JEE Main 2025 Paper 2B (B.Planning) Jan 30 Shift 2 Question Paper with Solutions PDF

Question Paper with Solutions

Conducted by the National Testing Agency (NTA)

Time Allowed: 3 Hours **Maximum Marks: 400**

General Instructions

(i) This paper is Paper 2B (B.Planning.) of JEE (Main) 2025, Session 1 (January), conducted by the National Testing Agency (NTA) in Computer Based Test (CBT) mode on 30 January 2025, Shift 2. The total duration is 3 hours.

(ii) The paper has 100 questions: Mathematics (25), Aptitude Test (50), Planning (25), in that order. Maximum marks: 400.

(iii) Mathematics has two sections. Section A has 20 multiple choice questions (MCQs) with four options, of which only one is correct. Section B has 5 numerical value questions. The answer to each numerical value question is a number.

(iv) Marking scheme (multiple choice questions): $+4$ for a correct answer, -1 for an incorrect answer and 0 for an unanswered question.

(v) Marking scheme (numerical value questions): $+4$ for a correct answer, -1 for an incorrect answer and 0 for an unanswered question.

(vi) Calculators, log tables, slide rules and electronic gadgets are not allowed.

Mathematics – Section A: Multiple Choice Questions (80 marks)

1. Let $A = \{1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12\}$. Let R be a relation on A defined by xRy if and only if $2x = 3y$. Let l and m be the minimum number of elements required to be added in R to make it reflexive and symmetric relations, respectively. Then $l + m$ is equal to : [4 marks]

(A) 13

(B) 14

(C) 15

(D) 16

Correct Answer: (D) 16

Solution:

Concept:

- A relation on A is a set of ordered pairs. Reflexivity requires (x, x) for every $x \in A$.
- Symmetry requires the reverse pair (y, x) whenever (x, y) belongs to the relation. Count only pairs that are missing.

Step 1: List the pairs in the given relation The equation $2x = 3y$ implies $x = 3k$ and $y = 2k$, where k is a positive integer. Both entries must lie between 1 and 12. Thus $k = 1, 2, 3, 4$, and the complete relation is

$$R = \{(3, 2), (6, 4), (9, 6), (12, 8)\}.$$

There are four pairs; extending the list to $k = 5$ would give $x = 15$, which is outside A.

Step 2: Count the missing diagonal pairs If a diagonal pair belonged to R, then $2x = 3x$, so $x = 0$. But zero is not in A. Therefore none of the twelve diagonal pairs is present. All must be added for reflexivity, giving $l = 12$.

Step 3: Count the missing reverse pairs The missing reverses are $(2, 3), (4, 6), (6, 9), (8, 12)$. Each is distinct and absent from R, so $m = 4$. This count makes the original relation symmetric independently of the reflexivity task. Adding diagonal pairs would not reduce the number of missing reverses. Hence

$$l + m = 12 + 4 = 16.$$

The totals 13, 14 and 15 would omit at least one required pair.

Step 4: Conclusion $l = 12$, $m = 4$, and therefore $l + m = 16$. Hence, the correct option is (D).

Quick Tip to Solve: Write the relation explicitly, then count missing diagonal pairs and missing reverse pairs separately; do not count the pairs already present.

2. If the domain of the function $f(x) = \frac{1}{\log_{10}(1-2x)} + \sqrt{2x+1}$ is $[\alpha, \beta) - \{0\}$, then $20\left(\alpha^2 + \beta^2\right)$ equals :

[4 marks]

(A) 8

(B) 10

(C) 12

(D) 13

Correct Answer: (B) 10

Solution:

Concept:

- For a real logarithm, its argument must be positive. A logarithm in the denominator must also be nonzero.
- A real square root requires a nonnegative radicand. The domain is the intersection of all restrictions.

Step 1: Apply the logarithm restrictions The argument of the logarithm is $1 - 2x$, so

$$1 - 2x > 0 \quad \Longrightarrow \quad x < \frac{1}{2}.$$

Equality is excluded because $\log_{10} 0$ is undefined. Also, the denominator cannot vanish. Since $\log_{10} u = 0$ precisely when $u = 1$, we require

$$1 - 2x \neq 1 \quad \Longrightarrow \quad x \neq 0.$$

A negative logarithm is allowed; only a zero denominator must be removed.

Step 2: Apply the square-root restriction and intersect The second term exists for real x exactly when

$$2x + 1 \geq 0 \quad \Longrightarrow \quad x \geq -\frac{1}{2}.$$

At $x = -1/2$, the square root is zero and the logarithm is $\log_{10} 2 \neq 0$, so this endpoint is included. Combining the conditions gives

$$\text{Dom}(f) = \left[-\frac{1}{2}, \frac{1}{2}\right) \setminus \{0\}.$$

Thus the stated interval parameters are $\alpha = -1/2$ and $\beta = 1/2$.

Step 3: Evaluate the required expression Squaring removes the sign of the lower endpoint:

$$20(\alpha^2 + \beta^2) = 20\left(\frac{1}{4} + \frac{1}{4}\right) = 10.$$

The excluded point zero does not change the interval endpoints. The other offered numbers, 8, 12 and 13, do not equal this endpoint calculation.

Step 4: Conclusion $20(\alpha^2 + \beta^2) = 10$. Hence, the correct option is (B).

Quick Tip to Solve: For a logarithm in a denominator, impose both positive argument and argument different from 1 before intersecting with the square-root domain.

3. If $\sqrt{-24-10i} = \alpha + i\beta$, $i = \sqrt{-1}$, $\alpha, \beta \in \mathbf{R}$, then $\alpha^2 + \beta^2$ is equal to : [4 marks]

(A) 22

(B) 24

(C) 26

(D) 29

Correct Answer: (C) 26

Solution:

Concept:

- For $z = \alpha + i\beta$, its squared modulus is $|z|^2 = \alpha^2 + \beta^2$.
- The modulus is multiplicative: $|z^2| = |z|^2$. This avoids choosing a sign for a complex square root.

Step 1: Square the given complex number Let $z = \alpha + i\beta$. The given condition implies

$$z^2 = -24 - 10i.$$

Comparing the real and imaginary parts of $(\alpha + i\beta)^2$ gives

$$\alpha^2 - \beta^2 = -24, \qquad 2\alpha\beta = -10.$$

Both relations must hold for either square root. In particular, α and β have opposite signs.

Step 2: Find the squared modulus Take moduli of $z^2 = -24 - 10i$:

$$\alpha^2 + \beta^2 = |z|^2 = |-24 - 10i|.$$

The modulus of the number on the right is

$$\sqrt{(-24)^2 + (-10)^2} = \sqrt{576 + 100} = \sqrt{676} = 26.$$

The quantity requested is the squared modulus of the square root, not the modulus of that square root; an additional square root is therefore unnecessary.

Step 3: Check with the real and imaginary parts Together with $\alpha^2 - \beta^2 = -24$, the sum 26 gives $\alpha^2 = 1$ and $\beta^2 = 25$. The root $1 - 5i$ indeed squares to $-24 - 10i$; its negative also works. Both have the same sum of squares, 26. Hence 22, 24 and 29 are excluded independently of the root sign.

Step 4: Conclusion $\alpha^2 + \beta^2 = 26$. Hence, the correct option is (C).

Quick Tip to Solve: If a question asks for the sum of squares of the real and imaginary parts of a square root, take the modulus of the original complex number.

4. The product of all real solutions of the equation $(3+2\sqrt{2})^{x^4-15}+(3-2\sqrt{2})^{x^4-15}=6$ is : [4 marks]

(A) $4\sqrt{14}$

(B) 14

(C) $2\sqrt{14}$

(D) 18

Correct Answer: (A) $4\sqrt{14}$

Solution:

Concept:

- The numbers $3+2\sqrt{2}$ and $3-2\sqrt{2}$ are positive reciprocals, because their product is 1.
- For a fixed positive base different from 1, the exponential function is one-to-one. A positive fourth power has two real fourth roots.

Step 1: Convert to a quadratic equation Put $a=3+2\sqrt{2}>1$ and $t=a^{x^4-15}>0$. Since $3-2\sqrt{2}=a^{-1}$, the given equation becomes

$$t+\frac{1}{t}=6 \quad \Longrightarrow \quad t^2-6t+1=0.$$

Multiplication by t is valid because an exponential is strictly positive. Solving the quadratic gives

$$t=3\pm 2\sqrt{2}=a \text{ or } a^{-1}.$$

Step 2: Find every real value of the original variable Injectivity of a^u gives $x^4-15=1$ or $x^4-15=-1$. Therefore

$$x^4=16 \quad \text{or} \quad x^4=14.$$

The complete set of real solutions is

$$x=2,-2,\sqrt[4]{14},-\sqrt[4]{14}.$$

All four satisfy the exponent condition, and there are no additional real fourth roots.

Step 3: Multiply the two opposite-root pairs The product of the first pair is $(2)(-2)=-4$. The product of the second pair is $-\sqrt{14}$, because $(\sqrt[4]{14})^2=\sqrt{14}$. Hence the requested product is

$$(-4)(-\sqrt{14})=4\sqrt{14}.$$

The positive sign comes from two negative pair-products. The other choices 14, $2\sqrt{14}$ and 18 do not account for all four real solutions.

Step 4: Conclusion The product of all real solutions is $4\sqrt{14}$. Hence, the correct option is (A).

Quick Tip to Solve: For reciprocal exponential bases, substitute one exponential as t. After solving for the exponent, include both signs of each real even root.

5. If the system of equations $x + 2y + 3az = 4$, $2x + 3y + 4z = 1$, $3x + 7y + 2z = b$ has infinitely many solutions, then $b - 40a$ is equals to : [4 marks]

(A) 4

(B) 1

(C) 2

(D) 3

Correct Answer: (D) 3

Solution:

Concept:

- Infinitely many solutions require the equations to be consistent and linearly dependent, leaving at least one free variable.
- A linear dependence among the coefficients must also hold among the right-hand constants. A zero determinant alone is not sufficient.

Step 1: Find the possible dependence of the third equation The coefficient pairs of x, y in the first two equations are $(1, 2)$ and $(2, 3)$. Their determinant is $3 - 4 = -1 \neq 0$, so these two equations are independent for every a. Seek the third equation as u times the first plus v times the second. Matching x and y gives

$$u + 2v = 3, \qquad 2u + 3v = 7.$$

Solving gives $v = -1$ and $u = 5$. Thus the only possible dependence is five times the first equation minus the second.

Step 2: Match the remaining coefficient and constant This linear combination is

$$3x + 7y + (15a - 4)z = 19.$$

To coincide with the printed third equation $3x + 7y + 2z = b$, we must have

$$15a - 4 = 2, \qquad b = 19.$$

Consequently $a = 2/5$. With these values, the third equation is redundant and the first two remain independent, so the consistent system has rank 2 in three unknowns and infinitely many solutions.

Step 3: Evaluate the requested combination Substituting the values gives

$$b - 40a = 19 - 40\left(\frac{2}{5}\right) = 19 - 16 = 3.$$

The other proposed values, 4, 1 and 2, fail this calculation. Matching only the coefficient condition would miss the necessary consistency requirement $b = 19$.

Step 4: Conclusion $a = 2/5$, $b = 19$, and $b - 40a = 3$. Hence, the correct option is (D).

Quick Tip to Solve: When two equations are visibly independent, express the third as their linear combination and match its constant as well as every coefficient.

6. Let a, b, c be positive real numbers such that $a, 7, c, b$ are in an arithmetic progression. If $ab = 3(a+b)$, then the largest value of b is : [4 marks]

(A) $9 - \sqrt{2}$

(B) $9 - 3\sqrt{2}$

(C) $9 + 3\sqrt{2}$

(D) $9 + 6\sqrt{2}$

Correct Answer: (C) $9 + 3\sqrt{2}$

Solution:

Concept:

- Four consecutive terms of an arithmetic progression can be written $a, a+d, a+2d, a+3d$, where d is the common difference.
- An algebraic candidate must also satisfy the stated positivity conditions; finding roots alone does not establish admissibility.

Step 1: Express the first term using the last term Since $a, 7, c, b$ are consecutive terms, $d = 7 - a$. Therefore

$$b = a + 3(7 - a) = 21 - 2a, \qquad a = \frac{21 - b}{2}.$$

Also c is the mean of the adjacent terms 7 and b, so $c = (7 + b)/2$. These expressions preserve the order of the four terms, whether the common difference is positive or negative.

Step 2: Use the product condition Substitute $a = (21 - b)/2$ into $ab = 3(a + b)$:

$$\frac{b(21 - b)}{2} = 3\left(\frac{21 - b}{2} + b\right).$$

Multiplying by 2 and collecting terms gives

$$21b - b^2 = 63 + 3b, \qquad b^2 - 18b + 63 = 0.$$

Completing the square yields $(b - 9)^2 = 18$, and hence

$$b = 9 \pm 3\sqrt{2}.$$

Step 3: Check positivity and choose the larger root Both candidates for b are positive. The corresponding first terms are $a = 6 \mp 3\sqrt{2}/2$, which are also positive, and $c = (7 + b)/2 > 0$. Thus both roots are admissible. The larger one is $9 + 3\sqrt{2}$; the option $9 - 3\sqrt{2}$ is the smaller admissible root. The values $9 - \sqrt{2}$ and $9 + 6\sqrt{2}$ do not satisfy $(b - 9)^2 = 18$.

Step 4: Conclusion The largest possible value of b is $9 + 3\sqrt{2}$. Hence, the correct option is (C).

Quick Tip to Solve: Use the fixed second term to express the fourth term in terms of the first, then check positivity after solving the resulting quadratic.

7. If there are 19 and 16 points on two distinct parallel lines L_1 and L_2, respectively, then the total number of triangles that can be formed using these points as vertices, is : [4 marks]

(A) 4983

(B) 4997

(C) 5016

(D) 5049

Correct Answer: (C) 5016

Solution:

Concept:

- A triangle requires three noncollinear vertices. Three points chosen on one straight line cannot form a triangle.
- Choose unordered vertex sets using combinations. With points on two distinct parallel lines, a triangle has two vertices on one line and one on the other.

Step 1: Count triangles with two vertices on the first line Choose two of the 19 points on L_1, and independently choose one of the 16 points on L_2. The third point is not on L_1, because the lines are distinct and parallel, so each choice gives a genuine triangle. The number is

$$\binom{19}{2}\binom{16}{1} = \frac{19 \cdot 18}{2} \cdot 16 = 171 \cdot 16 = 2736.$$

Step 2: Count triangles with two vertices on the second line The other possibility is to choose two of the 16 points on L_2 and one of the 19 points on L_1. This gives

$$\binom{16}{2}\binom{19}{1} = \frac{16 \cdot 15}{2} \cdot 19 = 120 \cdot 19 = 2280.$$

The two cases are disjoint because a three-vertex set cannot contain two vertices from both lines. They exhaust every noncollinear choice.

Step 3: Add and independently check the count The total number is $2736 + 2280 = 5016$. As a check, start with all three-point subsets of the 35 points and discard the collinear ones:

$$\binom{35}{3} - \binom{19}{3} - \binom{16}{3} = 6545 - 969 - 560 = 5016.$$

No division by 3 or 6 is needed because combinations already count each vertex set once. The other choices, 4983, 4997 and 5049, disagree with both counts.

Step 4: Conclusion The number of triangles is 5016. Hence, the correct option is (C).

Quick Tip to Solve: For points on two distinct parallel lines, count the two distributions of vertices: two on the first line plus one on the second, and vice versa.

8. If the mean of the frequency distribution

Variable (x_i)	1	3	4	7	9	Total
Frequency (f_i)	1	a	b	3	1	10

is 5, then its variance is : [4 marks]

(A) 5

(B) 5.1

(C) 5.2

(D) 5.3

Correct Answer: (C) 5.2

Solution:

Concept:

- For frequencies f_i, the total frequency is $N = \sum f_i$, and the mean is $\bar{x} = (\sum f_i x_i)/N$.
- The variance of the distribution is $\sigma^2 = (\sum f_i x_i^2)/N - \bar{x}^2$. Here the denominator is the total frequency, not one less than it.

Step 1: Use the total frequency and mean to find the unknowns The frequency row totals 10, so

$$1 + a + b + 3 + 1 = 10 \quad \Longrightarrow \quad a + b = 5.$$

Since the given mean is 5, the weighted sum of observations must be 50:

$$1 + 3a + 4b + 7 \cdot 3 + 9 = 50.$$

Thus $3a + 4b = 19$. Subtracting three times $a + b = 5$ gives $b = 4$, and hence $a = 1$. Both are valid nonnegative frequencies.

Step 2: Calculate the second moment Use the frequencies $1, 1, 4, 3, 1$ with the values $1, 3, 4, 7, 9$. The squared values must each be multiplied by their own frequencies:

$$\sum f_i x_i^2 = 1 \cdot 1^2 + 1 \cdot 3^2 + 4 \cdot 4^2 + 3 \cdot 7^2 + 1 \cdot 9^2.$$

This is $1 + 9 + 64 + 147 + 81 = 302$, giving the second moment $302/10 = 30.2$.

Step 3: Subtract the square of the mean The required variance is

$$\sigma^2 = 30.2 - 5^2 = 30.2 - 25 = 5.2.$$

For a direct check, the weighted sum of squared deviations from 5 is

$$1(1-5)^2 + 1(3-5)^2 + 4(4-5)^2 + 3(7-5)^2 + 1(9-5)^2 = 52.$$

Dividing by 10 again gives 5.2. The alternatives 5, 5.1 and 5.3 disagree with this exact sum; no rounding is involved.

Step 4: Conclusion The variance is 5.2. Hence, the correct option is (C).

Quick Tip to Solve: First determine missing frequencies from the total and mean; then multiply each squared value by its frequency before applying the variance formula.

9. In a question paper containing 10 quesions, A can solve 70% of the questions and B can solve 50% of the questions. The probability, that none of A and B will be able to solve the question, selected at random from the paper, is : [4 marks]

(A) $\frac{3}{10}$
(B) $\frac{3}{20}$
(C) $\frac{1}{5}$
(D) $\frac{2}{5}$

Correct Answer: Underdetermined as printed: the overlap is unspecified. The intended independence calculation gives (B), but is incompatible with ten fixed equally likely questions.

Solution:

Concept:

- For two events, inclusion–exclusion gives $P(A \cup B) = P(A) + P(B) - P(A \cap B)$. The event that neither person solves the selected question is the complement of their union.
- The product $P(A^c)P(B^c)$ equals $P(A^c \cap B^c)$ only under independence. Marginal percentages alone do not establish that condition.

Step 1: Count the two sets of solvable questions A can solve 7 of the ten questions and B can solve 5. Let k be the number both can solve. Their union then contains $7 + 5 - k = 12 - k$ questions. Since it cannot exceed ten and the intersection cannot exceed five, $2 \le k \le 5$, with k an integer.

Step 2: Calculate the probability in terms of the overlap The number neither can solve is $10-(12-k) = k - 2$. Therefore

$$P(\text{neither}) = \frac{k-2}{10} \in \left\{0, \frac{1}{10}, \frac{1}{5}, \frac{3}{10}\right\}.$$

For example, an overlap of four gives option (C), whereas an overlap of five gives option (A). Both configurations satisfy the stated percentages, so neither of these options is uniquely forced.

Step 3: Check the commonly intended product An independent-event model would instead give

$$(1 - 0.7)(1 - 0.5) = 0.3 \times 0.5 = \frac{3}{20},$$

which is option (B). However, independence was not stated. Moreover, with ten fixed equally likely questions this probability would require 1.5 questions to be solvable by neither person, which is impossible. Option (D), $2/5$, is also impossible because only three questions are outside A's solvable set.

Step 4: Conclusion The printed data do not determine a unique probability. Option (B), $3/20$, is the intended product under an additional independent-event model, but the literal ten-question sample space permits both (A) and (C); therefore no unique option is justified as printed.

Quick Tip to Solve: For a random question from a fixed paper, count the overlap of the two solvable sets before multiplying complementary probabilities.

10. Let the line $y = x + 3$ intersect the parabola $x^2 = 4y$ at the points A and B. If F is the focus of the parabola, then the area of triangle AFB is : [4 marks]

(A) 4

(B) 6

(C) 8

(D) 12

Correct Answer: (C) 8

Solution:

Concept:

- The parabola $x^2 = 4ay$ has vertex at the origin and focus $(0, a)$. Here $a = 1$, so its focus is $F = (0, 1)$.
- Intersection coordinates satisfy both equations. A triangle has area one-half the product of a chosen base and the perpendicular height to that base.

Step 1: Find the intersection points Substitute the line equation into the parabola:

$$x^2 = 4(x + 3) \quad \Longrightarrow \quad x^2 - 4x - 12 = 0.$$

Factoring gives $(x - 6)(x + 2) = 0$, hence $x = 6$ or $x = -2$. The corresponding ordinates are 9 and 1. Thus we may take $A = (6, 9)$ and $B = (-2, 1)$. Both points satisfy the original parabola, since $36 = 4(9)$ and $4 = 4(1)$.

Step 2: Choose a horizontal base through the focus The points $B = (-2, 1)$ and $F = (0, 1)$ have the same ordinate, so BF is a horizontal segment of length 2. The perpendicular distance from $A = (6, 9)$ to the line $y = 1$ is $9 - 1 = 8$. Hence

$$\text{Area}(AFB) = \frac{1}{2} \times 2 \times 8 = 8.$$

The height is measured to the line containing the base; its foot need not lie on the base segment.

Step 3: Check the result against the alternatives As a coordinate check, $\overrightarrow{FB} = (-2, 0)$ and $\overrightarrow{FA} = (6, 8)$; half the absolute determinant is $\frac{1}{2}|(-2)(8) - 0(6)| = 8$. Thus options (A), (B) and (D), which give 4, 6 and 12, do not equal the computed area.

Step 4: Conclusion The area of triangle AFB is 8 square units. Hence, the correct option is (C).

Quick Tip to Solve: After finding the focus, check whether it shares an ordinate or abscissa with an intersection point; this often supplies a very simple base.

11. Let $A\left(3, 3\sqrt{3}\right)$, $B(6, 0)$ and $C(\alpha, \beta)$ be the vertices of an equilateral triangle. Let its incentre be D, and P and Q be the feet of perpendiculars drawn from the point D on AC and BC, respectively. Then the area of quadrilateral $CPDQ$ is : [4 marks]

(A) $2\sqrt{3}$

(B) $3\sqrt{3}$

(C) $6\sqrt{3}$

(D) $8\sqrt{3}$

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

Solution:

Concept:

- In an equilateral triangle of side s, the altitude is $\sqrt{3}s/2$ and the inradius is $r = \sqrt{3}s/6$. All its standard centres coincide.
- The perpendicular from the incentre to a side of an equilateral triangle meets that side at its midpoint. A diagonal divides the requested quadrilateral into two right triangles.

Step 1: Calculate the common side length Using the given vertices,

$$AB = \sqrt{(6-3)^2 + (0-3\sqrt{3})^2} = \sqrt{9+27} = 6.$$

Therefore all sides of the equilateral triangle have length 6, and its altitude is $3\sqrt{3}$. Either possible location of the third vertex gives the same side lengths and area, so the individual values of α and β are unnecessary.

Step 2: Find the sides of the two right triangles Since D is the incentre, $DP = DQ = r$. For side length six,

$$r = \frac{6\sqrt{3}}{6} = \sqrt{3}.$$

Symmetry makes P and Q the midpoints of AC and BC, respectively. Consequently $CP = CQ = 3$. The perpendicularity conditions give right angles at P and Q, exactly the angles needed for the base–height area formula.

Step 3: Add the component areas Draw the diagonal conceptually from C to D. The two triangles CPD and CDQ have disjoint interiors and together form $CPDQ$. Thus

$$\text{Area}(CPDQ) = \frac{1}{2}(3)(\sqrt{3}) + \frac{1}{2}(3)(\sqrt{3}) = 3\sqrt{3}.$$

This is one-third of the whole triangle's area, $9\sqrt{3}$, as symmetry also requires. The other values $2\sqrt{3}$, $6\sqrt{3}$ and $8\sqrt{3}$ fail this area check.

Step 4: Conclusion The quadrilateral has area $3\sqrt{3}$ square units. Hence, the correct option is (B).

Quick Tip to Solve: For an equilateral triangle, replace an incentre-to-side perpendicular by the inradius and its foot by the side midpoint.

12. Let $E : \frac{x^2}{a^2} + \frac{y^2}{b^2} = 1$, $a > b$ be an ellipse of eccentricity $\frac{1}{\sqrt{3}}$. If the distance between the foci of E is 4, then the length of its latus rectum is : [4 marks]

(A) $\frac{4\sqrt{3}}{3}$

(B) $\frac{6\sqrt{3}}{3}$

(C) $\frac{8\sqrt{3}}{3}$

(D) $\frac{10\sqrt{3}}{3}$

Correct Answer: (C) $\frac{8\sqrt{3}}{3}$

Solution:

Concept:

- For $x^2/a^2 + y^2/b^2 = 1$ with $a > b > 0$, the foci are $(\pm c, 0)$, where $c = ae$ and $c^2 = a^2 - b^2$.
- The full latus rectum is the chord through a focus perpendicular to the major axis. Its length is $2b^2/a$, twice the semi-latus rectum.

Step 1: Use the distance between the foci The focal separation is $2c$, rather than c. The stated separation therefore gives $2c = 4$, hence $c = 2$. Since $e = 1/\sqrt{3}$,

$$a = \frac{c}{e} = 2\sqrt{3}, \qquad a^2 = 12.$$

This is the semi-major axis; the full major axis would be $4\sqrt{3}$. Keeping these half-lengths distinct avoids an extra factor of two.

Step 2: Find the semi-minor axis squared Apply the focal identity:

$$b^2 = a^2 - c^2 = 12 - 4 = 8.$$

Equivalently, $b^2 = a^2(1 - e^2) = 12(1 - 1/3) = 8$. Both routes agree, and $b^2 < a^2$, consistent with the major axis being along the horizontal coordinate axis.

Step 3: Evaluate and verify the complete chord length The latus rectum has length

$$\ell = \frac{2b^2}{a} = \frac{16}{2\sqrt{3}} = \frac{8}{\sqrt{3}} = \frac{8\sqrt{3}}{3}.$$

To check the factor of two, substitute $x = c = 2$ into the ellipse: $4/12 + y^2/8 = 1$, giving $y = \pm 4/\sqrt{3}$. Their vertical separation is indeed $8/\sqrt{3}$. Option (A) is only half this chord; options (B) and (D) also differ from its exact length.

Step 4: Conclusion The length of the latus rectum is $\frac{8\sqrt{3}}{3}$ units. Hence, the correct option is (C).

Quick Tip to Solve: Convert focal separation to c first, then use $a = c/e$ and $2b^2/a$; check that the requested length is the full chord.

13. Let a circle of radius 3 pass through the origin O and meet the coordinate axes at the points A and B. Then the locus of the centroid of the triangle AOB is : [4 marks]

(A) $x^2 + y^2 = 1$

(B) $x^2 + y^2 = 4$

(C) $3x^2 + 3y^2 = 4$

(D) $x^2 + y^2 = 12$

Correct Answer: (B) $x^2 + y^2 = 4$

Solution:

Concept:

- A triangle with vertices on the two coordinate axes and at the origin is right-angled at the origin. Its hypotenuse is a diameter of its circumcircle.
- The centroid is the coordinate-wise average of the three vertices. This relates the intercepts of the circle to the coordinates of the moving centroid.

Step 1: Express the circle through its axial intercepts Write $A = (u, 0)$, $B = (0, v)$, and $O = (0, 0)$. The circle through these points has equation

$$X^2 + Y^2 - uX - vY = 0.$$

Completing squares gives centre $(u/2, v/2)$ and radius $\sqrt{u^2 + v^2}/2$. Since the radius is three,

$$u^2 + v^2 = 36.$$

The same condition follows from the right-triangle fact that AB is a diameter of length six.

Step 2: Relate the centroid to the intercepts Let the centroid be $G = (x, y)$. Averaging the vertices gives

$$x = \frac{u + 0 + 0}{3} = \frac{u}{3}, \qquad y = \frac{0 + v + 0}{3} = \frac{v}{3}.$$

Thus $u = 3x$ and $v = 3y$. Substitute these into the radius condition, rather than treating the centroid as the centre of the original circle.

Step 3: Eliminate the moving intercepts We obtain

$$9x^2 + 9y^2 = 36 \quad \Longrightarrow \quad x^2 + y^2 = 4.$$

This is the circle of radius two centred at the origin. The nondegenerate triangles have $u, v \neq 0$, so their centroid positions exclude the axial limiting points; this does not change the locus equation among the given choices. Options (A), (C) and (D) give different squared radii, namely 1, $4/3$ and 12, and so fail the required intercept relation.

Step 4: Conclusion The locus equation is $x^2 + y^2 = 4$. Hence, the correct option is (B).

Quick Tip to Solve: For an axis-intercept triangle through the origin, write the intercepts as three times the centroid coordinates before eliminating them.

14. The length of the perpendicular from the point $(1, 2, 3)$ on the line $\frac{x-6}{3} = \frac{y-7}{2} = \frac{z-7}{-2}$ is : [4 marks]

(A) 5

(B) 6

(C) 4

(D) 7

Correct Answer: (D) 7

Solution:

Concept:

- A line written in symmetric form gives both a point A on it and a direction vector $\mathbf{d}$. The direction vector need not be a unit vector.
- If $\mathbf{v} = \overrightarrow{AP}$, the perpendicular distance satisfies $h^2 = |\mathbf{v}|^2 - (\mathbf{v} \cdot \mathbf{d})^2/|\mathbf{d}|^2$, obtained by subtracting the squared parallel projection.

Step 1: Extract the point and direction of the line The line passes through $A = (6, 7, 7)$ and has direction $\mathbf{d} = (3, 2, -2)$. For the given point $P = (1, 2, 3)$,

$$\mathbf{v} = P - A = (-5, -5, -4).$$

Thus

$$|\mathbf{v}|^2 = 25 + 25 + 16 = 66, \qquad |\mathbf{d}|^2 = 9 + 4 + 4 = 17.$$

The negative third direction ratio must be retained in the dot product.

Step 2: Remove the parallel component Calculate

$$\mathbf{v} \cdot \mathbf{d} = (-5)(3) + (-5)(2) + (-4)(-2) = -17.$$

Therefore

$$h^2 = 66 - \frac{(-17)^2}{17} = 66 - 17 = 49, \qquad h = 7.$$

Distance is nonnegative, so the negative square root is not admissible.

Step 3: Verify with the perpendicular foot The foot has parameter $t = (\mathbf{v} \cdot \mathbf{d})/|\mathbf{d}|^2 = -1$, giving $H = A - \mathbf{d} = (3, 5, 9)$. Then $P - H = (-2, -3, -6)$, whose dot product with $\mathbf{d}$ is $-6 - 6 + 12 = 0$. Its length is $\sqrt{4 + 9 + 36} = 7$, independently confirming the perpendicular distance. The values 5, 6 and 4 in the other options have squared lengths 25, 36 and 16, not 49.

Step 4: Conclusion The perpendicular distance is 7 units. Hence, the correct option is (D).

Quick Tip to Solve: Use squared lengths and the dot product to avoid a full cross-product expansion, then verify that the foot-to-point vector is perpendicular.

15. **Let L_1 be the line that passes through the point $(1, 2, -4)$ and be perpendicular to the two lines $\frac{x-8}{3} = \frac{y+19}{-16} = \frac{z-10}{7}$ and $\frac{x-15}{3} = \frac{y-29}{8} = \frac{z-5}{-5}$. If L_2 is the line $\vec{r} = 7\hat{i} - 6\hat{k} + \lambda(\hat{i} + 2\hat{j} + 2\hat{k})$, $\lambda \in \mathbf{R}$, then an angle between L_1 and L_2 is equal to :** [4 marks]

(A) $\frac{\pi}{6}$

(B) $\frac{\pi}{12}$

(C) $\cos^{-1}\left(\frac{4}{5}\right)$

(D) $\cos^{-1}\left(\frac{20}{21}\right)$

Correct Answer: (D) $\cos^{-1}\left(\frac{20}{21}\right)$

Solution:

Concept:

- A direction perpendicular to two nonparallel directions is their cross product. The location of a point on a line does not affect its direction or its angle with another line.
- For direction vectors $\mathbf{u}$ and $\mathbf{v}$, the acute angle between their lines satisfies $\cos\theta = |\mathbf{u} \cdot \mathbf{v}|/(|\mathbf{u}||\mathbf{v}|)$.

Step 1: Find a direction of the perpendicular line The two given directions are $\mathbf{a} = (3, -16, 7)$ and $\mathbf{b} = (3, 8, -5)$. Their cross product is

$$\mathbf{a} \times \mathbf{b} = \big(80 - 56,\ 21 + 15,\ 24 + 48\big) = (24, 36, 72).$$

Dividing by twelve, take $\mathbf{u} = (2, 3, 6)$ as the direction of L_1. The checks $\mathbf{u} \cdot \mathbf{a} = 6 - 48 + 42 = 0$ and $\mathbf{u} \cdot \mathbf{b} = 6 + 24 - 30 = 0$ confirm both perpendicularities.

Step 2: Read the direction of the second line In the vector equation of L_2, the coefficient of λ is its direction, so $\mathbf{v} = (1, 2, 2)$. The fixed vector $(7, 0, -6)$ specifies a point only. Now

$$|\mathbf{u}| = \sqrt{4 + 9 + 36} = 7, \qquad |\mathbf{v}| = \sqrt{1 + 4 + 4} = 3.$$

Also $\mathbf{u} \cdot \mathbf{v} = 2 + 6 + 12 = 20$.

Step 3: Calculate the angle and compare the choices Hence

$$\cos\theta = \frac{20}{7 \cdot 3} = \frac{20}{21}, \qquad \theta = \cos^{-1}\left(\frac{20}{21}\right).$$

This value is between zero and one, as required for an acute angle. The cosines of options (A) and (B) are $\sqrt{3}/2$ and $(\sqrt{6} + \sqrt{2})/4$, neither equal to $20/21$; option (C) gives the different ratio $4/5$.

Step 4: Conclusion An angle between the lines is $\cos^{-1}(20/21)$. Hence, the correct option is (D).

Quick Tip to Solve: For a line perpendicular to two given directions, simplify their cross product before taking its dot product with the final line direction.

16. Let f be a differentiable non-zero function and $3\int_0^x f(t)\mathrm{d}t = 2(f(x))^3$. Then $\int_0^1 \frac{3(f(x))^4}{\sqrt{1+(f(x))^{12}}}\mathrm{d}x$ is equal to : [4 marks]

(A) $\log_e(\sqrt{2}+2)$

(B) $\log_e(\sqrt{2}-1)$

(C) $\log_e(1+\sqrt{2})$

(D) $\log_e(3-\sqrt{2})$

Correct Answer: (C) $\log_e(1+\sqrt{2})$

Solution:

Concept:

- The fundamental theorem of calculus differentiates $\int_0^x f(t)\,dt$ to $f(x)$ where f is continuous. Apply the chain rule to the cubic on the other side.
- The standard antiderivative $\int du/\sqrt{1+u^2} = \ln\left(u+\sqrt{1+u^2}\right)+C$ follows by differentiation and is useful after converting the given relation to $f(x)^2$.

Step 1: Differentiate the given identity At the lower endpoint, the identity forces $f(0)=0$. On the nonzero branch for $x>0$, differentiate to obtain

$$3f(x) = 6f(x)^2 f'(x), \qquad 2f(x)f'(x) = 1.$$

The left-hand side is the derivative of $f(x)^2$. Hence $f(x)^2 = x + C$; continuity at zero together with $f(0)=0$ gives $C=0$. Therefore $f(x)^2 = x$ on the interval relevant to the integral.

Step 2: Express the integrand using even powers It follows that $f(x)^4 = x^2$ and $f(x)^{12} = x^6$. The sign of the nonzero branch makes no difference to these even powers. Consequently the requested integral is

$$I = \int_0^1 \frac{3x^2}{\sqrt{1+x^6}}\,dx.$$

Set $u = x^3$, giving $du = 3x^2\,dx$. The endpoints become $u=0$ and $u=1$, so

$$I = \int_0^1 \frac{du}{\sqrt{1+u^2}}.$$

Step 3: Evaluate the logarithmic expression Thus

$$I = \left[\ln\left(u+\sqrt{1+u^2}\right)\right]_0^1 = \ln(1+\sqrt{2}).$$

The lower endpoint contributes $\ln 1 = 0$. Option (B) is its negative because $\sqrt{2}-1 = (\sqrt{2}+1)^{-1}$, whereas the integral has a positive integrand. Options (A) and (D) have different logarithm arguments and do not equal this endpoint difference. Here the stated differentiability is used on $x>0$; the endpoint is treated by continuity, since the identity itself forces the endpoint value to be zero.

Step 4: Conclusion The integral equals $\ln(1+\sqrt{2})$. Hence, the correct option is (C).

Quick Tip to Solve: When an integral identity gives a cubic of a function, differentiate once and look for $(f^2)'$; even powers can then eliminate the branch sign.

17. Let $f(x) = \sum_{r=1}^{10} \cot^{-1}\left(1 - (x+r) + (x+r)^2\right)$, $x \geq 0$. **Then** $\lim_{x\to\infty}\left(\tan(f(x)) + \sec^2(f(x))\right)$ **is :**

[4 marks]

(A) 0

(B) 1

(C) 2

(D) not defined

Correct Answer: (B) 1

Solution:

Concept:

- For a positive real argument t, the principal value $\cot^{-1} t$ lies in $(0, \pi/2)$ and tends to zero as $t \to +\infty$.
- The limit of a finite sum is the sum of its termwise limits. The functions $\tan u$ and $\sec^2 u$ are continuous near $u = 0$, since $\cos 0 = 1 \neq 0$.

Step 1: Examine each inverse cotangent For each fixed integer r from 1 to 10, set $t = x + r$. The argument is $t^2 - t + 1 = (t - \frac{1}{2})^2 + \frac{3}{4}$, which is positive. As $x \to \infty$, this quadratic tends to positive infinity. Therefore every summand $\cot^{-1}(t^2 - t + 1)$ tends to zero, rather than to $\pi/2$.

Step 2: Pass the limit through the finite sum There are exactly ten summands, and their number does not grow with x. Hence

$$\lim_{x\to\infty} f(x) = \sum_{r=1}^{10} 0 = 0.$$

In particular, for all sufficiently large x, $f(x)$ lies in a small interval about zero containing no pole of tangent or secant. The limiting expression is thus well defined.

Step 3: Evaluate and compare the options Continuity now gives

$$\lim_{x\to\infty}\left(\tan f(x) + \sec^2 f(x)\right) = \tan 0 + \sec^2 0 = 0 + 1 = 1.$$

Option (A) omits the nonzero secant contribution. Option (C) would require an additional contribution of one from tangent, whereas its limit is zero. Option (D) is excluded because the cosine tends to one, so no denominator approaches zero.

Step 4: Conclusion The required limit is $\boxed{1}$. Hence, the correct option is (B).

Quick Tip to Solve: For a finite sum of inverse cotangents with arguments tending to positive infinity, first find the sum limit; then check the outer trigonometric functions for poles.

18. The area of the region, enclosed between the curves $y = \cos x$ and $y = |\cos x|$ for $0 \le x \le 3\pi$, is : [4 marks]

(A) 3

(B) 5

(C) 6

(D) 12

Correct Answer: (C) 6

Solution:

Concept:

- The area between two graphs is the integral of upper ordinate minus lower ordinate. Here $|\cos x| \ge \cos x$ throughout the interval.
- Where $\cos x \ge 0$, the graphs coincide; where $\cos x < 0$, their vertical separation is $-2\cos x$.

Step 1: Locate the nonzero enclosed regions On $[0, 3\pi]$, cosine is negative on $(\pi/2, 3\pi/2)$ and $(5\pi/2, 3\pi]$. It is nonnegative on the remaining intervals, so they contribute no area. Zeros at the interval boundaries do not change the integral. The first negative interval is a full lobe and the last is half a lobe.

Step 2: Integrate the upper-minus-lower difference The two contributions are

$$A_1 = -2\int_{\pi/2}^{3\pi/2} \cos x\, dx = -2(-1-1) = 4,$$

$$A_2 = -2\int_{5\pi/2}^{3\pi} \cos x\, dx = -2(0-1) = 2.$$

Although the cosine integral over a negative lobe is negative, the separation $-2\cos x$ is positive, as an area must be.

Step 3: Add the areas and eliminate the distractors Thus the total area is $A = A_1 + A_2 = 4 + 2 = 6$ square units. Integrating only $|\cos x|$ over the negative intervals gives 3, option (A), but that measures the distance from the axis, only half the separation between the two curves. Option (B) does not equal the sum of the two lobes. Option (D) doubles the correct area again. We must count precisely the separation once.

Step 4: Conclusion The enclosed area is $\boxed{6}$ square units. Hence, the correct option is (C).

Quick Tip to Solve: For the graphs of $g(x)$ and $|g(x)|$, ignore the positive intervals and double the area of the negative lobes.

19. If $\int_4^9 \frac{x-\sqrt{x}}{x(x-1)}\mathrm{d}x = \alpha$, then e^{α} is equal to : [4 marks]

(A) 9/4

(B) 16/9

(C) 4/9

(D) 4/3

Correct Answer: (B) 16/9

Solution:

Concept:

- A radical substitution $t = \sqrt{x}$ converts both the numerator and denominator into polynomials in t, with $dx = 2t\,dt$.
- The limits must change with the variable. The factor $t - 1$ may be cancelled here because the transformed interval is $[2, 3]$, away from $t = 1$.

Step 1: Replace the square root and transform the bounds Let $x = t^2$. The bounds $x = 4$ and $x = 9$ become $t = 2$ and $t = 3$, respectively. The integrand including its differential becomes

$$\frac{t^2 - t}{t^2(t^2 - 1)}\,2t\,dt = \frac{2t^2(t-1)}{t^2(t-1)(t+1)}\,dt = \frac{2}{t+1}\,dt.$$

Retaining the differential factor is essential.

Step 2: Evaluate the logarithmic integral Since $t + 1$ is positive on the entire transformed interval,

$$\alpha = 2\int_2^3 \frac{dt}{t+1} = 2[\ln(t+1)]_2^3 = 2\ln\frac{4}{3} = \ln\frac{16}{9}.$$

The result is positive, consistent with the positive original integrand for $4 \le x \le 9$.

Step 3: Exponentiate and distinguish the choices Using $e^{\ln u} = u$ for $u > 0$, we obtain $e^{\alpha} = 16/9$. Option (D), $4/3$, loses the factor 2 multiplying the logarithm; that factor becomes a square on exponentiation. Option (C) is below one and would correspond to a negative integral, contrary to the sign check. Option (A), $9/4$, is not the ratio $(3+1)^2/(2+1)^2$ dictated by the transformed bounds.

Step 4: Conclusion We obtain $\boxed{e^{\alpha} = \frac{16}{9}}$. Hence, the correct option is (B).

Quick Tip to Solve: When a square-root substitution simplifies a rational integrand, transform both bounds immediately and carry the differential factor through before cancelling.

20. If the function $f(x)$ defined by

$$f(x) = \begin{cases} \dfrac{\log_e(1+5x) - \log_e(1-2x)}{x}, & x \neq 0, \\ l, & x = 0 \end{cases}$$

is continuous at $x = 0$, then the value of l is: [4 marks]

(A) 3

(B) 2

(C) 5

(D) 7

Correct Answer: (D) 7

Solution:

Concept:

- Continuity at zero requires the assigned value $f(0) = l$ to equal the two-sided limit of the formula used for $x \neq 0$.
- The standard natural-logarithm limit is $\lim_{u\to 0} \ln(1+u)/u = 1$. Consequently $\lim_{x\to 0} \ln(1+ax)/x = a$.

Step 1: Check the domain near zero Both logarithms are real when $1 + 5x > 0$ and $1 - 2x > 0$, or $-1/5 < x < 1/2$. This interval contains zero and points on both sides of it. Therefore the two-sided continuity condition is meaningful; the zero denominator is handled by the limiting value rather than direct substitution.

Step 2: Evaluate the two logarithmic limits separately For the first term, put $u = 5x$; for the second, put $v = -2x$. Then

$$\lim_{x\to 0} \frac{\ln(1+5x)}{x} = 5,$$
$$\lim_{x\to 0} \frac{\ln(1-2x)}{x} = -2.$$

The second limit is negative because its inner linear coefficient is -2, not $+2$.

Step 3: Impose continuity and compare the choices The numerator subtracts the second logarithm, so the required limit is $5 - (-2) = 7$. Thus l must be 7. Option (A), 3, results from forgetting that the second logarithm already contributes a negative coefficient. Options (B) and (C) use only one coefficient instead of the difference of the two logarithms. Only option (D) makes the point value agree with the limit.

Step 4: Conclusion Continuity holds for $\boxed{l = 7}$. Hence, the correct option is (D).

Quick Tip to Solve: In a difference of logarithmic limits, retain the sign of each inner coefficient before applying the outer subtraction.

Mathematics – Section B: Numerical Value Questions (20 marks)

21. Let $A = \begin{bmatrix} 1 & 2 & 3 \\ 0 & 2 & 3 \\ 0 & 0 & 1 \end{bmatrix}$ and let P be a 3×3 matrix. If $AP = \begin{bmatrix} 1 & 0 & 1 \\ 1 & 1 & 0 \\ 0 & 1 & 1 \end{bmatrix}$ and $\begin{bmatrix} 1 & 0 & 2 \end{bmatrix} P \begin{bmatrix} 1 \\ 0 \\ 2 \end{bmatrix} = [k]_{1\times 1}$, then k is equal to _____. [4 marks]

Solution:

Concept:

- Matrix multiplication is associative: if $v = (1, 0, 2)^T$ and $y = Pv$, then $Ay = (AP)v$. This finds the requested scalar without calculating all nine entries of P.
- An upper triangular system is solved from its last equation upward. Here $\det A = 1 \cdot 2 \cdot 1 = 2 \neq 0$, so the system has a unique solution.

Step 1: Form the right-hand vector Write $B = AP$ and $v = \begin{bmatrix} 1 & 0 & 2 \end{bmatrix}^T$. Multiplication gives

$$Bv = \begin{bmatrix} 1 & 0 & 1 \\ 1 & 1 & 0 \\ 0 & 1 & 1 \end{bmatrix} \begin{bmatrix} 1 \\ 0 \\ 2 \end{bmatrix} = \begin{bmatrix} 3 \\ 1 \\ 2 \end{bmatrix}.$$

Thus the unknown vector $y = Pv$ satisfies $Ay = (3, 1, 2)^T$.

Step 2: Solve the triangular equations If $y = (y_1, y_2, y_3)^T$, the last row gives $y_3 = 2$. The second row gives $2y_2 + 3y_3 = 1$, hence $y_2 = -5/2$. Finally $y_1 + 2y_2 + 3y_3 = 3$ yields $y_1 = 2$. Therefore

$$Pv = \begin{bmatrix} 2 \\ -5/2 \\ 2 \end{bmatrix}.$$

A direct check gives $2 - 5 + 6 = 3$ in the first row and $-5 + 6 = 1$ in the second.

Step 3: Evaluate the row-vector product The requested 1×1 matrix is $v^T Pv$. Its single entry is

$$k = \begin{bmatrix} 1 & 0 & 2 \end{bmatrix} \begin{bmatrix} 2 \\ -5/2 \\ 2 \end{bmatrix} = 1(2) + 0(-5/2) + 2(2) = 6.$$

The middle component does not enter the final scalar because the corresponding entry of the row vector is zero, although it was needed to determine the first component.

Step 4: Conclusion The requested dimensionless matrix entry is $\boxed{k = 6}$.

Quick Tip to Solve: For a scalar of the form $u^T Pv$ when AP is known, solve $A(Pv) = (AP)v$ first; a full matrix inverse is usually unnecessary.

22. If $\left({}^{10}C_1\right)^2 + 2\left({}^{10}C_2\right)^2 + \ldots + 10\left({}^{10}C_{10}\right)^2 = m\left({}^{n}C_m\right)$**, then** $m+n$ **equals _____.** [4 marks]

Solution:

Concept:

- The weighted binomial identity $r\binom{10}{r} = 10\binom{9}{r-1}$ follows directly from factorials and removes the factor r from each summand.
- Vandermonde's identity states $\sum_j \binom{a}{j}\binom{b}{N-j} = \binom{a+b}{N}$. It counts selections of N objects from two disjoint groups.

Step 1: Write the entire sum in summation notation The given expression is $S = \sum_{r=1}^{10} r\binom{10}{r}^2$. Apply the weighted identity to one of the two equal binomial factors and use symmetry on the other:

$$S = 10\sum_{r=1}^{10}\binom{9}{r-1}\binom{10}{10-r}.$$

The lower indices in each product add to $(r-1)+(10-r) = 9$.

Step 2: Apply the convolution identity With $j = r-1$, the range is $j = 0, \ldots, 9$, so

$$S = 10\sum_{j=0}^{9}\binom{9}{j}\binom{10}{9-j} = 10\binom{19}{9} = 10\binom{19}{10}.$$

For a direct interpretation, selecting nine objects from groups of sizes nine and ten can be separated according to how many are chosen from the first group. All possible choices of j are included exactly once.

Step 3: Match the requested form The intended binomial-identity representation has the same number outside and as the lower index: $10\binom{19}{10}$. It therefore supplies $m = 10$, $n = 19$, and $m+n = 29$. The symmetry step is needed to obtain this particular form. This identifies the intended representation, although the numerical equation by itself does not uniquely determine the integers m, n.

Step 4: Conclusion The intended identity-based pair is $m = 10$, $n = 19$, giving $\boxed{m+n = 29}$. Strictly, the equation alone does not guarantee uniqueness: the sum is 923780, which also equals $1\binom{923780}{1}$. Thus $(m,n) = (1, 923780)$ is another literal solution, with $m+n = 923781$; 29 is the intended binomial-identity answer.

Quick Tip to Solve: For a weighted sum of squared binomial coefficients, absorb the weight into one factor, apply Vandermonde, then use symmetry to match the required lower index.

23. If $\sum_{x=1}^{n^2} \sqrt{(x\cos(\cot^{-1}x)+\sin(\cot^{-1}x))^2-1} = An^4+Bn^2$, then $2(A+B)$ equals _____.

[4 marks]

Solution:

Concept:

- For $\theta = \cot^{-1}x$ with $x \geq 1$, the principal angle is acute. Therefore $\sin\theta = 1/\sqrt{x^2+1}$ and $\cos\theta = x/\sqrt{x^2+1}$.
- The square root denotes its nonnegative value: $\sqrt{x^2} = |x|$. Here every summation index is positive, so this becomes x.

Step 1: Simplify the trigonometric combination For each term, take $\theta = \cot^{-1}x$. The preceding sine and cosine values give

$$x\cos\theta + \sin\theta = \frac{x^2+1}{\sqrt{x^2+1}} = \sqrt{x^2+1}.$$

No negative sign is possible because both sine and cosine are positive for the principal acute angle.

Step 2: Reduce the radical to the index Squaring the preceding expression and subtracting one gives $x^2+1-1 = x^2$. Thus the complete summand is

$$\sqrt{(x\cos\theta+\sin\theta)^2-1} = \sqrt{x^2} = x.$$

Retaining the absolute value until the positive-index condition is used avoids an incorrect sign in other domains.

Step 3: Sum and compare coefficients There are n^2 terms, from 1 through n^2. Their sum is

$$\sum_{x=1}^{n^2} x = \frac{n^2(n^2+1)}{2} = \frac{1}{2}n^4 + \frac{1}{2}n^2.$$

Comparing this polynomial expression with An^4+Bn^2 gives $A = B = 1/2$. It follows that $2(A+B) = 2(1/2+1/2) = 2$. As a quick check, for $n = 1$ the only summand is 1 and $A+B = 1$, in agreement with the derived coefficients.

Step 4: Conclusion The coefficients are $A = B = \frac{1}{2}$, and the required dimensionless value is $\boxed{2}$.

Quick Tip to Solve: Convert the inverse angle into sine and cosine ratios first; then simplify the whole radical before evaluating the finite sum.

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24. Let $\vec{a} = 2\hat{i}+\hat{j}-\hat{k}$ and $\vec{b} = 3\hat{i}+2\hat{j}+4\hat{k}$. Let for some $\lambda, \mu \in \mathbf{R}$, a vector $\vec{c} = \lambda\vec{a}+\mu\vec{b}$. If $\vec{a}\cdot\vec{c} = 16$ and $\vec{b}\times\vec{c} = -12\hat{i}+22\hat{j}-2\hat{k}$, then $|\vec{c}|^2$ equals _____.

[4 marks]

Solution:

Concept:

- The cross product is bilinear and $\vec{b}\times\vec{b} = \vec{0}$, so $\vec{b}\times\vec{c} = \lambda(\vec{b}\times\vec{a})$. This determines λ independently of μ.

- The dot product gives $\vec{a}\cdot\vec{c}=\lambda|\vec{a}|^2+\mu(\vec{a}\cdot\vec{b})$. The squared magnitude is the sum of the squares of the Cartesian components.

Step 1: Determine the first coefficient using the cross product Calculate the product in the specified order, $\vec{b}\times\vec{a}$, not its negative:

$$\vec{b}\times\vec{a}=(2(-1)-4(1),\ 4(2)-3(-1),\ 3(1)-2(2))=(-6,11,-1).$$

The supplied cross product $(-12,22,-2)$ is twice this vector. Thus $\lambda=2$, consistently in all three components.

Step 2: Determine the second coefficient using the dot product The needed scalar products are

$$|\vec{a}|^2=2^2+1^2+(-1)^2=6,\qquad \vec{a}\cdot\vec{b}=2(3)+1(2)-1(4)=4.$$

Substitute into $\vec{a}\cdot\vec{c}=16$: $2(6)+4\mu=16$, so $\mu=1$.

Step 3: Construct the vector and calculate its squared length Therefore $\vec{c}=2\vec{a}+\vec{b}=(7,4,2)$, and

$$|\vec{c}|^2=7^2+4^2+2^2=49+16+4=69.$$

The original conditions can be checked directly: $\vec{a}\cdot\vec{c}=14+4-2=16$, while $\vec{b}\times\vec{c}=(4-16,28-6,12-14)=(-12,22,-2)$. Both agree, confirming the cross-product sign and the two coefficients.

Step 4: Conclusion The vector is $\vec{c}=7\hat{i}+4\hat{j}+2\hat{k}$, and $\boxed{|\vec{c}|^2=69}$.

Quick Tip to Solve: Use a cross product with one spanning vector to eliminate its own coefficient, then a dot product to recover the other coefficient. Keep the order of cross products fixed.

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25. If the differential equation for the family of circles passing through the points $(19,0)$ and $(-19,0)$ is $2xy\,\mathrm{d}x+\left(\alpha x^2+\beta y^2+\gamma\right)\mathrm{d}y=0$, then $\alpha+\beta+\gamma$ is equal to _____. [4 marks]

Solution:

Concept:

- A circle has equation $x^2+y^2+2gx+2fy+c=0$. Substituting the two fixed points determines two of its constants.
- Differentiate the resulting one-parameter family once, then eliminate its remaining parameter to obtain its differential equation.

Step 1: Impose the two fixed points Substitution of $(19,0)$ and $(-19,0)$ gives

$$361+38g+c=0,\qquad 361-38g+c=0.$$

Subtracting these equations gives $76g=0$, so $g=0$, and then $c=-361$. Thus the family is

$$x^2+y^2+2fy-361=0.$$

Its centres lie on the perpendicular bisector of the chord joining the two specified points, namely the y-axis, consistent with $g = 0$.

Step 2: Differentiate and eliminate the parameter Treat f as a constant for each circle. Differentiating gives

$$2x\,\mathrm{d}x + (2y + 2f)\,\mathrm{d}y = 0.$$

Multiply by y, and use $2fy = 361 - x^2 - y^2$ from the family equation:

$$2xy\,\mathrm{d}x + (2y^2 + 2fy)\,\mathrm{d}y = 0,$$
$$2xy\,\mathrm{d}x + (-x^2 + y^2 + 361)\,\mathrm{d}y = 0.$$

This elimination avoids dividing by y, so the algebra does not discard the two given points on the x-axis.

Step 3: Compare the coefficients The coefficient of $\mathrm{d}x$ already has the stated normalization $2xy$. Hence direct comparison of the coefficient of $\mathrm{d}y$ gives $\alpha = -1$, $\beta = 1$ and $\gamma = 361$. The signs are fixed by this normalization; multiplying only one coefficient by minus one would change the differential equation.

Step 4: Conclusion

$$\alpha + \beta + \gamma = -1 + 1 + 361 = \boxed{361}.$$

Quick Tip to Solve: For circles through $(a, 0)$ and $(-a, 0)$, first reduce the family to $x^2 + y^2 + 2fy = a^2$; eliminate $2fy$ after differentiating.

Aptitude Test (200 marks)

26. Structure which is designed to look impressive and wonderful from a far distance, has a : [4 marks]

(A) Micro scale

(B) Human scale

(C) Monumental scale

(D) Nano scale

Correct Answer: (C) Monumental scale

Solution:

Concept:

- Architectural scale describes the perceived size of a building or space in relation to a reference, especially a human observer and the surrounding setting.
- Monumental scale creates a powerful, impressive presence through large dimensions and commanding proportions. It is intended to be appreciated from a distance as well as nearby.

Step 1: Identify the intended visual effect The decisive words are "impressive and wonderful from a far distance." At a long viewing distance, small decorative details have little visual impact. The overall height, mass, silhouette and proportions of the structure must instead produce a striking presence.

This is the aim associated with monumental architectural scale.

Step 2: Distinguish monumental scale from human scale Human scale relates a space or object closely to the size and everyday experience of a person, such as a conveniently proportioned doorway or a comfortable room. Such a design may be attractive, but the term does not specifically describe the grand distant impact asked for. Monumental scale deliberately emphasizes grandeur and an imposing overall form, so option (C) matches both the intended impression and viewing distance.

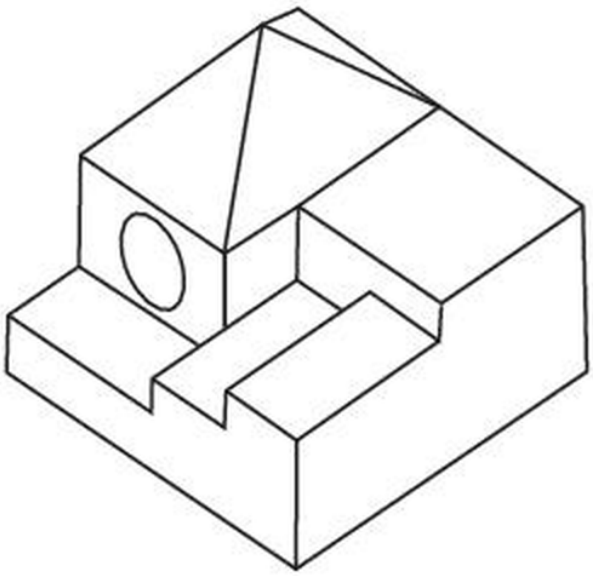
Step 3: Eliminate the remaining alternatives Micro scale refers to very small dimensions or a close level of observation, and nano scale refers to still smaller dimensions. Neither describes the dominant overall form of a structure seen from far away. Thus (A) and (D) contradict the distance and grandeur in the question, while (B) denotes a different proportional relationship. The classification concerns perceived scale, not simply whether an object has decorative details.

Step 4: Conclusion The structure has **monumental scale**. Hence, the correct option is (C).

Quick Tip to Solve: Link "grand," "imposing" and "visible from a distance" with monumental scale; link everyday bodily proportions with human scale.

27. The question fig. shows the 3D view of an object. Identify the correct number of visible surfaces.

[4 marks]



(A) 11

(B) 14

(C) 12

(D) 13

Correct Answer: (D) 13

Solution:

Concept:

- Count each separately bounded visible face once. A change of slope or a drawn boundary identifies a different visible surface; hidden bottom and rear faces are not included.
- Separate the visible regions into sloping faces, horizontal platforms and vertical faces. Include the separately bounded circular region on the front wall, rather than treating the entire drawing as a collection of rectangular blocks.

Step 1: Count the sloping and horizontal faces The roof at the upper left has three visible triangular regions: the broad left triangle, the broad triangle facing the central recess, and the narrow rear triangle beside the apex. These contribute three surfaces. Four horizontal regions can then be followed without repeating one: the high platform on the right, the low platform on the left, the recessed central channel, and the low platform on the right. Thus this first group contributes $3 + 4 = 7$ visible surfaces.

Step 2: Count the upright and circular regions There are five upright planar regions: the front wall containing the circle, the short side wall immediately to its right, the inner wall below the high right platform, the large outer front face, and the large outer right face. The circular region on the front wall has its own closed boundary and contributes one further visible region. This gives $5 + 1 = 6$ additional surfaces. Do not count each corner or each line segment as a surface, and do not add unseen faces beneath the block.

Step 3: Add the groups and check the options The complete count is

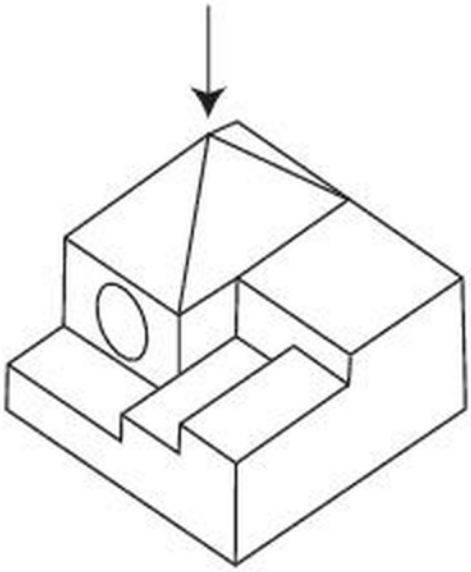
$$3 + 4 + 5 + 1 = 13.$$

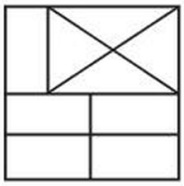
Options (A) and (C), 11 and 12, omit visible regions, such as the narrow roof triangle or the circular region. Option (B), 14, adds a face that is not separately visible or counts one existing region twice. The correct count follows the actual bounded regions, including small ones, rather than the number of apparent solid pieces.

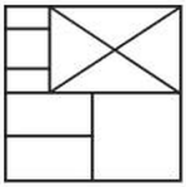
Step 4: Conclusion There are 13 visible surfaces. Hence, the correct option is (D).

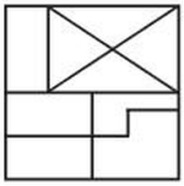
Quick Tip to Solve: Count in groups by orientation, and then scan for small enclosed regions such as the narrow roof triangle and the circle.

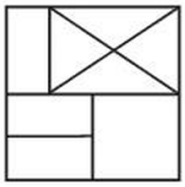
28. The question figure shows the 3D view of an object. Identify the correct view looking in the direction of arrow. [4 marks]

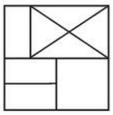


(A) 

(B) 

(C) 

(D) 

Correct Answer: (D) 

Solution:

Concept:

- An orthographic view is obtained by looking parallel to the arrow. A downward arrow selects the top view, which records the horizontal footprint and the boundaries between visible upper surfaces.
- Vertical height does not appear as height in a top view. A circle on a vertical side wall therefore does not appear as a circle in the plan; roof ridges and platform boundaries do remain visible.

Step 1: Choose the viewing direction The arrow points vertically down towards the object. We must therefore select the plan, not a front or side elevation. The outer footprint becomes a rectangle. At the rear, the roof projects as a rectangular region subdivided by its sloping-face edges; the diagonals meet within that region. The strip beside the roof stays unsplit because there is no extra transverse edge across that upper strip.

Step 2: Track the platform boundaries In the foreground, the recessed channel and adjacent platforms

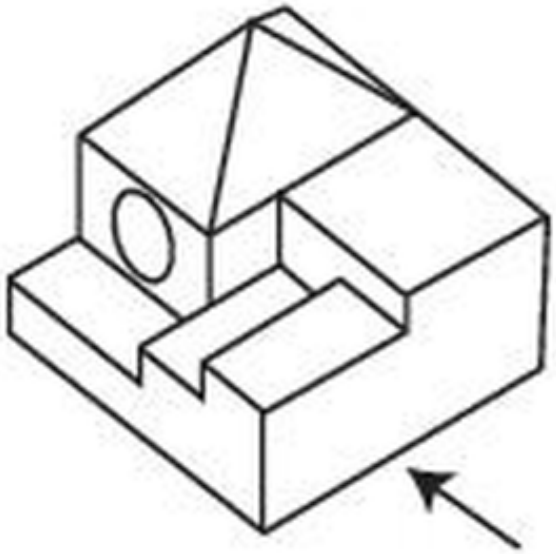
create a horizontal division across only the left-hand portion of the lower region. The right-hand lower portion remains one continuous rectangular area in the plan. An edge that changes the height of a vertical face must not be extended through a horizontal surface where no boundary exists. Option (D) shows the roof region, the narrow rear strip, the left-hand subdivisions and the undivided lower-right region in their correct relative positions.

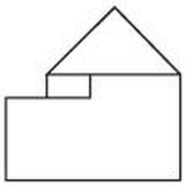
Step 3: Reject the extra divisions Option (A) continues a horizontal division across the lower-right region, adding an edge absent from the top view. Option (B) breaks the narrow rear strip into smaller pieces, which the object does not show from above. Option (C) introduces a stepped division into the lower-right region; that is a height-profile feature rather than the required plan boundary. Removing these invented divisions leaves exactly the arrangement shown in (D).

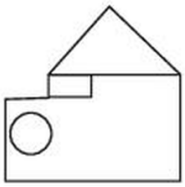
Step 4: Conclusion The view in the downward direction is the top view shown in option (D). Hence, the correct option is (D).

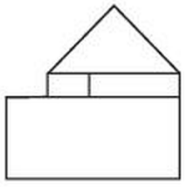
Quick Tip to Solve: First identify whether the arrow asks for plan or elevation; then reject any option that extends an edge across a continuous visible surface.

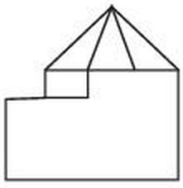
29. The question figure shows the 3D view of an object. Identify the correct view looking in the direction of arrow. [4 marks]

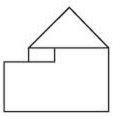


(A) 

(B) 

(C) 

(D) 

Correct Answer: (A) 

Solution:

Concept:

- A side elevation records the outline and visible edges seen along the arrow. Edges parallel to the viewing direction collapse together, while faces perpendicular to it appear with their true profile.
- A marking on a face turned away from the viewing direction is not transferred to the visible side. For a roof, only ridges and boundaries visible in that projection are retained.

Step 1: Read the arrow and establish the silhouette The arrow approaches the broad right-hand side of the object. Looking in that direction gives a side elevation with a low front portion, a higher portion behind it and a triangular roof above the raised part. The top of the low portion meets the raised block at a small step. The broad outer side wall hides internal features lying behind it; the result is not a transparent view through the object.

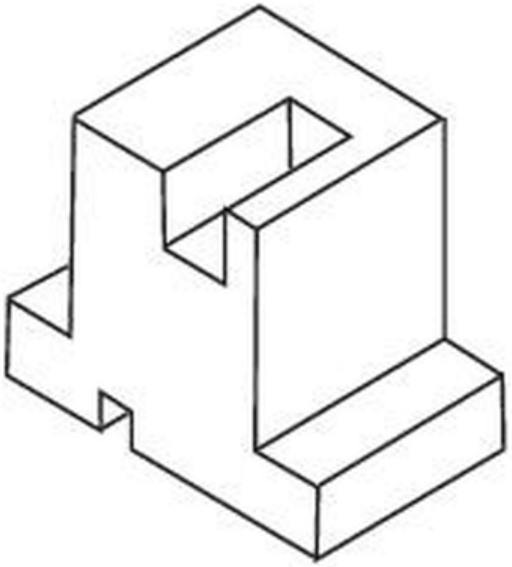
Step 2: Identify the visible internal edges The circular feature is on the other upright wall, so it is not seen as a circle from the indicated right-hand side. The roof projects as a simple triangle without the additional diagonal lines visible in the perspective drawing. The small rectangular step beneath the left end of the roof remains, but the higher right-hand portion of the side wall is continuous with the main body. Option (A) preserves this profile and the small step without inventing an edge through that continuous face.

Step 3: Compare all four choices Option (B) wrongly places the circle on the side elevation. Option (C) adds a long horizontal division across the side below the roof and changes the small stepped boundary. Option (D) includes additional roof lines that do not appear in the indicated elevation. These are differences in visibility, not merely differences in drawing style. Option (A) alone has the correct stepped outline, plain visible side and undivided triangular roof.

Step 4: Conclusion The right-side elevation in the arrow direction is shown in option (A). Hence, the correct option is (A).

Quick Tip to Solve: After matching the outer profile, check which faces can actually be seen; hidden markings and perspective roof edges must not be copied into the elevation.

30. The question figure shows the 3D view of an object. Identify the correct Number of visible surfaces. [4 marks]



(A) 9

(B) 10

(C) 11

(D) 12

Correct Answer: (B) 10

Solution:

Concept:

- A visible surface is one exposed region bounded by edges in the drawing. Count the continuous front face once even when its outer boundary has several steps or notches.
- Recesses expose small inner regions that are easy to overlook. Conversely, faces beneath the object or behind an opaque wall are hidden and are not counted.

Step 1: Count the main upper body and its recess The uppermost U-shaped horizontal face is one continuous surface. The large front upright face is a second surface, and the large right upright face is a third. Within the upper recess, one long inner face and two small triangular regions are separately bounded and visible. These three recessed regions bring the upper-body count to $3 + 3 = 6$. The short vertical boundaries in the recess divide actual faces; the several corners around the large front outline do not divide that front face into several surfaces.

Step 2: Count the surfaces belonging to the base The base exposes a small horizontal ledge on the left and a larger horizontal ledge on the right. Its outer right-hand upright face is another region, below the long right ledge. Finally, the small notch at the bottom of the front outline reveals a small inner face. These are four additional visible surfaces. The broad front face already counted in the first step remains continuous around the notch, so counting it again as a separate base-front face would duplicate it.

Step 3: Check the total against the alternatives Adding the two groups gives

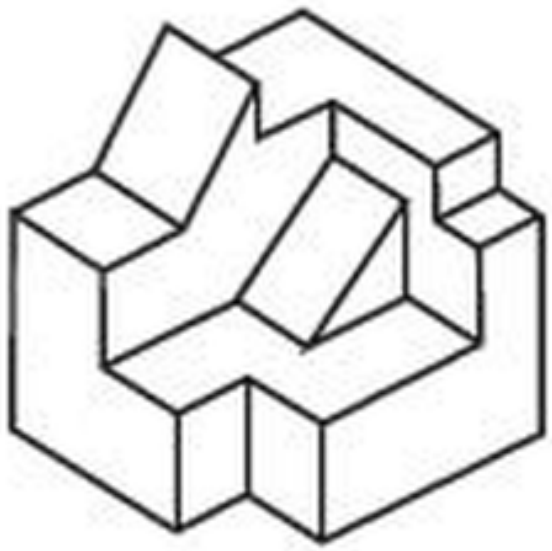
$$6 + 4 = 10.$$

The count nine in option (A) misses a small exposed face, particularly the inner face of the bottom notch. Counts eleven and twelve in options (C) and (D) require either splitting a continuous face without a separating edge, counting the front face twice, or adding a hidden face. Ten counts every displayed surface once and only once.

Step 4: Conclusion The object has 10 visible surfaces. Hence, the correct option is (B).

Quick Tip to Solve: Trace each closed visible region once; inspect recessed corners and small notches after counting the large faces.

31. The question figure shows the 3D view of an object. Identify the correct number of visible surfaces. [4 marks]



(A) 13

(B) 14

(C) 15

(D) 18

Correct Answer: (B) 14

Solution:

Concept:

- Count visible faces rather than solids, edges or corners. Two portions of one continuous planar region form one surface unless a real edge separates them.
- For a complicated stepped figure, first group the faces by orientation: inclined faces, horizontal faces and vertical faces. This prevents a large irregular outline from being counted repeatedly.

Step 1: Identify the inclined and horizontal regions Two inclined rectangular faces are visible: the ramp rising at the upper left and the central sloping face. There are four horizontal regions: the upper rear U-shaped platform, the left-hand shelf beside the first ramp, the small shelf on the upper right, and the lower platform surrounding the central ramp. Even though the lower platform has an irregular boundary, it is continuous and counts once. These inclined and horizontal regions give $2 + 4 = 6$ surfaces.

Step 2: Count all eight upright regions The upright regions are the broad inner wall below the left ramp, the inner rear wall below the upper platform, the short outer face at the upper-right step, and the triangular end face beside the central ramp. The remaining four are the large outer left face, the large outer right face, and the two small inward-facing walls of the notch at the front. Following these eight bounded regions around the object avoids counting any line or corner as if it were a face.

Step 3: Combine the counts and eliminate alternatives The number of visible surfaces is therefore

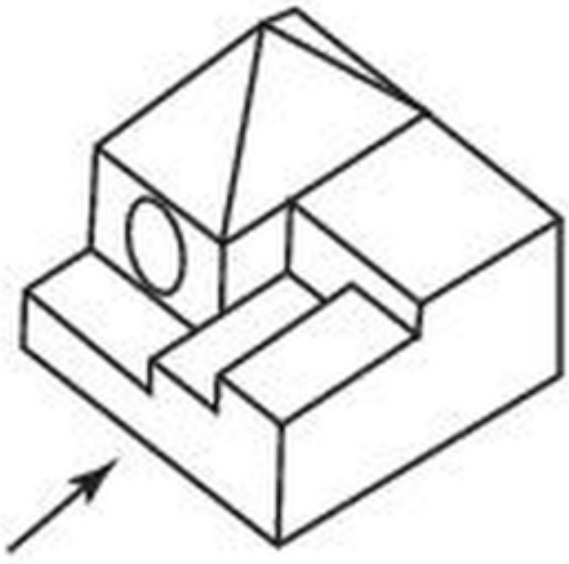
$$2 + 4 + 8 = 14.$$

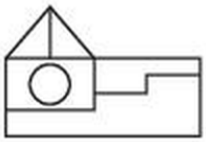
Option (A), thirteen, omits one of the small exposed vertical regions. Option (C), fifteen, counts an extra face by subdividing a continuous region, and option (D), eighteen, overcounts several edges or hidden parts. In particular, the two sides of the front notch are genuine separate faces, whereas the connected lower horizontal platform remains a single face.

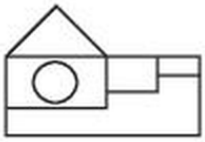
Step 4: Conclusion There are 14 visible surfaces. Hence, the correct option is (B).

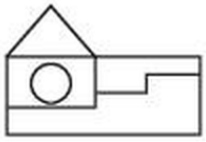
Quick Tip to Solve: Use an orientation checklist: two sloping, four horizontal and eight upright regions, paying special attention to the two walls of the front notch.

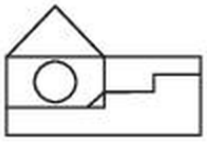
32. The question figure shows the 3D view of an object. Looking in the direction of arrow identify the correct view. [4 marks]

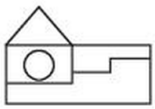


(A) 

(B) 

(C) 

(D) 

Correct Answer: (C) 

Solution:

Concept:

- The arrow determines the observer position. A front elevation retains height and width, while depth collapses; it is not an isometric copy of the three-dimensional drawing.
- A circle on the wall facing the observer is visible in the elevation. The roof outline and the stepped platform profile must be projected separately, retaining only the edges that remain visible.

Step 1: Project the front wall and roof The arrow points towards the face containing the circular feature. Thus the front elevation must show the circle in the raised left-hand wall. Above this wall the roof has a triangular outline. The perspective ridge that runs backwards does not become a vertical dividing line down the triangle. Beneath the raised wall, the front platform produces a horizontal line; these features fix the left-hand part of the required elevation.

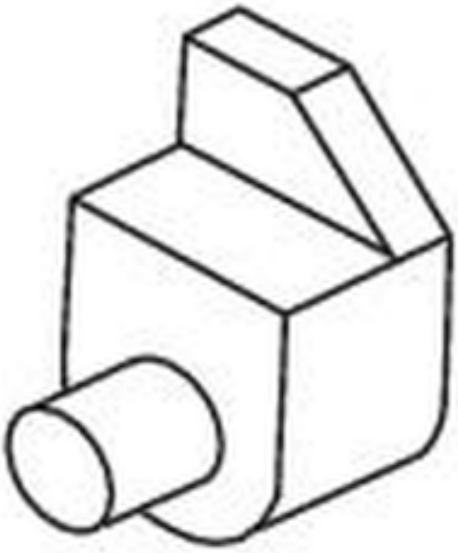
Step 2: Follow the stepped profile to the right The projecting platforms and the recessed channel create a stepped boundary in the right-hand portion of the front view. The first lower level continues rightwards and then rises near the far right. The upper boundary of the right-hand block is straight, while the lower visible division steps upwards. The correct drawing must preserve this order of levels and the continuous front face, without moving the vertical step or adding a sloping edge to it. These features are shown by option (C).

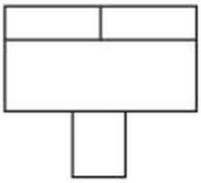
Step 3: Check the distracting features in the other views Option (A) adds a central vertical line in the roof triangle, although that perspective edge does not appear in this elevation. Option (B) places the right-hand step differently, producing a larger rectangular recess instead of the shown sequence of levels. Option (D) introduces a short diagonal boundary at the lower end of the raised wall, which is not part of the front projection. Option (C) alone combines the circle, plain triangular roof and correctly positioned horizontal and vertical step edges.

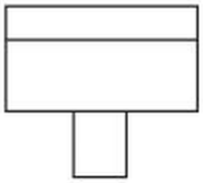
Step 4: Conclusion The front elevation looking along the arrow is option (C). Hence, the correct option is (C).

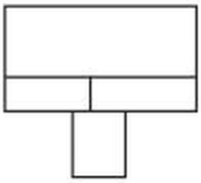
Quick Tip to Solve: Match three features independently: the visible circle, the roof outline and the position of each step; a familiar silhouette alone is insufficient.

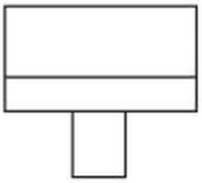
33. The question figure shows the 3D view of an object. Identify the correct top view. [4 marks]

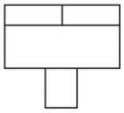


(A) 

(B) 

(C) 

(D) 

Correct Answer: (A) 

Solution:

Concept:

- An orthographic top view projects the object vertically onto a horizontal plane. It preserves width and depth while removing height.
- Visible changes of surface appear as edges in the plan. A horizontal cylinder projects as a rectangle when viewed from above.

Step 1: Trace the outer plan Look vertically downward rather than along either sloping isometric axis. The main block has a rectangular footprint. The cylinder projects outward from the front of this block; its circular end is vertical, so the top view shows a narrow rectangular extension rather than a circle. This establishes the common outer arrangement used by the answer figures.

Step 2: Locate the raised rear portion The raised feature occupies the rear strip of the block. Its top has a short level portion followed by an inclined portion. The boundary between these two surfaces is a real change in slope and remains visible from above. Therefore the narrow rear strip needs an

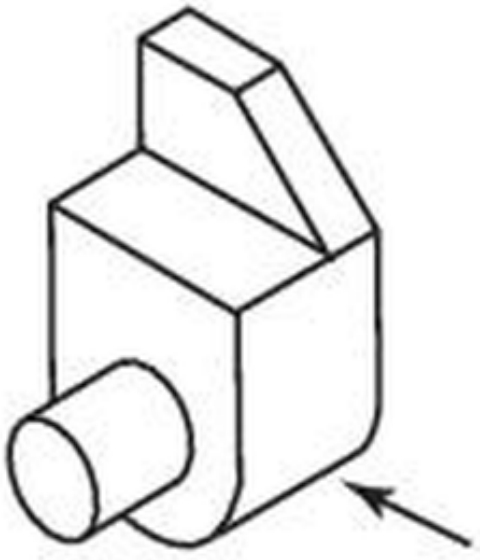
internal dividing line as well as the long boundary separating it from the broad front portion.

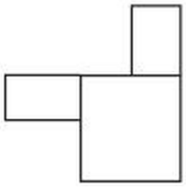
Step 3: Compare the four plans Figure A places the narrow divided strip at the rear and the cylinder extension at the front. Figure B places the strip correctly but omits its internal dividing edge. Figure C puts the narrow divided strip at the front, next to the cylinder, which reverses the raised feature. Figure D also places the strip at the wrong end and omits its internal division.

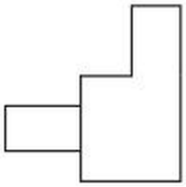
Step 4: Conclusion The correct top view has the front rectangular projection and the divided strip at the rear. Hence, the correct option is (A).

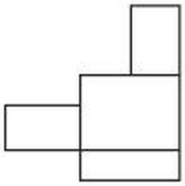
Quick Tip to Solve: In a top view, first locate the front projection, then use it to distinguish the rear strip from its reversed alternative.

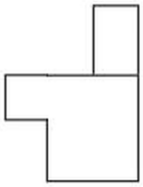
34. The question figure shows the 3D view of an object. Identify the correct view looking in the direction of arrow. [4 marks]

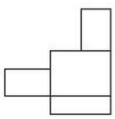


(A) 

(B) 

(C) 

(D) 

Correct Answer: (C) 

Solution:

Concept:

- The viewing arrow fixes the line of sight. Orthographic projection removes depth along that direction but preserves vertical heights and transverse positions.
- A cylindrical projection viewed from its side has a rectangular outline; a circular outline occurs only when looking along its axis.

Step 1: Fix the side from the arrow The arrow points toward the right-hand side of the object. View the body squarely from that direction. The cylinder projects to the left in the resulting elevation, while the raised portion at the back occupies the upper right. The cylinder must therefore appear as a horizontal rectangular projection on the left, not as a circular end view.

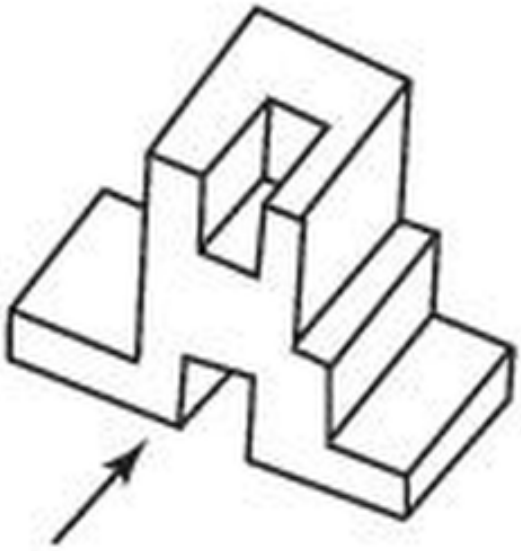
Step 2: Match the projected levels Start with the full-height rectangular body, then place the cylinder projection at its shown level and the taller rear feature above it. Follow the horizontal edges through the side projection: the lower horizontal level associated with the cylinder and body detail continues into the main body in the required view. The rear upper extension is bounded by a vertical line down to the top of the main body. Figure C retains these boundaries and their relative positions.

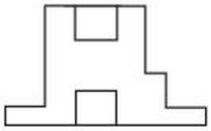
Step 3: Eliminate the incomplete views Figure A does not retain the required horizontal division across the main rectangular body. Figure B changes the cylinder position and the stepped outline, so the projection does not meet the body at the same levels. Figure D merges the cylinder projection into a continuous outer shoulder and omits the required internal boundaries. These are geometric differences, not merely changes of drawing scale.

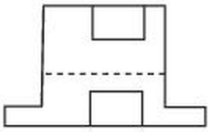
Step 4: Conclusion The side elevation in the indicated direction matches the projected outline and internal edges in figure C. Hence, the correct option is (C).

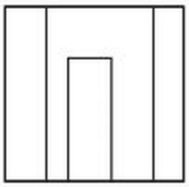
Quick Tip to Solve: For an arrow-view problem, compare the heights of each horizontal edge after fixing the viewing direction; do not choose from the silhouette alone.

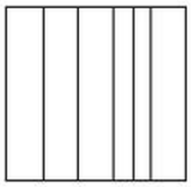
35. The question figure shows the 3D view of an object. Identify the correct view of the object looking in the direction of arrow. [4 marks]

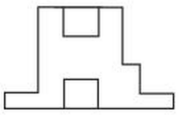


(A) 

(B) 

(C) 

(D) 

Correct Answer: (A) 

Solution:

Concept:

- A directional elevation is obtained by looking along the arrow and projecting parallel lines onto a plane perpendicular to it.
- An opening visible from that direction remains an opening in the elevation. Changes in level create steps in the outer outline.

Step 1: Identify the face being viewed The arrow points toward the front face with the central lower opening and the upper notch. Looking in this direction removes the depth of the object. Its lower base therefore becomes a broad horizontal strip, while the tall middle portion rises above it. The upper notch and lower rectangular opening must both remain recognizable.

Step 2: Trace the asymmetric outline The left side rises directly from the low base to the taller central part. On the right there is an additional intermediate ledge before the outline descends to the low base. Thus the elevation is not symmetric: its right edge has an extra step. The top notch opens

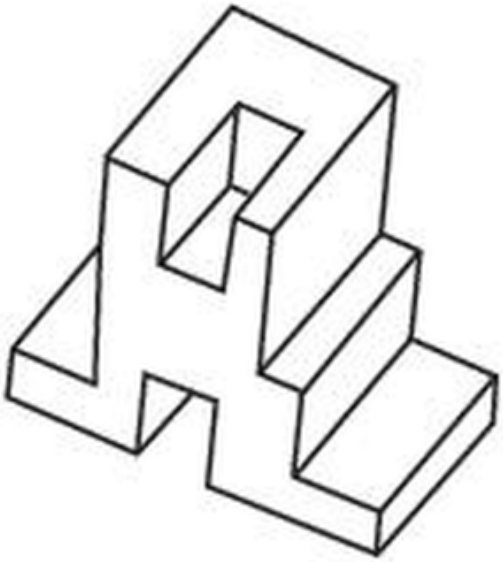
downward into the central mass, whereas the bottom opening cuts upward from the base.

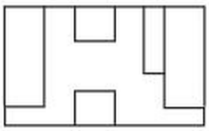
Step 3: Check all the answer figures Figure A contains both central openings, the broad base and the extra right-hand step. Figure B wrongly makes the side outline symmetric and adds a dashed transverse line that does not replace the visible right ledge. Figure C has a rectangular outer boundary and fails to show the front stepped profile and top notch. Figure D shows vertical strips, which correspond to looking down across successive levels rather than along the stated arrow.

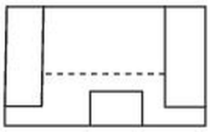
Step 4: Conclusion The visible front profile, including its asymmetric right-hand ledge, is shown in figure A. Hence, the correct option is (A).

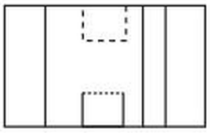
Quick Tip to Solve: Use an asymmetric ledge as an orientation marker; it often distinguishes the correct elevation from an attractive but symmetric distractor.

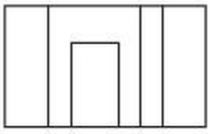
36. In a question figure a 3D object is given. Identify the correct top view of the object amongst the answer figures. [4 marks]

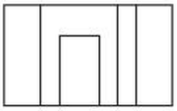


(A) 

(B) 

(C) 

(D) 

Correct Answer: (D) 

Solution:

Concept:

- A top view is a vertical projection of the object. Horizontal widths and depths remain visible, while vertical heights collapse onto the plan.
- Visible boundaries between terraces and recesses must be distinguished from the openings seen only in a front elevation.

Step 1: Trace the footprint Look down on the complete base. Its outside boundary becomes a rectangle. The central raised portion and the side ledges occupy different width bands, so their boundaries project as lines running along the depth of this rectangle. The additional ledge on one side produces a narrower strip there; it does not create a stepped outside boundary in the plan.

Step 2: Locate the upper recess The opening in the top of the raised portion is visible from above. It appears as a rectangular recess entering from the front side of the central band. The lower opening visible in the front face does not create a second independent notch in the upper surface. The plan should therefore retain one visible central recess, with the surrounding level boundaries arranged as straight strips.

Step 3: Compare the alternatives Figure D gives the rectangular footprint, the longitudinal level boundaries and the visible central recess. Figure A mixes the stepped front elevation with the plan and introduces the wrong arrangement of crosswise boundaries. Figure B uses a dashed transverse edge and misses the correct visible recess arrangement. Figure C shows the recess boundaries as hidden dashed lines, although the top opening can be seen directly from above.

Step 4: Conclusion The required top view is the rectangular plan with the visible central recess in figure D. Hence, the correct option is (D).

Quick Tip to Solve: Separate a top recess from an opening low in the front face: the two need not produce two notches when viewed vertically downward.

37. How many edges does a cube have ? [4 marks]

(A) 8

(B) 10

(C) 6

(D) 12

Correct Answer: (D) 12

Solution:

Concept:

- An edge of a solid is the line segment where two adjacent faces meet. A cube has square faces, and each edge belongs to exactly two faces.
- Faces, edges and vertices are different features: faces are surfaces, edges are line segments and vertices are corner points. Counting one of these does not directly count the others.

Step 1: Count the edges in three separate groups Think of the cube as having a top square and an identical bottom square, joined at corresponding corners. The top square contributes four edges, and the bottom square contributes four different edges. Four further vertical edges join the top corners to the bottom corners. These three groups do not overlap, and together they contain every edge of the cube. Therefore,

$$E = 4 + 4 + 4 = 12.$$

Step 2: Check the count and compare the choices As an independent check, count the sides of all six square faces. This gives $6 \times 4 = 24$ face-sides. Each actual edge was counted twice because it is shared by two faces, so the number of distinct edges is

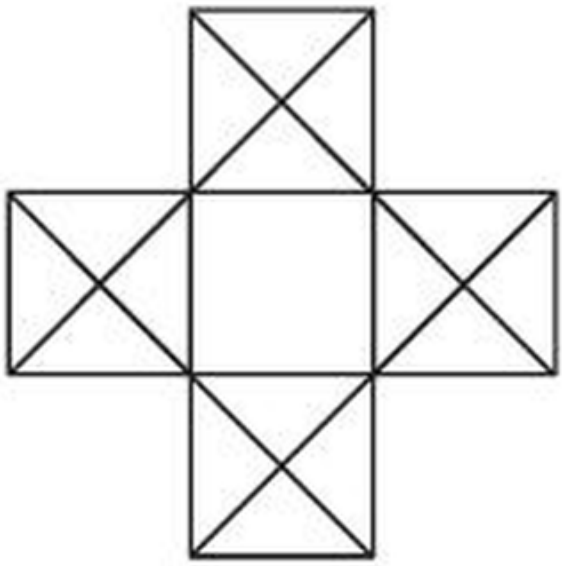
$$E = \frac{6 \times 4}{2} = 12.$$

Option (A), 8, gives the number of vertices rather than edges. Option (C), 6, gives the number of faces. Option (B), 10, omits two edges and does not agree with either complete counting method. Only option (D) agrees with the count.

Step 3: Conclusion A cube has $\boxed{12}$ edges. Hence, the correct option is (D).

Quick Tip to Solve: For a cube, count four top edges, four bottom edges and four joining edges; keep the counts of faces (6) and vertices (8) separate.

38. How many squares are there in the given figure ? [4 marks]



(A) 5

(B) 8

(C) 6

(D) 7

Correct Answer: (C) 6

Solution:

Concept:

- A square must have four equal straight sides and four right angles. Its orientation may be horizontal or tilted.
- Count figures by size and orientation, using only continuous line segments actually present in the diagram.

Step 1: Count the axis-aligned squares The cross consists of a central square and one equal square on each of its four sides. These give five axis-aligned squares. A larger axis-aligned square would require missing corner regions of the cross and complete outer sides through them. Those sides are not drawn, so no larger axis-aligned square can be added.

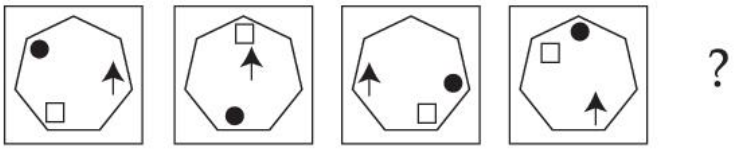
Step 2: Find the tilted square The diagonals of the four outer squares meet at their centres. Join these four centres by following the existing diagonal segments through the corners of the central square. Each resulting side consists of two collinear half-diagonals, and adjacent sides are perpendicular. The four equal sides therefore enclose one additional square tilted through a right-angle bisector relative to the original squares.

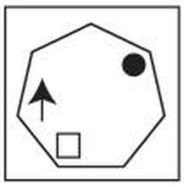
Step 3: Exclude incomplete combinations The other triangular pieces do not have the four complete straight sides needed for an additional square. In particular, the diagonals do not continue through the central square, so imaginary extensions across it cannot be counted. The total is five axis-aligned squares plus one tilted square, giving six. Five misses the tilted square, whereas seven and eight include incomplete figures.

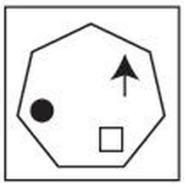
Step 4: Conclusion The total number of squares is $5 + 1 = 6$. Hence, the correct option is (C).

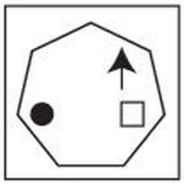
Quick Tip to Solve: After counting ordinary squares, trace a possible tilted boundary continuously; a crossing or a suggestive shape alone does not complete a square.

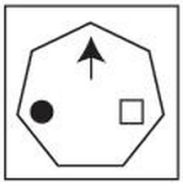
39. Which of the given shapes would complete the sequence ? [4 marks]

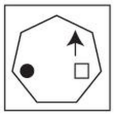


(A) 

(B) 

(C) 

(D) 

Correct Answer: (C) 

Solution:

Concept:

- A visual sequence can be solved by tracking each symbol separately rather than treating the entire picture as one rotating object.
- Positions move around the polygon, but the upright arrow keeps its own orientation; translation around the boundary is not rotation of the symbol.

Step 1: Follow the dot and the square Read the four frames from left to right. The dot progresses from the upper-left area to the bottom, then to the lower-right area and then to the top. Its next position is in the lower-left area. Independently, the hollow square moves from the lower-left area to the top, then to the lower-right area and then to the upper-left area. Its next position is on the lower-right side, above the bottom edge.

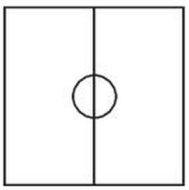
Step 2: Continue the arrow movement The arrow remains upright throughout the sequence. Its location moves around the figure: it is on the right in the first frame, near the top in the second, on the left in the third and toward the lower right in the fourth. Continuing this progression places it in the upper-right region in the next frame. Keep both its arrowhead and the downward shaft; merely choosing an upright triangular mark is insufficient.

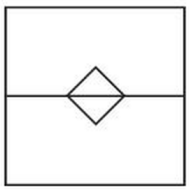
Step 3: Compare the candidate arrangements Figure C combines a lower-left dot, a square on the lower-right side and an upright arrow in the upper-right region. Figure A repeats an earlier arrangement, including a dot on the right. Figure B puts the square too low, near the bottom vertex rather than at the next side position. Figure D places the arrow at the top rather than in the required upper-right position.

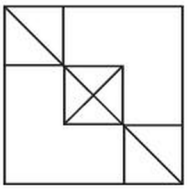
Step 4: Conclusion Only figure C continues the positions of all three symbols together. Hence, the correct option is (C).

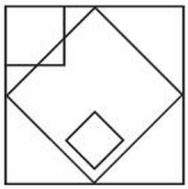
Quick Tip to Solve: Track the dot, square and arrow in three separate short sequences, then select the option satisfying all three predictions.

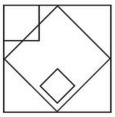
40. **Identify the figure which is odd from rest :** [4 marks]

(A) 

(B) 

(C) 

(D) 

Correct Answer: (D) 

Solution:

Concept:

- Figures can be classified by a transformation that leaves each complete arrangement unchanged.
- Half-turn symmetry means that rotating the entire figure through 180° maps every line and internal shape onto an existing counterpart.

Step 1: Test the first two figures In figure A, the outer square, central circle and vertical line all coincide with themselves after a half-turn. In figure B, the central diamond and horizontal line similarly return to their original positions inside the outer square. Thus both figures have rotational symmetry of order two, irrespective of the different shapes drawn at their centres.

Step 2: Test the third figure carefully In figure C, the upper-left subdivision corresponds to the lower-right subdivision under a half-turn. Their diagonals also match. The central crossed square maps onto itself, while the two remaining outer regions exchange positions. The entire arrangement therefore satisfies the same half-turn test as figures A and B; its lack of a central circle or diamond is irrelevant.

Step 3: Locate the failure in the fourth figure The large central diamond of figure D is itself symmetric, but the whole arrangement is not. Its small square at the upper left has no matching square at the lower right. Likewise, the small diamond near the bottom would move toward the top, where no identical diamond is drawn. A classification must include these internal details, not just the outer square or the large diamond.

Step 4: Conclusion Figure D alone lacks the half-turn symmetry shared by the other three complete figures. Hence, the correct option is (D).

Quick Tip to Solve: Test a proposed odd-one-out rule on every line in each figure; symmetry of the large outline alone may hide an asymmetric small detail.

41. Identify the mirror image of the given word along X-X' axis : [4 marks]



(A) 

(B) 

(C) 

(D) 

Correct Answer: (A) 

Solution:

Concept:

- A vertical mirror reverses horizontal positions while keeping the top and bottom of the word unchanged.
- Both the order of the letters and the shape of each nonsymmetric letter must be reversed; reversing the order alone does not give a true mirror image.

Step 1: Reverse the letter positions The word is DAYLIGHTING and the axis X-X′ is vertical on its right. The last G is nearest the mirror and becomes the first letter when the reflected word is read from left to right. The positional order is therefore G, N, I, T, H, G, I, L, Y, A, D, with each glyph reflected horizontally.

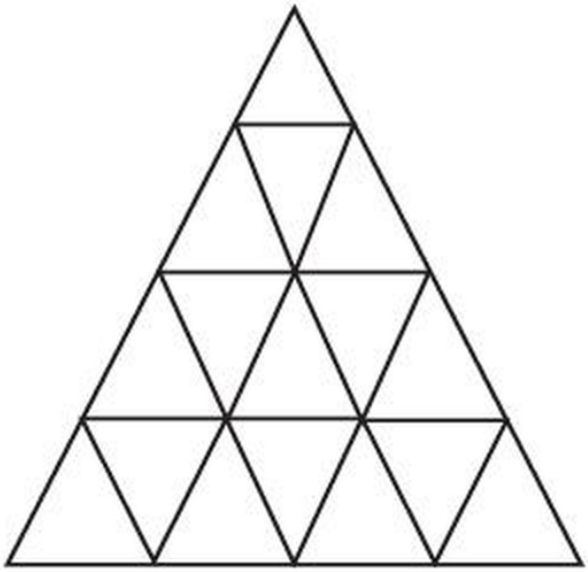
Step 2: Check the distinctive letter shapes The two Gs must both open in the reflected direction. The final D must have its curved side on the left and its straight stem on the right. The L must have its lower horizontal stroke extending to the left rather than to the right. These asymmetric letters make reliable checks; letters such as A, I and T offer less information because their shapes are approximately symmetric about a vertical line.

Step 3: Compare the image options Figure A reverses the complete sequence and mirrors the individual letter shapes consistently. Figure B does not preserve the required reflected sequence through the middle letters. Figures C and D contain upright or inconsistently reflected letters, so they do not reproduce every stroke as a vertical mirror would. A plausible-looking reversed word must still pass the checks on both Gs, L and D.

Step 4: Conclusion The consistent horizontal reflection of DAYLIGHTING is shown in figure A. Hence, the correct option is (A).

Quick Tip to Solve: For a long mirrored word, check the nearest end letter first, then two asymmetric internal letters; this is faster than reading every reversed glyph.

42. What is the total number of triangles in the given diagram ? [4 marks]



(A) 27

(B) 26

(C) 23

(D) 22

Correct Answer: (A) 27

Solution:

Concept:

- Count triangles by orientation and by side length in units of the smallest triangular cell.
- A triangle is counted only when all three straight sides are present. Larger triangles made from several cells count once each.

Step 1: Count the upward-pointing triangles The outer triangle has four small side-length units. For upward triangles of one-unit side, the rows contain 1, 2, 3 and 4, giving 10. For side length two, there are 1, 2 and 3 positions, giving 6. Three-unit triangles have 1 and 2 positions, giving 3. Finally the whole outer figure is one four-unit triangle. Thus the upward count is

$$10 + 6 + 3 + 1 = 20.$$

Step 2: Count the downward-pointing triangles The inverted triangles cannot be ignored. There are six of the smallest inverted triangles, arranged in rows of 1, 2 and 3. There is also one larger inverted triangle of side length two: its horizontal top side spans the middle horizontal segment, and its lower vertex lies at the middle of the base. No larger inverted triangle can fit within the four-unit outer boundary. The downward count is therefore

$$6 + 1 = 7.$$

Step 3: Combine the disjoint categories The two orientation classes do not overlap, and the size

categories within each class are distinct. Adding them gives

$$20 + 7 = 27.$$

The alternative 26 typically results from overlooking the larger inverted triangle. The values 23 and 22 omit further composite triangles. Counting only the smallest triangular cells would also miss valid larger boundaries.

Step 4: Conclusion There are 27 triangles in all. Hence, the correct option is (A).

Quick Tip to Solve: Make two columns, upward and downward, then count each side length separately; the larger inverted triangle is easy to overlook.

43. Choose the appropriate option which most closely resembles the water image of the given word 'FROG' : [4 marks]

(A) 

(B) 

(C) 

(D) 

Correct Answer: (C) 

Solution:

Concept:

- A water image is a reflection in a horizontal line. It reverses top and bottom while preserving left-to-right order.
- A horizontal reflection differs from a vertical mirror image and from a half-turn: those other operations alter the order or horizontal direction of the letters.

Step 1: Preserve the word order The word FROG is reflected as though its image appeared below a horizontal water surface. The letter positions must still run from F to R to O to G when viewed from left to right. Each letter is upside down, but the first and last positions are not exchanged. This immediately excludes any candidate that puts the G on the left and the F on the right.

Step 2: Reflect the asymmetric strokes In the F, the long upper arm moves to the bottom, while the middle arm remains at its corresponding reflected height. The R has its bowl moved to the lower region and its diagonal leg moved toward the upper right; the vertical stroke stays on the left. The O changes little because it is nearly symmetric about a horizontal line. The G must retain its horizontal handedness while its top and bottom features exchange places.

Step 3: Select the complete transformation Figure C preserves the sequence F-R-O-G and flips the letters vertically in the required way. Figure A reverses the sequence instead of giving a water reflection. Figure B has an incorrect reflected form within the word, so matching the overall order is not enough. Figure D also reverses the end-to-end order and therefore represents a different transformation. The strokes of F and R distinguish the otherwise similar candidates.

Step 4: Conclusion The horizontal reflection of FROG is represented by figure C. Hence, the correct option is (C).

Quick Tip to Solve: For water images, keep the letter order fixed and inspect an asymmetric letter such as F or R to check the top-bottom reversal.

44. Identify the mirror image of the given word along X-X' axis : [4 marks]



(A) ENTABLATURE

(B) ƎЯUTAJBATNƎ

(C) ƎЯUTALBATNƎ

(D) ƎЯUTALBATNƎ

Correct Answer: (B) ƎЯUTAJBATNƎ

Solution:

Concept:

- Reflection in a vertical axis reverses left and right but does not interchange the upper and lower parts of the figure.
- For a word, each letter changes position in the sequence and each individual nonsymmetric glyph is also reflected.

Step 1: Read the letters from the mirror end The printed word is ENTABLATURE. The mirror is vertical and lies on the right, so the final E is the first letter encountered in the reflected image. Reversing the positional sequence gives E, R, U, T, A, L, B, A, T, N, E. These are letter identities only: their actual glyphs must also be mirror-reversed.

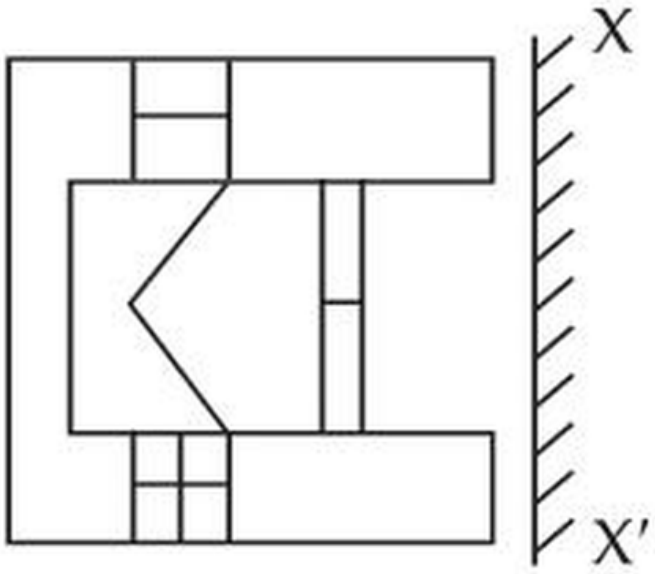
Step 2: Check the asymmetric glyphs The initial reflected E must open to the left. The R near that end must have its vertical stem on the right and its bowl and diagonal leg reflected accordingly. In the middle, the reflected L must have its foot extending left, and the reflected B must have its straight side on the right. At the far end, the other E must also face left. These checks eliminate images that reverse only some letters.

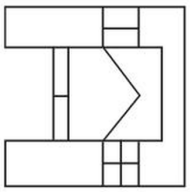
Step 3: Compare the four images Figure B satisfies the full sequence and the horizontal reversal of the glyphs. Figure A simply repeats the original word without reflection. Figure C retains an incorrectly facing E at its left end and has other unreflected forms. Figure D does not consistently mirror the internal letters, particularly the central group. The answer must reproduce every visible stroke, not merely the first and last positions.

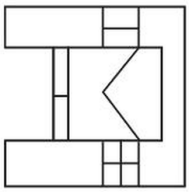
Step 4: Conclusion The correct mirror image of ENTABLATURE is figure B. Hence, the correct option is (B).

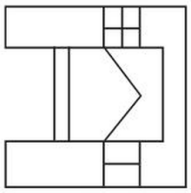
Quick Tip to Solve: Write the reversed letter identities first, then check the handedness of E, R, L and B; symmetric letters are less useful for rejecting distractors.

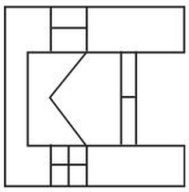
45. Identify the correct mirror image of the given figure along X-X' axis : [4 marks]

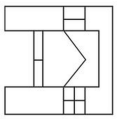


(A) 

(B) 

(C) 

(D) 

Correct Answer: (A) 

Solution:

Concept:

- A vertical mirror reverses horizontal positions but leaves every feature at its original height.
- Internal partitions must reflect together with the outer outline. A correct silhouette with a wrongly directed chevron or swapped subdivisions is still incorrect.

Step 1: Reflect the outer arrangement The original figure has a continuous vertical strip on the left

and long horizontal arms extending toward the mirror on the right. After reflection, the continuous strip must lie on the right and the long arms must extend to the left. The small vertical subdivision beside the central panel also moves to the left of that panel. This fixes the broad arrangement before considering the finer lines.

Step 2: Keep the upper and lower details at their heights The top small rectangle is divided into two horizontal compartments, whereas the corresponding bottom region has four small compartments. A vertical reflection moves these groups horizontally but does not exchange them. Therefore the two-compartment group must remain at the top and the four-compartment group at the bottom. The central left-pointing chevron reverses to point right.

Step 3: Reject the three distractors Figure A has the right-hand outer strip, leftward arms, right-pointing chevron and correctly retained top and bottom subdivisions. Figure B leaves the chevron pointing the wrong way. Figure C swaps the upper and lower compartment patterns, which a vertical mirror cannot do. Figure D keeps the broad left-right arrangement of the original, so it fails the outer-outline test before the internal details are even considered.

Step 4: Conclusion Every outer and internal feature is correctly reflected in figure A. Hence, the correct option is (A).

Quick Tip to Solve: Check three independent features: outer handedness, chevron direction and the unchanged vertical order of unequal small compartments.

46. Which among the following is an excellent hardwood (timber) for furniture ? [4 marks]

(A) Royal Palm

(B) Rose

(C) Shisham

(D) Accacia

Correct Answer: (C) Shisham

Solution:

Concept:

- Furniture timber is selected for strength, durability, dimensional stability, workability and the quality of its finished surface.
- Shisham, also called Indian rosewood, is a well-known hardwood used for furniture and cabinet work. The name rosewood does not mean the wood of an ordinary rose bush.

Step 1: Identify the established furniture hardwood Shisham is the timber obtained from *Dalbergia sissoo*. Its hard, strong wood has an attractive grain and can be worked and polished for furniture. These properties make it a standard choice for items such as tables, chairs, cabinets and other joinery. Thus the description of an excellent furniture hardwood directly identifies Shisham among the listed choices.

Step 2: Compare the remaining choices Royal Palm is a palm rather than a conventional furniture hardwood tree; its stem structure differs from the secondary wood of the broad-leaved timber trees

normally used in cabinet making. Rose names the flowering plant here, and must not be confused with Indian rosewood. Acacia species can also provide useful hard timber, but the question asks for the characteristic excellent furniture timber among these alternatives. Shisham is the specifically established Indian furniture wood intended by that description. It would be incorrect to reject Acacia on the claim that all acacia wood is soft or unusable.

Step 3: Conclusion Shisham is the excellent hardwood used for furniture in this question. Hence, the correct option is (C).

Quick Tip to Solve: Associate Shisham with Indian rosewood and furniture; distinguish the trade name rosewood from the ordinary flowering rose plant.

47. Which colour scheme is typically considered to be calming and is often used in bedrooms and bathrooms ? [4 marks]

(A) Warm colours (red, orange)

(B) Cool colours (blue, green)

(C) Triadic colours (green, orange and purple)

(D) Primary colour (red, blue, yellow)

Correct Answer: (B) Cool colours (blue, green)

Solution:

Concept:

- Blue and green belong to the cool part of the colour wheel and are commonly associated with calm, freshness and visual rest.
- Colour temperature describes a visual and psychological impression. The effect of a colour scheme also depends on saturation, lightness, lighting and the proportions of the colours used.

Step 1: Match the desired atmosphere to a colour family A bedroom is generally intended for rest, while a bathroom often seeks a clean, fresh and tranquil atmosphere. Cool colours, especially softer blues and greens, commonly support these effects. Blue is associated with water and sky, and green with vegetation, so these hues are frequently selected when a calm interior is desired. The wording asks what is typically considered calming, rather than asserting that every use of blue or green produces the same response.

Step 2: Eliminate the other colour schemes Red and orange are warm colours and are more often associated with energy, stimulation and visual warmth. A green-orange-purple triad combines widely separated hues and can create a lively, contrasting composition; its classification alone does not describe a quiet, cool palette. A red-blue-yellow primary scheme likewise contains strong contrasts and includes the stimulating warm hues red and yellow. Either of those schemes can be softened by careful design, but neither is the standard answer to a question about a typically calming colour family. The blue-green alternative fits the intended interior mood most directly.

Step 3: Conclusion Cool colours, such as blue and green, are typically considered calming and are often used in bedrooms and bathrooms. Hence, the correct option is (B).

Quick Tip to Solve: For a question linking colour to a restful interior, first identify cool blues and greens; then distinguish this from triadic or primary-colour contrast.

48. Bharat Mandapam is designed by which architecture firm ? [4 marks]

(A) Archohm

(B) Arcop

(C) C.P. Kukreja

(D) Hafeez Contractor

Correct Answer: (B) Arcop

Solution:

Concept:

- Architectural-awareness questions test the association between a named building and its design practice. The identity of the building must be distinguished from its owner, operator and construction contractor.
- Bharat Mandapam is the convention complex at Pragati Maidan, New Delhi. Its architectural design is associated with ARCOP in collaboration with Aedas.

Step 1: Identify the project and its design association The name Bharat Mandapam refers to the International Exhibition-cum-Convention Centre developed at Pragati Maidan. The relevant design association is ARCOP and Aedas. Since ARCOP is one of the four alternatives and Aedas is not listed separately, the matching choice is Arcop. A collaborative design credit is compatible with selecting one of the collaborating practices when that is the practice included in the options.

Step 2: Compare the names in the options Archohm and Arcop are different architecture firms, despite the similar beginnings of their names, so option (A) cannot be substituted merely on spelling resemblance. C.P. Kukreja and Hafeez Contractor are also established names in Indian architecture, but they are not the project-design association sought here. Their general prominence is insufficient evidence for linking them to this particular convention centre. The direct building-to-practice match therefore eliminates options (A), (C) and (D). The question asks for the design firm, so the answer should not instead name the venue's management body or an engineering contractor.

Step 3: Conclusion Bharat Mandapam is associated with the architectural design collaboration of ARCOP and Aedas; the listed firm is Arcop. Hence, the correct option is (B).

Quick Tip to Solve: Remember the pair Bharat Mandapam–ARCOP, and distinguish Arcop from the similarly named Archohm when comparing the options.

49. **Gable : Roof : : Pier : _____.** [4 marks]

(A) Door

(B) Column

(C) Railing

(D) Floor

Correct Answer: (B) Column

Solution:

Concept:

- A verbal analogy connects architectural terms by their category, function or association. Identify the relationship in the first pair before comparing the choices.
- A gable is the usually triangular upper portion of an end wall beneath a pitched roof. A pier is a solid upright support and belongs with column-like structural elements.

Step 1: Interpret the first pair In the pair Gable : Roof, the first word names an architectural feature closely associated with the second. A gable occurs at the end of a pitched roof, where its outline follows the sloping roof edges. The required completion should similarly connect a pier with the corresponding class of building element. The analogy concerns architectural terminology; it does not mean that a gable and a roof are identical.

Step 2: Classify a pier and compare the options A pier is a vertical load-bearing support, often a substantial masonry support. Its structural role is comparable to that of a column: it carries loads from construction above and transfers them downward. Thus Column, option (B), is the appropriate association. A door is an opening with a movable closure, a railing is a protective barrier, and a floor is a horizontal surface. None of options (A), (C) or (D) identifies the upright support represented by a pier.

Step 3: Conclusion The completed analogy is Gable : Roof : : Pier : Column. Hence, the correct option is (B).

Quick Tip to Solve: For building-term analogies, first distinguish upright supports from horizontal surfaces, openings and protective barriers.

50. In which architectural style are you most likely to find "chhatris" as decorative elements ?

[4 marks]

(A) Gothic

(B) Baroque

(C) Mughal

(D) Renaissance

Correct Answer: (C) Mughal

Solution:

Concept:

- A chhatri is an elevated pavilion, commonly with a dome supported on pillars; its name evokes an umbrella-like form.
- Architectural styles can be identified from recurring elements. Chhatris are characteristic of Indian traditions, including Rajput and Mughal architecture.

Step 1: Identify the decorative element A chhatri often takes the form of a small domed canopy placed on a roof, terrace, corner or pavilion. Its open sides and elevated silhouette make it a conspicuous decorative feature. Mughal buildings frequently incorporate these canopies as part of their roofline and pavilion composition. The question asks for the most likely style among the listed choices, rather than claiming that chhatris occur exclusively in one tradition.

Step 2: Eliminate the other styles Gothic architecture is usually recognized by pointed arches, ribbed vaulting and flying buttresses, rather than chhatris. Baroque architecture emphasizes dramatic spatial effects, elaborate ornament and dynamic compositions; the named Indian canopy is not its identifying element. Renaissance architecture draws strongly on classical orders, balance and proportion. Of these four choices, Mughal is the style directly associated with chhatris. The fact that other styles may also use domes does not make every domed architectural feature a chhatri.

Step 3: Conclusion Chhatris are most likely to be found among the decorative features of Mughal architecture in the given choices. Hence, the correct option is (C).

Quick Tip to Solve: Connect the word chhatri with a small pillared, umbrella-like domed pavilion; then look for the Indian architectural tradition among the options.

51. Which of these is a well known proportion that is aesthetically pleasing and used in architecture ?

[4 marks]

(A) Golden ratio

(B) Newton's constant

(C) Moore's law

(D) Symmetry ratio

Correct Answer: (A) Golden ratio

Solution:

Concept:

- The golden ratio is a particular proportional relationship between a larger length and a smaller length, frequently discussed in art and architectural composition.
- If the larger segment is a and the smaller is b, the golden division satisfies $\frac{a+b}{a} = \frac{a}{b} = \phi$, where $a > b > 0$.

Step 1: Identify the named proportion Put $\phi = a/b$ in the defining relationship. Dividing the numerator and denominator by b gives

$$\phi = 1 + \frac{1}{\phi} \quad \Rightarrow \quad \phi^2 - \phi - 1 = 0.$$

The positive root is

$$\phi = \frac{1+\sqrt{5}}{2} \approx 1.618.$$

This is the golden ratio, a well-known proportion used to relate dimensions in rectangles and other compositions. It is conventionally associated with visually pleasing proportions, although aesthetic judgement is not determined by a numerical ratio alone.

Step 2: Check the remaining choices Newton's constant is the gravitational constant of physics, not a proportion for architectural dimensions. Moore's law concerns the growth of transistor counts in integrated circuits; it is unrelated to spatial proportion. Symmetry describes balance under a reflection, rotation or another transformation, but Symmetry ratio is not the established named proportion asked for here. Therefore only option (A) identifies the familiar proportion described in the question.

Step 3: Conclusion The well-known architectural proportion is the golden ratio, approximately 1.618 : 1. Hence, the correct option is (A).

Quick Tip to Solve: Remember the golden ratio through the relation whole : larger = larger : smaller, rather than confusing proportion with symmetry.

52. The primary function of a 'roof truss' is _____.

Choose the appropriate answer from the following : [4 marks]

(A) To increase the interior space

(B) To act as a wind breaker

(C) To provide thermal comfort

(D) To support the weight of the roof

Correct Answer: (D) To support the weight of the roof

Solution:

Concept:

- A roof truss is a framework of connected members, usually arranged in triangles, designed to span between supports.
- Its primary structural task is to carry roof loads and transfer them to supporting walls or columns through forces in its members.

Step 1: Trace the load path The roof covering and the construction resting on the truss have weight. Depending on the roof arrangement, that load reaches the truss directly or through secondary members such as purlins. The truss then transfers the load to its end supports. Its triangulated arrangement provides a stable framework for spanning the building, with members carrying mainly axial tension or compression in the idealized structural model. Supporting the roof is therefore its fundamental purpose.

Step 2: Distinguish the primary function from other effects A truss may help span a room without intermediate supports, but increasing interior space is not the basic function that defines it; some truss forms also occupy space below the roof. It is not a wind breaker: resisting structural wind forces is different from shielding an area as a barrier. Thermal comfort mainly depends on such features as insulation, ventilation and the roof envelope, not on the truss alone. Options (A), (B) and (C) therefore describe possible indirect effects or different building functions. Option (D) states the essential load-supporting role.

Step 3: Conclusion The primary function of a roof truss is to support the weight of the roof and transmit its loads to the supports. Hence, the correct option is (D).

Quick Tip to Solve: For a structural component, ask where the load comes from and where it goes; a roof truss connects roof loads to the walls or columns.

53. Hawa Mahal located at Jaipur was built by : [4 marks]

(A) Maharaja Jai Singh - II

(B) Ushtad Ahmad Lahouri

(C) Maharaja Sawai Pratap Singh

(D) Ustad Khalil

Correct Answer: (C) Maharaja Sawai Pratap Singh

Solution:

Concept:

- Questions linking a monument to a ruler usually ask for its commissioning patron. The patron and the architect are different roles.
- Hawa Mahal, the Palace of Winds in Jaipur, was commissioned by Maharaja Sawai Pratap Singh in 1799.

Step 1: Recall the monument and its patron Hawa Mahal belongs to Jaipur's palace setting and is recognized by its many small windows and distinctive screened facade. Its commissioning ruler was Maharaja Sawai Pratap Singh. In a monument-awareness question, the phrase built by commonly identifies the ruler responsible for commissioning the building. It should not be confused with the separate task of preparing the architectural design or with the earlier foundation of the city.

Step 2: Distinguish the listed names Maharaja Jai Singh II is strongly associated with the foundation and planning of Jaipur, which makes option (A) a tempting association. However, that association does not identify the patron of Hawa Mahal: the building belongs to the later reign of Sawai Pratap Singh. Ustad Ahmad Lahouri, written as Ushtad Ahmad Lahouri in option (B), is associated with Mughal architecture and the Taj Mahal, not with the patronage of Hawa Mahal. Ustad Khalil in option (D) is also not its commissioning ruler. Option (C) alone gives the correct ruler for this particular monument.

Step 3: Conclusion Hawa Mahal at Jaipur was built under the patronage of Maharaja Sawai Pratap Singh. Hence, the correct option is (C).

Quick Tip to Solve: Keep Jaipur's founder Jai Singh II separate from Hawa Mahal's patron Sawai Pratap Singh; a city and a later monument need not share the same patron.

54. The textural appearance of "exposed aggregate" concrete is created by : [4 marks]

(A) Polishing the surface

(B) Adding artificial pigments

(C) Using high grade cement

(D) Using stones in the mix

Correct Answer: (D) Using stones in the mix

Solution:

Concept:

- Concrete contains cement paste and aggregates such as sand and coarse stone. Exposed-aggregate concrete deliberately displays the aggregate at its surface.
- The distinctive texture comes from visible stones and their size, shape, colour and distribution, after the superficial paste is removed or otherwise prevented from concealing them.

Step 1: Explain how the textured finish is obtained In an ordinary finished concrete surface, the cement paste can cover the aggregate. For an exposed-aggregate finish, selected aggregate is made visible at the face, commonly by washing or brushing away a controlled surface layer of paste while retaining the embedded stones. The revealed particles give the face its granular, textured appearance. Thus the material that produces the characteristic visible texture is the stone aggregate in the mix. Merely adding stones without exposing them would not by itself create the finish.

Step 2: Match the mechanism to the options Option (D), Using stones in the mix, identifies the aggregate responsible for the appearance and is the appropriate answer among the choices. Polishing primarily produces a smoother surface and is not the characteristic process asked for here, even though some polished concrete can also reveal aggregate. Artificial pigments mainly change colour rather than create the stone-particle texture. High-grade cement relates to the binder's properties; its grade does not determine whether coarse aggregate is visibly exposed. Therefore options (A), (B) and (C) do not identify the defining source of this texture.

Step 3: Conclusion The textured appearance is produced by the stones or aggregate in the mix when they are exposed at the surface. Hence, the correct option is (D).

Quick Tip to Solve: Read exposed aggregate literally: the aggregate becomes visible. Distinguish a textured stone surface from changes in colour or cement strength.

55. The term 'International style' is used to describe architecture that : [4 marks]

(A) Is derived from ancient Greek architecture

(B) Focuses on decoration and ornamentation

(C) Focuses on functionality and simple geometric forms

(D) Uses traditional building materials

Correct Answer: (C) Focuses on functionality and simple geometric forms

Solution:

Concept:

- The International Style is associated with modern architecture, simple geometric volumes, functional planning and a reduction of applied ornament.
- Its visual language often uses clean lines, regularity and modern construction materials; historical decorative styles are not its defining basis.

Step 1: Identify the defining design approach The question refers to a named architectural movement rather than any building designed outside its own country. In the International Style, the composition typically emphasizes straightforward geometric forms and spaces suited to their uses. Facades are generally expressed through clean surfaces and regular arrangements rather than elaborate historical ornament. The combination of functionality and simple geometric forms in option (C) therefore captures the intended architectural character.

Step 2: Compare each alternative Option (A) describes derivation from ancient Greek architecture, a relationship more appropriate to classical or revival traditions. Option (B) emphasizes decoration and ornamentation, which conflicts with the International Style's characteristic avoidance of unnecessary applied ornament. Option (D) makes traditional building materials the defining criterion, whereas International Style architecture is strongly associated with modern construction, including steel, reinforced concrete and glass. An individual building may use different materials, but the movement is not defined by a preference for traditional materials. The general design approach, not one incidental material, decides the answer.

Step 3: Conclusion The International Style focuses on functionality and simple geometric forms. Hence, the correct option is (C).

Quick Tip to Solve: For the International Style, group clean geometry, functional spaces and limited ornament together; do not interpret international as merely foreign.

56. Which of the following finishing materials is known for its textured surface and is commonly used in facades ? [4 marks]

(A) Glass

(B) Stucco

(C) Steel

(D) Timber

Correct Answer: (B) Stucco

Solution:

Concept:

- Stucco is a plaster or render finish applied to building surfaces, especially exterior walls, and can be worked into a variety of textures.
- A facade is a building's external face. The question asks for a material characteristically used to create a textured finish, rather than any material that could possibly be textured.

Step 1: Identify the characteristic finish Stucco is applied in a workable state to a prepared wall surface. Tools and application techniques can give it rough, stippled, swirled or other textured finishes as it sets. This makes it a familiar facade treatment where a continuous rendered surface is desired. Its association with intentionally worked surface texture fits both clues in the question: a finishing material and common use on external building faces.

Step 2: Evaluate the other materials Glass is widely used on facades, but ordinary architectural glass is typically a smooth glazing surface; special textured glass does not make it the most characteristic answer here. Steel can form structural members or facade panels, but a worked plaster-like texture is not its defining finishing quality. Timber has a natural grain and can be used as cladding, yet the standard material identified by this combination of facade rendering and applied texture is stucco. Thus options (A), (C) and (D) can appear in buildings without matching the question's characteristic description as closely as option (B).

Step 3: Conclusion Stucco is the finishing material known for a textured surface and commonly used on facades. Hence, the correct option is (B).

Quick Tip to Solve: Associate stucco with textured exterior render; distinguish an applied wall finish from glazing, metal panels and timber cladding.

57. Central Vista Redevelopment Project was designed by which architect ? [4 marks]

(A) B.V. Doshi

(B) Bimal Patel

(C) Charles Correa

(D) U.C. Jain

Correct Answer: (B) Bimal Patel

Solution:

Concept:

- An architect-identification question is answered by matching the named project with its design architect, rather than with a famous architect working in the same country.
- The Central Vista redevelopment in New Delhi is associated with Bimal Patel and his architectural practice HCP.

Step 1: Identify the project and architect Central Vista refers to the governmental precinct in New Delhi. The redevelopment project, including the new Parliament building, is associated with architect Bimal Patel. This distinguishes the contemporary redevelopment from the original imperial capital plan and its earlier architects.

Step 2: Eliminate the other names B.V. Doshi is associated with works such as the Indian Institute of Management Bangalore and Aranya housing. Charles Correa is associated with projects such as Jawahar Kala Kendra in Jaipur. U.C. Jain is a different Indian architect. None of these three is the architect credited with the named Central Vista redevelopment.

Step 3: Conclusion The architect is Bimal Patel. Hence, the correct option is (B).

Quick Tip to Solve: Keep the original New Delhi capital complex and the modern Central Vista redevelopment separate when matching architects.

58. Guggenheim Museum located in Manhattam, New York city was designed by : [4 marks]

(A) Gustave Eiffel

(B) Frank Llyod Wright

(C) John Russel Pope

(D) Tom Wright

Correct Answer: (B) Frank Llyod Wright

Solution:

Concept:

- A museum must be identified by its city as well as its name, because different Guggenheim museums have different architects.
- The Solomon R. Guggenheim Museum in Manhattan, New York, was designed by Frank Lloyd Wright.

Step 1: Use the location to identify the building The question specifies Manhattan in New York City.

This identifies Wright's Guggenheim Museum, recognised for its continuous spiral ramp around a central atrium. The spelling of the architect's name in the option refers to Frank Lloyd Wright.

Step 2: Compare the other architects Gustave Eiffel is associated with the Eiffel Tower and major metal structures, not this museum. John Russell Pope designed the West Building of the National Gallery of Art in Washington, D.C. Tom Wright is associated with the Burj Al Arab in Dubai. These project associations rule out the remaining choices; a Guggenheim museum in another city must not be substituted.

Step 3: Conclusion The Manhattan Guggenheim Museum was designed by Frank Lloyd Wright. Hence, the correct option is (B).

Quick Tip to Solve: Link New York Guggenheim to Wright and its spiral ramp; always check the city before recalling the architect.

59. Which organisation maintains the registration of Architects in India ? [4 marks]

(A) Indian Institute of Architects

(B) Council of Architecture

(C) Council of Indian Architects

(D) Institute of Architect of India

Correct Answer: (B) Council of Architecture

Solution:

Concept:

- A statutory registration body maintains the professional register; a voluntary professional association serves a different purpose.
- The Council of Architecture is the statutory body established under the Architects Act, 1972, and maintains the register of architects in India.

Step 1: Identify the function asked for The operative word is registration. The question asks which organisation maintains the official professional register, rather than which organisation represents architects, arranges professional meetings or promotes architecture. This regulatory function belongs to the Council of Architecture.

Step 2: Distinguish the alternatives The Indian Institute of Architects is a professional association and is not the body maintaining the statutory register under the Architects Act. Council of Indian Architects and Institute of Architect of India are not the name of the statutory registering council. Their similar wording must not be mistaken for the Council of Architecture.

Step 3: Conclusion The Council of Architecture maintains the registration of architects in India. Hence, the correct option is (B).

Quick Tip to Solve: For registration, remember Council of Architecture; distinguish a statutory council from a professional institute.

60. 'Fenestration' in architecture refers to : [4 marks]

(A) The layout of columns

(B) Materials used for roofing

(C) Windows and openings

(D) Construction of walls

Correct Answer: (C) Windows and openings

Solution:

Concept:

- Fenestration concerns the arrangement, design and distribution of windows and other openings in a building facade.
- Openings influence daylight, ventilation, views and the visual rhythm of an elevation; they are distinct from the structural column layout.

Step 1: Interpret the architectural term Fenestration describes how openings are placed and composed in the external envelope. A facade may have regularly spaced windows, large glazed openings or a particular pattern of window sizes. These are all aspects of fenestration, so windows and openings is the direct match.

Step 2: Separate openings from other building features The layout of columns describes the structural grid or support arrangement. Materials used for roofing concern the roof covering and construction. Construction of walls concerns their material, thickness and method of assembly. Although windows may be inserted in walls, fenestration does not mean wall construction in general. These distinctions eliminate the other three alternatives.

Step 3: Conclusion Fenestration refers to windows and openings. Hence, the correct option is (C).

Quick Tip to Solve: When a term concerns the pattern of windows across a facade, think fenestration rather than structure or roofing.

61. National Gallery of Art was designed by whom ? [4 marks]

(A) I.M. Pie

(B) Louis XII

(C) F.L. Wright

(D) Le Corbusier

Correct Answer: (A) I.M. Pie

Solution:

Concept:

- Large museum complexes may contain buildings by different architects; the building or wing must be distinguished when giving a precise attribution.
- I.M. Pei designed the East Building of the National Gallery of Art in Washington, D.C.; the original West Building was designed by John Russell Pope.

Step 1: Identify the association represented in the options Among the listed names, I.M. Pei is the

architect associated with the National Gallery of Art through its East Building. The option spells the surname as Pie, but the architect meant is Pei. The general wording of the question should not be taken to attribute every part of the museum complex to him.

Step 2: Check the alternative names Louis XII was a French monarch, not the designer of this gallery building. Frank Lloyd Wright designed the Guggenheim Museum in New York, while Le Corbusier is associated with works such as the Chandigarh Capitol Complex. Neither is the designer of the National Gallery's East Building. Thus Pei is the relevant architect among these choices.

Step 3: Conclusion For the National Gallery of Art's East Building, the architect is I.M. Pei, represented by the printed name I.M. Pie. Hence, the correct option is (A).

Quick Tip to Solve: Remember the distinction: National Gallery of Art East Building–Pei; West Building–Pope.

62. What does 'ISI' stands for ? [4 marks]

(A) International Standard of Instruments

(B) Indian Standards of Isometrics

(C) International Standards of Isometrics

(D) Indian Standards Institute

Correct Answer: (D) Indian Standards Institute

Solution:

Concept:

- The letters ISI in the familiar quality mark originate in the name of India's earlier national standards organisation.
- The historical organisation was the Indian Standards Institution. The printed option Indian Standards Institute is the intended reference to that organisation.

Step 1: Expand the letters in the standards context Here I means Indian, S means Standards and the final I refers to the standards institution. The ISI mark is associated with conformity to Indian standards, including standards for many building products; it is not a term for drawing an isometric view or for an international instrument classification.

Step 2: Compare the printed expansions International Standard of Instruments incorrectly changes the national standards body into an international instruments organisation. Both options containing Isometrics confuse a method of pictorial representation with product standardisation. The remaining choice, Indian Standards Institute, clearly identifies the intended Indian standards organisation, though its exact historical title uses Institution rather than Institute.

Step 3: Conclusion The intended answer is Indian Standards Institute as printed; the precise historical name is Indian Standards Institution. Hence, the correct option is (D).

Quick Tip to Solve: In ISI, remember Indian Standards; do not confuse product standards with isometric architectural drawings.

63. The famous 'Parthenon' is located in which city ? [4 marks]

(A) Cairo

(B) Athens

(C) Paris

(D) Rome

Correct Answer: (B) Athens

Solution:

Concept:

- The Parthenon is an ancient Greek temple on the Acropolis in Athens, dedicated to Athena.
- A monument-location question requires the city containing that monument; similar classical buildings elsewhere do not change its location.

Step 1: Identify the monument The Parthenon belongs to the ancient Athenian Acropolis. Its association with Athena and classical Greek temple architecture locates it in Athens, Greece. The question asks for its city, so Athens is the required level of geographical identification.

Step 2: Eliminate the other cities Cairo is in Egypt and is associated with a different architectural setting; it does not contain the ancient Greek Parthenon. Paris contains a building called the Pantheon, whose similar name can be misleading. Rome also has the Pantheon, an ancient Roman temple with a domed interior. Parthenon and Pantheon are different monuments, so neither Paris nor Rome answers this question.

Step 3: Conclusion The Parthenon is located in Athens. Hence, the correct option is (B).

Quick Tip to Solve: Keep Parthenon–Athens separate from Pantheon–Rome; the similar names are a common location trap.

64. 'PRASAD' scheme stands for : [4 marks]

(A) Perception and Rejuvenation And Spiritual Association Drive

(B) Pilgrimage Rejuvenation and Spiritual Augmented Drive

(C) Pilgimage Regeneration and Social Association Drive

(D) Perception and Reform Analysis in social and Demography

Correct Answer: (B) Pilgrimage Rejuvenation and Spiritual Augmented Drive

Solution:

Concept:

- The PRASAD scheme concerns pilgrimage destinations and their development as centres of spiritual tourism.
- The original expansion is Pilgrimage Rejuvenation and Spiritual Augmentation Drive. The listed phrase using Augmented is the intended near-match, although Augmentation is the correct noun.

Step 1: Match the purpose and the acronym The scheme combines pilgrimage, rejuvenation and spiritual development. These core words distinguish it from a general social survey, demographic

analysis or perception study. Reading the full expansion gives Pilgrimage Rejuvenation and Spiritual Augmentation Drive; the word and contributes the connecting A in the abbreviation.

Step 2: Assess the printed alternatives The option beginning Pilgrimage Rejuvenation is the only one that preserves the scheme's actual subject and principal wording. Perception and Rejuvenation replaces pilgrimage and adds an unrelated association. Pilgimage Regeneration and Social Association replaces rejuvenation and spiritual augmentation. Perception and Reform Analysis in social and Demography describes an unrelated activity. The printed Augmented in the remaining option should be understood as a wording error for Augmentation, not learned as the exact official expansion.

Step 3: Conclusion PRASAD expands to Pilgrimage Rejuvenation and Spiritual Augmentation Drive. Option (B) is the intended answer, with Augmentation in place of its printed Augmented.

Quick Tip to Solve: Associate PRASAD with pilgrimage and spiritual rejuvenation, and remember the noun Augmentation in its expansion.

65. Match List - I with List - II.

List - I	List - II		
(A)	B.V. Doshi, India	(I)	Pritzker Award in 2004
(B)	Philip Johnson, United States	(II)	Pritzker Award in 1995
(C)	Tadao Ando, Japan	(III)	Pritzker Award in 2018
(D)	Zaha Hadid, Iraq	(IV)	Pritzker Award in 1979

Choose the correct answer from the options given below : [4 marks]

(A) -(III), (B)-(IV), (C)-(II), (D)-(I)

(B) -(III), (B)-(II), (C)-(IV), (D)-(I)

(C) -(II), (B)-(III), (C)-(I), (D)-(IV)

(D) -(II), (B)-(I), (C)-(III), (D)-(IV)

Correct Answer: (A) -(III), (B)-(IV), (C)-(II), (D)-(I)

Solution:

Concept:

- The Pritzker Architecture Prize is an annual architecture award; each architect must be paired with the year in which that architect received it.
- In a matching question, form all four factual pairs before choosing the option. The Roman numerals identify the descriptions in List II, not their chronological positions.

Step 1: Match Doshi and Johnson Balkrishna Vithaldas Doshi received the Pritzker Architecture Prize in 2018. Consequently, List I entry (A) matches List II entry (III). Philip Johnson was the inaugural laureate in 1979, so entry (B) matches (IV). These two pairs already distinguish the correct arrangement from the alternatives, but the remaining pairs should still be checked.

Step 2: Match Ando and Hadid Tadao Ando received the prize in 1995, giving (C)-(II). Zaha Hadid received the prize in 2004, giving (D)-(I). The chronological order is therefore Johnson, Ando, Hadid and Doshi; it is different from the order in which the names appear in the question.

Step 3: Compare the complete matching The required sequence, in List I order, is (III), (IV), (II), (I). Only the first option contains that sequence. The second option interchanges Johnson and Ando. The third and fourth options incorrectly assign Doshi to 1995, and their other assignments also fail the award-year check.

Step 4: Conclusion Doshi matches 2018, Johnson 1979, Ando 1995 and Hadid 2004. Hence, the correct option is (A).

Quick Tip to Solve: Use Johnson as the 1979 anchor, then arrange Ando (1995), Hadid (2004) and Doshi (2018) chronologically before mapping the Roman numerals.

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66. Match List - I with List - II.

List - I	List - II		
(A)	Colosseum	(I)	Temple dedicated to the Goddess Athena
(B)	Parthenon	(II)	Church, Italy
(C)	Milan Cathedral	(III)	Roman goddess of freedom
(D)	Statue of Liberty	(IV)	Roman Amphitheatre

Choose the correct answer from the options given below : [4 marks]

(A) -(III), (B)-(I), (C)-(II), (D)-(IV)

(B) -(IV), (B)-(II), (C)-(III), (D)-(I)

(C) -(IV), (B)-(I), (C)-(II), (D)-(III)

(D) -(III), (B)-(IV), (C)-(I), (D)-(II)

Correct Answer: (C) -(IV), (B)-(I), (C)-(II), (D)-(III)

Solution:

Concept:

- Monuments can be matched by their original function, religious dedication or symbolic identity. Similar fame does not imply a similar architectural function.
- A complete match must use each description once: an amphitheatre, a temple, a church and a personification of liberty are distinct categories.

Step 1: Identify the ancient Roman and Greek buildings The Colosseum in Rome is an amphitheatre: its arena and surrounding tiers of seating served public spectacles. Thus (A) matches (IV). The Parthenon on the Athenian Acropolis is the temple associated with Athena, giving (B)-(I). An amphitheatre is a performance and spectator building, whereas the Parthenon has the religious identity stated in the list.

Step 2: Identify the cathedral and statue Milan Cathedral, or the Duomo of Milan, is a Christian cathedral in Italy. It therefore matches the church description, (C)-(II). The Statue of Liberty personifies liberty through the classical female figure associated with the Roman goddess Libertas; it matches (D)-(III). This is a symbolic identification, not a claim that the statue itself is a Roman-era temple.

Step 3: Reject the other sequences The correct Roman-numeral sequence is (IV), (I), (II), (III). The first option assigns the freedom-goddess description to the Colosseum. The second pairs the Parthenon

with the church description and Milan Cathedral with the goddess description. The fourth incorrectly classifies the Parthenon as an amphitheatre. Each fails at least one clear functional match.

Step 4: Conclusion Colosseum matches the amphitheatre, Parthenon the Athena temple, Milan Cathedral the church and Statue of Liberty the freedom-goddess description. Hence, the correct option is (C).

Quick Tip to Solve: First separate building types: Colosseum is an amphitheatre, Parthenon a temple and Milan Cathedral a church; the symbolic liberty description then fits the statue.

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67. Match List - I with List - II.

List - I	List - II		
(A)	Abacus	(I)	Vertical member of railing
(B)	Bollard	(II)	Top part of column
(C)	Baluster	(III)	Tapered upright structure rising from roof
(D)	Pinnacle	(IV)	Short free standing column

Choose the correct answer from the options given below : [4 marks]

(A) -(III), (B)-(I), (C)-(II), (D)-(IV)

(B) -(II), (B)-(IV), (C)-(I), (D)-(III)

(C) -(IV), (B)-(II), (C)-(III), (D)-(I)

(D) -(II), (B)-(III), (C)-(IV), (D)-(I)

Correct Answer: (B) -(II), (B)-(IV), (C)-(I), (D)-(III)

Solution:

Concept:

- Architectural vocabulary identifies elements by their location, form and function. A name must be interpreted in its building context rather than by an unrelated everyday meaning.
- An abacus belongs to a column capital, a baluster to a railing, a bollard is a short independent post, and a pinnacle is a tapering vertical architectural feature.

Step 1: Place the abacus and bollard In classical architecture, an abacus is the slab forming the uppermost part of a column capital. It is therefore associated with the top part of a column, (A)-(II). A bollard is a short upright post, often used to restrict vehicle access or mark an edge. Of the descriptions supplied, a short free standing column is its match, (B)-(IV).

Step 2: Place the baluster and pinnacle A baluster is one of the small vertical members that support a handrail; repeated balusters form a balustrade. It matches the vertical member of a railing, (C)-(I). A pinnacle is a slender, tapered upright architectural element, often rising above a roof or parapet. Thus (D) matches (III), the tapered structure rising from the roof.

Step 3: Check every option against location The required sequence is (II), (IV), (I), (III), which appears in the second option. The first wrongly makes an abacus a roof feature. The third assigns the abacus to an independent short column and the baluster to a roof feature. The fourth starts with the correct abacus pair but wrongly makes the bollard the roof feature and the pinnacle a railing member.

Step 4: Conclusion Abacus matches the column top, bollard the short free standing column, baluster the railing member and pinnacle the roof feature. Hence, the correct option is (B).

Quick Tip to Solve: Associate each word with its location: abacus at a column top, baluster below a handrail, bollard at ground level and pinnacle above the roof.

68. Match List - I with List - II.

List - I	List - II		
(A)	Matt	(I)	Silk like gloss
(B)	Satin	(II)	Highest level of gloss
(C)	Semi-gloss	(III)	More gloss than a satin finish
(D)	Glossy	(IV)	Lowest level of gloss

Choose the correct answer from the options given below : [4 marks]

(A) -(II), (B)-(I), (C)-(IV), (D)-(III)

(B) -(IV), (B)-(III), (C)-(I), (D)-(II)

(C) -(II), (B)-(I), (C)-(III), (D)-(IV)

(D) -(IV), (B)-(I), (C)-(III), (D)-(II)

Correct Answer: (D) -(IV), (B)-(I), (C)-(III), (D)-(II)

Solution:

Concept:

- Gloss describes the visible sheen produced by reflection from a finished surface. Matt, satin, semi-gloss and glossy finishes form an increasing sequence of sheen.
- The relevant order among the given finishes is matt, satin, semi-gloss, then glossy. This ranking concerns reflectivity, rather than the hue or lightness of the paint colour.

Step 1: Fix the least and most reflective finishes Matt is the least shiny finish in the list and diffuses reflected light, so it matches the lowest level of gloss: (A)-(IV). Glossy is at the opposite end, with the strongest sheen among these choices. It matches the highest level of gloss: (D)-(II). These two end points establish the direction of the ranking.

Step 2: Match the intermediate finishes Satin has a soft sheen, conventionally described as silk-like rather than strongly mirror-like. Thus (B)-(I). Semi-gloss has a more noticeable shine than satin, but is below a fully glossy finish. It therefore matches the explicitly comparative description, (C)-(III). No absolute reflectance number is needed because the question asks only for the named categories.

Step 3: Eliminate inconsistent arrangements The required sequence is (IV), (I), (III), (II). The first option makes matt the highest-gloss finish and semi-gloss the lowest. The second correctly identifies the end points but interchanges satin and semi-gloss. The third again makes matt highest and glossy lowest. Only the fourth arrangement preserves both the end points and the order of the intermediate finishes.

Step 4: Conclusion Matt has the lowest gloss, satin a silk-like sheen, semi-gloss more sheen than satin and glossy the highest gloss. Hence, the correct option is (D).

Quick Tip to Solve: Remember increasing sheen in this order: matt, satin, semi-gloss, glossy. Use the two extremes to eliminate options before checking the middle pair.

69. Given below are two statements :

Statement (I) : Human scale in architecture refers to the design dimensions that are comfortable for human interaction.

Statement (II) : Monumental scale is most suitable for intimate and cozy spaces.

In the light of the above statements, choose the most appropriate answer from the options given below : [4 marks]

(A) Both **Statement I** and **Statement II** are correct

(B) Both **Statement I** and **Statement II** are incorrect

(C) **Statement I** is correct but **Statement II** is incorrect

(D) **Statement I** is incorrect but **Statement II** is correct

Correct Answer: (C) **Statement I** is correct but **Statement II** is incorrect

Solution:

Concept:

- Architectural scale describes how the size of a space or element is perceived in relation to people and to its surroundings. It is a relationship, rather than merely a measured length.
- Human scale supports comfortable use and interaction; monumental scale deliberately creates an impression of grandeur through dimensions larger than ordinary human needs.

Step 1: Assess Statement I using the human body Doors, seats, stairs and gathering spaces are experienced through human height, reach, movement and interpersonal distance. When their dimensions allow comfortable movement and interaction, the design relates well to human scale. Statement I accurately describes this relationship and is therefore correct. Human scale does not require every element to have the same size as a person; it requires a comfortable and intelligible relationship to the user.

Step 2: Assess Statement II using the intended atmosphere Monumental scale is associated with impressiveness, ceremony, public importance or awe. Oversized halls, very high ceilings and massive elements can emphasize grandeur but do not ordinarily provide the enclosure and closeness associated with an intimate, cozy setting. Such settings are better served by dimensions closer to human scale. Therefore Statement II is incorrect.

Step 3: Choose the matching truth combination The truth values are I: correct and II: incorrect. The first option fails because it accepts Statement II; the second fails because it rejects Statement I. The fourth reverses both truth values. Only the third option states the combination established by considering both architectural scales separately.

Step 4: Conclusion Statement I is correct, while Statement II is incorrect. Hence, the correct option is (C).

Quick Tip to Solve: Link human scale with bodily comfort and interaction; link monumental scale with grandeur and awe, then judge the desired atmosphere.

70. Given below are two statements :

Statement (I) : A colour triangle is basically an arrangement of colors within a triangle, based on the additive combination of three primary colours at its corners. Where primary colours are yellow, red and blue.

Statement (II) : Secondary colours on the other hand are created when equal amounts of any two primary colours are mixed together.

In the light of the above statements, choose the most appropriate answer from the options given below : [4 marks]

(A) Both **Statement I** and **Statement II** are correct

(B) Both **Statement I** and **Statement II** are incorrect

(C) **Statement I** is correct but **Statement II** is incorrect

(D) **Statement I** is incorrect but **Statement II** is correct

Correct Answer: (D) **Statement I** is incorrect but **Statement II** is correct

Solution:

Concept:

- Additive mixing combines coloured light. Its standard primaries are red, green and blue; red and yellow and blue are the traditional artist colour primaries, not the additive-light set.
- In elementary colour theory, a secondary colour results from mixing two primary colours in equal proportions. The particular resulting colours depend on the colour model being used.

Step 1: Test the whole of Statement I A triangular arrangement can place three primary colours at its corners, but that geometrical description does not make every primary system additive. The statement explicitly combines the word additive with yellow, red and blue. In the standard additive-light model, red and green light make yellow; yellow is consequently a secondary colour there, while green is a primary. Thus the stated primary set cannot be the additive RGB set, and Statement I as worded is incorrect.

Step 2: Test Statement II in the elementary colour model The rule for secondary colours is the equal-proportion mixing of a pair of primaries. In the traditional red-yellow-blue artist model, red plus yellow gives orange, yellow plus blue gives green, and blue plus red gives violet. In additive RGB mixing, the secondary set is yellow, cyan and magenta. Although the two systems differ, the elementary pairwise construction in Statement II is correct.

Step 3: Resolve the option choice The literal statements give I: incorrect and II: correct. Both-true overlooks the wrong additive-primary set in Statement I; both-false wrongly rejects the secondary-colour rule. The combination I true and II false reverses the demonstrated evaluations. Therefore the fourth option fits the wording.

Step 4: Conclusion The supplied key selects the first option, but its acceptance of Statement I conflicts with the printed word additive: yellow is formed from red and green light and is not an RGB primary. Statement I is incorrect and Statement II correct. Hence, the correct option is (D).

Quick Tip to Solve: Before judging a colour-mixing claim, identify the medium: additive light uses RGB; the traditional artist model uses red, yellow and blue.

71. Given below are two statements :

Statement (I) : Due to sun, we have day and night, seasons, rains, winds, plants and human life.

Statement (II) : The lattitude of a place is an angle of the place with reference to the plane passing through the equator on earth.

In the light of the above statements, choose the most appropriate answer from the options given below : [4 marks]

(A) Both **Statement I** and **Statement II** are correct

(B) Both **Statement I** and **Statement II** are incorrect

(C) **Statement I** is correct but **Statement II** is incorrect

(D) **Statement I** is incorrect but **Statement II** is correct

Correct Answer: (A) Both **Statement I** and **Statement II** are correct

Solution:

Concept:

- The Sun provides Earth with light and energy. Earth rotation, axial tilt and revolution determine how that sunlight is distributed over time and place.
- Latitude is the angular position north or south of the equatorial plane. The equator has zero latitude, while the poles have latitudes of ninety degrees north or south.

Step 1: Interpret the solar effects in Statement I The illuminated side of the rotating Earth has day, while the side facing away has night. Axial tilt combined with revolution changes the seasonal distribution of solar energy. Solar heating supports evaporation and the water cycle; unequal heating contributes to pressure differences and winds. Sunlight also supplies the energy for photosynthesis, which supports plants and, directly or indirectly, human life. Thus Statement I correctly recognizes the Sun as the common energy and illumination source; it does not mean that Earth rotation or axial tilt can be omitted from the mechanisms.

Step 2: Check the latitude definition in Statement II Latitude specifies the angle of a place north or south relative to the equatorial plane. In the usual spherical-Earth construction, the angle is measured at Earth centre between the direction to the place and that plane. This distinguishes latitude from longitude, which is measured around the Earth from a reference meridian. The statement gives the correct reference plane and angular interpretation.

Step 3: Compare the truth values with the options Both statements are correct in the geographical context of the question. The both-incorrect choice rejects both valid ideas. Each mixed choice rejects one correct statement: either the latitude definition or the Sun influence. Accordingly, only the both-correct option is suitable.

Step 4: Conclusion Statements I and II are both correct. Hence, the correct option is (A).

Quick Tip to Solve: For solar effects separate the energy source from Earth motions; for latitude remember the equatorial plane, while longitude uses a reference meridian.

72. Given below are two statements :

Statement (I) : Precipitation is the collective term that indicates the prevailing humidity conditions.

Statement (II) : Precipitation is measured by rain gauges and expressed in millimetres per time unit.

In the light of the above statements, choose the most appropriate answer from the options given below : [4 marks]

(A) Both **Statement I** and **Statement II** are correct

(B) Both **Statement I** and **Statement II** are incorrect

(C) **Statement I** is correct but **Statement II** is incorrect

(D) **Statement I** is incorrect but **Statement II** is correct

Correct Answer: (D) **Statement I** is incorrect but **Statement II** is correct

Solution:

Concept:

- Humidity describes water vapour present in air. Precipitation describes water falling from the atmosphere to the surface, such as rain, snow, sleet or hail.
- A rain gauge measures the amount of rainfall as an equivalent depth over a horizontal collecting area. Accumulation is reported in millimetres for a specified interval, and rainfall rate in millimetres per unit time.

Step 1: Distinguish water vapour from falling water Statement I equates precipitation with prevailing humidity conditions. These are different meteorological quantities: humid air can exist without any precipitation, and precipitation consists of falling liquid drops or solid particles rather than water vapour. Condensation and cloud processes can precede precipitation, but the terms remain distinct. Therefore Statement I is incorrect.

Step 2: Check the instrument and unit in Statement II A rain gauge collects rainfall over a known area. Dividing the collected volume by the collection area yields a length, the equivalent rainfall depth, which is commonly expressed in millimetres. If the collection is observed over an hour or a day, one can report the amount for that interval or a rate in millimetres per hour or per day. Frozen precipitation can be converted to its liquid-water equivalent. Hence the statement correctly identifies the standard instrument and the depth-per-time reporting used for precipitation.

Step 3: Choose the literal truth combination The evaluations are I: incorrect and II: correct. Both-correct mistakenly identifies precipitation with humidity; both-incorrect wrongly rejects the gauge measurement. The option saying I correct and II incorrect reverses the meanings established above. The fourth choice is therefore supported by the definitions and dimensional check.

Step 4: Conclusion The supplied key selects the third option, but precipitation is falling water rather than humidity, and rain-gauge readings are equivalent water depths over an observation interval. Statement I is incorrect and Statement II is correct. Hence, the correct option is (D).

Quick Tip to Solve: Ask whether the water is vapour in the air or falling to the ground: the former concerns humidity; the latter is precipitation measured as depth over time.

73. Identify the temple style of India represented in the given figure : [4 marks]



(A) Nagara style

(B) Dravidian style

(C) Orissan style

(D) Vesara style

Correct Answer: (B) Dravidian style

Solution:

Concept:

- Indian temple styles can be distinguished by the form of the tower above the sanctum and by the arrangement of its successive storeys.
- A Dravidian vimana typically rises as a stepped, pyramidal series of diminishing tiers. Nagara towers generally have a curvilinear profile.

Step 1: Examine the dominant tower The temple in the photograph has a strongly tiered, pyramidal tower. Its horizontal storeys become smaller as they rise, and the surfaces are articulated with repeated architectural details. The smaller structures in the foreground also use stacked horizontal elements. These visible features point to the southern Dravidian tradition.

Step 2: Compare the remaining styles A Nagara temple is usually recognised by the curving outline of its main shikhara, rather than this clearly stepped pyramid. The Orissan or Kalinga tradition is a regional northern tradition, with a characteristic curvilinear sanctum tower; its pyramidal assembly hall alone is not a reason to classify every tiered temple as Orissan. Vesara denotes a Deccan tradition combining northern and southern features, but the photograph does not present a distinctive mixed form that would outweigh the plainly Dravidian tower.

Step 3: Conclusion The stepped pyramidal vimana identifies the temple as Dravidian style. Hence, the correct option is (B).

Quick Tip to Solve: Look first at the main sanctum tower: a sequence of diminishing horizontal tiers is a strong clue to Dravidian architecture.

74. Identify the famous building in the given picture : [4 marks]



(A) Qutub Minar

(B) Jama Masjid

(C) Taj Mahal

(D) Hagia Sophia

Correct Answer: (B) Jama Masjid

Solution:

Concept:

- A monument should be identified by its combination of visible features, such as dome arrangement, minarets, facade and building material.
- Jama Masjid in Delhi has a broad mosque facade, three domes and tall minarets at its outer sides, with prominent red sandstone and pale stone detailing.

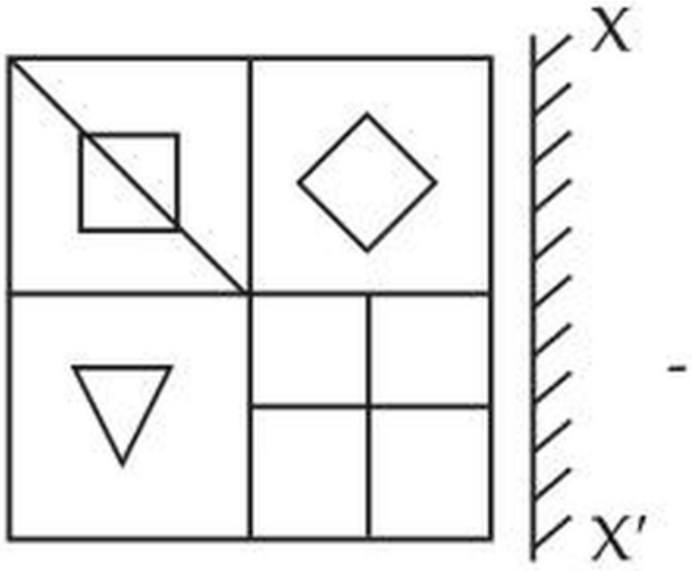
Step 1: Recognise the mosque facade The photograph shows a wide prayer-hall frontage with a large central arched entrance. Three domes rise behind it, while two tall, slender minarets flank the building. The red facade and contrasting pale stone bands, together with this arrangement of domes and minarets, identify Jama Masjid in Delhi.

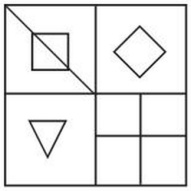
Step 2: Eliminate the other monuments Qutub Minar is a single tall, tapering tower, not a broad domed prayer hall. The Taj Mahal is a predominantly white-marble mausoleum with one dominant central bulbous dome and four detached corner minarets around its platform. Hagia Sophia is associated with a large central dome and supporting semi-domes in a very different massing; it does not have the red sandstone three-dome facade shown here. Thus the overall composition, rather than the presence of a dome alone, decides the identification.

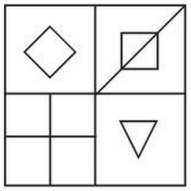
Step 3: Conclusion The building in the picture is Jama Masjid. Hence, the correct option is (B).

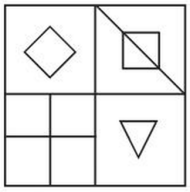
Quick Tip to Solve: For this photograph, combine all three clues: the red facade, three domes and a pair of tall flanking minarets.

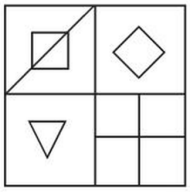
75. Identify the correct mirror image of the given figure along X-X' axis : [4 marks]

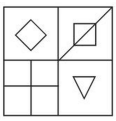


(A) 

(B) 

(C) 

(D) 

Correct Answer: (B) 

Solution:

Concept:

- Reflection in the vertical line $X - X'$ reverses left and right while preserving the height of every point.
- Every point and its reflected image are at equal perpendicular distances from the mirror line; reflection is not a rotation.

Step 1: Exchange the left and right compartments The original upper-right compartment contains a diamond, so the reflected upper-left compartment must contain that diamond. The downward-pointing triangle in the lower-left moves to the lower-right but continues to point downward. The four small squares in the lower-right move to the lower-left. These three checks require the two columns of the large square to exchange places.

Step 2: Check the diagonal and the small square The original upper-left diagonal runs from the outer upper-left corner towards the centre of the large square. After reflection it lies in the upper-right

compartment and runs from the centre towards the outer upper-right corner. The small square moves with that diagonal. Option (B) satisfies this direction as well as all three compartment checks. Option (A) repeats the original arrangement. Option (C) exchanges compartments but gives the upper-right diagonal the wrong direction. Option (D) retains the original left-right placement of the diamond, triangle and four-square grid.

Step 3: Conclusion The complete left-right reflection, including the reversed diagonal, is shown in option (B). Hence, the correct option is (B).

Quick Tip to Solve: Check one asymmetric line after moving the large shapes: the diagonal distinguishes a true reflection from a merely rearranged figure.

Planning (100 marks)

76. The main focus/goal of "Sustainable Urban Planning" is : [4 marks]

(A) Reducing the density of population

(B) Maximizing land use for development

(C) Increasing automobile dependency

(D) Reducing environmental impact and promoting green spaces

Correct Answer: (D) Reducing environmental impact and promoting green spaces

Solution:

Concept:

- Sustainable urban planning meets present urban needs while conserving resources and protecting environmental quality for future generations.
- Its measures include efficient resource use, reduced pollution, accessible public transport, and the preservation or creation of green and open spaces.

Step 1: Identify the environmental objective Reducing environmental impact addresses the pressure that buildings, transport and infrastructure place on air, water, land and energy resources. Promoting green spaces supports shade, recreation, habitat and storm-water management. These two aims directly express sustainable urban planning and therefore match option (D).

Step 2: Distinguish goals from unsuitable single measures Reducing population density is not an end in itself: poorly planned low-density expansion can increase travel distances and land consumption. Maximizing land use for development, if it means developing as much land as possible, can sacrifice ecological areas and open space; sustainable planning instead seeks appropriate and efficient use. Increasing automobile dependency raises reliance on road travel and can increase fuel use, emissions and congestion. Sustainability commonly supports walking, cycling and public transport. Consequently none of (A), (B) or (C) states the main goal as accurately as (D).

Step 3: Conclusion The main goal is reducing environmental impact and promoting green spaces. Hence, the correct option is (D).

Quick Tip to Solve: Choose an objective that balances urban development with environmental protection, rather than treating density or construction volume as an end in itself.

77. **"_____" is used to visualize and plan land use patterns in the city.** [4 marks]

(A) Building code

(B) Master plan

(C) Figure Ground Plan

(D) Site Analysis diagram

Correct Answer: (B) Master plan

Solution:

Concept:

- A master plan is a comprehensive framework for a city's future spatial development, including the distribution of major land uses and infrastructure.
- A land-use plan distinguishes activities such as housing, commerce, industry, public facilities and recreation, and relates them to transport networks.

Step 1: Match the scale and purpose The question asks for a tool used to visualize and plan land-use patterns throughout a city. A master plan provides this city-wide spatial framework. Its maps and proposals show how different uses should be arranged, where development may occur, and how facilities and movement networks support that pattern. Thus both the planning function and the city scale point to option (B).

Step 2: Separate the other tools by function A building code sets requirements governing buildings, such as safety and construction standards; it is not the comprehensive city land-use plan. A figure-ground plan depicts built masses and unbuilt spaces, helping one understand urban form, but it does not by itself allocate the full range of future land uses. A site-analysis diagram records conditions, opportunities and constraints at a particular site. It assists design decisions but is narrower in scope than a plan for the whole city. These tools can support planning without being interchangeable with a master plan.

Step 3: Conclusion A master plan is used to visualize and plan land-use patterns at the city scale. Hence, the correct option is (B).

Quick Tip to Solve: Use scale and purpose to distinguish the choices: city-wide future land-use allocation points to a master plan.

78. 'H.I.G' stands for : [4 marks]

(A) Hierarchy Income Group

(B) Housing Income Group

(C) High Income Group

(D) Homogeneous Income Group

Correct Answer: (C) High Income Group

Solution:

Concept:

- Housing programmes commonly classify households into income groups so that housing types and eligibility can be related to economic capacity.
- In the abbreviation H.I.G., the letters name the income category: H for High, I for Income and G for Group.

Step 1: Expand the abbreviation Reading each letter in its housing and planning context gives H.I.G. as High Income Group. The phrase describes the higher-income category of households; it does not name a building type or a method of arranging urban land. The question asks only for this expansion, so no numerical income threshold is needed.

Step 2: Check each competing expansion Hierarchy Income Group is not the standard expansion: although income categories can be ordered, the letter H here means High rather than Hierarchy. Housing Income Group is too general and substitutes the subject area for the specific income level. Homogeneous Income Group would mean a group with similar incomes, but similarity is not what the initial H represents in this abbreviation. The same naming pattern is visible in L.I.G. for Low Income Group and M.I.G. for Middle Income Group. This comparison confirms that the first letter identifies the income level and that option (C) supplies the correct wording.

Step 3: Conclusion H.I.G. stands for High Income Group. Hence, the correct option is (C).

Quick Tip to Solve: Remember LIG, MIG and HIG together: Low, Middle and High Income Group; the first letter changes with the income category.

79. Following are the population density of 03-different sectors of a city :

Sector-A = 150 persons/Ha.

Sector-B = 230 persons/Ha.

Sector-C = 400 persons/Ha.

Find out the 'Avg. population density' of the city. [4 marks]

(A) 226.66 persons/Ha.

(B) 260 persons/Ha.

(C) 326.66 persons/Ha.

(D) 390 persons/Ha.

Correct Answer: (B) 260 persons/Ha.

Solution:

Concept:

- The arithmetic mean of n reported values is their sum divided by n. Here the question supplies three sector-density values.
- Density has units of persons per hectare. Averaging density values retains those units; it does not turn them into a population count.

Step 1: Calculate the mean of the three reported densities Using the equally weighted average of the three sector values gives

$$\overline{D} = \frac{D_A + D_B + D_C}{3} = \frac{150 + 230 + 400}{3} = \frac{780}{3} = 260 \text{ persons/ha.}$$

All three measurements already use the same unit, so no conversion is required.

Step 2: Interpret the result and compare the options The arithmetic mean is exactly 260, which matches option (B). The other listed values, 226.66, 326.66 and 390, do not equal $780/3$. Notice the distinction between this average of reported sector densities and an area-weighted city density. If the sector areas are A_A, A_B, A_C, the latter is

$$D_{\text{city}} = \frac{150A_A + 230A_B + 400A_C}{A_A + A_B + A_C}.$$

The question gives no sector areas, so its listed answer uses the arithmetic average of the three values. This also equals the overall city density when the sectors have equal areas; one must not silently apply it to unequal areas when those areas are known.

Step 3: Conclusion The requested arithmetic mean of the three stated densities is 260 persons/ha, the interpretation represented by the choices. Hence, the correct option is (B).

Quick Tip to Solve: Average the three given rates for this question; when sector areas are provided, calculate total population divided by total area instead.

80. Document published by government for the development of a 'city' for next 20 years is called :

[4 marks]

(A) Future Plan

(B) Growth Plan

(C) Master Plan

(D) Site Plan

Correct Answer: (C) Master Plan

Solution:

Concept:

- A master plan is a long-term document that guides the spatial development of a city and coordinates its land uses, transport and public infrastructure.
- A planning horizon describes the future period for which needs and development proposals are considered; the question specifies a horizon of twenty years.

Step 1: Match the description to the recognised document A government-published document for a city's development over the next twenty years corresponds to a master plan. It sets out a broad framework for future land uses, movement networks, housing, public facilities and other urban needs. Its city-wide scope and long-term perspective distinguish it from a plan for one individual project.

Step 2: Compare the scope of the other names Future Plan and Growth Plan are broad descriptive expressions: either might describe an intention to develop, but neither is the recognised term sought by this combination of city-wide coverage and a long planning horizon. A Site Plan shows the arrangement of buildings, access, open space and other features within a particular plot or project site. It cannot by itself serve as the comprehensive development document for an entire city. Thus the twenty-year reference should be read together with the words city and development, rather than being treated as the name of a separate kind of plan.

Step 3: Conclusion The document is a Master Plan. Hence, the correct option is (C).

Quick Tip to Solve: City-wide development over a long horizon suggests a master plan; the arrangement within a particular plot suggests a site plan.

81. Given below are two statements :

Statement (I) : Agora was a part of the towns of 'Indus Valley Civilisation'.

Statement (II) : Towns of 'Indus Valley Civilisation' are laid with road network and sewer lines.

In the light of the above statements, choose the most appropriate answer from the options given below : [4 marks]

(A) Both **Statement I** and **Statement II** are true

(B) Both **Statement I** and **Statement II** are false

(C) **Statement I** is true but **Statement II** is false

(D) **Statement I** is false but **Statement II** is true

Correct Answer: (D) **Statement I** is false but **Statement II** is true

Solution:

Concept:

- An agora was the public gathering and market space of an ancient Greek town. A familiar urban feature must be associated with its own civilisation, rather than with every early planned settlement.
- Indus Valley towns are distinguished by organised streets and drainage. Their surviving layouts provide evidence of planning at both the street and neighbourhood levels.

Step 1: Evaluate Statement I The word agora belongs to ancient Greek civic life: people gathered there for trade and public activity. It is not the characteristic name for a public space in Harappan or Indus Valley towns. The presence of organised towns in both civilisations does not make their architectural terms interchangeable. Thus, Statement I is false.

Step 2: Evaluate Statement II Harappa and Mohenjo-daro provide well-known examples of planned streets and drains. Roads formed an organised network, while house drains connected to larger street drains; many drains were covered and could be inspected or cleaned. These drainage arrangements are what the statement describes as sewer lines. Hence, Statement II is true.

Step 3: Match the truth values to the options The required combination is false for I and true for II. Option (A) wrongly accepts the Greek agora as an Indus feature, option (B) wrongly denies Indus drainage planning, and option (C) reverses both conclusions. Only option (D) matches the historical evidence.

Step 4: Conclusion Statement I is false, but Statement II is true. Hence, the correct option is (D).

Quick Tip to Solve: Associate agora with ancient Greece; associate the Indus Valley with planned streets and covered drainage.

82. Given below are two statements :

Statement (I) : Without control over development and use of land and building, no planning will be successful.

Statement (II) : Development controls are statutory in nature and the planning/development authority has the power to punish the defaulters.

In the light of the above statements, choose the correct answer from the options given below :

[4 marks]

(A) Both **Statement I** and **Statement II** are true

(B) Both **Statement I** and **Statement II** are false

(C) **Statement I** is true but **Statement II** is false

(D) **Statement I** is false but **Statement II** is true

Correct Answer: (A) Both **Statement I** and **Statement II** are true

Solution:

Concept:

- Urban planning sets a proposed pattern of land use and development. Development control translates that pattern into enforceable conditions for actual construction and changes of use.
- Statutory controls derive their authority from applicable planning legislation and regulations. Their enforcement is subject to the powers and procedures that the law provides.

Step 1: Assess the need for development control A plan may allocate land for housing, industry, roads, open space and public facilities. If owners could build anywhere, change uses freely or disregard access and building requirements, those allocations could not reliably be implemented. Controls on development and the use of land and buildings are therefore essential to effective planning. Statement I is true in this planning context.

Step 2: Assess the statutory character of controls Development controls are not merely design suggestions. Permission requirements, land-use regulations and building rules operate within a statutory framework. The competent authority can take the enforcement action authorised by that framework against violations, including applicable penalties or proceedings. The exact remedy depends on the legislation, but the underlying power to enforce compliance makes Statement II true.

Step 3: Select the combination Both statements correctly describe the relationship between planning and its implementation. Option (B) denies both the need for control and its legal basis. Options (C) and (D) incorrectly reject one of these valid statements. Option (A) is the only combination that accepts both.

Step 4: Conclusion Both Statement I and Statement II are true. Hence, the correct option is (A).

Quick Tip to Solve: Distinguish the plan, which states the intended development pattern, from statutory development control, which helps enforce it.

83. Given below are two statements :

Statement (I) : The urban climate will have deviations from the regional macro climate.

Statement (II) : The manmade environment impacts the micro climate of a particular area which deviates from the macro climate of the region.

In the light of the above statements, choose the most appropriate answer from the options given below : [4 marks]

(A) Both **Statement I** and **Statement II** are true

(B) Both **Statement I** and **Statement II** are false

(C) **Statement I** is true but **Statement II** is false

(D) **Statement I** is false but **Statement II** is true

Correct Answer: (A) Both **Statement I** and **Statement II** are true

Solution:

Concept:

- Macroclimate describes climatic conditions over a large region. Microclimate describes local conditions influenced by nearby surfaces, buildings, vegetation and human activity.
- The built environment can alter heat storage, evaporation, radiation and wind movement. Thus, an urban area can have a local climate different from that of its wider region.

Step 1: Evaluate the urban-climate statement Cities replace much natural ground cover with buildings, paved roads and other hard surfaces. These materials absorb and store heat differently from soil and vegetation. Energy use and traffic can add heat, while reduced vegetation limits evaporative cooling. Consequently, urban temperatures and other local climatic conditions can deviate from the regional background. Statement I is true.

Step 2: Evaluate the role of the built environment Buildings cast shade, obstruct or channel winds, and change the exchange of radiation between surfaces and the sky. Pavement affects runoff and evaporation, while parks and water bodies can modify nearby temperature and humidity. These are direct mechanisms by which a manmade environment changes the microclimate of a particular area. Statement II is therefore true.

Step 3: Compare the offered answers Both statements are consistent with the distinction between regional and local climate. Statement II also supplies a mechanism for the deviation described in Statement I, although the options ask only whether the statements are true. Option (B) rejects both valid statements; (C) and (D) each reject one. Therefore, select (A).

Step 4: Conclusion Both Statement I and Statement II are true. Hence, the correct option is (A).

Quick Tip to Solve: For urban microclimate, check four influences: surface materials, vegetation, building geometry and heat released by human activity.

84. Name the 'Administrative Capital' of Punjab and Haryana : [4 marks]

(A) New Delhi

(B) Chandigarh

(C) Amritsar

(D) Gurugram

Correct Answer: (B) Chandigarh

Solution:

Concept:

- An administrative capital is the city in which the main institutions of a government are located. It need not be the largest commercial city or the best-known cultural centre of the state.
- Chandigarh is a Union Territory and serves as the shared capital of Punjab and Haryana. Its own territorial administration and its role for the two states are distinct facts.

Step 1: Identify the shared administrative centre The question asks for one city serving both Punjab and Haryana, rather than a separate city for each state. Chandigarh is the common capital and contains major state-government institutions, including the shared Capitol Complex. Its status as a Union Territory does not prevent it from functioning as the capital of both neighbouring states.

Step 2: Eliminate the cities with other roles New Delhi is the national capital and is not the shared state capital asked for here. Amritsar is an important city of Punjab with major religious, cultural and commercial significance, but it is not the administrative capital of Punjab and Haryana. Gurugram is a major business and urban centre in Haryana, but commercial prominence is different from capital status.

Step 3: Match the identified city to its label The only option naming the shared administrative capital is Chandigarh, listed under (B). The question concerns a governmental function, so population size, economic importance and the fame of a city are not the deciding criteria. Recognising Chandigarh as both a Union Territory and a shared capital resolves the possible confusion.

Step 4: Conclusion Chandigarh is the administrative capital shared by Punjab and Haryana. Hence, the correct option is (B).

Quick Tip to Solve: When a capital question names Punjab and Haryana together, recall Chandigarh; do not substitute either state's prominent commercial or cultural city.

85. The "green belt" in urban planning is _____. [4 marks]

(A) An area of urban sprawl

(B) A highway running through the city

(C) An area of protected green space to prevent urban sprawl

(D) A zone of industrial development

Correct Answer: (C) An area of protected green space to prevent urban sprawl

Solution:

Concept:

- A green belt is a protected area of predominantly open or green land around or between urban areas. Its planning role includes restraining outward urban spread and retaining open countryside.
- Urban sprawl is the extensive, often dispersed outward expansion of built development. A green belt is a measure used to contain such expansion, rather than another name for it.

Step 1: Identify the purpose of the green belt The important words are green and belt: a band or zone of open land is protected from unrestricted urban development. It can help prevent neighbouring settlements from merging and maintain a clear distinction between built-up areas and their surrounding countryside. Protection of this land also supports open-space and environmental functions.

Step 2: Compare each proposed definition Option (A), an area of urban sprawl, describes the expansion that the green belt is intended to restrain. Option (B) describes transport infrastructure; even a landscaped highway is not by that fact a green belt. Option (D) allocates land for industrial building, which is a development use rather than the defining open-space purpose. Option (C) directly combines protected green space with prevention of sprawl.

Step 3: Select the planning definition Choose the option based on the land-use function of the zone. A green belt need not be an ornamental garden or a continuous wall of trees: the essential feature is protected open or green land serving growth-management objectives. Thus, the third option provides the relevant general definition without confusing it with a road or an industrial district.

Step 4: Conclusion A green belt is an area of protected green space used to prevent urban sprawl. Hence, the correct option is (C).

Quick Tip to Solve: Link a green belt to containment of outward growth: it protects open land instead of designating land for further urban construction.

86. Name the person responsible for 'Green Revolution' in India : [4 marks]

(A) Lal Bahadur Shastri

(B) A.P.J. Abdul Kalam

(C) M.S. Swaminathan

(D) Subramaniyam Swamy

Correct Answer: (C) M.S. Swaminathan

Solution:

Concept:

- The Green Revolution refers to the major increase in agricultural productivity associated with improved crop varieties and supporting inputs such as irrigation, fertilisers and improved farming practices.
- M. S. Swaminathan is recognised as the father of the Green Revolution in India. The question seeks this leading scientific association, not every political or institutional contributor.

Step 1: Recall the Indian scientific association M. S. Swaminathan was an agricultural scientist closely associated with adapting and promoting high-yielding crop technology for Indian conditions. The resulting agricultural transformation involved research, farmers, public policy and infrastructure, but his name is the standard answer when the Indian Green Revolution is matched with a person.

Step 2: Distinguish the other named individuals Lal Bahadur Shastri emphasised the importance of farmers and national food production, but he is not the scientist conventionally identified as the father of India's Green Revolution. A. P. J. Abdul Kalam is associated primarily with aerospace and missile development and later served as President of India. Subramaniyam Swamy is associated with economics and public life, rather than leadership of this agricultural research movement.

Step 3: Choose the correct scope of the answer The phrase in India is decisive: it asks for the Indian figure associated with the agricultural transformation. It does not ask who invented every technology or imply that a national change was the work of only one person. Among the given names, M. S. Swaminathan is the appropriate match and is listed as option (C).

Step 4: Conclusion M. S. Swaminathan is the person associated with the Green Revolution in India. Hence, the correct option is (C).

Quick Tip to Solve: Remember the pairing: M. S. Swaminathan and India's Green Revolution; do not confuse agricultural science with aerospace achievements.

87. Who stated "Man needs his difficulties because they are necessary to enjoy success." [4 marks]

(A) Swami Vivekananda

(B) Mother Teresa

(C) A.P.J. Abdul kalam

(D) Mahatma Gandhi

Correct Answer: (C) A.P.J. Abdul kalam

Solution:

Concept:

- Quotation-identification questions require matching the particular wording to the person with whom it is associated. A broadly similar philosophy is not enough to assign a quotation to someone else.
- The statement about needing difficulties in order to enjoy success is associated with A. P. J. Abdul Kalam. It expresses the motivational theme of learning through challenge and perseverance.

Step 1: Recognise the quoted wording The clue is the complete contrast between difficulties and the enjoyment of success. This familiar motivational statement is attributed to A. P. J. Abdul Kalam. The task is to identify that attribution; it does not ask for an interpretation of a scientific theory or for the date of a speech.

Step 2: Separate meaning from attribution The sentence suggests that overcoming obstacles helps a person appreciate achievement. Several public figures have spoken about courage, service or perseverance, so the general moral alone cannot establish authorship. Swami Vivekananda's emphasis on strength, Mother Teresa's association with service and Mahatma Gandhi's emphasis on moral action do not make any of them the match for this particular wording.

Step 3: Match the name to the listed choice A. P. J. Abdul Kalam appears in option (C). Options (A), (B) and (D) name other influential personalities but do not match the conventional attribution of the quoted sentence. No additional quotation, occasion or publication needs to be invented to answer this identification question: the required result is the name corresponding to the supplied words.

Step 4: Conclusion The quotation is associated with A. P. J. Abdul Kalam. Hence, the correct option is (C).

Quick Tip to Solve: In quotation MCQs, recognise the distinctive wording first; a shared theme such as courage or perseverance does not establish the speaker.

88. Match the correct term for 'Sthapati' : [4 marks]

(A) Geographer

(B) Engineer

(C) Doctor

(D) Planner

Correct Answer: (D) Planner

Solution:

Concept:

- In traditional Indian architecture, a sthapati is a master designer or architect-builder who directs the conception and organisation of a built work. The role includes deciding layout, proportions and spatial arrangement.
- The options give broad modern occupational labels rather than the exact term architect. The appropriate match must therefore be selected from the functions represented by the available choices.

Step 1: Identify the traditional role Sthapati refers to the leading designer or master architect in the traditional building process. This person conceives the arrangement of the work and guides its execution, rather than simply describing a place or treating a patient. Planning and coordinating the layout are central to this role.

Step 2: Compare the available professional terms A geographer studies places and spatial relationships, so option (A) does not identify the master designer of a built work. A doctor treats health conditions, making option (C) unrelated. Engineering involves technical design and construction and therefore has some overlap with building practice, but option (B) does not express the intended planning and spatial-design association as directly as the offered term planner.

Step 3: Choose the closest offered correspondence The precise historical term is broader than any single modern professional label: architect or master builder would be a more direct translation if offered. Within this question's set of choices, planner is the intended counterpart, because it captures the conception, organisation and direction of the built layout. Thus, select option (D), without interpreting the historical role as identical to every duty of a modern town-planning professional.

Step 4: Conclusion Among the given terms, Sthapati corresponds most appropriately to Planner. Hence, the correct option is (D).

Quick Tip to Solve: Recall Sthapati as the master architect or designer; when that exact term is absent, match the planning and layout function among the choices.

89. Identify the full form of 'WHO' : [4 marks]

(A) World Health Organisation

(B) World Health Opinion

(C) World Human Organisation

(D) World Human Orientation

Correct Answer: (A) World Health Organisation

Solution:

Concept:

- An abbreviation is expanded by identifying the established name of the institution, not by choosing any words that happen to share its initials.
- WHO is the United Nations specialised agency concerned with international public health. Its three initials represent World, Health and Organization; Organisation is the alternative spelling used in this question.

Step 1: Expand each initial The first letter W stands for World, indicating the international scope of the institution. The second letter H stands for Health, identifying its field of work. The final letter O stands for Organisation, identifying it as an institution. Thus the expansion reads World Health Organisation in the spelling of option (A).

Step 2: Check the competing expansions World Health Opinion in option (B) replaces the institutional word Organisation with Opinion; it does not name the agency. World Human Organisation in option (C) incorrectly replaces Health with Human. World Human Orientation in option (D) changes both the second and third words. Although each phrase yields the letters WHO, only option (A) is the recognised expansion. The health function is the decisive clue, and the word Organisation distinguishes the correct answer from the closest distractor, option (B).

Step 3: Conclusion WHO stands for World Health Organisation. Hence, the correct option is (A).

Quick Tip to Solve: For organisation abbreviations, verify both the subject word and the institutional word: here Health and Organisation, not merely the initials.

90. A person starts moving from point 'A' towards 'East' direction for 100 meters. Then he moves in 'South' direction for 50 meters. Again he changes the direction and moves 100 meters towards 'West' direction. At last he moves 50 meters further in 'North' direction. Identify the 2D shape he has formed after finishing this journey : [4 marks]

(A) A triangle

(B) A square

(C) A rectangle

(D) A circle

Correct Answer: (C) A rectangle

Solution:

Concept:

- Opposite cardinal directions are parallel, while an east-west direction is perpendicular to a north-south direction.
- A rectangle is a closed quadrilateral with four right angles. A square additionally requires all four sides to be equal.

Step 1: Trace the four displacements Take the starting point as $A = (0, 0)$, with east as positive x and north as positive y. Moving 100 metres east gives $B = (100, 0)$. Moving 50 metres south gives $C = (100, -50)$. Moving 100 metres west gives $D = (0, -50)$. Finally, moving 50 metres north returns to $A = (0, 0)$. The horizontal and vertical displacements each cancel, so the path is closed.

Step 2: Classify the closed path The consecutive side lengths are $100, 50, 100, 50$ metres. Every change of direction makes a right angle, and the opposite sides have equal lengths and are parallel. These properties identify a rectangle of length 100 metres and breadth 50 metres. Option (A) is excluded because the path has four sides, not three. Option (B) is excluded because adjacent sides are unequal: $100 \neq 50$. Option (D) is excluded because the journey follows four straight segments with corners, not a continuous circular curve. The zero final displacement does not mean that no shape was traced; it means that the boundary closes.

Step 3: Conclusion The journey traces a rectangle measuring 100 metres by 50 metres. Hence, the correct option is (C).

Quick Tip to Solve: Write the successive coordinates: returning to the origin proves closure, while the lengths and turning angles distinguish a rectangle from a square.

91. **Match List - I with List - II.**

List - I	List - II		
(A)	Radial City	(I)	Chandigarh
(B)	Linear City	(II)	Kolkata
(C)	Organic City	(III)	New Delhi
(D)	Grid Iron Pattern City	(IV)	Varanasi

Choose the correct answer from the options given below : [4 marks]

(A) -(I), (B)-(III), (C)-(IV), (D)-(II)

(B) -(III), (B)-(II), (C)-(IV), (D)-(I)

(C) -(II), (B)-(IV), (C)-(III), (D)-(I)

(D) -(IV), (B)-(III), (C)-(I), (D)-(II)

Correct Answer: (B) -(III), (B)-(II), (C)-(IV), (D)-(I)

Solution:

Concept:

- An urban pattern describes the arrangement of roads and built-up areas; the characteristic planned or historical form determines the match.
- Radial layouts spread around major centres, linear layouts follow an elongated corridor, organic layouts develop incrementally, and gridiron layouts use an organised rectangular network.

Step 1: Match the planned patterns New Delhi is associated with radial avenues and major focal points in its planned layout, so Radial City matches (III). Chandigarh is the example of an ordered gridiron and sector-based plan, so Grid Iron Pattern City matches (I). These two distinctive planned examples establish (A)-(III) and (D)-(I). The pattern labels refer to characteristic urban form; they do not imply that every street in the present metropolitan area has the same geometry.

Step 2: Match the remaining cities Kolkata developed predominantly along the Hooghly river corridor, making it the linear-city example among the choices: (B)-(II). The older urban fabric of Varanasi is associated with incremental, organic development and irregular lanes, giving (C)-(IV). In List-I order, the complete sequence is therefore III, II, IV, I. This is the sequence in option (B). Option (A) wrongly assigns the radial pattern to Chandigarh; option (C) wrongly assigns the organic pattern to New Delhi; option (D) wrongly assigns the gridiron pattern to Kolkata. Each therefore fails at least one defining association.

Step 3: Conclusion The matches in List-I order are III, II, IV, I. Hence, the correct option is (B).

Quick Tip to Solve: Anchor the two distinctive planned cities first: New Delhi is radial and Chandigarh is gridiron; then fit Kolkata and Varanasi to the remaining patterns.

92. Match List - I with List - II.

List - I(States)	List - II(Reserve forest)		
(A)	Kerala	(I)	Kaziranga
(B)	Assam	(II)	Pench
(C)	Rajasthan	(III)	Periyar
(D)	Madhya Pradesh	(IV)	RanthamBor

Choose the correct answer from the options given below : [4 marks]

(A) -(II), (B)-(III), (C)-(I), (D)-(IV)

(B) -(III), (B)-(I), (C)-(IV), (D)-(II)

(C) -(I), (B)-(II), (C)-(III), (D)-(IV)

(D) -(IV), (B)-(II), (C)-(I), (D)-(III)

Correct Answer: (B) -(III), (B)-(I), (C)-(IV), (D)-(II)

Solution:

Concept:

- This matching exercise tests the geographical location of the named protected areas rather than the order in which the two lists are printed.
- Complete the state-to-place pairing first, then translate each place into its Roman numeral in List-II. A proposed option must satisfy all four pairs.

Step 1: Locate Periyar and Kaziranga Periyar is in Kerala, giving (A)-(III). Kaziranga is in Assam, giving (B)-(I). These well-known locations already select the sequence beginning III, I. The places printed on the same horizontal row in the question are not automatically partners: the point of a matching table is to rearrange the second list according to geographical knowledge.

Step 2: Complete and verify the mapping Ranthambore, written RanthamBor in the list, is in Rajasthan, giving (C)-(IV). Pench is the Madhya Pradesh association in this list, giving (D)-(II); the wider Pench landscape also extends into Maharashtra, which is not a listed choice. The complete sequence is III, I, IV, II, matching option (B). Option (A) incorrectly associates Kerala with Pench and Assam with Periyar. Option (C) incorrectly puts Kaziranga with Kerala. Option (D) incorrectly pairs Kerala with Ranthambore and assigns Periyar to Madhya Pradesh. Thus the alternatives fail the location check, while every pair in option (B) fits.

Step 3: Conclusion The correct matches are Kerala-Periyar, Assam-Kaziranga, Rajasthan-Ranthambore and Madhya Pradesh-Pench. Hence, the correct option is (B).

Quick Tip to Solve: Use Kerala-Periyar and Assam-Kaziranga as location anchors, then check both remaining state pairs before selecting the code.

93. **Match List - I with List - II.**

List - I	List - II		
(A)	Jordan	(I)	Burj-Al-Arab
(B)	Cairo	(II)	Hanging Gardens
(C)	Babylon	(III)	Pyramids
(D)	UAE	(IV)	Dead Sea

Choose the correct answer from the options given below : [4 marks]

(A) -(III), (B)-(I), (C)-(II), (D)-(IV)

(B) -(IV), (B)-(III), (C)-(I), (D)-(II)

(C) -(IV), (B)-(III), (C)-(II), (D)-(I)

(D) -(II), (B)-(IV), (C)-(I), (D)-(III)

Correct Answer: (C) -(IV), (B)-(III), (C)-(II), (D)-(I)

Solution:

Concept:

- Match each named place with the geographical feature or landmark conventionally associated with it; a matching option is correct only when all its pairs agree.
- The list includes both natural and built features. The Dead Sea is a natural water body, while the pyramids, Hanging Gardens and Burj-Al-Arab are landmark associations.

Step 1: Identify the geographical and ancient associations Jordan borders the Dead Sea, so Jordan matches (IV). The pyramids of Giza are in the Cairo metropolitan region of Egypt, giving Cairo-(III). Babylon is traditionally associated with the Hanging Gardens, one of the ancient wonders, giving Babylon-(II). The question asks for this conventional historical association; it does not require treating the debated archaeological location of the gardens as a different listed answer.

Step 2: Complete the modern landmark pair and test the codes Burj-Al-Arab is the well-known hotel in Dubai in the United Arab Emirates, so UAE matches (I). The full sequence for (A), (B), (C), (D) is consequently IV, III, II, I. Option (C) has exactly this sequence. Option (A) incorrectly pairs Jordan with the pyramids and Cairo with Burj-Al-Arab. Option (B) gets Jordan and Cairo right but exchanges the Babylon and UAE associations, placing Burj-Al-Arab with Babylon. Option (D) incorrectly links Jordan to the Hanging Gardens and Cairo to the Dead Sea. Checking the last two pairs is essential because options (B) and (C) begin identically.

Step 3: Conclusion The matches in List-I order are IV, III, II, I. Hence, the correct option is (C).

Quick Tip to Solve: When two codes share their first pairs, test the distinctive modern landmark: Burj-Al-Arab belongs to Dubai in the UAE, not to Babylon.

94. Match List - I with List - II.

List - I	List - II		
(A)	Housing area	(I)	Ecological zone
(B)	Shopping mall/area	(II)	Industrial zone
(C)	Urban forest	(III)	Residential zone
(D)	Factory/workshop	(IV)	Commercial zone

Choose the correct answer from the options given below : [4 marks]

(A) -(IV), (B)-(III), (C)-(II), (D)-(I)

(B) -(II), (B)-(I), (C)-(IV), (D)-(III)

(C) -(I), (B)-(II), (C)-(III), (D)-(IV)

(D) -(III), (B)-(IV), (C)-(I), (D)-(II)

Correct Answer: (D) -(III), (B)-(IV), (C)-(I), (D)-(II)

Solution:

Concept:

- Land-use zones group areas by their primary function. The activity carried out on the land determines its category.
- Residential zones accommodate housing, commercial zones support trade and services, industrial zones accommodate production, and ecological zones protect environmental functions.

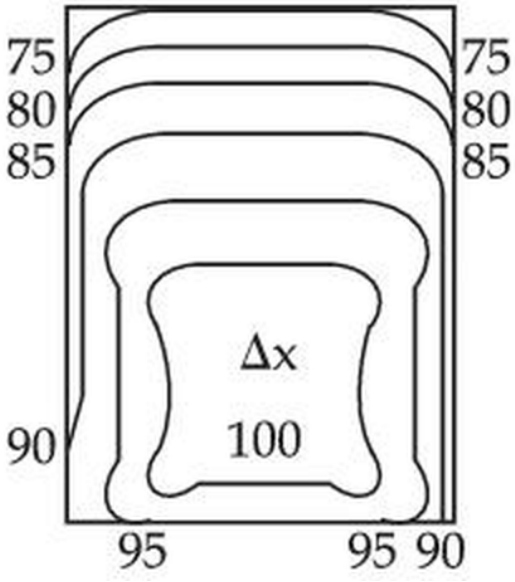
Step 1: Classify housing and shopping A housing area is used primarily for dwelling, so it belongs to the Residential zone, giving (A)-(III). A shopping mall or shopping area is used for the sale of goods and associated services, so it belongs to the Commercial zone, giving (B)-(IV). The size of the buildings is not the deciding factor: a large housing complex remains residential, whereas a mall remains commercial because of its principal use.

Step 2: Classify green space and production An urban forest serves ecological functions such as habitat, environmental protection and green cover, so it matches the Ecological zone: (C)-(I). A factory or workshop is associated with manufacturing, processing or production activities, so it matches the Industrial zone: (D)-(II). The complete code is III, IV, I, II, which is option (D). Option (A) incorrectly treats housing as commercial and urban forest as industrial. Option (B) wrongly treats housing as industrial and shopping as ecological. Option (C) incorrectly assigns housing to the ecological category and the factory to the commercial category. Only option (D) preserves all four primary land uses.

Step 3: Conclusion The correct sequence in List-I order is III, IV, I, II. Hence, the correct option is (D).

Quick Tip to Solve: Ask what the land is mainly used for: living, buying and selling, environmental protection, or production. Then match the corresponding zone.

95. In the given diagram the 'Δx' is located in a _____. [4 marks]



(A) Plain land

(B) Ridge

(C) River Valley

(D) Steep slope

Correct Answer: (A) Plain land

Solution:

Concept:

- Contours join locations of equal elevation. Closely spaced contours indicate a steeper slope, whereas a broad area without closely packed contours represents gentler or relatively level ground.
- The terrain at the marked point must be distinguished from the slopes surrounding it. Absolute elevation alone does not determine whether the local ground is flat or steep.

Step 1: Locate the mark within the contours The mark denoted by the triangle and x lies well inside the innermost contour in the broad central area associated with the elevation 100. The surrounding contours carry lower elevations, including 95, 90, 85, 80 and 75. Thus the central location is elevated relative to its surroundings, but it is not on the closely spaced contour belt at the outer edges. The question concerns the type of ground at the marked location, not the gradient of the outer boundary.

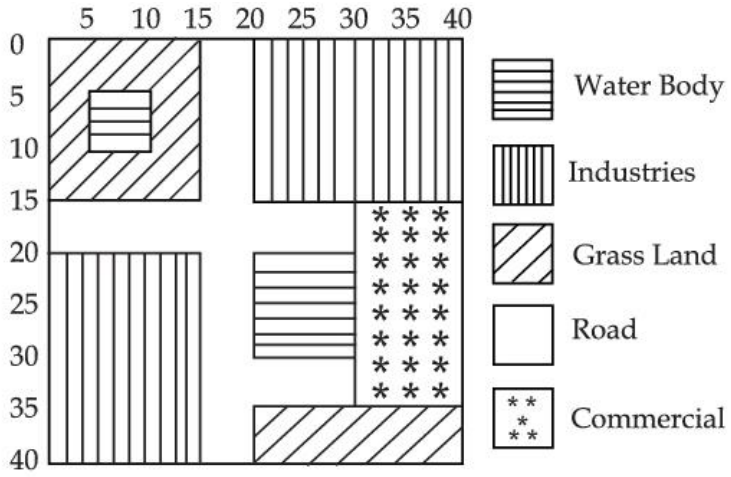
Step 2: Compare the four terrain descriptions Among the supplied choices, Plain land best describes the relatively level central area containing the mark. A steep slope would be indicated by tightly packed contours at that location, which is not the case. A river valley would have lower ground along a drainage line and characteristic contour bends pointing upstream; the central values here increase inward instead. A ridge describes an elongated crest with falling ground on either side, whereas the mark is placed in a broad enclosed interior rather than on a narrow crest. The higher central elevation does not rule out locally plain ground; levelness and height above the surroundings are different properties.

Step 3: Conclusion The mark is in the relatively level central area, so the appropriate choice is Plain

land. Hence, the correct option is (A).

Quick Tip to Solve: Inspect contour spacing immediately around the marked point; do not call a high central area steep merely because lower contours surround it.

96. What is the percentage area covered by water bodies in the given plan ? [4 marks]



(A) 7.81%

(B) 7.25%

(C) 5.10%

(D) 9.15%

Correct Answer: (A) 7.81%

Solution:

Concept:

- The legend identifies water bodies by horizontal hatching. Only regions with that pattern contribute to the required water area.
- The percentage is $100 \times A_{\text{water}}/A_{\text{total}}$. For a rectangle, area equals length multiplied by breadth; common scale factors cancel in the ratio.

Step 1: Read the dimensions and identify both water regions The full plan spans 40 units horizontally and 40 units vertically, so its total area is $40 \times 40 = 1600$ square units. There are two horizontally hatched water regions. The small upper-left region has width 5 units and height 5 units, giving $5 \times 5 = 25$ square units. The central region extends from 20 to 30 on both coordinate scales, giving width 10 units, height 10 units and area $10 \times 10 = 100$ square units. The water-body sample drawn in the legend is outside the plan and must not be counted.

Step 2: Add the water areas and calculate the percentage The total water area is

$$A_{\text{water}} = 25 + 100 = 125.$$

Hence

$$\text{Water percentage} = \frac{125}{1600} \times 100 = 7.8125\%.$$

Rounded to two decimal places, this is 7.81%, agreeing with option (A). The percentages in options (B), (C) and (D) do not result from the two water rectangles divided by the whole 40-by-40 plan. Vertical hatching represents industries, diagonal hatching represents grass land, and stars represent commercial land; none of those areas belongs in the water numerator.

Step 3: Conclusion The water bodies cover 7.81% of the plan. Hence, the correct option is (A).

Quick Tip to Solve: Use the legend before measuring, add every region with the water pattern, and divide by the entire plan area, including roads.

97. What is the full form of 'D.R.D.O.' ? [4 marks]

(A) Defence Redevelopment Design Office

(B) Defence Research & Development Organisation

(C) Development of Research of Defence Objects

(D) Defence Research Design Organisation

Correct Answer: (B) Defence Research & Development Organisation

Solution:

Concept:

- An institutional abbreviation is expanded using the exact official words represented by its letters, not simply a phrase that sounds relevant to its work.
- DRDO is India's Defence Research and Development Organisation. Its name combines the purpose, defence, with the linked activities of research and development.

Step 1: Expand the four letters Read D as Defence, R as Research, the second D as Development, and O as Organisation. The conjunction "and" connects Research and Development but does not contribute another letter to the abbreviation. Thus the complete expansion is Defence Research and Development Organisation. The ampersand in option (B) is simply another way of writing "and", so it does not change the name.

Step 2: Check the alternatives against the name Option (A) substitutes Redevelopment and Design for Research and Development and ends with Office instead of Organisation. It therefore does not give the institution's name. Option (C) incorrectly begins with Development, rearranges the words and uses Objects as its final word. Option (D) retains Defence, Research and Organisation, making it a tempting distractor, but its third word is Design. The third word must be Development. Although design can be part of developing defence technology, that activity does not replace the word in the organisation's official name. Only option (B) reproduces all the required words in their correct order.

Step 3: Conclusion D.R.D.O. stands for **Defence Research and Development Organisation**. Hence, the correct option is (B).

Quick Tip to Solve: Remember DRDO as "Defence + Research and Development + Organisation"; the second D means Development, not Design.

98. Which of the following cities started as a port during the colonial period and is presently the financial capital of India ? [4 marks]

(A) Kolkata

(B) Chennai

(C) Mumbai

(D) Goa

Correct Answer: (C) Mumbai

Solution:

Concept:

- A city may be identified by combining its historical development with its dominant modern function. Each clue must refer to the same place.
- Mumbai, formerly Bombay, developed as a major colonial port and is widely known as India's financial capital because of its concentration of banking, securities markets and corporate activity.

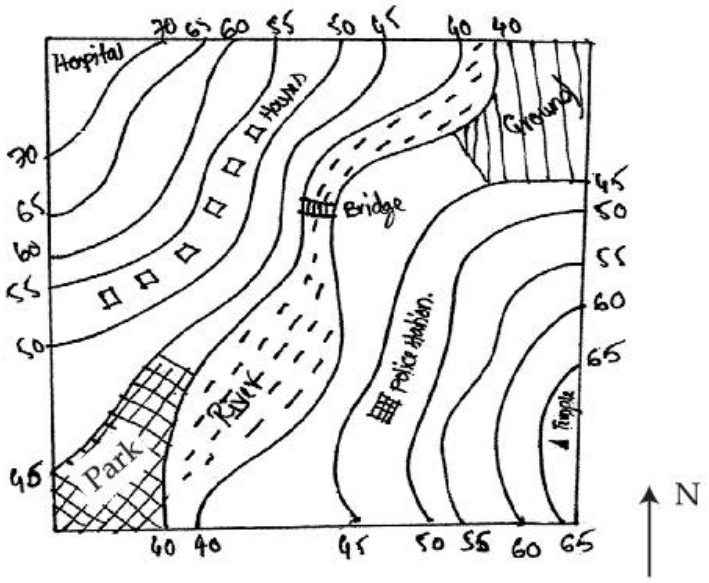
Step 1: Combine the historical and functional clues The port clue points to a coastal settlement whose growth was closely linked to maritime trade during colonial rule. Mumbai's sheltered harbour and trading connections helped it develop into a major commercial city. The decisive second clue is "financial capital of India". This description identifies Mumbai, which is associated with major financial institutions, the Reserve Bank of India's central office and the country's leading stock exchanges. The question describes the city's development as a colonial port; it does not require the claim that no settlement existed there before colonial rule.

Step 2: Eliminate places that do not meet both clues Kolkata is also an important colonial port and was a centre of British administration and commerce, but it is not the city conventionally identified as India's financial capital. Chennai likewise grew as a colonial coastal trading centre, so the port clue alone cannot distinguish it from other choices. However, Chennai does not satisfy the financial-capital clue. Goa has a long history of Portuguese colonial rule and maritime trade, but the option names a state and it does not meet the financial-capital description. Mumbai alone combines the historical port association with the modern financial role specified in the question.

Step 3: Conclusion The city is **Mumbai**, formerly Bombay. Hence, the correct option is (C).

Quick Tip to Solve: When several options were colonial ports, use the second clue: "financial capital of India" identifies Mumbai.

99. In the given diagram hospital was planned to be built on the contour level 65 and the ground was proposed at the contour level 45, houses were planned on the eastern part of the river on the contour level 40, where the existing ground is located. If a person plans to travel from ground to temple and return to the house, what is the level of the existing park ? [4 marks]



(A) 40-45

(B) 50-55

(C) 65-70

(D) 45-50

Correct Answer: (A) 40-45

Solution:

Concept:

- A contour line joins points at the same elevation. A place between two neighbouring contours lies within the elevation range given by those two lines.
- The map's labelled contour values change in steps of 5. Read the lines enclosing the requested feature rather than using the proposed level of a different facility.

Step 1: Locate the existing park and its bounding contours The park is the hatched area in the lower-left part of the map, on the western side of the river. Follow its outer, uphill boundary to the contour labelled 45 at the left edge. Follow the boundary nearer the river to the line labelled 40 at the bottom edge. The park therefore occupies the strip between the 40 and 45 contours. No interior contour marked 50, 55, 65 or 70 passes through this park. The map determines a range of levels, not a single exact elevation for every point of the park.

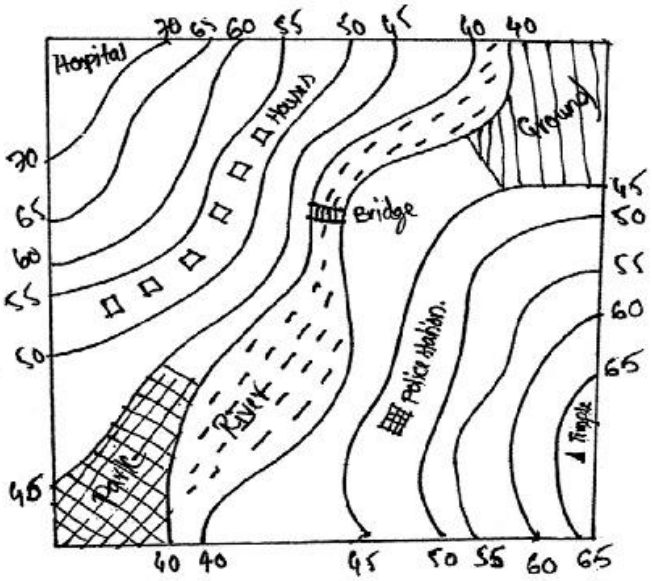
Step 2: Separate the existing feature from the proposed changes The stem discusses a hospital proposed at level 65, a ground proposed at level 45 and houses planned on the eastern side near level 40. These proposals and the person's journey do not change the contour labels enclosing the existing park. Read that park directly from its position in the diagram. Option (A), 40–45, matches its two bounding contours. Option (B), 50–55, would require the park to lie farther uphill between different

lines. Option (C), 65–70, corresponds to much higher terrain near the upper-left part of the map. Option (D), 45–50, selects the neighbouring uphill band instead of the park's river-side band.

Step 3: Conclusion The existing park lies in the contour-level range 40–45. Hence, the correct option is (A).

Quick Tip to Solve: Trace both boundaries of the named feature to their printed contour labels; proposed uses and journey descriptions do not alter those elevations.

100. In the given diagram if a person has to travel from hospital to ground crossing the bridge how many contour intervals have to be crossed ? [4 marks]



(A) 7

(B) 8

(C) 9

(D) 6

Correct Answer: (B) 8

Solution:

Concept:

- A route across a contour map must be followed through every rise and fall. A contour of the same elevation can be crossed more than once on opposite sides of a valley.
- Adjacent labelled contours differ by 5. Here the question's count concerns the successive contour crossings along the hospital–bridge–ground route, not the numerical value of that constant vertical interval.

Step 1: Follow the descent from the hospital to the bridge Locate the hospital at the upper-left of the map and the bridge across the river near its centre. Moving from the hospital down the western slope towards this bridge crosses the contours labelled 70, 65, 60, 55, 50, 45 and 40, in that order.

This gives seven crossings before reaching the river crossing. Count the contour marked 70 as well: the hospital is drawn on its higher side. The river bank and the outline of the map are not additional contours.

Step 2: Continue across the bridge to the ground After crossing the bridge, the route rises on the eastern bank to the ground at the upper-right. That ground lies between the eastern 40 and 45 contours, so the route crosses the eastern 40 contour once more but does not need to cross the 45 contour. The complete count is therefore

$$7 + 1 = 8.$$

Option (A), seven, omits the additional crossing on the eastern side. Option (C), nine, would add an unnecessary crossing of the 45 contour beyond the ground's band. Option (D), six, misses part of the descent. Taking only the difference between starting and ending elevations would also miss the descent to the river followed by the climb on the opposite bank.

Step 3: Conclusion The hospital–bridge–ground route crosses 8 contour lines: seven on the western descent and the eastern 40 contour on the climb to the ground. The supplied answer key selects seven, but that omits the eastern crossing visible in the diagram. Hence, the correct option is (B).

Quick Tip to Solve: Count both sides of a river valley separately: crossing the same contour value again on the opposite slope adds another crossing.