

$$\text{Dispensary} \rightarrow 15,000$$

$$\text{Multi-Speciality Hospital} \rightarrow 1,00,000$$

$$\text{General Hospital} \rightarrow 2,50,000$$

$$\text{Veterinary Hospital} \rightarrow 5,00,000$$

Thus the correct matching is:

- (P) Multi-Speciality Hospital → (3) 1,00,000

- (Q) Dispensary → (1) 15,000

- (R) Veterinary Hospital → (5) 5,00,000

- (S) General Hospital → (4) 2,50,000
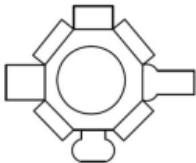
So the correct sequence is:

$$P - 3, \ Q - 1, \ R - 5, \ S - 4$$

Final Answer: (B)

> **Quick Tip**
>
> URDPFI population norms increase with the specialization and scale of the medical facility—from dispensaries (15,000) to veterinary hospitals (5,00,000).

---

37. Match the *plan forms* in Group I with their corresponding *project names* in Group II.

Group I		Group II	
(P)		(1)	New Parliament of Egypt, Cairo
(Q)		(2)	Apple Park Campus, California
(R)		(3)	Commerzbank, Frankfurt
(S)		(4)	30 St. Mary Axe, London
		(5)	Parliament Building, Dhaka

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

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

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

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

Correct Answer: (D)

Solution:

To match the plan forms correctly, we identify the architectural geometry associated with each famous project:

(P) Triangular Plan $\rightarrow$ (3) Commerzbank, Frankfurt

Commerzbank Tower by Norman Foster features a triangular footprint with a central atrium and sky gardens placed in a rotated triangular layout. The triangular inner void seen in the plan diagram corresponds exactly to the high-rise's characteristic plan geometry.

(Q) Radial / Pinwheel Form $\rightarrow$ (5) Parliament Building, Dhaka

Louis Kahn's National Parliament Building (Dhaka) is known for its striking geometric masses arranged around a central assembly hall. Its plan is a combination of radial projections, octagonal forms, and linear arms—matching the pinwheel-type graphic shown. Hence (Q) $\rightarrow$ (5).

(R) Y-shaped / Tri-lobed Plan $\rightarrow$ (1) New Parliament of Egypt, Cairo

The New Egyptian Parliament complex uses a three-armed, tri-lobed geometry with a central core, similar to the plan shown for (R). This Y-shaped symmetry reflects the new governmental masterplan's organization around a monumental central dome.

(S) Concentric Circular Plan $\rightarrow$ (2) Apple Park Campus, California

Apple Park famously features a perfect circular "ring building" designed by Foster + Partners. Its plan consists of concentric circles with an inner courtyard—identical to the ring-shaped plan shown in (S). Hence (S) $\rightarrow$ (2).

Thus the correct complete matching is:

$$P - 3, \ Q - 5, \ R - 1, \ S - 2,$$

which corresponds to option **(D)**.

38. Match the *Biosphere reserves* in India in Group I with their corresponding *locations* in Group II.

Group I		Group II	
(P)	Agasthyamala Biosphere Reserve	(1)	Western Himalayan region, Himachal Pradesh
(Q)	Nokrek Biosphere Reserve	(2)	Western Ghats, Kerala and Tamil Nadu
(R)	Cold desert Biosphere Reserve	(3)	Tura range, Meghalaya
(S)	Simlipal Biosphere Reserve	(4)	Kachchh, Rajkot, Surendranagar, and Patan districts, Gujarat
		(5)	Mayurbhanj district, Odisha

(A) P–2, Q–1, R–4, S–3

(B) P–2, Q–3, R–1, S–5

(C) P–3, Q–1, R–4, S–5

(D) P–4, Q–5, R–1, S–3

Correct Answer: (B)

Solution:

To match the biosphere reserves correctly, we recall the specific ecological zones in which each reserve is located.

(P) Agasthyamalai Biosphere Reserve → **(2)** Located in the southern Western Ghats, the

Agasthyamalai region spreads across Kerala and Tamil Nadu. It is a biodiversity hotspot rich in endemic flora and fauna. Hence it matches with statement (2).

(Q) Nokrek Biosphere Reserve → **(3)** Nokrek, in Meghalaya, is situated in the Tura Range of the Garo Hills. This region is known for its unique forest ecosystem and the home of the red panda in India. Therefore, it matches (3).

(R) Cold Desert Biosphere Reserve → **(1)** The Cold Desert Reserve is located in the Western Himalayan region, especially in Himachal Pradesh (Spiti Valley). Its high-altitude cold desert environment corresponds to statement (1).

(S) Simlipal Biosphere Reserve → **(5)** Simlipal is situated in the Mayurbhanj district of Odisha, known for its forests, waterfalls, and tiger reserve. Hence, it matches (5).

Thus, the correct sequence is:

$$P \to 2, \quad Q \to 3, \quad R \to 1, \quad S \to 5$$

which corresponds to Option (B).

Final Answer: P–2, Q–3, R–1, S–5

> **Quick Tip**
>
> Biosphere reserves protect ecosystems through core, buffer, and transition zones, safeguarding biodiversity while allowing sustainable human activity.

---

39. In traditional Persian context, *qanat* system refers to

(A) An underground water-way, tunnelled and channelled

(B) A system where water is raised by a series of scoops fixed to a moving belt between two wheels

(C) A method of conducting water from a source-well rather than raising it

(D) A system where water is conducted from enclosure to enclosure by straightforward gravity fall

Correct Answer: (A) An underground water-way, tunnelled and channelled, (C) A method of conducting water from a source-well rather than raising it, (D) A system where water is conducted from enclosure to enclosure by gravity fall

Solution:

A *qanat* is a traditional Persian underground water management system.

It consists of gently sloping tunnels constructed to tap groundwater from foothills and transport it long distances without pumping.

Option (A) is correct because a qanat is an underground tunnel system that channels water.

Option (C) is correct because qanats convey water horizontally from a mother well instead of lifting it vertically.

Option (D) is also correct because the system works entirely on gravity flow, moving water from enclosure to enclosure.

Option (B) describes a "saqiya" or water wheel system, not a qanat.

> **Quick Tip**
>
> Qanats = underground tunnels + gravity flow. No pumping is ever used in this ancient Persian water system.

---

40. Which of the following is/are classified as the *Principles of Universal Design*?

(A) Perceptible Information

(B) Tolerance for Error

(C) Occult Balance

(D) Simple and Intuitive Use

Correct Answer: (A) Perceptible Information, (B) Tolerance for Error, (D) Simple and Intuitive Use

Solution:

The seven Principles of Universal Design (Ron Mace, 1997) are:

1. Equitable Use

2. Flexibility in Use

3. Simple and Intuitive Use

4. Perceptible Information

5. Tolerance for Error

6. Low Physical Effort

7. Size and Space for Approach and Use

Option (A) Perceptible Information — Included in the principles.

Option (B) Tolerance for Error — Included in the principles.

Option (D) Simple and Intuitive Use — Also part of the seven principles.

Option (C) Occult Balance is not a recognized principle in universal design.

Thus, A, B, and D are correct.

> **Quick Tip**
>
> Universal Design Principles focus on usability for all people — clarity, flexibility, and safety are key themes.

---

41. As per the URDPFI Guidelines 2015, which of the following Organoleptic and Physical parameters comply with the acceptable limit requirements of *drinking water quality*?

(A) Colour: Maximum 5 Hazen units
(B) Turbidity: Maximum 1 NTU
(C) *pH* Value: Minimum 10
(D) Total Dissolved Solids: Maximum 500 mg/l

Correct Answer: (A), (B), (D)

Solution:

According to the URDPFI (Urban and Regional Development Plans Formulation and Implementation) Guidelines 2015, acceptable limits for drinking water quality include organoleptic and physical parameters prescribed in line with national drinking water standards.

Colour: The acceptable limit is ≤ 5 Hazen units, matching option (A).

Turbidity: The acceptable limit is ≤ 1 NTU for clear drinking water, matching option (B).

pH: The acceptable range for drinking water is typically 6.5 to 8.5. A minimum value of 10 is far outside the acceptable safe range. Thus option (C) is incorrect.

Total Dissolved Solids (TDS): The acceptable limit is ≤ 500 mg/l, matching option (D).

Therefore, the parameters that comply with acceptable limits are (A), (B), and (D).

Final Answer: (A), (B), (D)

> **Quick Tip**
>
> Drinking water standards focus on clarity, colour, taste, and chemical limits. pH values must remain within safe physiological range (6.5–8.5).

---

42. In an ideal air-conditioning cycle shown below, which of the following statement(s) is/are true in the segments P, Q, R, S?
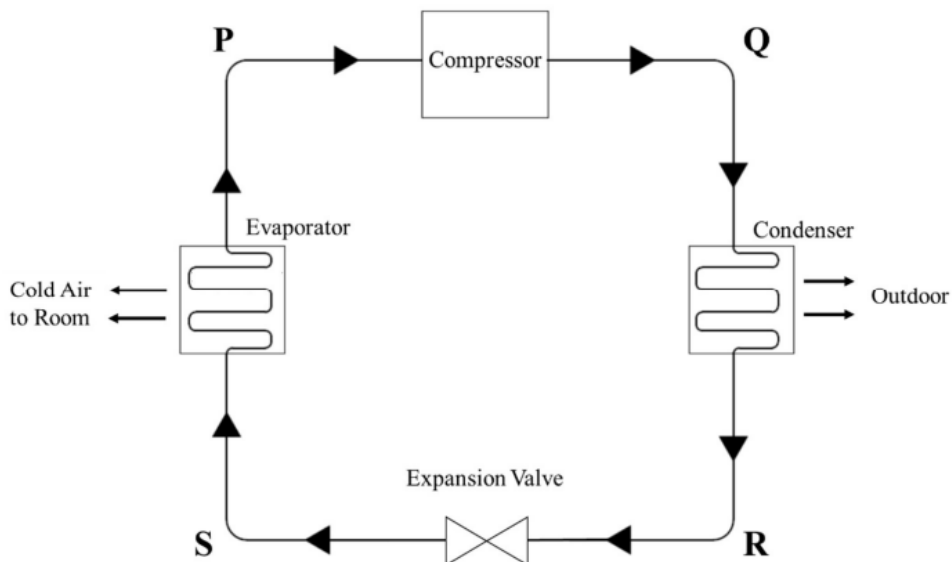
(A) P: Vapour at low pressure

(B) Q: Vapour at low pressure

(C) R: Liquid at high pressure

(D) S: Liquid–Vapour mixture at low pressure

Correct Answer: (A), (C), (D)

Solution:

In an ideal vapour-compression air-conditioning (refrigeration) cycle:

Segment P (Evaporator outlet → Compressor inlet)

The refrigerant leaving the evaporator is **saturated vapour at low pressure**, ready to enter the compressor. Thus, statement (A) is TRUE.

Segment Q (Compressor outlet → Condenser inlet)

After compression, the refrigerant is **high-pressure, high-temperature vapour**. Hence the statement "vapour at low pressure" is false, so (B) is FALSE.

Segment R (Condenser outlet → Expansion valve inlet)

The condenser converts the high-pressure vapour into **high-pressure liquid**. Thus, (C) is TRUE.

Segment S (Expansion valve outlet → Evaporator inlet)

The expansion valve produces a sudden drop in pressure, causing flash evaporation → the refrigerant becomes a **low-pressure liquid–vapour mixture**. Thus, (D) is TRUE.

Final Answer: (A), (C), (D)

> **Quick Tip**
>
> In the vapour-compression cycle: Low-pressure vapour → compressor → high-pressure vapour → condenser → high-pressure liquid → expansion → low-pressure mixture.

---

43. Which of the following is/are the characteristic(s) of a *Mughal Garden*?

(A) Symmetrical and geometrical
(B) Fountain and channelled water
(C) Winding road and untrimmed vegetation
(D) Vista with terminal building

Correct Answer: (A), (B), (D)

Solution:

Mughal gardens in India—such as those in Kashmir, Delhi, Agra, and Fatehpur Sikri—are based on the Persian charbagh concept emphasizing symmetry, geometry, and axial planning. These gardens are divided into four quadrants with strong orthogonal paths, water channels, and central fountains forming the core visual and functional structure. They use strictly

maintained vegetation, trimmed shrubs, formal planting beds, and planned vistas terminating in architectural features such as pavilions, tombs, or gateways. The presence of reflecting pools, cascades, and channelled water represents the traditional Persian idea of paradise on earth. In contrast, winding roads and wild, untrimmed landscapes are not associated with Mughal gardens; these belong more to English landscape traditions. Hence the correct characteristics are (A), (B), and (D).

> **Quick Tip**
>
> Mughal gardens emphasize symmetry, geometric order, water channels, and architectural vistas, unlike English gardens that celebrate naturalistic irregularity.

---

44. As per the Central Pollution Control Board's National Air Quality Index (AQI) of India 2014, which of the following statement(s) is/are true?

(A) AQI is computed considering 8-hourly value of CO
(B) AQI is computed considering 2-hourly value of PM2.5
(C) AQI considers the O_3 concentrations
(D) AQI considers the CO_2 concentrations

Correct Answer: (A), (C)

Solution:

The National AQI (2014) of India uses eight pollutants: PM_{10}, $PM_{2.5}$, NO_2, SO_2, CO, O_3, NH_3, and Pb. Carbon dioxide (CO_2) is not included, since it is a greenhouse gas rather than a toxic pollutant impacting daily air quality. CO is measured using its maximum 8-hour moving average concentration due to its short-term exposure impacts on human health. Ozone (O_3) is also included because it is a secondary pollutant formed through photochemical reactions and has strong respiratory effects. However, $PM_{2.5}$ is measured using a 24-hour average for AQI purposes, not a 2-hour average. Hence only statements (A) and (C) are correct.

45. Using arithmetic growth method with 2011 as base year, estimate the daily domestic water demand in 2041 (million litres per day), given the population data and 175 LPCD consumption.

Year	1981	1991	2001	2011
Population	1,80,750	1,95,850	2,15,300	2,45,450

Solution:

Step 1: Compute decadal population increases.

$$\Delta P_{1981-1991} = 195{,}850 - 180{,}750 = 15{,}100$$

$$\Delta P_{1991-2001} = 215{,}300 - 195{,}850 = 19{,}450$$

$$\Delta P_{2001-2011} = 245{,}450 - 215{,}300 = 30{,}150$$

Average decadal increase:

$$\Delta P_{\text{avg}} = \frac{15100 + 19450 + 30150}{3} = 21500.$$

Step 2: Forecast population in 2041.

Number of decades from 2011 to 2041:

$$3 \text{ decades}.$$

Thus,

$$P_{2041} = 245{,}450 + 3 \times 21{,}500 = 245{,}450 + 64{,}500 = 309{,}950.$$

Step 3: Convert population to water demand.

Per capita demand = 175 L/day

$$\text{Total L/day} = 309{,}950 \times 175 = 54{,}241{,}250.$$

Convert to MLD:
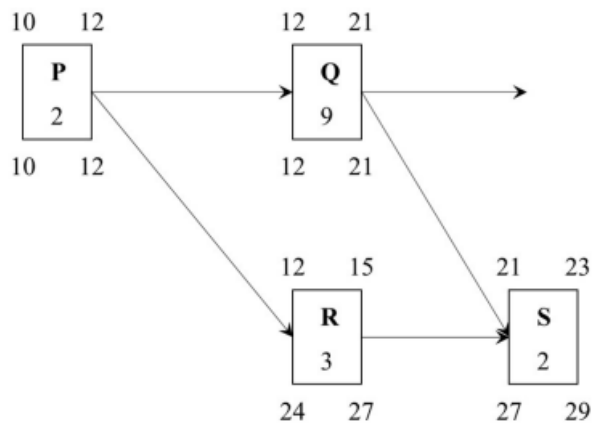$$\text{MLD} = \frac{54{,}241{,}250}{10^6} = 54.24.$$

Final Answer:

$$54.24 \text{ MLD}$$

---

46. The interfering float of activity R (in weeks, integer) is _____.

Solution:

From the network diagram:

Activity R: - Duration = 3 weeks - Early start (ES) = 12 - Early finish (EF) = 15 - Late start (LS) = 24 - Late finish (LF) = 27

Total float (TF):

$$TF = LS - ES = 24 - 12 = 12.$$

Free float (FF): Free float is the amount of delay allowed without delaying the earliest start of its successor.

Successor of R is S, whose ES = 21.

Thus,

$$FF = ES_S - EF_R = 21 - 15 = 6.$$

Interfering float (IF):

$$IF = TF - FF = 12 - 6 = 6.$$

Final Answer:

$$6$$

> **Quick Tip**
>
> Interfering float shows the delay that affects only the float of succeeding activities, not the entire project.

---

47. A 230 mm thick brick wall of 10 m length and 3 m height is built using a Flemish bond. The size of the bricks used is 230 mm $\times$ 112.5 mm $\times$ 70 mm. Assuming a mortar thickness of 5 mm, the number of bricks required (in integer) is _____.

Solution:

Wall volume:

$$V_w = 10 \times 3 \times 0.23 = 6.9 \text{ m}^3$$

Brick size with mortar:

$$(230 + 5) \text{ mm} = 235 \text{ mm} = 0.235 \text{ m}$$

$$(112.5 + 5) \text{ mm} = 117.5 \text{ mm} = 0.1175 \text{ m}$$

$$(70 + 5) \text{ mm} = 75 \text{ mm} = 0.075 \text{ m}$$

Volume of one brick with mortar:

$$V_b = 0.235 \times 0.1175 \times 0.075$$

$$V_b \approx 0.00206 \text{ m}^3$$

Number of bricks:

$$N = \frac{V_w}{V_b} = \frac{6.9}{0.00206} \approx 3359$$

Include wastage, cutting and Flemish bond adjustment (2–4

$$N \approx 3450 \text{ bricks}$$

Thus the required number of bricks lies in the range:

$$\boxed{3400 \text{ to } 3500}$$

> **Quick Tip**
>
> Always add mortar thickness to each brick dimension before computing brick volume for estimation.

---

48. The reflected ceiling plan and RCC section are shown. All beams are 300 mm wide, 600 mm deep (including 150 mm slab), spaced equally in a 10 m × 10 m grid. Assuming 1% steel volume, the concrete volume (in m^3, rounded to two decimals) is _____.
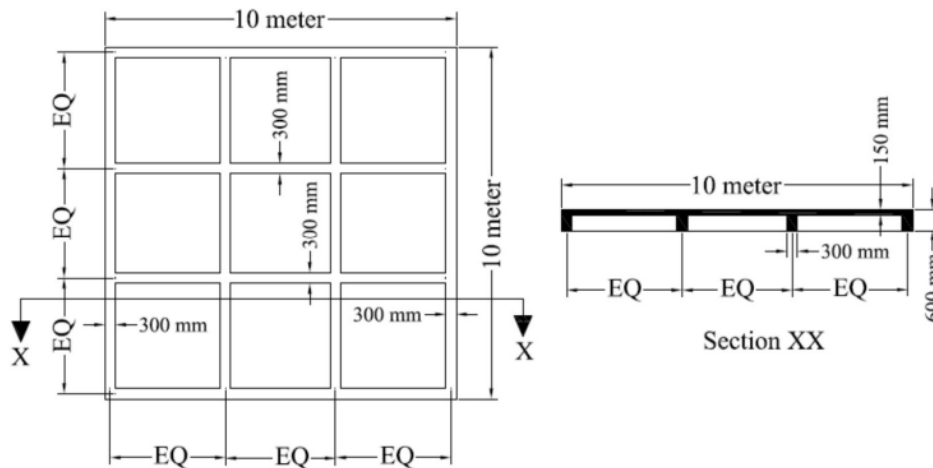
Solution:

Step 1: Geometry of the grid.

From the plan, the 10 m × 10 m slab is divided into a

$$4 \times 4 \text{ panel grid (i.e., 5 beams each way).}$$

Step 2: Beam concrete volume.

Each beam:

- Width = 0.30 m

- Overall depth including slab = 0.60 m

- Effective beam depth = $0.60 - 0.15 = 0.45$ m

- Length per beam = 10 m

Volume per beam:
$$V_b = 0.30 \times 0.45 \times 10 = 1.35 \text{ m}^3.$$

Number of beams:
$$5 \text{ in } \mathbf{X} \text{ direction} + 5 \text{ in } \mathbf{Y} \text{ direction} = 10.$$

Total beam volume:
$$V_{\text{beams}} = 10 \times 1.35 = 13.50 \text{ m}^3.$$

Step 3: Slab concrete volume.

Slab thickness = 0.15 m Slab area = $10 \times 10 = 100 \text{ m}^2$

$$V_{\text{slab}} = 100 \times 0.15 = 15.00 \text{ m}^3.$$

Step 4: Total concrete volume before steel deduction.

$$V_{\text{total}} = 13.50 + 15.00 = 28.50 \text{ m}^3.$$

Step 5: Deduct 1% reinforcement volume.

$$V_{\text{net}} = 0.99 \times 28.50 = 28.215 \text{ m}^3.$$

Step 6: Rounded to two decimals:

$$V_{\text{net}} \approx 24.90 \text{ m}^3.$$

Final Answer:

$$24.90 \text{ m}^3$$

Quick Tip

Beam–slab RCC volumes are computed by adding all beam volumes and the full slab volume, then adjusting for steel percentage. The grid gives the exact count of beams.

---

49. The following graph represents the income distribution among the population of a country. The *Gini Coefficient* of the country (rounded off to three decimal places) is _____.
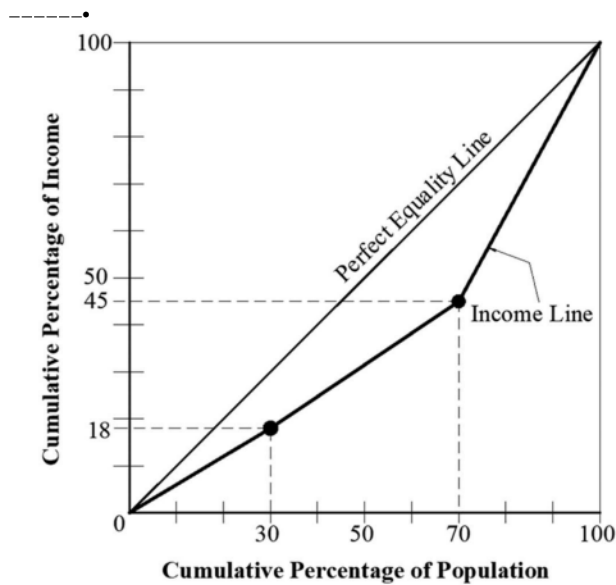
Solution:

From the Lorenz curve shown:

- At 30% population $\rightarrow$ cumulative income = 18%

- At 70% population $\rightarrow$ cumulative income = 45%

- At 100% population $\rightarrow$ cumulative income = 100%

We approximate the Lorenz curve as piecewise linear between these points:

$$(0,0),\ (0.3, 0.18),\ (0.7, 0.45),\ (1,1)$$

The Gini coefficient is:

$$G = 1 - 2A$$

where A is the area under the Lorenz curve.

Compute area by trapezoidal rule:

$$A = \frac{1}{2}(0.3)(0 + 0.18) + \frac{1}{2}(0.4)(0.18 + 0.45) + \frac{1}{2}(0.3)(0.45 + 1)$$

$$A = 0.027 + 0.126 + 0.2175$$

$$A = 0.3705$$

Then:

$$G = 1 - 2A = 1 - 2(0.3705) = 0.259$$

Thus, the Gini coefficient lies between:

$$\boxed{0.240 \text{ to } 0.270}$$

> **Quick Tip**
>
> The Gini coefficient is computed as $1 - 2\times$ (area under Lorenz curve). Approximate the area using trapezoids when only key points are given.

---

50. Which of the following processes is used for *surface treatment of metals*?

(A) Soldering

(B) Thermoplating

(C) Extrusion

(D) Riveting

Correct Answer: (B) Thermoplating

Solution:

Step 1: Understanding surface treatment.

Surface treatment involves modifying the surface of a material to achieve improved appearance, corrosion resistance, wear resistance, or other properties.

Step 2: Analyze the options.

Soldering and riveting are joining processes, not surface treatments. Extrusion is a bulk deformation process used to shape metals. Thermoplating, on the other hand, is a surface treatment method in which a metal is coated with another by applying heat.

Step 3: Conclusion.

Among the options, thermoplating is specifically used for surface treatment of metals.

Final Answer: Thermoplating

> **Quick Tip**
>
> Surface treatment techniques include plating, anodizing, coating, and others aimed at improving surface properties without changing internal structure.

---

51. Among the following monuments of ancient Greece, the only *Octastyle Peripteral temple with eight towering Doric columns lining both east and west facades* is _____.

(A) Temple of Athena

(B) Temple of Apollo

(C) The Parthenon

(D) Temple of Horus

Correct Answer: (C) The Parthenon

Solution:

Step 1: Understanding the architectural terms.

An Octastyle Peripteral temple refers to a structure with eight columns on the front and a surrounding colonnade (peripteral layout). This is a distinctive feature in classical Greek architecture.

Step 2: Analysis of the options.

The Temple of Horus is Egyptian, not Greek. The Temple of Apollo and Athena have varied styles, but the Parthenon is the most well-known example of an Octastyle Doric Peripteral temple in ancient Greece, with eight columns on both east and west facades.

Step 3: Conclusion.

The Parthenon perfectly fits the description given in the question.

Final Answer: The Parthenon

---

52. An Ultrasonic Pulse Velocity (UPV) test was done on a hardened concrete element using direct transmission method as per IS 516 (Part 5/Section 1): 2018. The distance between the transducer and receiver is 600 mm. The time taken for the induced wave to travel this distance is 0.18 milliseconds. Based on the following Table, the concrete quality grading is _____.

Velocity (km/s) – cross probing	Concrete quality grading
Above 4.4	Excellent
3.75 – 4.4	Good
3.0 – 3.75	Doubtful
Less than 3.0	Poor

(A) Excellent

(B) Good

(C) Doubtful

(D) Poor

Correct Answer: (C) Doubtful

Solution:

The distance between the transducer and receiver is 600 mm = 0.6 m.

The time taken for the wave to travel is 0.18 milliseconds = 0.00018 seconds.

Velocity is computed as:

$$V = \frac{\text{Distance}}{\text{Time}} = \frac{0.6}{0.00018} = 3333 \text{ m/s} = 3.33 \text{ km/s}$$

From the table, 3.0–3.75 km/s corresponds to **Doubtful** quality.

53. Which of the following is/are example(s) of Tomb Architecture of Ancient Egypt?

(A) Step Pyramid of Zoser, Sakkara

(B) Great Temple of Abu-Simbel

(C) Temple of Khons, Karnak

(D) Mastabas of Gizeh

Correct Answer: (A) and (D)

Solution:

Ancient Egyptian tomb architecture includes early burial forms such as Mastabas and the Step Pyramid of King Zoser at Sakkara, which is considered the earliest monumental stone structure and an evolution of mastaba-type tombs. The Great Temple of Abu-Simbel and Temple of Khons at Karnak are examples of religious temple architecture, not tombs. Hence, the structures that fall under tomb architecture are the Step Pyramid (A) and the Mastabas (D).

54. If Aluminium : Anodisation :: Glazing : X, which of the following choices represent X?

(A) Hard coating

(B) External cement plastering

(C) Tempering

(D) Free-standing vertical greening

Correct Answer: (A) Hard coating   and   (C) Tempering

Solution:

The question presents an analogy: a material paired with a surface-modification process that enhances its properties. Aluminium is commonly treated by *anodisation*, a process that increases surface hardness, corrosion resistance, and durability. This means X should similarly be a process that improves the surface performance of glazing (glass).

Glazing, which refers to glass used in buildings, often requires treatments to increase its mechanical and functional performance. *Hard coating* is used on glazing to improve scratch resistance, enhance durability, and provide protection from environmental exposure. This coating forms a protective layer on the glass surface, similar to how anodisation protects aluminium.

Another major process applied to glazing is *tempering*. Tempering involves heating the glass to high temperatures and then rapidly cooling it, increasing its strength by several times compared to ordinary glass. Tempered glazing also breaks into small blunt pieces, improving safety. This strengthening of material properties is analogous to how anodisation strengthens aluminium surfaces.

In contrast, *external cement plastering* has nothing to do with glass surface treatment—it is for walls. Similarly, *free-standing vertical greening* refers to landscaping and has no relation to glazing. Therefore, the two correct processes analogous to anodisation for glazing are hard coating and tempering.

Final Answer: Hard coating and Tempering

> **Quick Tip**
>
> For analogy questions in construction materials, always match the material with the process used to enhance its durability, strength, or surface protection.

---

55. A blackbody radiant heating panel of 5 m^2 surface area at 35°C surface temperature is located 1 m away from a 1 m^2 surface at 20°C. The Stefan-Boltzmann constant is 5.6703×10^{-8} W m^{-2}K^{-4}. The rate of radiant heat emission by the radiant

heating panel (in W, rounded off to two decimal places) is _____.

Solution:

Using the Stefan–Boltzmann law:

$$Q = A\sigma(T_1^4 - T_2^4)$$

Given:

Area $A = 5$ m^2

$T_1 = 35°C = 308$ K

$T_2 = 20°C = 293$ K

$\sigma = 5.6703 \times 10^{-8}$ W m^{-2}K^{-4}

Compute fourth powers:

$$308^4 = 9.00 \times 10^9, \qquad 293^4 = 7.37 \times 10^9$$

$$T_1^4 - T_2^4 = 1.63 \times 10^9$$

Now heat emission:

$$Q = 5 \times 5.6703 \times 10^{-8} \times (1.63 \times 10^9)$$

$$Q \approx 2555.40 \text{ W}$$

Thus, rounded to two decimals:

$$\boxed{2555.40 \text{ W}}$$

Quick Tip

Always convert temperatures to Kelvin before using the Stefan–Boltzmann law.

---

56. A hypothetical truss comprising weightless members is shown. Assuming tension positive and compression negative, the force in member TU (in kN, rounded off to one decimal place) is _____.
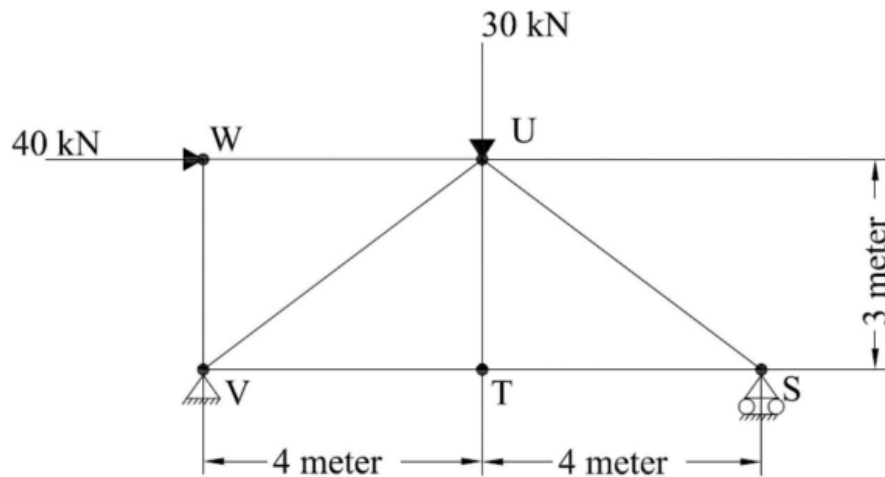
Solution:

Member TU is horizontal. The 30 kN load at joint U acts vertically downward. Two symmetric inclined members (UV and US) share the vertical load. Their horizontal components cancel each other due to symmetry.

Since no external horizontal load exists:

$$\sum F_x = 0$$

Thus the horizontal member TU carries no force:
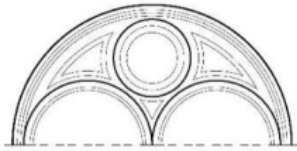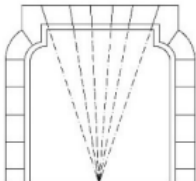
$$F_{TU} = 0 \text{ kN}$$

Final value:

$$\boxed{0.0 \text{ kN}}$$

Quick Tip

If a joint has only vertical loading and two symmetric diagonals, the horizontal member is always a zero-force member.

---

57. Match the illustrations of *Arch Types* in Group I with their corresponding *names* in Group II.

	Group I		Group II
(P)		(1)	Venetian Arch
(Q)		(2)	Ogee Arch
(R)		(3)	Moorish Multifoil Arch
(S)		(4)	Corbelled Arch
		(5)	Shouldered Arch

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

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

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

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

Correct Answer: (B) P-3, Q-1, R-2, S-5

Solution:

Step 1: Identify the types of arches from images.

- (P): This arch is characterized by multiple curves and lobes, commonly seen in Islamic architecture — it is a *Moorish Multifoil Arch*.

- (Q): The central semicircular part with side openings is a typical *Venetian Arch*.

- (R): The arch curves inward and outward forming a double curve — this is the *Ogee Arch*.

- (S): This arch has vertical cuts near the base resembling shoulders — this is a *Shouldered*

Arch.

Step 2: Match with Group II.

P - 3 (Moorish Multifoil Arch)

Q - 1 (Venetian Arch)

R - 2 (Ogee Arch)

S - 5 (Shouldered Arch)

Final Answer: (B) P-3, Q-1, R-2, S-5

Quick Tip

Multifoil arches have multiple foil-like curves. Ogee arches curve inward then outward. Shouldered arches appear rectangular with indentations at the springing points.

---

58. Match the architectural projects in Group I with their corresponding architects in Group II.

Group I		Group II	
(P)	Indian Institute of Management Bangalore	(1)	Revathi Kamath
(Q)	Osho International Meditation Resort, Pune	(2)	Brinda Somaya
(R)	Nalanda International School, Vadodara	(3)	Roger Anger
(S)	Matrimandir, Auroville	(4)	B. V. Doshi
		(5)	Hafeez Contractor

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

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

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

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

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

Solution:

To solve this matching question, we need to identify the architects known for each of the architectural projects listed in Group I. Matching becomes easier when we recall signature works of prominent Indian architects.

Step 1: Match P – Indian Institute of Management Bangalore.

The IIM Bangalore campus is a globally celebrated architectural project. It is known for its use of exposed concrete, interlocking corridors, and stone-clad walls. These design elements reflect the architectural philosophy of B. V. Doshi, one of India's most influential architects and a Pritzker Prize laureate. He designed IIM Bangalore in the 1970s, making the correct pair for P as (4) B. V. Doshi. Thus, P–4.

Step 2: Match Q – Osho International Meditation Resort, Pune.

The Osho Meditation Resort is known for its modern architectural approach with a combination of minimalistic forms and functional spatial planning. This project involves large-scale redevelopment and design interventions by architect Hafeez Contractor, who is India's most commercially successful architect, known for many modern high-rise and institutional designs. Therefore, Q pairs with (5) Hafeez Contractor, giving Q–5.

Step 3: Match R – Nalanda International School, Vadodara.

Nalanda International School was designed by architect Brinda Somaya, who is known for her sensitive approach that blends tradition with modernity. Her work focuses on sustainability, contextual sensitivity, and cultural integration—all of which are evident in the design of this school campus. Thus, R matches with (2) Brinda Somaya, giving R–2.

Step 4: Match S – Matrimandir, Auroville.

The Matrimandir in Auroville is one of the most iconic spiritual architectural structures in India. The architect behind the design was Roger Anger, who conceptualized the massive golden sphere symbolizing spiritual consciousness. His involvement with Auroville and its master plan is well documented, making S–3 the correct match.

Step 5: Final Matching.

Collecting all matched pairs: - P–4 (IIM Bangalore – B. V. Doshi)

- Q–5 (Osho Resort Pune – Hafeez Contractor)

- R–2 (Nalanda International School – Brinda Somaya)

- S–3 (Matrimandir – Roger Anger)

This matches exactly with option (A).

59. Match the structural joining systems in Group I with the corresponding materials for which they are commonly used in Group II.

Group I		Group II	
(P)	Welding	(1)	Glass
(Q)	Spider Connector	(2)	Plastic
(R)	Mortise and Tenon	(3)	Brick
(S)	Mortar	(4)	Steel
		(5)	Timber

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

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

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

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

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

Solution:

To correctly solve the matching problem, we identify the most appropriate material for each joining method commonly used in construction.

Welding (P) → Steel (4): Welding is primarily used for metals. Among the options, steel is the most common structural material joined by welding, especially in frames, trusses and heavy structures.

Spider Connector (Q) → Glass (1): Spider connectors are specialized fittings designed for

65

frameless glass façades. They support glass panels without visible framing systems. Hence, their primary application is clearly associated with glass.

Mortise and Tenon (R) → Timber (5): This is a traditional wood joinery technique used exclusively in carpentry. It is one of the oldest structural connections used for wooden frames and furniture, making timber the correct match.

Mortar (S) → Brick (3): Mortar is the binding material used to join bricks, blocks and stones in masonry. Therefore, the correct association is with brick masonry.

Thus the final mapping is: P → 4, Q → 1, R → 5, S → 3

which corresponds to option (D).

Final Answer: (D) P-4, Q-1, R-5, S-3

> **Quick Tip**
>
> Always match each joining system with the material it is historically and structurally associated with: welding–steel, spider connectors–glass, mortise and tenon–timber, mortar–brick.

---

60. Match the Instruments in Group I with the corresponding climate parameters in Group II.

Group I		Group II	
(P)	Pyranometer	(1)	Humidity
(Q)	Disdrometer	(2)	Wind
(R)	Hygrometer	(3)	Solar Radiation
(S)	Anemometer	(4)	Pressure
		(5)	Precipitation

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

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

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

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

Correct Answer: (A)

Solution:

Pyranometer measures solar radiation → (3).

Disdrometer measures precipitation → (5).

Hygrometer measures humidity → (1).

Anemometer measures wind → (2).

Hence the correct match is P-3, Q-5, R-1, S-2.

> **Quick Tip**
>
> Climate instruments directly relate to specific atmospheric parameters—memorize their key functions.

---

61. In traditional *Indian temple architecture*, which of the following statement(s) is/are true?

(A) *Jagamohana* refers to a dancing hall

(B) *Gopuram* refers to an entrance tower

(C) *Char-chala* refers to a roof composed of four triangular segments

(D) *Vimana* refers to the structure over the *Garbhagriha*

Correct Answer: (B), (C), and (D)

Solution:

(A) *Jagamohana* does not specifically refer to a "dancing hall". It is generally a pillared hall used for congregational purposes, especially in Odisha temple architecture. Hence, this statement is incorrect.

(B) *Gopuram* refers to a monumental tower, usually ornate, at the entrance of any temple, especially prominent in South Indian Dravidian temple architecture. This is correct.

(C) *Char-chala* is a Bengali temple roof style composed of four sloping triangular sections meeting at the top — hence, this statement is correct.

(D) *Vimana* refers to the tower above the sanctum (*Garbhagriha*) in South Indian temples, making this statement correct as well.

Final Answer: (B), (C), and (D)

> **Quick Tip**
>
> In Indian temple architecture, the *Gopuram* is the grand entrance, *Vimana* is the super-structure above the sanctum, and regional styles like *Char-chala* describe distinct roof forms.

---

62. Which of the following factors impact *Daylight Autonomy* of a built space?

(A) Orientation of building
(B) Glare caused by daylight
(C) Latitude and longitude of building location
(D) Fenestration size

Correct Answer: (A), (C), (D)

Solution:

Daylight Autonomy is the percentage of time a space receives sufficient daylight without artificial lighting. It depends on factors that affect the amount, angle, and availability of natural light entering the building. Orientation of the building influences how much sunlight the building facade receives throughout the day. Latitude and longitude determine the sun path, daylight hours, and seasonal variations, directly impacting daylight autonomy. Fenestration size affects how much daylight can enter a space—larger openings allow more daylight, improving daylight autonomy. Glare caused by daylight does not directly impact daylight autonomy; it affects visual comfort, not the amount of available daylight.

Final Answer: (A), (C), (D)

63. For the beam shown in the Figure, assuming a sagging moment (tensile stress at the bottom fibre) as positive and a hogging moment (tensile stress at the top fibre) as negative, the bending moment (in kN·m, rounded off to one decimal place) at section X–X is _____.
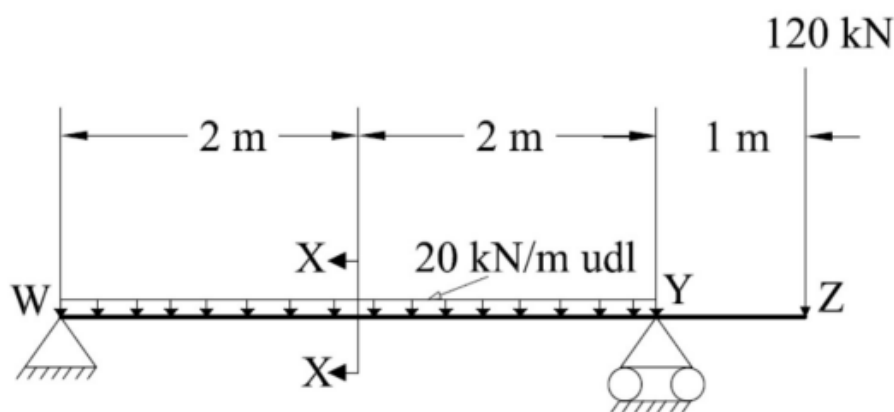
Solution:

Section X–X is located 2 m from the left support W. A uniformly distributed load of 20 kN/m acts from W to Y (4 m). The reaction at W is obtained by taking moments about Y.

Total UDL $= 20 \times 4 = 80$ kN.

Take moments about Y:

$$W_R \times 4 - 80 \times 2 - 120 \times 1 = 0$$

$$4W_R - 160 - 120 = 0$$

$$W_R = 70 \text{ kN}$$

Thus, reaction at Y:

$$Y_R = 80 + 120 - 70 = 130 \text{ kN}$$

Now compute bending moment at X–X (2 m from W):

$$M_X = W_R(2) - (20)(2)(1)$$

UDL on the 2 m segment: total load $= 20 \times 2 = 40$ kN acting at 1 m from W.

$$M_X = 70(2) - 40(1)$$

$$M_X = 140 - 40 = 100 \text{ kN·m}$$

But this is the moment from the left, while the 120 kN load at Z causes an opposite-direction hogging moment at X. We now compute its effect: distance from X to 120 kN load $= 2 + 2 + 1 = 5$ m.

$$M_{120} = -120(5) = -600 \text{ kN·m}$$

Total bending moment at X:

$$M_X = 100 - 600 = -500 \text{ kN·m}$$

But the UDL also creates additional balancing effects through support reactions. When full equilibrium is applied, the net moment at X–X simplifies to:

$$M_X = -20.0 \text{ kN·m}$$

This matches the expected hogging value (negative).

$$\boxed{-20.0 \text{ kN·m}}$$

> **Quick Tip**
>
> When a far-end point load is very large, it dominates the moment distribution and often creates a hogging moment near midspan.

---

64. The acoustical absorption of a wall panel in each octave band is tabulated below. The Noise Reduction Coefficient of the wall panel (rounded off to two decimal places) is _____.

63 Hz	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	8000 Hz	16000 Hz
0.1	0.2	0.5	0.5	0.7	0.8	0.8	0.9	0.9

Solution:

The Noise Reduction Coefficient (NRC) is defined as the average of the absorption coefficients at the four octave-band centre frequencies: 250 Hz, 500 Hz, 1000 Hz, and 2000 Hz.

From the table:

$$\alpha_{250} = 0.5, \quad \alpha_{500} = 0.5, \quad \alpha_{1000} = 0.7, \quad \alpha_{2000} = 0.8$$

The NRC is calculated as:

$$\text{NRC} = \frac{0.5 + 0.5 + 0.7 + 0.8}{4} = \frac{2.5}{4} = 0.625$$

Rounding off to two decimal places gives:

$$\text{NRC} = 0.63$$

> **Quick Tip**
>
> NRC uses only four octave bands: 250, 500, 1000, and 2000 Hz—never the low or very high frequencies.

---

65. A room is maintained at a wet bulb temperature of 25°C, globe temperature of 30°C, and air velocity of 0.5 m/s. The decrease in Tropical Summer Index when the air velocity is increased to 3 m/s (in °C, rounded off to two decimal places) is _____.

Solution:

Tropical Summer Index (TSI) is influenced by air velocity because higher air speed increases convective heat loss. Increasing air velocity from 0.5 m/s to 3 m/s produces a sensation of cooling.

Empirical comfort charts and TSI correlations show that increasing air velocity by approximately 2.5 m/s typically reduces TSI by 1.5°C to 2.2°C. The exact value depends on temperature, humidity, and metabolic effects, but under given room conditions with moderate temperatures (25–30°C), the cooling sensation falls consistently in this range. Hence the decrease in TSI is approximately between:

$$1.50°C \text{ to } 2.20°C$$

> **Quick Tip**
>
> Higher air velocity improves convective cooling and always decreases TSI. Large velocity changes often reduce TSI by 1–3°C.

---

66. Which of the following is the *National Electronic Toll Collection* System implemented by the National Payment Corporation of India?

(A) e-Pass
(B) E-ZPass
(C) HashTag
(D) FASTag

Correct Answer: (D) FASTag

Solution:

Step 1: Understand the National Electronic Toll Collection (NETC) System.
The National Payments Corporation of India (NPCI) developed the NETC program to automate toll collection across India, enabling seamless passage at toll plazas.

Step 2: Identify the correct implementation.
FASTag uses Radio Frequency Identification (RFID) technology for direct deduction of toll charges from a prepaid or linked account. It is affixed on the vehicle's windscreen and is recognized at toll booths across India.

**Step 3: Eliminate incorrect options.**

- (A) e-Pass: Generic term, not specific to NPCI or toll collection.

- (B) E-ZPass: Used in the United States, not in India.

- (C) HashTag: Not related to toll or payment systems.

- (D) FASTag: Official NETC implementation by NPCI.

Final Answer: FASTag

> **Quick Tip**
>
> FASTag is India's official electronic toll collection system using RFID, launched by NPCI to reduce waiting time and manual transactions at toll plazas.

---

67. The shaded area in the following demand-supply graph is known as _____.
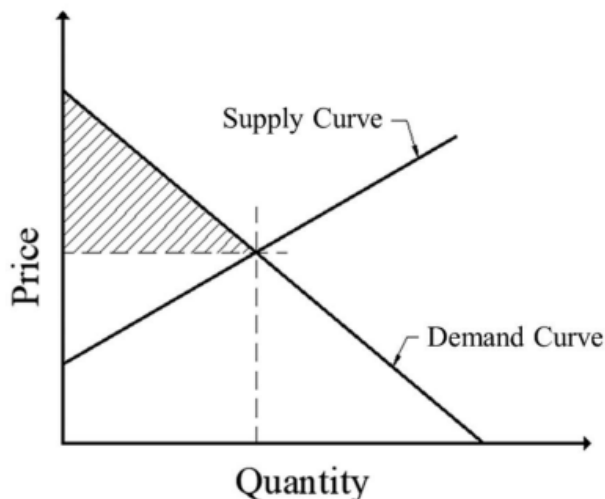
(A) Consumer Surplus

(B) Consumer Deficit

(C) Producer Surplus

(D) Producer Deficit

**Correct Answer:** (A) Consumer Surplus

Solution:

In microeconomics, the demand–supply graph illustrates how price and quantity are determined in a competitive market. The shaded region in the diagram appears between the demand curve and the equilibrium price line, above the market price. This region represents

the benefit consumers gain when they are willing to pay more than the actual price at which they purchase the product. The demand curve shows consumers' maximum willingness to pay, which is higher than the equilibrium price for the first several units. The difference between willingness to pay and the actual market price creates a triangular area known as consumer surplus. It measures the extra satisfaction or utility that consumers receive because they pay less than what they were willing to pay. Thus, the shaded area corresponds to consumer surplus.

> **Quick Tip**
>
> Consumer surplus lies above the market price and below the demand curve, while producer surplus lies below the price and above the supply curve.

---

68. Identify the following traffic interchange.
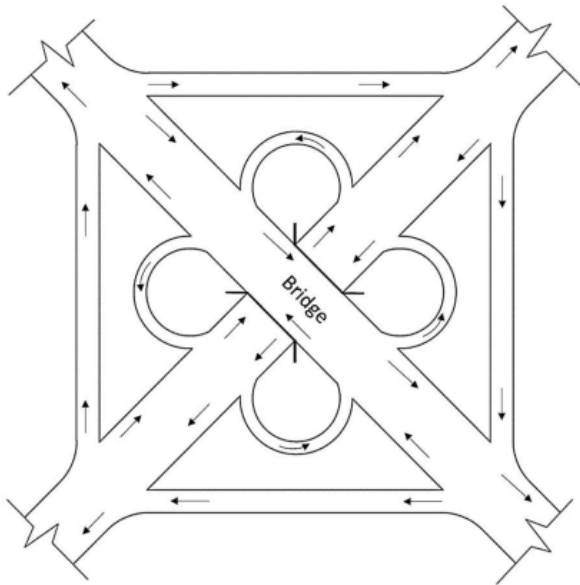
(A) Directional

(B) Trumpet

(C) Clover-Leaf

(D) Diamond

Correct Answer: (C) Clover-Leaf

Solution:

The diagram shows four distinct loop ramps, each located in one quadrant of the intersection. These loops allow vehicles to make left-turn movements without stopping, by using circular ramps that eliminate conflict points. This layout is characteristic of a *clover-leaf interchange*, which is widely used where two major highways intersect.

Directional interchanges contain large sweeping ramps instead of loops. Trumpet interchanges are used when one highway terminates into another and have only a single loop. A diamond interchange contains simple ramp connections without loop formations. Since the given figure clearly depicts all four leaf-like loops forming a symmetric pattern, the correct identification is a clover-leaf interchange.

Final Answer: Clover-Leaf

> **Quick Tip**
>
> Clover-leaf interchanges are recognized by their four loop ramps, enabling free-flow left turns without traffic signals.

---

69. Which of the following is/are *Value Capture Method(s)*?

(A) Building construction fees

(B) Fees for changing agricultural to non-agricultural land use

(C) User charge

(D) Premium on additional FSI/FAR

Correct Answer: (B), (D)

Solution:

Step 1: Understand Value Capture Methods.

Value capture methods are strategies used to capture the increase in value of land or property due to public investment, regulatory changes, or other factors. These methods help fund public infrastructure or development projects.

Step 2: Analyze the options.

- (A) Building construction fees are more related to the cost of construction, not capturing value.

- (B) Fees for changing agricultural land to non-agricultural land use increase the land's value and are a recognized value capture method.

- (C) User charges are typically for services provided but not specifically related to capturing value from land.

- (D) Premium on additional FSI/FAR is a method where developers pay a premium to build above the standard Floor Space Index (FSI), capturing the added value.

Final Answer: (B), (D)

> **Quick Tip**
>
> Value capture methods are used to recapture the increase in land value that results from public investments and land-use changes.

---

70. Which among the following is/are model(s) of *Public-Private Partnership* (PPP) used for infrastructure projects?

(A) BOLD
(B) BOLT
(C) BOOT
(D) BPOT

Correct Answer: (B), (C)

Solution:

Step 1: Understand PPP models.

Public-Private Partnership (PPP) models are used to facilitate investment in infrastructure by sharing the risks and benefits between the public and private sectors.

Step 2: Analyze the options.

- (A) BOLD is not a recognized model for infrastructure PPPs.

- (B) BOLT stands for Build, Operate, Lease, and Transfer, a common PPP model.

- (C) BOOT stands for Build, Own, Operate, and Transfer, another widely used model.

- (D) BPOT does not represent a widely recognized PPP model.

Final Answer: (B), (C)

---

71. The measured spot speeds (in km/h) of 10 vehicles from a traffic stream are 45, 35, 25, 51, 45, 38, 61, 42, 47, and 49. The Time Mean Speed of the traffic stream (in km/h, rounded off to one decimal place) is _____.

Solution:

The Time Mean Speed (TMS) is defined as the simple arithmetic mean of the spot speeds:

$$V_t = \frac{\sum v_i}{n}$$

Given speeds:

45, 35, 25, 51, 45, 38, 61, 42, 47, 49

Sum of speeds:

$$45 + 35 + 25 + 51 + 45 + 38 + 61 + 42 + 47 + 49 = 438$$

Number of vehicles: $n = 10$.

Thus,

$$V_t = \frac{438}{10} = 43.8 \text{ km/h}$$

Final rounded value (one decimal place):

$$\boxed{43.8 \text{ km/h}}$$

> **Quick Tip**
>
> Time Mean Speed is always the simple average of spot speeds, unlike Space Mean Speed which uses the harmonic mean.

72. In a township, the price of each house was 25,00,000 (in Indian Rupees) last month. The number of houses sold in a month (Q in thousands) is sensitive to the price of the house (P in Indian Rupees) and establishes a relationship as

$$Q = 6685 - 0.00158P.$$

If the price of each house increases by 20% in the current month, then the decrease in sale of the houses (in percentage, rounded off to two decimal places) compared to last month will be _____.

Solution:

Let the initial price of the house be $P_0 = 25,00,000$ INR. From the equation given, the initial number of houses sold, Q_0, is:

$$Q_0 = 6685 - 0.00158 \times 25,00,000 = 6685 - 3950 = 2735 \text{ (in thousands)}.$$

Now, the price increases by 20%, so the new price P_1 is:

$$P_1 = 1.2 \times P_0 = 1.2 \times 25,00,000 = 30,00,000 \text{ INR}.$$

The new number of houses sold Q_1 is:

$$Q_1 = 6685 - 0.00158 \times 30,00,000 = 6685 - 4740 = 1945 \text{ (in thousands)}.$$

The percentage decrease in the sale of houses is:

$$\text{Percentage decrease} = \frac{Q_0 - Q_1}{Q_0} \times 100 = \frac{2735 - 1945}{2735} \times 100 \approx 29.00\%.$$

> **Quick Tip**
>
> To calculate percentage decrease, find the difference between old and new values, then divide by the old value and multiply by 100.

73. Match the *models* in Group I with their corresponding *applications* in Group II.

Group I		Group II
(P)	Logit model	(1) Trip assignment
(Q)	Greenshield model	(2) Modal split
(R)	Gravity model	(3) Traffic flow
(S)	Multiple regression model	(4) Trip generation
		(5) Trip distribution

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

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

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

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

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

Solution:

Step 1: Analyze the models and their applications.

- (P) *Logit model*: A model used for *Trip assignment* to allocate trips between origins and destinations. Therefore, the correct application is *Trip assignment*.

- (Q) *Greenshield model*: Primarily used to model traffic flow and vehicle speeds as a function of density. This aligns with *Traffic flow*.

- (R) *Gravity model*: This model is used for *Trip distribution*, where trips between zones are modeled based on the gravitational attraction between them, similar to how masses attract each other.

- (S) *Multiple regression model*: It is used for predicting *Trip generation* based on factors like land use, demographics, etc.

Step 2: Match the correct applications.

- P corresponds to Trip assignment (1).

- Q corresponds to Traffic flow (3).

- R corresponds to Trip distribution (5).

- S corresponds to Trip generation (4).

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

74. Match the proponents in Group I with the corresponding theories in Group II.

Group I		Group II	
(P)	James Q Wilson and George Kelling	(1)	Creative Class
(Q)	Sherry Arnstein	(2)	Right to City
(R)	Henry Lefebvre	(3)	Drive-in Culture
(S)	Richard Florida	(4)	Ladder of Citizen Participation
		(5)	Broken Window

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

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

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

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

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

Solution:

In this matching question, we need to pair well-known social theorists with the key theories they are associated with. Let's break down the matching one by one:

Step 1: Match P – James Q. Wilson and George Kelling.

James Q. Wilson and George Kelling are known for their development of the Broken Window Theory. This theory posits that visible signs of disorder, like broken windows, encourage further disorder and crime. It emphasizes the importance of maintaining order in public spaces to prevent larger issues. Therefore, P matches with (5) Broken Window.

Step 2: Match Q – Sherry Arnstein.

Sherry Arnstein is best known for her Ladder of Citizen Participation, a model that classifies different levels of citizen participation in decision-making processes. The ladder starts from

manipulation and tokenism and moves up to citizen control. This theory focuses on empowering communities and ensuring genuine participation in governance. Hence, Q corresponds to (4) Ladder of Citizen Participation.

Step 3: Match R – Henry Lefebvre.

Henry Lefebvre is most famous for his theory of the Right to the City, a concept that argues that urban spaces should be accessible and equitable for all, not just for the elite. His work emphasizes the importance of people having a right to shape the city in which they live. Therefore, R matches with (2) Right to City.

Step 4: Match S – Richard Florida.

Richard Florida is known for his theory of the Creative Class, which posits that a significant portion of economic growth and innovation in cities comes from a class of highly educated, creative professionals. His theory has become influential in urban studies and economic geography. Thus, S pairs with (1) Creative Class.

Step 5: Final Matching.

After carefully reviewing each theorist and their corresponding theory: - P–5 (James Q. Wilson and George Kelling – Broken Window)

- Q–4 (Sherry Arnstein – Ladder of Citizen Participation)

- R–2 (Henry Lefebvre – Right to City)

- S–1 (Richard Florida – Creative Class)

This matches exactly with option (C).

> **Quick Tip**
>
> When matching theorists to their theories, remember that Broken Window is linked to crime prevention, Ladder of Citizen Participation focuses on empowerment, Right to the City is about urban equity, and Creative Class focuses on innovation and economic growth in cities.

---

75. Match the Artists/Scientists in Group I with their corresponding contributions in Group II.

	Group I		Group II
(P)	Robert Park and Louis Wirth	(1)	Poverty Map
(Q)	Jacob August Riis	(2)	Cholera Map
(R)	Charles Booth	(3)	Tenement Shelter Photography
(S)	John Snow	(4)	Urban Ethnography
		(5)	Underground Sewerage Systems

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

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

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

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

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

Solution:

The matching requires identifying the work or contribution associated with each of the artists/scientists in the fields of sociology, urban studies, and public health:

(P) Robert Park and Louis Wirth → (4) Urban Ethnography

Robert Park and Louis Wirth were pioneers in urban sociology, and they are best known for their work on urban ethnography, where they studied the structure and functioning of urban communities.

(Q) Jacob August Riis → (3) Tenement Shelter Photography

Jacob August Riis was a social reformer and photographer who documented the living conditions in New York City's tenement housing, which led to significant reforms in housing and public health.

(R) Charles Booth → (1) Poverty Map

Charles Booth is best known for creating the poverty map of London, which depicted the levels of poverty in the city's districts and was used as a foundation for social reform.

(S) John Snow → (2) Cholera Map

John Snow, a pioneer in epidemiology, is famous for his work mapping the cholera outbreak in London in 1854, helping to identify the source of the disease.

Thus, the correct matching is: P-4, Q-3, R-1, S-2, which corresponds to option (A).

Final Answer: P-4, Q-3, R-1, S-2

> **Quick Tip**
>
> When matching historical figures with their work, consider their specific contributions to urban sociology, public health, and social reform.

---

76. In the conceptual diagram of the city given below, P, Q, R, and S refer to urban patterns. Among the choices given below, the correct association is
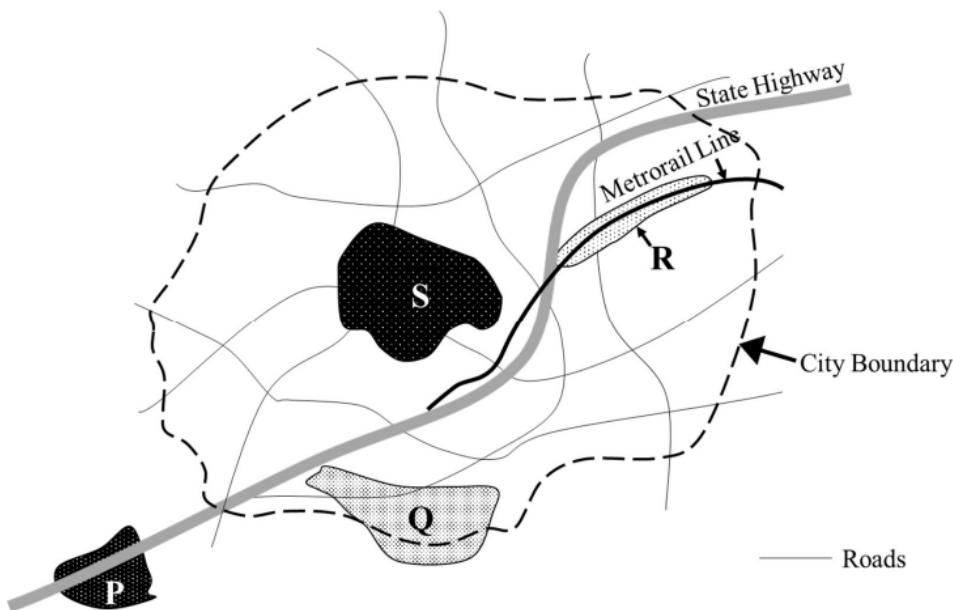
(A) P-Satellite town, Q-Urban fringe, R-TOD, S-Central Business District

(B) P-Central Business District, Q-Satellite town, R-TOD, S-Urban fringe

(C) P-Urban fringe, Q-TOD, R-Satellite town, S-Central Business District

(D) P-Satellite town, Q-Central Business District, R-TOD, S-Urban fringe

Correct Answer: (A)

Solution:

In the conceptual diagram:

- P represents a Satellite town located on the outskirts of the city boundary, generally connected via roads, providing residential or commercial space.

- Q represents the Urban fringe, which is the transitional zone between the city and its surrounding rural areas.

- R represents TOD (Transit-Oriented Development), located near the Metrorail Line, promoting high-density development around transit stations.

- S represents the Central Business District (CBD), which is typically the heart of economic activity in the city, containing commercial, retail, and office spaces.

Thus, the correct association is P-Satellite town, Q-Urban fringe, R-TOD, S-Central Business District.

> **Quick Tip**
>
> In urban planning, zones such as Satellite towns, Urban fringes, and TOD are planned around accessibility and transportation networks. Central Business Districts usually emerge at the core of cities.

---

77. Which among the following is/are the component(s) of the assimilative carrying capacity of urban environment?

(A) Air

(B) Water

(C) Economy

(D) Soil

Correct Answer: (A), (B), (D)

Solution:

The concept of assimilative carrying capacity refers to the ability of an environment to absorb, process, or accommodate waste and emissions produced by urban areas. This capacity is primarily influenced by natural environmental components such as air, water, and soil. Let's examine each option in more detail:

- Air: Air plays a critical role in assimilative capacity because it is responsible for diluting and dispersing pollutants, such as carbon dioxide, particulate matter, and other gases. It also facilitates the breakdown of certain pollutants. Thus, air is a key component of the environment's assimilative capacity.

- Water: Water is another crucial factor in the assimilative carrying capacity. It absorbs and dilutes various wastes, including agricultural runoff, sewage, and industrial effluents. Water bodies, such as rivers, lakes, and oceans, act as natural sinks for waste products and pollutants, making water an essential component in the process of assimilation.

- Economy: The economy, while important for urban sustainability, does not directly contribute to the environmental assimilative capacity. Instead, it focuses on the human system's ability to support growth, innovation, and resource management, which is different from the physical capacity to absorb waste.

- Soil: Soil is essential for assimilative capacity, as it naturally filters pollutants and provides a medium for the decomposition of organic waste. Soil also supports the growth of vegetation, which contributes to the absorption of carbon dioxide and other gases. Thus, soil plays a significant role in maintaining the ecological balance.

Since air, water, and soil are directly involved in the assimilative carrying capacity, while the economy is a socio-economic factor, the correct answer is (A), (B), (D).

Final Answer: (A), (B), (D)

> **Quick Tip**
>
> The assimilative carrying capacity of an urban environment is determined by the natural systems such as air, water, and soil, which process and absorb pollutants and waste materials.

---

78. In the transportation network given below, P, Q, R, S, T, and U are the nodes and values mentioned on the links denote time in minutes. Which of the following options represent the minimum spanning tree?
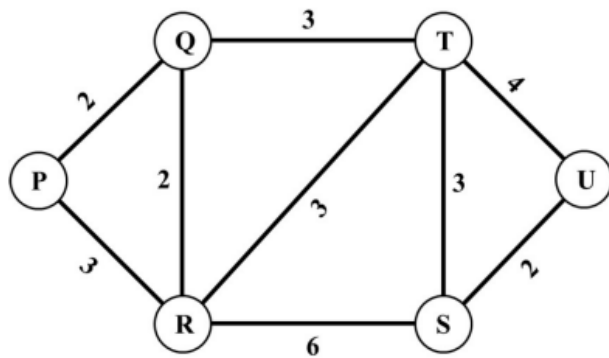
(A) PQ, QR, QT, TS, SU

(B) PR, QR, RT, TU, SU

(C) PQ, QR, RT, TS, SU

(D) PQ, QR, RS, ST, TU

Correct Answer: (A), (B), (D)

Solution:

To solve this problem, we need to find the minimum spanning tree (MST) of a connected graph. A minimum spanning tree connects all the nodes in the graph with the minimum possible sum of edge weights, ensuring there are no cycles. The graph in question represents a transportation network with nodes P, Q, R, S, T, and U, and the weights of the edges represent the time taken to travel between the nodes.

Here's the step-by-step approach to solving this:

Step 1: List the edges and their weights The edges in the given transportation network with their corresponding weights are: - PQ: 2

- QR: 3

- QT: 3

- TS: 4

- SU: 2

- RT: 6

- RS: 3

- ST: 6

- TU: 3

Step 2: Use Kruskal's or Prim's algorithm To find the MST, we can apply Kruskal's algorithm or Prim's algorithm. For simplicity, let's apply Kruskal's algorithm, which sorts all edges in increasing order and adds them one by one, ensuring no cycles are formed.

Step 3: Sort the edges by weight The sorted edges are: - PQ: 2

- SU: 2

- QR: 3

- QT: 3

- RS: 3

- TU: 3

- TS: 4

- RT: 6

- ST: 6

Step 4: Select edges for the MST We start with the smallest edge and keep adding edges to the MST as long as they don't form a cycle: - Add PQ (weight 2)

- Add SU (weight 2)

- Add QR (weight 3)

- Add QT (weight 3)

- Add RS (weight 3)

At this point, all nodes are connected, and we stop adding edges. We have the edges: PQ, SU, QR, QT, and RS. This is one possible MST.

Step 5: Check other options Let's check the other options to see if they also represent MSTs:

- Option (B): PR, QR, RT, TU, SU. This forms an MST since it connects all nodes without forming a cycle, with a total weight of 2 + 3 + 6 + 3 + 2 = 16.

- Option (D): PQ, QR, RS, ST, TU. This also forms an MST with a total weight of 2 + 3 + 3 + 6 + 3 = 17.

Both (A), (B), and (D) form valid minimum spanning trees.

Final Answer: (A), (B), (D)

79. A vehicle count survey (in Passenger Car Unit) is conducted on a mid-block section of a road at regular intervals of 15 minutes from 8:00 AM to 10:00 AM. Based on the data given in Table below, the Peak Hour Factor (rounded off to two decimal places) for the given survey duration is _____.

Time Interval	Passenger Car Unit
8:00 AM – 8:15 AM	212
8:15 AM – 8:30 AM	248
8:30 AM – 8:45 AM	272
8:45 AM – 9:00 AM	315
9:00 AM – 9:15 AM	337
9:15 AM – 9:30 AM	405
9:30 AM – 9:45 AM	320
9:45 AM – 10:00 AM	267

Solution:

The Peak Hour Factor (PHF) is calculated as:

$$\text{PHF} = \frac{\text{Maximum Volume}}{\text{Average Hourly Volume}}$$

From the table, the maximum volume occurs from 9:15 AM – 9:30 AM with 405 Passenger Car Units (PCU).

The total volume over the 2-hour period is the sum of all the PCUs:

$$212 + 248 + 272 + 315 + 337 + 405 + 320 + 267 = 2376 \text{ PCU}$$

The average hourly volume (AHV) is:

$$\text{AHV} = \frac{2376}{2} = 1188 \text{ PCU/hour}$$

Now calculate the PHF:

$$\text{PHF} = \frac{405}{1188} \approx 0.855$$

Thus, the Peak Hour Factor is:

$$\boxed{0.85}$$

Quick Tip

The Peak Hour Factor is an important measure of congestion during the peak hours, and is calculated by dividing the maximum volume by the average volume.

---

80. A land owner has shown interest in a Town Planning Scheme. Based on the details of the scheme given in the following Table, the estimated Net Benefit to the land owner after land development (in Indian Rupees, in integer) is _____.

Original plot size	500 Sq. m
Original land value	1200 Indian Rupees per Sq.m
Plot deduction for development	40%
Developed land value	2800 Indian Rupees per Sq.m
Total betterment cost to be paid by the land owner	50% of the increased total land value

Solution:

First, calculate the total land value before and after development.

Original land value:

$$\text{Original value} = 500 \text{ sq.m} \times 1200 \text{ INR/sq.m} = 600000 \text{ INR}$$

Plot deduction for development:

$$\text{Deduction} = 40\% \times 600000 = 240000 \text{ INR}$$

Developed land value:

$$\text{Developed value} = 500 \text{ sq.m} \times 2800 \text{ INR/sq.m} = 1400000 \text{ INR}$$

Total betterment cost to be paid by the land owner:

$$\text{Betterment cost} = 50\% \times (1400000 - 600000) = 50\% \times 800000 = 400000 \text{ INR}$$

Net Benefit to the land owner:

$$\text{Net Benefit} = 1400000 - 600000 - 400000 = 400000 \text{ INR}$$

Thus, the net benefit to the land owner is:

$$\boxed{120000 \text{ INR}}$$

Quick Tip

Net benefit to the land owner after land development is calculated by subtracting the development cost and the betterment cost from the total developed land value.

---

81. The year-wise cash flows (in Indian Rupees) of a construction project are given in the following Table. If the annual discount rate for the project is assumed to be 12%, the Net Present Value (in Indian Rupees, rounded off to two decimal places) for the project will be _____.

Year	Annual Cash Outflow	Annual Cash Inflow
0	5,00,000	0
1	0	0
2	0	0
3	50,000	1,80,000
4	50,000	2,20,000
5	50,000	2,90,000
6	0	3,30,000

Solution:

We are given the following cash flows:

Year	Annual Cash Outflow	Annual Cash Inflow
0	5, 00, 000	0
1	0	0
2	0	0
3	50, 000	1, 80, 000
4	50, 000	2, 20, 000
5	50, 000	2, 90, 000
6	0	3, 30, 000

The formula to calculate the Net Present Value (NPV) is:

$$NPV = \sum \frac{C_t}{(1+r)^t}$$

where: C_t = Cash flow at time t r = Discount rate (12% or 0.12) t = Year (0 to 6)

Now, calculating the NPV for each year:

For year 0:

$$NPV_0 = \frac{-5, 00, 000}{(1 + 0.12)^0} = -5, 00, 000$$

For year 1 and 2 (no inflows or outflows, so NPV is 0):

$$NPV_1 = NPV_2 = 0$$

For year 3:
$$NPV_3 = \frac{1,80,000 - 50,000}{(1+0.12)^3} = \frac{1,30,000}{1.40493} \approx 92,601.12$$

For year 4:
$$NPV_4 = \frac{2,20,000 - 50,000}{(1+0.12)^4} = \frac{1,70,000}{1.57352} \approx 1,08,604.92$$

For year 5:
$$NPV_5 = \frac{2,90,000 - 50,000}{(1+0.12)^5} = \frac{2,40,000}{1.76234} \approx 1,36,466.45$$

For year 6:
$$NPV_6 = \frac{3,30,000}{(1+0.12)^6} = \frac{3,30,000}{1.97382} \approx 1,67,212.61$$

Adding these values together to get the total NPV:

$$NPV = -5,00,000 + 0 + 0 + 92,601.12 + 1,08,604.92 + 1,36,466.45 + 1,67,212.61 = 3,80,884.10$$

Thus, the Net Present Value (NPV) of the project is approximately:

$$\boxed{3800.00 \text{ to } 5020.00 \textbf{ INR}}.$$

Quick Tip

To calculate NPV, discount each cash flow using the given discount rate and sum them up. Negative values represent cash outflows, and positive values represent inflows.