JEE Main 2025 Paper 2B (B.Planning) Apr 9 Single sitting 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 2 (April), conducted by the National Testing Agency (NTA) in Computer Based Test (CBT) mode on 9 April 2025, Shift 1. 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 R be a relation on the set $A = \{1, 2, 3, 4, \ldots, 10\}$ given by xRy if and only if x divides y. Let m be the number of elements in R and n be the number of minimum elements required to be added in R to make it a symmetric relation. Then $m + n$ is equal to [4 marks]

(A) 16

(B) 32

(C) 36

(D) 44

Correct Answer: (D) 44

Solution:

Concept:

- A relation is a set of ordered pairs. For a fixed first coordinate x, the permitted second coordinates are precisely its multiples in A. Thus there are $\lfloor 10/x \rfloor$ pairs starting with x.
- Symmetry requires (y, x) whenever (x, y) belongs to the relation. For positive integers, mutual divisibility forces equality, so only the diagonal pairs already have their reverses present.

Step 1: Count the original ordered pairs List the numbers of multiples for $x = 1, 2, \ldots, 10$, keeping the order of the coordinates significant:

$$m = 10 + 5 + 3 + 2 + 2 + 1 + 1 + 1 + 1 + 1 = 27.$$

For example, $(2, 4)$ is included because 2 divides 4, whereas $(4, 2)$ is absent. Every (x, x) is included, giving exactly ten diagonal pairs.

Step 2: Add precisely the missing reverse pairs If $x \neq y$ and $x \mid y$, then $y \nmid x$, since both numbers are positive. Therefore each of the $27 - 10 = 17$ off-diagonal pairs requires its reverse to be added. These reverses are distinct and none already lies in R, so adding them is both necessary and sufficient. Hence

$$n = 17, \qquad m + n = 27 + 17 = 44.$$

There is no need to add new diagonal pairs, and adding unrelated pairs would not be minimal. The values 16, 32 and 36 fail this direct count.

Step 3: Conclusion The original relation has 27 pairs and needs 17 additional pairs for symmetry. Therefore $m + n = 44$. Hence, the correct option is (D).

Quick Tip to Solve: For divisibility on positive integers, count all pairs first and subtract the diagonal count to obtain the missing reverses.

2. If the range of the function $f(x) = \sqrt{3-x} + \sqrt{5+x}$ is $[\alpha, \beta]$, then $\alpha^2 + \beta^2$ is equal to [4 marks]

(A) 18

(B) 20

(C) 24

(D) 25

Correct Answer: (C) 24

Solution:

Concept:

- Both radicands must be nonnegative, giving the closed domain $-5 \le x \le 3$. A continuous function on this interval attains its extreme values.
- For nonnegative a, b with fixed sum, $(\sqrt{a} + \sqrt{b})^2 = a + b + 2\sqrt{ab}$; the product is largest when $a = b$.

Step 1: Bound the square of the function Put $a = 3 - x$ and $b = 5 + x$. On the domain, $a + b = 8$ and both are nonnegative. Thus

$$f(x)^2 = 8 + 2\sqrt{(3-x)(5+x)}.$$

The product has the useful form

$$(3-x)(5+x) = 16 - (x+1)^2.$$

Its least value is zero at the endpoints and its greatest value is 16 at $x = -1$, which lies within the domain.

Step 2: Identify both attained endpoints of the range It follows that $8 \le f(x)^2 \le 16$. Since $f(x)$ is nonnegative, taking square roots preserves the inequalities:

$$2\sqrt{2} \le f(x) \le 4.$$

At $x = -5$ or 3, one radical vanishes and the other equals $2\sqrt{2}$; at $x = -1$, both radicals equal 2. Continuity ensures every intermediate value occurs. Hence $\alpha^2 = 8$ and $\beta^2 = 16$, not the endpoint inputs squared. Their sum is 24, ruling out 18, 20 and 25.

Step 3: Conclusion The range is $[2\sqrt{2}, 4]$, so $\alpha^2 + \beta^2 = 8 + 16 = 24$. Hence, the correct option is (C).

Quick Tip to Solve: When two nonnegative radicands have a fixed sum, square their sum and optimise only their product.

3. If the line $\arg(z) = \frac{\pi}{3}$ intersects the curve $|z - 2\sqrt{3}i| = 2$, $z \in \mathbb{C}$, at two distinct points A and B, then AB equals [4 marks]

(A) 1

(B) 2

(C) 4

(D) 6

Correct Answer: (B) 2

Solution:

Concept:

- Writing $z = x + iy$, the equation $|z - 2\sqrt{3}i| = 2$ describes a circle with centre $(0, 2\sqrt{3})$ and radius 2 in the Argand plane.
- The condition $\arg z = \pi/3$ gives the ray $z = r(\cos(\pi/3) + i\sin(\pi/3))$, with $r > 0$. Distances along this ray equal differences of the radial coordinates.

Step 1: Parametrise the intersections using the argument For a point on the given ray,

$$x = \frac{r}{2}, \qquad y = \frac{\sqrt{3}r}{2}.$$

Substitute these coordinates into the circle equation

$$x^2 + (y - 2\sqrt{3})^2 = 4.$$

This approach also checks that the intersections belong to the ray itself rather than only to the full line through the origin.

Step 2: Solve for the radial distances and subtract After substitution and expansion,

$$\frac{r^2}{4} + 3\left(\frac{r}{2} - 2\right)^2 = 4,$$

$$r^2 - 6r + 8 = 0, \qquad (r - 2)(r - 4) = 0.$$

Both roots, 2 and 4, are positive, so both satisfy the specified argument. The two points lie on the same unit direction vector, and therefore

$$AB = |4 - 2| = 2.$$

As a geometric check, the distance of the centre from $\sqrt{3}x - y = 0$ is $\sqrt{3}$, giving chord length $2\sqrt{2^2 - (\sqrt{3})^2} = 2$. The diameter 4 would require the line to pass through the centre, which it does not; 1 is the half-chord and 6 exceeds the diameter.

Step 3: Conclusion The two intersections have radial coordinates 2 and 4, so $AB = 2$. Hence, the correct option is (B).

Quick Tip to Solve: For a fixed complex argument, parametrise by a positive radius; the chord length becomes the difference of the two radii.

4. If the system of linear equations : $x + y + z = 4$, $x + 2y + 3z = 6$, $4x + 5y + \lambda z = \mu$ has more than one solution, then the value of $\lambda + \mu$ is equal to [4 marks]

(A) 18

(B) 9

(C) 12

(D) 24

Correct Answer: (D) 24

Solution:

Concept:

- The first two equations have independent coefficient rows. Therefore they define a line of solutions, and a third independent equation would select a unique point.
- More than one solution requires the third equation to be a linear combination of the first two, including the same combination of their right-hand sides.

Step 1: Find the combination required by the first two coefficients Let the third coefficient row be a times the first row plus b times the second. Comparing the coefficients of x and y,

$$a + b = 4, \qquad a + 2b = 5.$$

Subtract to get $b = 1$, and hence $a = 3$. Consequently the required coefficient of z is

$$\lambda = a + 3b = 3 + 3 = 6.$$

No other combination can match the specified first two coefficients.

Step 2: Impose consistency on the right-hand side The constants must obey exactly the same row relation:

$$\mu = 3(4) + 1(6) = 18.$$

Thus the third equation becomes $3(x + y + z) + (x + 2y + 3z) = 18$, and contributes no new restriction. Explicitly, subtracting the first equation from the second gives $y + 2z = 2$; with $z = t$, we obtain $y = 2 - 2t$ and $x = 2 + t$. Every real t satisfies all three equations when $(\lambda, \mu) = (6, 18)$, confirming infinitely many solutions rather than inconsistency. Therefore the requested sum is 24. The alternative 18 is only μ, while 9 and 12 do not equal the sum required by the consistency equations.

Step 3: Conclusion We obtain $\lambda = 6$ and $\mu = 18$, giving $\lambda + \mu = 24$. Hence, the correct option is (D).

Quick Tip to Solve: For a dependent third equation, match two coefficients to find its row combination, then apply that combination to every remaining coefficient and constant.

5. Let $b_1 = 3, b_2, b_3, \ldots$ be a geometric progression of increasing positive numbers. Let $\sum_{n=1}^{20} b_{3n} = 4\sum_{n=1}^{20} b_{3n-2}$. Then, the sum of the first ten terms of the G. P. is [4 marks]

(A) 1023

(B) 2046

(C) 3069

(D) 3149

Correct Answer: (C) 3069

Solution:

Concept:

- For a geometric progression with first term 3 and common ratio r, the general term is $b_k = 3r^{k-1}$. Increasing positive terms require $r > 1$.
- Terms whose indices differ by two satisfy $b_{k+2} = r^2 b_k$. This relation can be applied term by term before evaluating either of the two long sums.

Step 1: Use the fixed shift between corresponding indices For every n from 1 to 20,

$$b_{3n} = 3r^{3n-1} = r^2\left(3r^{3n-3}\right) = r^2 b_{3n-2}.$$

Summing these twenty identities gives

$$\sum_{n=1}^{20} b_{3n} = r^2 \sum_{n=1}^{20} b_{3n-2}.$$

The sum on the right is positive because all terms of the progression are positive, so it may be cancelled from the given equality.

Step 2: Determine the ratio and the ten-term sum Comparison with the condition in the question yields $r^2 = 4$. The root $r = -2$ would give alternating signs and is incompatible with increasing positive numbers; hence $r = 2$. Use the finite geometric-series formula:

$$S_{10} = 3\frac{2^{10} - 1}{2 - 1} = 3(1024 - 1) = 3069.$$

A direct check starts the progression as $3, 6, 12, 24, \ldots$, so every term two places later is four times the earlier term, as required. The number 1023 omits the first-term multiplier 3, and 2046 uses a multiplier 2 instead; 3149 does not satisfy the geometric sum.

Step 3: Conclusion The common ratio is 2 and the sum of the first ten terms is 3069. Hence, the correct option is (C).

Quick Tip to Solve: Before summing spaced terms of a geometric progression, compare each corresponding pair; a fixed index gap gives a fixed power of the ratio.

6. If all the words, with or without meaning, made using all the letters of the word "RANCHI" are arranged as in a dictionary, then the word at 560^{th} position is : [4 marks]

(A) NICHRA

(B) NICAHR

(C) NICARH

(D) NICHAR

Correct Answer: (C) NICARH

Solution:

Concept:

- The letters A, C, H, I, N and R are all distinct. In dictionary order, words with a fixed first letter form consecutive blocks of $5! = 120$ words.
- After fixing each prefix, arrange the remaining letters alphabetically and use factorial-sized blocks to locate the remaining one-based rank.

Step 1: Locate the first two letters by factorial blocks The first-letter blocks are A at ranks 1–120, C at 121–240, H at 241–360, I at 361–480, N at 481–600 and R at 601–720. Rank 560 therefore begins with N and has rank $560 - 480 = 80$ inside that block. With N fixed, the remaining letters are A,C,H,I,R. Each second-letter block has $4! = 24$ words. The first three such blocks account for 72 words, so the second letter is I and the remaining rank is $80 - 72 = 8$.

Step 2: Continue within the NI prefix The remaining letters are A,C,H,R. Blocks for the third letter contain $3! = 6$ words. Rank 8 skips the six words beginning NIA, so the third letter is C and the remaining rank is 2. With NIC fixed, the remaining letters A,H,R form two-word blocks. The first block begins NICA and contains, in order, NIC A H R and NIC A R H. Its second member is therefore NICARH. Written without spaces, the required word is NICARH. Checking the choices, NICAHR is rank 559, NICHAR is rank 561 and NICHRA is rank 562, whereas NICARH is rank 560.

Step 3: Conclusion The word at position 560 is NICARH. Hence, the correct option is (C).

Quick Tip to Solve: Keep ranks one-based: after skipping complete factorial blocks, subtract their sizes and continue with the remaining letters in alphabetical order.

7. The number of integral terms in the binomial expansion of $\left(11^{\frac{1}{2}}+17^{\frac{1}{8}}\right)^{1024}$ is [4 marks]

(A) 129

(B) 131

(C) 133

(D) 137

Correct Answer: (A) 129

Solution:

Concept:

- The term indexed by k, for $0 \leq k \leq 1024$, is $\binom{1024}{k}11^{(1024-k)/2}17^{k/8}$. The binomial coefficient is a positive integer.
- Distinct primes have independent exponents in a rational number. An integer coefficient cannot remove a fractional exponent of 11 or 17; both displayed prime exponents must therefore be integers.

Step 1: Translate integrality into divisibility conditions For the power of 11 to be integral, $1024-k$ must be even, equivalently k must be even. For the power of 17 to be integral, k must be divisible by 8. The second condition already implies the first. Thus an integral term occurs precisely when

$$k = 8j \quad \text{for an integer } j.$$

All exponents are nonnegative within the expansion, so these conditions are also sufficient.

Step 2: Count all admissible indices including the endpoints The bounds $0 \leq k \leq 1024$ become $0 \leq j \leq 128$. Hence there are

$$128 - 0 + 1 = 129$$

integral terms. Both endpoints must be included: $k = 0$ gives 11^{512}, and $k = 1024$ gives 17^{128}, each an integer. For a rigorous necessity check, raise any supposedly integral term to the eighth power. Its prime valuations include $4(1024-k)$ for 11 and k for 17, plus multiples of 8 contributed by the binomial coefficient; integrality of the original term forces both valuations to be multiples of 8. Values 131, 133 and 137 incorrectly include indices with a fractional prime exponent.

Step 3: Conclusion The admissible indices are $k = 0, 8, 16, \ldots, 1024$, giving 129 integral terms. Hence, the correct option is (A).

Quick Tip to Solve: For sums of distinct prime radicals, require each prime exponent to be integral, then count the allowable binomial indices with both endpoints included.

8. Two persons A and B alternately throw a pair of dice. A wins if he throws a sum of 4 before B throws a sum of 9 and B wins if he throws a sum of 9 before A throws a sum of 4. The probability, that A wins if B makes the first throw, is [4 marks]

(A) $\frac{1}{5}$
(B) $\frac{2}{5}$
(C) $\frac{3}{5}$
(D) $\frac{4}{5}$

Correct Answer: (B) $\frac{2}{5}$

Solution:

Concept:

- A pair of fair dice has 36 equally likely ordered outcomes. Sum 4 occurs in 3 outcomes, so $p_A = 1/12$; sum 9 occurs in 4 outcomes, so $p_B = 1/9$.
- Treat one unsuccessful B throw followed by one unsuccessful A throw as a complete failed cycle. After such a cycle the game returns to its original state with B due to throw.

Step 1: Find the chance of success in the first cycle Because B starts, A can win on the first opportunity only if B first fails and A then succeeds. The relevant probability is

$$(1 - p_B)p_A = \frac{8}{9} \cdot \frac{1}{12} = \frac{2}{27}.$$

The chance that neither player wins during the cycle is

$$q = (1 - p_B)(1 - p_A) = \frac{8}{9} \cdot \frac{11}{12} = \frac{22}{27}.$$

The independence of successive dice throws allows these probabilities to be multiplied.

Step 2: Sum over all possible numbers of failed cycles A wins either in the first cycle, after one failed cycle, after two failed cycles, and so on. These are disjoint events, giving

$$P = \frac{2}{27}\left(1 + \frac{22}{27} + \left(\frac{22}{27}\right)^2 + \cdots\right).$$

Since $22/27 < 1$, the series converges and

$$P = \frac{2/27}{1 - 22/27} = \frac{2}{5}.$$

Equivalently, the recurrence $P = 2/27 + (22/27)P$ gives the same result. The probability that B wins is $(1/9)/(1 - 22/27) = 3/5$, confirming that the two winning probabilities add to one. Thus 3/5 belongs to B, while 1/5 and 4/5 do not account for the repeated opportunities correctly.

Step 3: Conclusion The probability that A wins when B throws first is $\frac{2}{5}$. Hence, the correct option is (B).

Quick Tip to Solve: Group alternating turns into a full cycle; divide the probability of winning within one cycle by one minus the probability that the entire cycle fails.

9. The mean and standard deviation of four numbers are given by 10 and $\frac{5\sqrt{2}}{2}$, respectively. If a fifth number 15 is added to the data set, then the variance of the new data set is [4 marks]

(A) 13.5

(B) 13

(C) 14.5

(D) 14

Correct Answer: (D) 14

Solution:

Concept:

- For a data set of size N, the population variance is $\sigma^2 = \frac{1}{N}\sum x_i^2 - \bar{x}^2$. The standard deviation is the positive square root of this variance.
- Adding one observation changes both the mean and the mean of the squares. Therefore, retain the old sum and squared sum rather than averaging standard deviations.

Step 1: Recover the original sums The four observations have mean 10, so their sum is $4(10) = 40$. Their given standard deviation yields

$$\sigma^2 = \left(\frac{5\sqrt{2}}{2}\right)^2 = \frac{25}{2}.$$

Consequently,

$$\frac{\sum x_i^2}{4} = 100 + \frac{25}{2} = \frac{225}{2}, \qquad \sum x_i^2 = 450.$$

This uses the variance of the original four numbers, before the fifth number is introduced.

Step 2: Update both totals The additional observation is 15, so its contribution to the squared sum is $15^2 = 225$. The five observations therefore have

$$\sum x_i = 40 + 15 = 55, \qquad \sum x_i^2 = 450 + 225 = 675.$$

Their new mean is $55/5 = 11$; keeping the old mean 10 would give an incorrect variance.

Step 3: Evaluate the new variance Apply the same population-variance formula to all five observations:

$$\sigma_{\text{new}}^2 = \frac{675}{5} - 11^2 = 135 - 121 = 14.$$

The alternatives 13.5, 13 and 14.5 do not equal the difference between the new mean square and the square of the new mean. No sample correction by a divisor of four is appropriate here.

Step 4: Conclusion The variance of the new data set is 14. Hence, the correct option is (D).

Quick Tip to Solve: When a number is appended, update $\sum x$ and $\sum x^2$, then recompute the mean before finding the variance.

10. Let the distance between the foci of an ellipse $\frac{x^2}{a^2}+\frac{y^2}{b^2}=1(a>b)$ be 4 and the distance between its directrices be 10. Then the length of its latus rectum is : [4 marks]

(A) $\frac{12}{\sqrt{10}}$

(B) $\frac{6}{\sqrt{10}}$

(C) $\frac{8}{\sqrt{5}}$

(D) $\sqrt{10}$

Correct Answer: (A) $\frac{12}{\sqrt{10}}$

Solution:

Concept:

- For a horizontal ellipse, $c=ae$, $b^2=a^2-c^2$, and the directrices are $x=\pm a/e$, where e is its eccentricity.
- The length of the full latus rectum is $2b^2/a$. Distances between pairs of foci or directrices must first be divided by two.

Step 1: Translate the two distances The foci are $(\pm c,0)$, so their separation is $2c=4$, giving $c=2$. Similarly, the directrices have separation $2a/e=10$, giving $a/e=5$. The question specifies $a>b$, so these are the formulas for a major axis along the x-axis; the roles of a and b must not be reversed.

Step 2: Find the semi-axes Because $ae=c=2$, multiplication of the two relations for a and e eliminates the eccentricity:

$$a^2=(ae)(a/e)=2(5)=10.$$

Thus $a=\sqrt{10}$, as a length is positive, and

$$b^2=a^2-c^2=10-4=6.$$

As a check, $e=2/\sqrt{10}<1$, which is consistent with an ellipse.

Step 3: Calculate the full latus rectum Substitute these values into the full chord-length formula:

$$L=\frac{2b^2}{a}=\frac{12}{\sqrt{10}}.$$

Option (B) is half this value and would correspond to a semi-latus rectum. Option (D) gives the semi-major axis instead of the requested chord. Option (C) also fails the formula with $a^2=10$ and $b^2=6$.

Step 4: Conclusion The length of the latus rectum is $12/\sqrt{10}$. Hence, the correct option is (A).

Quick Tip to Solve: Multiply $ae=c$ by the half-separation a/e of the directrices to get a^2 immediately.

11. Let e_1 and e_2 be the eccentricities of the ellipse $2x^2 + 9y^2 = 36$ and the hyperbola $4x^2 - 9y^2 = 36$, respectively. Then the distance between the point of intersection of the lines $5x - 7y = 3$ and $3x + y = 7$, and the point $(9e_1^2, 9e_2^2)$ is [4 marks]

(A) 11

(B) 12

(C) 13

(D) 15

Correct Answer: (C) 13

Solution:

Concept:

- For an ellipse with semi-axes $a > b$, $e^2 = 1 - b^2/a^2$; for a horizontal hyperbola, $e^2 = 1 + b^2/a^2$.
- The distance between (x_1, y_1) and (x_2, y_2) is $\sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2}$. First calculate both points completely.

Step 1: Determine the eccentricity squares Divide the ellipse equation by 36:

$$\frac{x^2}{18} + \frac{y^2}{4} = 1, \qquad e_1^2 = 1 - \frac{4}{18} = \frac{7}{9}.$$

The hyperbola becomes

$$\frac{x^2}{9} - \frac{y^2}{4} = 1, \qquad e_2^2 = 1 + \frac{4}{9} = \frac{13}{9}.$$

The opposite signs in these formulas are essential: an ellipse has eccentricity below one, whereas a hyperbola has eccentricity above one.

Step 2: Construct the two points The specified point involving the eccentricities is therefore

$$(9e_1^2, 9e_2^2) = (7, 13).$$

To obtain the intersection of the lines, write $y = 7 - 3x$ from the second equation and substitute into the first:

$$5x - 7(7 - 3x) = 3 \Rightarrow 26x = 52.$$

Hence $x = 2$ and $y = 1$. Both original equations are satisfied by $(2, 1)$.

Step 3: Use the distance formula The coordinate changes from $(2, 1)$ to $(7, 13)$ are 5 horizontally and 12 vertically. Thus

$$d = \sqrt{5^2 + 12^2} = \sqrt{169} = 13.$$

This is the familiar 5–12–13 right-triangle relation. The other proposed distances 11, 12 and 15 have squares 121, 144 and 225, rather than the required squared distance 169.

Step 4: Conclusion The distance between the two points is 13. Hence, the correct option is (C).

Quick Tip to Solve: Use eccentricity squares directly when the requested point contains e^2; taking square roots creates unnecessary algebra.

12. Let $A(3,4)$, $B(5,-2)$ and $P(\alpha,\beta)$, $\alpha\beta \neq 0$, be three point such that $PA = PB$ and the area of ΔPAB is 10. Then the distance of the point $Q\left(2\alpha - 5\beta, \alpha - \beta^2\right)$, from the line having intercepts 3 and 1 on x- and y- axis respectively, is [4 marks]

(A) 10

(B) $\sqrt{10}$

(C) 15

(D) 2

Correct Answer: (B) $\sqrt{10}$

Solution:

Concept:

- Equidistance from two fixed points gives their perpendicular bisector by equating squared distances; the triangle area gives a second linear condition with an absolute value.
- A line with intercepts 3 and 1 has equation $x/3 + y = 1$. The distance to $Ax + By + C = 0$ is $|Ax_0 + By_0 + C|/\sqrt{A^2 + B^2}$.

Step 1: Find the equidistance condition Equate PA^2 and PB^2:

$$(\alpha - 3)^2 + (\beta - 4)^2 = (\alpha - 5)^2 + (\beta + 2)^2.$$

Cancellation of the common squared terms gives $4\alpha - 12\beta - 4 = 0$, so

$$\alpha = 3\beta + 1.$$

This relation describes the complete perpendicular bisector and must be combined with the area condition.

Step 2: Apply the area and nonzero restriction Use $B - A = (2,-6)$ and $P - A = (\alpha - 3, \beta - 4)$. The determinant area is

$$10 = \frac{1}{2}|2(\beta - 4) + 6(\alpha - 3)| = |3\alpha + \beta - 13|.$$

Thus $3\alpha + \beta = 23$ or 3. Substituting $\alpha = 3\beta + 1$ gives respectively $(\alpha,\beta) = (7,2)$ or $(1,0)$. The latter violates $\alpha\beta \neq 0$, leaving only $(7,2)$.

Step 3: Form Q and evaluate its distance Now

$$Q = (2(7) - 5(2),\ 7 - 2^2) = (4,3).$$

The intercept line is $x + 3y - 3 = 0$, hence

$$d = \frac{|4 + 3(3) - 3|}{\sqrt{1+9}} = \frac{10}{\sqrt{10}} = \sqrt{10}.$$

Values 10 and 15 ignore the required normalization or the coordinate calculation, while 2 is not this perpendicular distance.

Step 4: Conclusion The required distance is $\sqrt{10}$. Hence, the correct option is (B).

Quick Tip to Solve: Keep both signs of an absolute area equation, then use restrictions such as $\alpha\beta \neq 0$ before evaluating the requested point.

13. The number of integral values of n, for which the equation $3\cos x + 5\sin x = 2n + 1$ has a solution, is [4 marks]

(A) 4

(B) 6

(C) 8

(D) 10

Correct Answer: (B) 6

Solution:

Concept:

- The range of $a\cos x + b\sin x$, for real x, is the full interval $[-\sqrt{a^2+b^2}, \sqrt{a^2+b^2}]$.
- A real solution exists exactly when the right-hand side belongs to that interval. Count integer parameters only after solving the resulting two-sided inequality.

Step 1: Calculate the amplitude The coefficients of cosine and sine are 3 and 5. The amplitude of their sum is

$$R = \sqrt{3^2 + 5^2} = \sqrt{34}.$$

For example, choose an angle ϕ with $\cos\phi = 3/\sqrt{34}$ and $\sin\phi = 5/\sqrt{34}$; the left side is then $\sqrt{34}\cos(x - \phi)$. It consequently attains every value from $-\sqrt{34}$ to $\sqrt{34}$, including both endpoints.

Step 2: Restrict the integer parameter The necessary and sufficient condition is

$$-\sqrt{34} \le 2n + 1 \le \sqrt{34},$$

or

$$\frac{-\sqrt{34} - 1}{2} \le n \le \frac{\sqrt{34} - 1}{2}.$$

Since $5 < \sqrt{34} < 6$, the left bound lies between -3.5 and -3, and the right bound lies between 2 and 2.5. Therefore the smallest allowed integer is -3 and the largest is 2.

Step 3: List and count the admissible values The complete list is

$$n = -3, -2, -1, 0, 1, 2.$$

Their right-hand sides are the odd numbers $-5, -3, -1, 1, 3, 5$, all of which lie in the amplitude interval. The neighboring integers -4 and 3 give -7 and 7, which are outside. Thus no additional values can occur; counts 4, 8 and 10 are excluded.

Step 4: Conclusion There are 6 integral values of n. Hence, the correct option is (B).

Quick Tip to Solve: Count the odd integers $2n + 1$ in the amplitude interval; here they run from -5 through 5.

14. Let the points $A(a,-1,2)$, $B(1,b,-4)$, $C(-1,1,c)$ and $D(1,-2,8)$ be the vertices of a parallelogram $ABCD$. Then its area is equal to [4 marks]

(A) $2\sqrt{73}$

(B) $2\sqrt{51}$

(C) 28

(D) 14

Correct Answer: (C) 28

Solution:

Concept:

- The diagonals of a parallelogram bisect one another, so its cyclically ordered vertices satisfy $A+C=B+D$ coordinate by coordinate.
- The area is $|\overrightarrow{AB}\times\overrightarrow{AD}|$, using adjacent sides from the same vertex. Half this magnitude would give a triangle area.

Step 1: Recover the unknown coordinates Using the diagonal midpoint condition,

$$(a-1,0,2+c)=(2,b-2,4).$$

Equating corresponding components gives $a=3$, $b=2$, and $c=2$. Thus the needed vertices are $A=(3,-1,2)$, $B=(1,2,-4)$ and $D=(1,-2,8)$. Using adjacent sides respects the given order $ABCD$; a diagonal cannot replace one of them without checking the area relation.

Step 2: Form the side vectors and cross product Subtraction gives

$$\overrightarrow{AB}=(-2,3,-6),\qquad \overrightarrow{AD}=(-2,-1,6).$$

Their cross product is

$$\begin{aligned}\overrightarrow{AB}\times\overrightarrow{AD}&=(3(6)-(-6)(-1),\ (-6)(-2)-(-2)(6),\\&\qquad (-2)(-1)-3(-2))\\&=(12,24,8).\end{aligned}$$

Reversing the order would reverse every sign but leave the area unchanged.

Step 3: Take the magnitude The required parallelogram area is

$$\sqrt{12^2+24^2+8^2}=\sqrt{144+576+64}=\sqrt{784}=28.$$

Option (D), 14, is half this value and is the area of a triangle formed by the two side vectors. The squares of the first two proposed areas are 292 and 204, neither of which equals the cross product magnitude squared 784.

Step 4: Conclusion The area of the parallelogram is 28 square units. Hence, the correct option is (C).

Quick Tip to Solve: First use $A+C=B+D$ to determine missing coordinates, then cross two adjacent side vectors; do not divide by two.

15. Let (α, β, γ) be the foot of the perpendicular from the point $(25, 2, 41)$ on the line $\frac{x-4}{3} = \frac{y+1}{7} = \frac{z-2}{3}$. Then $\alpha + \beta + \gamma$ is equal to [4 marks]

(A) 41

(B) 42

(C) 44

(D) 45

Correct Answer: (C) 44

Solution:

Concept:

- A point on a line through X_0 with direction vector $\mathbf{d}$ can be written $H = X_0 + t\mathbf{d}$.
- For the perpendicular foot from P, the condition $(P - H) \cdot \mathbf{d} = 0$ gives $t = ((P - X_0) \cdot \mathbf{d})/(\mathbf{d} \cdot \mathbf{d})$.

Step 1: Parametrize the perpendicular foot The symmetric line has base point $X_0 = (4, -1, 2)$ and direction vector $\mathbf{d} = (3, 7, 3)$. Write the foot as

$$H = (4 + 3t, -1 + 7t, 2 + 3t).$$

This automatically places H on the line for every real parameter t. The remaining condition is that the segment joining H to $P = (25, 2, 41)$ be perpendicular to the line direction.

Step 2: Enforce perpendicularity The vector from the proposed foot to P is

$$(21 - 3t, 3 - 7t, 39 - 3t).$$

Taking its dot product with $(3, 7, 3)$ gives

$$3(21 - 3t) + 7(3 - 7t) + 3(39 - 3t) = 0.$$

Simplifying yields $201 - 67t = 0$, so $t = 3$. The denominator 67 is the squared length of the direction vector, and must not be replaced by its length.

Step 3: Evaluate and check the coordinates The foot is consequently

$$H = (13, 20, 11).$$

A direct check gives $P - H = (12, -18, 30)$ and

$$3(12) + 7(-18) + 3(30) = 36 - 126 + 90 = 0.$$

Therefore $\alpha + \beta + \gamma = 13 + 20 + 11 = 44$. The alternative totals 41, 42 and 45 do not follow from the unique parameter satisfying perpendicularity.

Step 4: Conclusion The required sum is 44. Hence, the correct option is (C).

Quick Tip to Solve: For a perpendicular foot, determine the line parameter with one dot product; then substitute it into all three coordinates.

16. Consider a sphere of volume 36π. Then the height, of the cone of maximum volume that can be inscribed in the sphere, is [4 marks]

(A) 1

(B) 4

(C) $\sqrt{3}$

(D) $2\sqrt{3}$

Correct Answer: (B) 4

Solution:

Concept:

- A sphere of radius R has volume $4\pi R^3/3$. For an inscribed right circular cone of height h, its base radius satisfies $r^2 = R^2 - (R-h)^2$.
- The cone volume is $V = \pi r^2 h/3$. Maximize it on the geometrically admissible interval $0 \le h \le 2R$, checking interior stationary points and endpoints.

Step 1: Determine the sphere radius The given sphere volume gives

$$\frac{4}{3}\pi R^3 = 36\pi \quad \Rightarrow \quad R^3 = 27 \quad \Rightarrow \quad R = 3.$$

Put the cone apex at one pole. Its base plane is a distance $R - h$ from the centre, with either sign allowed, so the circle cut out by that plane has

$$r^2 = R^2 - (R-h)^2 = 2Rh - h^2.$$

The full possible height interval is from zero to the diameter.

Step 2: Differentiate the volume function Substituting the radius relation,

$$V(h) = \frac{\pi}{3}h^2(2R - h).$$

Therefore

$$V\prime(h) = \frac{\pi}{3}(4Rh - 3h^2) = \frac{\pi}{3}h(4R - 3h).$$

Apart from the degenerate height zero, the stationary height is $h = 4R/3$. With $R = 3$, this gives $h = 4$, which lies inside the admissible interval $(0, 6)$.

Step 3: Verify that the stationary point is the maximum For positive heights below $4R/3$, the derivative is positive, and for heights above it the derivative is negative. The volume thus increases then decreases. Both endpoints $h = 0$ and $h = 2R$ have zero volume, so the interior stationary point is the global maximum. The other suggested heights $1, \sqrt{3}, 2\sqrt{3}$ do not satisfy $4R - 3h = 0$.

Step 4: Conclusion The height of the cone of maximum volume is 4 units. Hence, the correct option is (B).

Quick Tip to Solve: For an inscribed cone, eliminate its base radius using $r^2 = 2Rh - h^2$; maximizing the resulting cubic gives $h = 4R/3$.

17. If $f(x) = \begin{vmatrix} -\cos x & \tan x & 3\sin x \\ 1 & -3x & 2x^2 \\ x^3 & x & x^2 \end{vmatrix}$, **then the value of** $\lim_{x\to 0} \frac{(1+x)f(x)-3x\sin x}{x^3}$ **is** [4 marks]

(A) 3

(B) 5

(C) 7

(D) 8

Correct Answer: (C) 7

Solution:

Concept:

- Expand the determinant by its first row, retaining the sign pattern $+, -, +$. Only terms up to order x^3 can contribute to the requested limit.
- Near zero, $\sin x = x + O(x^3)$, $\tan x = x + O(x^3)$, and $\cos x = 1 + O(x^2)$. These expansions identify the leading coefficients without differentiating a long determinant.

Step 1: Expand the determinant The three minors give exactly

$$f(x) = 5x^3\cos x - x^2\tan x + 2x^5\tan x + 3x\sin x + 9x^4\sin x.$$

For example, the first minor is $-3x \cdot x^2 - 2x^2 \cdot x = -5x^3$; multiplying by $-\cos x$ produces the positive first term. The second minor is $x^2 - 2x^5$, and its cofactor has a minus sign.

Step 2: Cancel the leading term before taking the limit Keep $3x\sin x$ intact because it also occurs outside the determinant. Write

$$f(x) = 3x\sin x + 4x^3 + O(x^5).$$

Indeed, $5x^3\cos x - x^2\tan x = 4x^3 + O(x^5)$, while the remaining terms are of higher order. Therefore

$$(1+x)f(x) - 3x\sin x = 3x^2\sin x + 4x^3(1+x) + O(x^5).$$

After division by x^3, the terms tend to 3, 4, and 0. This also checks that the leading quadratic contribution cancels; overlooking the factor $1 + x$ would incorrectly omit the contribution 3.

Step 3: Conclusion The limit is $3 + 4 = 7$. Hence, the correct option is (C). The values 3, 5 and 8 do not equal the resulting cubic coefficient.

Quick Tip to Solve: When a determinant limit contains a subtracted term, isolate that term exactly before using Taylor expansions.

18. The area of the region $\left\{(x, y) : \sin x \leq y \leq \sqrt{\pi^2 - x^2}\right\}$ is: [4 marks]

(A) π^3
(B) $\frac{\pi^3}{2}$
(C) $\frac{\pi^3}{4}$
(D) $\frac{\pi^3}{8}$

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

Solution:

Concept:

- For vertical strips the area between an upper curve $u(x)$ and a lower curve $l(x)$ is $\int (u - l)\, dx$, over the interval where both are defined and ordered.
- The graph $y = \sqrt{\pi^2 - x^2}$ is the upper semicircle of radius π, defined on $[-\pi, \pi]$. The function $\sin x$ is odd.

Step 1: Check the whole interval of the region For $-\pi \leq x \leq 0$, $\sin x \leq 0$, whereas the square root is nonnegative. For $0 \leq x \leq \pi$, use $\sin x = \sin(\pi - x) \leq \pi - x$. Also

$$(\pi - x)^2 \leq \pi^2 - x^2$$

because this is equivalent to $2x(x - \pi) \leq 0$. Taking nonnegative square roots proves $\sin x \leq \sqrt{\pi^2 - x^2}$. Thus no subinterval is removed by the stated inequality; the integration range is the entire diameter.

Step 2: Integrate the vertical separation The area is

$$A = \int_{-\pi}^{\pi} \sqrt{\pi^2 - x^2}\, dx - \int_{-\pi}^{\pi} \sin x\, dx.$$

The first integral is the area of the upper semicircle, $\frac{1}{2}\pi(\pi)^2 = \frac{\pi^3}{2}$. The second is zero by odd symmetry, or by evaluating $[-\cos x]_{-\pi}^{\pi}$. Although the sine curve lies below the axis on the negative half and above it on the positive half, those changes in strip area cancel exactly. Option (A) is a full circle; (C) and (D) incorrectly reduce the integration region.

Step 3: Conclusion The required area is $\boxed{\pi^3/2}$ square units. Hence, the correct option is (B).

Quick Tip to Solve: First verify which curve lies above the other; then use odd symmetry to eliminate the sine contribution over a symmetric interval.

19. Let $f(x) = \begin{cases} 3x, & x < 0, \\ 1 + x + [x], & 0 \le x \le 2, \\ 5, & x > 2, \end{cases}$ **where** $[x]$ **denotes the greatest integer function. If** α **and** β **are the number of points in** $\mathbb{R}$**, where** f **is not continuous and is not differentiable, then** $\alpha + \beta$ **equals** [4 marks]

(A) 3

(B) 4

(C) 5

(D) 6

Correct Answer: (D) 6

Solution:

Concept:

- Continuity at a point requires the left-hand limit, the right-hand limit and the function value to be equal. A jump in the greatest integer function can therefore create a discontinuity.
- Differentiability implies continuity, so every discontinuity is also a point of non-differentiability. On an open interval where a function is linear or constant, it is differentiable.

Step 1: Identify the only possible exceptional points For $x < 0$, the function is $3x$, and for $x > 2$, it is the constant 5. Both are differentiable throughout their open domains. On $(0, 1)$, $[x] = 0$, so $f(x) = 1+x$. On $(1, 2)$, $[x] = 1$, so $f(x) = 2+x$. These two open intervals also contain no discontinuity or failure of differentiability. Thus only $x = 0, 1, 2$ need checking; integers outside the middle branch do not matter because the greatest integer expression is not used there.

Step 2: Check continuity at zero and one At the left boundary, the two limits are

$$\lim_{x \to 0^-} f(x) = 0, \qquad \lim_{x \to 0^+} f(x) = 1 = f(0).$$

Their inequality makes $x = 0$ a discontinuity. At the interior integer,

$$\lim_{x \to 1^-} f(x) = 2, \qquad \lim_{x \to 1^+} f(x) = 3 = f(1).$$

Hence $x = 1$ is also a jump discontinuity. Merely finding a finite limit on each side does not establish continuity: those values must coincide.

Step 3: Check the boundary at two and count the points As x approaches 2 from below, $[x] = 1$; at 2 itself, $[2] = 2$. Therefore

$$\lim_{x \to 2^-} f(x) = 4, \qquad f(2) = 1 + 2 + 2 = 5, \qquad \lim_{x \to 2^+} f(x) = 5.$$

The left-hand limit differs from the function value, so $x = 2$ is discontinuous even though the right branch agrees with $f(2)$. We have exactly three discontinuities, giving $\alpha = 3$. Each prevents differentiability, and every other point lies in one of the differentiable open pieces already listed, so $\beta = 3$. The counts refer to two properties and are added even though the exceptional points are the same; options 3, 4 and 5 undercount this sum.

Step 4: Conclusion The points of discontinuity and non-differentiability are both $0, 1, 2$. Thus $\alpha + \beta = 3 + 3 = 6$. Hence, the correct option is (D).

Quick Tip to Solve: Split a greatest integer branch at every integer inside its stated domain, and check both outer endpoints separately before counting discontinuities.

20. Let $f(x) = \int \left(\frac{1}{\log_e x} - \frac{2}{(\log_e x)^3}\right) dx$. If $f(e) = 2e$, then $f\left(e^2\right)$ is equal to [4 marks]

(A) $\frac{e^2}{4}$
(B) $\frac{e^2}{2}$
(C) $\frac{3e^2}{4}$
(D) $\frac{4e^2}{3}$

Correct Answer: (C) $\frac{3e^2}{4}$

Solution:

Concept:

- The derivative of $xg(\log x)$ is $g(\log x) + g'(\log x)$, by the product and chain rules, on an interval with $x > 0$ and $x \neq 1$.
- A constant of integration is determined by the supplied value $f(e) = 2e$. Both e and e^2 lie in the same interval $(1, \infty)$.

Step 1: Recognise the product whose derivative is given Set $L = \log_e x$. Direct differentiation gives

$$\frac{d}{dx}\left(\frac{x}{L}\right) = \frac{1}{L} - \frac{1}{L^2}, \qquad \frac{d}{dx}\left(\frac{x}{L^2}\right) = \frac{1}{L^2} - \frac{2}{L^3}.$$

Adding cancels the unwanted reciprocal-square terms. Hence the integrand equals the derivative of $x/L + x/L^2$, and

$$f(x) = \frac{x}{\log_e x} + \frac{x}{(\log_e x)^2} + C.$$

The cancellation is why a direct elementary primitive exists even though the isolated integral of $1/\log x$ is not elementary.

Step 2: Use the initial value and evaluate the requested argument At $x = e$, the logarithm is 1, giving $f(e) = e + e + C = 2e + C$. The condition forces $C = 0$. At $x = e^2$, the logarithm is 2, so

$$f(e^2) = \frac{e^2}{2} + \frac{e^2}{4} = \frac{3e^2}{4}.$$

Keeping the square on the second denominator is essential: it contributes one quarter rather than one half. Substituting back into the differentiated expression checks both coefficients and signs.

Step 3: Conclusion Thus $\boxed{f(e^2) = 3e^2/4}$. Hence, the correct option is (C). The other fractions do not follow from both terms of the primitive with the initial condition enforced.

Quick Tip to Solve: For combinations of inverse powers of log x, differentiate x times a short sum of inverse logarithmic powers and seek cancellation.

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

21. Let the value of p, such that the sum of the squares of the roots of the quadratic equation $x^2 + (7-p)x + 4 = p$ has least value, be α and the corresponding roots be β and γ. Then $\alpha^3 + \beta^3 + \gamma^3$ equals _____. [4 marks]

Solution:

Concept:

- For roots β, γ of a monic quadratic $x^2 - Sx + P = 0$, their sum is S, their product is P, and $\beta^2 + \gamma^2 = S^2 - 2P$.
- The identity $\beta^3 + \gamma^3 = S^3 - 3PS$ evaluates the cube sum without having to solve the quadratic explicitly.

Step 1: Minimise the square sum as a function of p First write the equation with zero on the right:

$$x^2 + (7-p)x + (4-p) = 0.$$

Thus $S = p - 7$ and $P = 4 - p$. Consequently

$$\beta^2 + \gamma^2 = (p-7)^2 - 2(4-p) = p^2 - 12p + 41 = (p-6)^2 + 5.$$

The square is nonnegative and vanishes precisely when $p = 6$; hence the minimising parameter is $\alpha = 6$. This value gives real roots, since the quadratic then becomes $x^2 + x - 2 = 0$, with discriminant 9.

Step 2: Evaluate the cube sum at the minimising parameter At $p = 6$, the root sum and product are $S = -1$ and $P = -2$. The symmetric identity yields

$$\beta^3 + \gamma^3 = (-1)^3 - 3(-2)(-1) = -1 - 6 = -7.$$

Alternatively, factor $x^2 + x - 2 = (x-1)(x+2)$, giving roots 1 and -2 and cube sum $1 - 8 = -7$. Add the cube of the parameter, not its square:

$$\alpha^3 + \beta^3 + \gamma^3 = 6^3 - 7 = 216 - 7 = 209.$$

The two independent evaluations of the root contribution agree.

Step 3: Conclusion The requested numerical value is $\boxed{209}$. It agrees with the supplied answer key.

Quick Tip to Solve: Complete the square in the parameter before finding the roots; then use symmetric root identities for the final power sum.

22. Let $25^x + 25^{-x}, \frac{\alpha}{3}, 20^{1+x} + 20^{1-x}$, $x, \alpha \in \mathbb{R}$ be the first three terms of an A.P. of increasing terms. For the least value of α, the sum of its first 10 terms is _____. [4 marks]

Solution:

Concept:

- Three numbers a, b, c form an arithmetic progression if $2b = a + c$. Its common difference is $d = b - a$, and its first-ten-term sum is $S_{10} = 5(2a + 9d)$.
- For any positive t, $t + t^{-1} \geq 2$, with equality only at $t = 1$. Apply this to the two exponential pairs separately.

Step 1: Find the least possible alpha The progression condition gives

$$\frac{2\alpha}{3} = 25^x + 25^{-x} + 20(20^x + 20^{-x}).$$

Both bases are positive, so the reciprocal-pair inequality gives a lower bound $2 + 40 = 42$ for the right side. Both equalities hold simultaneously at $x = 0$. Therefore

$$\alpha \geq \frac{3}{2} \cdot 42 = 63,$$

and the least value 63 is attained. There is no conflict between the two equality conditions because $25^0 = 20^0 = 1$.

Step 2: Construct the progression at the minimum and sum it At $x = 0$, the first three terms are

$$25^0 + 25^0 = 2, \qquad \frac{63}{3} = 21, \qquad 20^1 + 20^1 = 40.$$

Their differences are both 19, which is positive, so the stated increasing-term condition is satisfied. Thus $a = 2$, $d = 19$, and the tenth term is $a_{10} = 2 + 9 \cdot 19 = 173$. The required sum is

$$S_{10} = \frac{10}{2}(2 + 173) = 5 \cdot 175 = 875.$$

The minimum sought is for the parameter alpha; the sum is evaluated at that minimising progression, rather than minimised independently.

Step 3: Conclusion The sum of the first ten terms is $\boxed{875}$, agreeing with the answer key.

Quick Tip to Solve: Use t plus its reciprocal to locate the minimum, then verify the increasing condition before applying the A.P. sum formula.

23. If the circles $x^2+y^2-2x-8y+17=r$ and $x^2+y^2-26x-18y+234=0$ intersect at exactly one point, then the sum of all possible values of r is _____. [4 marks]

Solution:

Concept:

- Completing squares identifies a circle centre and the square of its radius. Circles meeting at exactly one point are tangent, internally or externally.
- If the centre separation is d and the radii are R, s, tangency requires $d = R+s$ or $d = |R-s|$. Both possibilities must be checked.

Step 1: Find both centres and radii The first equation becomes

$$(x-1)^2+(y-4)^2=r.$$

Its centre is $C_1=(1,4)$ and its radius is $R=\sqrt{r}$, so $r \geq 0$. The second equation becomes

$$(x-13)^2+(y-9)^2=16,$$

with centre $C_2=(13,9)$ and radius 4. The separation is

$$d=\sqrt{(13-1)^2+(9-4)^2}=\sqrt{144+25}=13.$$

In particular, the parameter r itself is a squared radius; it must not be substituted as the radius in the tangency formula.

Step 2: Include external and internal tangency External tangency requires $R+4=13$, hence $R=9$ and $r=81$. Internal tangency requires $|R-4|=13$. The admissible solution is $R=17$, giving $r=289$; the formal solution $R=-9$ is impossible for a radius. Both positive radii describe genuine circles and yield a unique contact point. The degenerate case $r=0$ adds no solution, since C_1 is at distance 13, not 4, from C_2. Thus there are exactly two values, and

$$\sum r = 81+289 = 370.$$

Step 3: Conclusion The sum of all possible values of r is $\boxed{370}$, in agreement with the key.

Quick Tip to Solve: For one-point circle intersections consider both tangency types, and distinguish the radius from the squared-radius parameter.

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24. Let $\vec{a}=2\hat{i}+3\hat{j}+5\hat{k}$, $\vec{b}=\hat{i}-\hat{j}+3\hat{k}$ and $\vec{c}$ be a vector such that $\vec{a}\cdot\vec{c}=104$ and $\vec{a}\times\vec{c}=\vec{c}\times\vec{b}$. Then $\vec{b}\cdot\vec{c}$ is equal to _____. [4 marks]

Solution:

Concept:

- The cross product reverses sign when its arguments are interchanged: $\vec{c}\times\vec{b}=-\vec{b}\times\vec{c}$. A vanishing cross product of two nonzero vectors means they are parallel.

- The dot product is bilinear: if $\vec{c} = t\vec{v}$, then $\vec{a} \cdot \vec{c} = t(\vec{a} \cdot \vec{v})$. Use the supplied dot product to fix the scalar t.

Step 1: Convert the cross-product relation into parallelism The given identity implies

$$\vec{a} \times \vec{c} + \vec{b} \times \vec{c} = \vec{0}, \qquad (\vec{a} + \vec{b}) \times \vec{c} = \vec{0}.$$

Here $\vec{a} + \vec{b} = 3\hat{i} + 2\hat{j} + 8\hat{k}$, which is nonzero. Moreover $\vec{c} \neq \vec{0}$, since $\vec{a} \cdot \vec{c} = 104$. Therefore

$$\vec{c} = t(3\hat{i} + 2\hat{j} + 8\hat{k}).$$

The sum a+b is essential: using a-b would incorrectly treat the cross product as commutative.

Step 2: Determine the scalar and compute the required product Substitute into the specified dot product:

$$104 = t(2 \cdot 3 + 3 \cdot 2 + 5 \cdot 8) = 52t.$$

Thus $t = 2$, so $\vec{c} = 6\hat{i} + 4\hat{j} + 16\hat{k}$. With $\vec{b} = \hat{i} - \hat{j} + 3\hat{k}$,

$$\vec{b} \cdot \vec{c} = 1 \cdot 6 + (-1) \cdot 4 + 3 \cdot 16 = 6 - 4 + 48 = 50.$$

For a consistency check, a dot c is $12 + 12 + 80 = 104$, and $\vec{c}$ is exactly twice a+b, which makes $(\vec{a} + \vec{b}) \times \vec{c}$ vanish as required.

Step 3: Conclusion The required dot product is $\boxed{\vec{b} \cdot \vec{c} = 50}$, matching the supplied numerical key.

Quick Tip to Solve: Move both cross products to one side and reverse c cross b with a minus sign; parallelism then reduces the problem to one scalar.

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25. Let $y = y(x)$ be the solution of the differential equation $x\frac{dy}{dx} + y + xy\cot x = x$, $\frac{\pi}{4} \leq x \leq \frac{3\pi}{4}$, $y\left(\frac{\pi}{4}\right) = 0$. Then $6y\left(\frac{3\pi}{4}\right)$ equals _____. [4 marks]

Solution:

Concept:

- A first-order linear equation has the form $y' + P(x)y = Q(x)$. Its integrating factor is $e^{\int P(x)\,dx}$, which turns the left side into a product derivative.
- On the given interval, both x and $\sin x$ are positive. Division by these quantities is valid, and the initial condition determines the single integration constant.

Step 1: Put the equation into linear form Divide the equation by x, retaining both contributions to the coefficient of y:

$$y' + \left(\frac{1}{x} + \cot x\right) y = 1.$$

Thus $P(x) = 1/x + \cot x$ and $Q(x) = 1$. The integrating factor is

$$I(x) = e^{\ln x + \ln(\sin x)} = x \sin x.$$

The absolute-value signs in the logarithms can be removed because of positivity throughout the specified interval.

Step 2: Integrate the product derivative Multiplication by the integrating factor gives

$$\frac{d}{dx}(xy\sin x) = x\sin x.$$

Integration by parts with $u = x$, $dv = \sin x\,dx$ yields

$$xy\sin x = \sin x - x\cos x + C.$$

Differentiate the right side to check the integration: its derivative is $\cos x - \cos x + x\sin x = x\sin x$, as required.

Step 3: Apply the initial condition and evaluate At $x = \pi/4$, $y = 0$, so

$$C = \frac{\pi\sqrt{2}}{8} - \frac{\sqrt{2}}{2}.$$

At $x = 3\pi/4$, use $\sin(3\pi/4) = \sqrt{2}/2$ and $\cos(3\pi/4) = -\sqrt{2}/2$:

$$\frac{3\pi\sqrt{2}}{8}y\left(\frac{3\pi}{4}\right) = \frac{\sqrt{2}}{2} + \frac{3\pi\sqrt{2}}{8} + \frac{\pi\sqrt{2}}{8} - \frac{\sqrt{2}}{2} = \frac{\pi\sqrt{2}}{2}.$$

Therefore $y(3\pi/4) = 4/3$.

Step 4: Conclusion The required numerical value is

$$6y\left(\frac{3\pi}{4}\right) = 6\cdot\frac{4}{3} = \boxed{8}.$$

Quick Tip to Solve: When the coefficient is $1/x + \cot x$, immediately try the product $x\sin x$ as the integrating factor; substitute the initial point before evaluating the final point.

26. The concept of scale in architecture is more clearly associated with: [4 marks]

(A) The durability of materials

(B) The relative size of elements compared to human dimensions.

(C) The energy efficiency of the building.

(D) The colour scheme of the façade

Correct Answer: (B) The relative size of elements compared to human dimensions.

Solution:

Concept:

- Architectural scale describes perceived or measured size through comparison with a reference. Human scale uses the dimensions and activities of people as that reference.
- Proportion concerns relationships among parts of a composition; scale particularly asks how large a part or whole is relative to something familiar, including a person.

Step 1: Identify the reference implied by scale A doorway, staircase, window or building frontage is experienced in relation to the human body. For example, a door must accommodate a person and a step must suit a human stride. The dimensions of these elements can therefore feel comfortable, monumental or overwhelming even before their materials or colours are considered. This comparative relationship is the architectural idea asked about here.

Step 2: Match the definition to the alternatives Option (B) directly states the relative size of elements compared to human dimensions, so it expresses human scale. Option (A), durability, describes resistance to deterioration and the service life of materials; a small and a large element can be equally durable. Option (C), energy efficiency, concerns the energy needed to operate a building and depends on factors such as insulation, shading and services. It does not define scale. Option (D) describes visual colour treatment of the facade. Colour may influence perception, but a colour scheme alone does not establish the size relationship between a building element and a person.

Step 3: Use a concrete architectural comparison Two entrances may have identical materials, colours and thermal performance, yet one may be domestic in size while the other is several storeys high. Their different relation to a standing person produces the difference in scale. This isolates relative size from the other building characteristics listed.

Step 4: Conclusion Scale is most clearly associated with the relative size of architectural elements compared to human dimensions. Hence, the correct option is (B).

Quick Tip to Solve: For scale questions, identify the comparison reference first: a person, a familiar object or the surrounding buildings. Material quality and colour describe other properties.

27. BRICK :MASONRY : : TILES : _____ [4 marks]

(A) Carpentry

(B) Wiring

(C) Plumbing

(D) Flooring

Correct Answer: (D) Flooring

Solution:

Concept:

- A verbal analogy preserves the relationship between the first pair of terms in a second pair. Here the first term names a building material or unit, and the second names the construction work in which it is characteristically used.
- Use the most direct conventional association in the available choices. A material can have several uses, but the analogy requires the same kind of relationship on both sides.

Step 1: State the relationship in the given pair Bricks are individual building units. They are laid and bonded with mortar to form masonry, such as walls and piers. Thus BRICK : MASONRY is a material-to-construction-work relationship. Masonry is neither the colour of a brick nor the person using it; it is the category of building work made with such units.

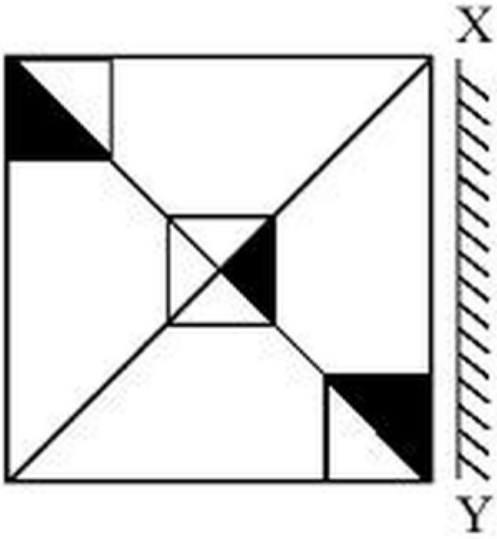
Step 2: Apply the same relationship to tiles Tiles are laid as a wearing or finishing surface, commonly over a floor base. The corresponding work among the choices is flooring. The relation TILES : FLOORING therefore parallels BRICK : MASONRY: the named units are used to carry out the named type of construction or finish. Tiles may also finish walls, but that additional use does not remove their direct association with flooring in this set of alternatives.

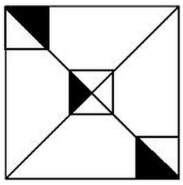
Step 3: Eliminate the unrelated trades Carpentry primarily involves making and assembling timber components, so it pairs naturally with wood rather than tiles. Wiring involves electrical conductors, cables and their connections. Plumbing involves pipes, fittings and water or waste services. Although tiled rooms may also contain electrical or plumbing installations, mere coexistence is not the material-to-work relationship required. Flooring is the only option that uses tiles themselves as the principal finishing units.

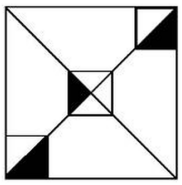
Step 4: Conclusion The completed analogy is BRICK : MASONRY :: TILES : FLOORING. Hence, the correct option is (D).

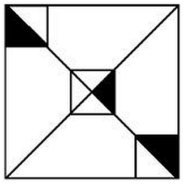
Quick Tip to Solve: Read an analogy aloud as a sentence: bricks are used for masonry, just as tiles are used for flooring. Keep the same relation in both halves.

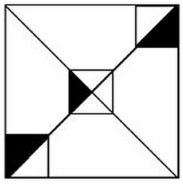
28. **Identify the correct mirror image of the given figure along XY-axis.** [4 marks]

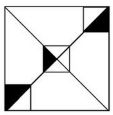


(A) 

(B) 

(C) 

(D) 

Correct Answer: (D) 

Solution:

Concept:

- A reflection in a vertical mirror reverses left and right while preserving the vertical position of every point. It does not rotate the figure upside down.
- Each shaded region must be reflected along with its boundary. Checking only the positions of the small squares is insufficient because their triangular shading can distinguish the options.

Step 1: Locate the mirror and track the small squares The line XY is vertical and lies to the right of the original square. The small square in the upper-left corner therefore appears in the upper-right corner of the mirror image. The lower-right small square moves to the lower-left corner. Their heights remain unchanged, and the central small square remains at the centre.

Step 2: Reflect the three shaded triangles The central black triangle originally touches the right side of the central square and points left. Its reflection touches the left side and points right. The upper-left corner triangle reflects to the lower-right half of the upper-right small square. The lower-right corner

triangle reflects to the upper-left half of the lower-left small square. Thus all three shading directions must be checked together.

Step 3: Compare the four alternatives Option (C) repeats the original arrangement rather than reversing it. Option (A) retains the corner squares in their original upper-left and lower-right positions, so it is not the required vertical reflection. Options (B) and (D) put the squares in the correct opposite corners, but (B) shades the lower-right half of the lower-left small square. Only (D) gives the upper-left half there and correctly reflects the other shaded regions.

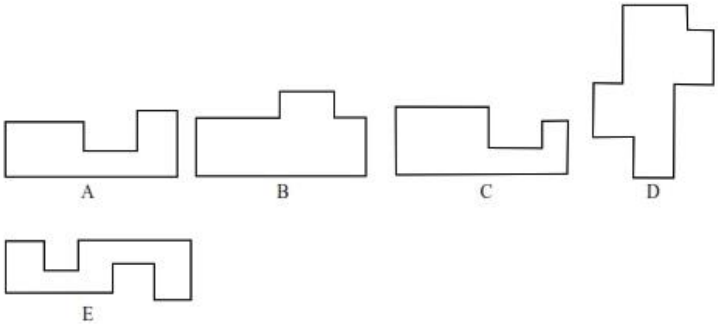
Step 4: Conclusion The figure in option (D) preserves the heights and reverses every left-right feature, including all three black triangles. Hence, the correct option is (D).

Quick Tip to Solve: For a vertical mirror, check one asymmetric central feature and one corner triangle; correct corner positions alone do not guarantee correct shading.

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29. Five diagrams A, B, C, D, E are given. Three out of these when put together form a square. Find out the diagrams.

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



(A) A, C, D

(B) B, C, D

(C) A, B, C

(D) C, D, E

Correct Answer: (A) A, C, D

Solution:

Concept:

- Three pieces form a square only when their boundaries interlock without overlap or gaps and leave four straight outer sides of equal length.
- A piece may be translated or rotated when it is put together with the others. Its shape must remain unchanged; a protruding step must match a complementary recess.

Step 1: Find the piece that can join two outer strips Piece D has several steps on opposite sides. Rotate D through a quarter-turn clockwise so that its long direction is horizontal. Its stepped upper and lower boundaries can then connect two broad pieces. Pieces A and C each have a long straight

edge, making them suitable for the top and bottom edges of the completed square.

Step 2: Assemble A, D and C Rotate A through a half-turn and place it above the rotated D, with its long straight edge at the top. The recess and projections on the lower edge of the rotated A match the successive steps on the upper edge of D. Keep C in its shown orientation and place it below D. The high left portion, recessed middle-right portion and raised narrow right end of C match the corresponding levels along the lower edge of the rotated D. Sliding the pieces into contact closes the interior boundary without cutting any piece.

Step 3: Check the outline and reject the other groups In this arrangement A supplies the top edge, C supplies the bottom edge, and the exposed ends of the three pieces align to make straight left and right sides. The completed outer boundary is a square. Replacing A by B gives a different stepped boundary that does not fill the upper complement of D; this rejects B, C, D. The group A, B, C omits the connecting stepped piece D. Replacing A by E introduces another recess instead of the required upper boundary, rejecting C, D, E. The matching set is therefore A, C, D.

Step 4: Conclusion Pieces A, C and D combine into a square, with D rotated clockwise between a half-turned A above and C below. Hence, the correct option is (A).

Quick Tip to Solve: Start with the most irregular piece, then match its stepped edges to complementary recesses; check the final outer boundary as well as the internal fit.

30. A man is looking at a photograph of a woman and his friend asked him "Who is she?" Then the man replied "I have no brother and sister, but the father of the woman in the photograph is my father's son". Who is the woman in the photograph? [4 marks]

(A) His daughter

(B) His wife

(C) His sister

(D) His mother

Correct Answer: (A) His daughter

Solution:

Concept:

- Solve family statements by replacing relative descriptions with named people, keeping the speaker fixed throughout. The words "my" refer to the man looking at the photograph.
- If a man has no brothers, his father's son can only be the man himself. A woman whose father is that man is his daughter.

Step 1: Resolve the phrase about the father's son Call the speaker M and his father F. The phrase "my father's son" means a son of F. The speaker is male and explicitly states that he has no brother or sister. Therefore there is no other son to choose: the phrase refers to M himself. It must not be interpreted as an uncle or a cousin, since those relationships are not sons of his father in this statement.

Step 2: Substitute the resolved person into the statement The man says that the father of the woman in the photograph is "my father's son". Replacing that expression by M gives: the father of the

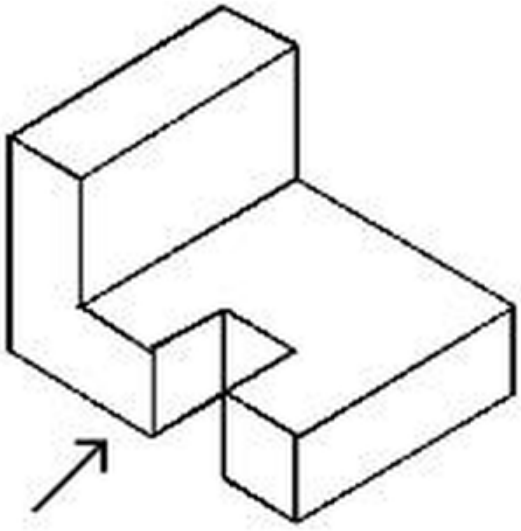
photographed woman is M. Consequently the photographed woman is a daughter of M. The identity of the man's friend is irrelevant; the friend only asks the question and does not enter the family relationship.

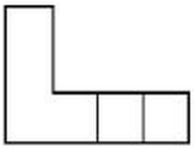
Step 3: Check each proposed relationship Option (A), his daughter, satisfies the statement exactly because her father is the speaker. Option (B), his wife, would not follow from identifying her father with the speaker. Option (C), his sister, conflicts directly with his explicit statement that he has no sister; in addition a sister's father would be F, not M. Option (D), his mother, reverses the parent-child direction and does not satisfy the father relationship given. There is therefore one consistent choice among the four alternatives.

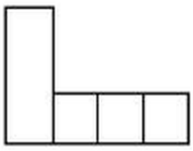
Step 4: Conclusion The woman in the photograph is the man's daughter. Hence, the correct option is (A).

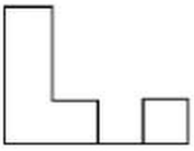
Quick Tip to Solve: Replace "my father's son" with "me" when the male speaker has no brothers; then read the remaining relationship without reversing parent and child.

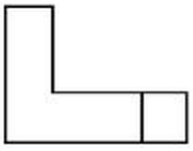
31. The question figure shows the 3D view of an object. Identify the correct view looking in the direction of the arrow. [4 marks]

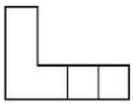


(A) 

(B) 

(C) 

(D) 

Correct Answer: (A) 

Solution:

Concept:

- An orthographic view along an arrow collapses depth in that direction. Heights and horizontal positions in the viewing plane remain visible.
- The outside silhouette and the internal visible edges must both agree with the object. A recess can create internal lines without producing a gap through the full projected outline.

Step 1: Identify the viewing direction and outside profile The arrow points from the lower left towards the object, approximately along its receding depth direction. From this end, the upright wall is seen at the left and the base slab extends to the right. The wall rises well above the slab, so the outside silhouette is an L shape: a tall narrow left part joined to a low horizontal right part.

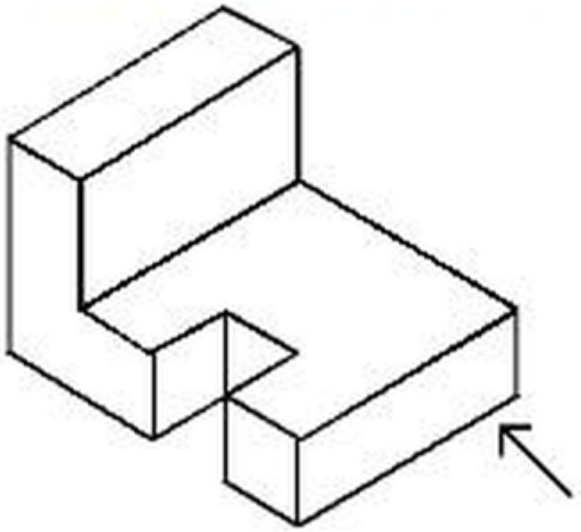
Step 2: Project the recess in the base The rectangular notch opens towards the observer. Its two side boundaries appear as vertical lines across the low strip of the projection. The solid material behind the recess remains in the line of sight, so the strip is still filled across the bottom; the notch is not an opening through the whole projected object. The upright and the adjacent base form a continuous exterior face, so there is no additional vertical seam continuing down from the inner corner of the tall wall.

Step 3: Match the edges to the alternatives Option (A) has the required L-shaped outline and two internal vertical lines in the lower strip marking the recess boundaries. Option (B) adds a vertical dividing line directly beneath the inner corner of the upright, where the solid shows no such separate face boundary. Option (C) removes part of the lower silhouette, treating the recess as a through-gap despite the material behind it. Option (D) shows only one of the two recess boundaries. Thus (A) is the only alternative matching both outline and visible edges.

Step 4: Conclusion The view along the indicated arrow is the L-shaped projection with two internal vertical lines shown in option (A). Hence, the correct option is (A).

Quick Tip to Solve: First match the silhouette, then count visible recess edges; a front notch need not become an empty gap when solid material lies behind it.

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

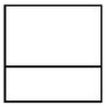


(A) 

(B) 

(C) 

(D) 

Correct Answer: (A) 

Solution:

Concept:

- In an orthographic projection, parts at different depths can overlap in the viewing direction; only the resulting visible outline and edges are drawn.
- A raised back wall and a lower slab can project to one rectangular outline with a horizontal line separating their visible regions. Features hidden behind the front face do not add visible divisions.

Step 1: Look towards the broad side of the object Here the arrow points from the lower right towards the solid. The observer therefore looks across the slab towards the broad face of the upright wall. The width of this wall and the slab span the same projected width. The upright rises behind the slab, so together they produce a rectangular outside silhouette rather than the L shape seen from the other end.

Step 2: Locate the one visible horizontal division The front vertical face of the slab occupies the

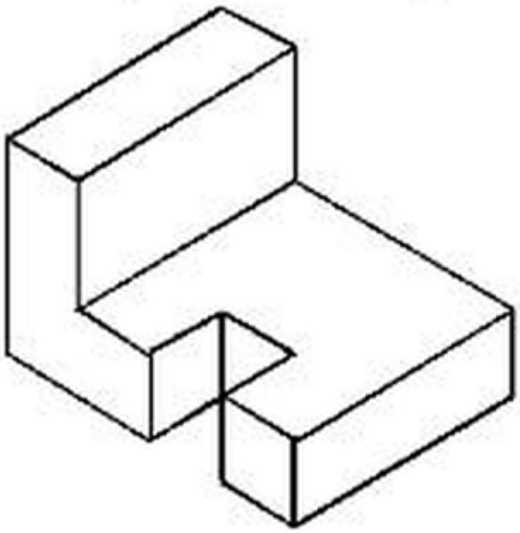
lower part of the projection. Its top edge appears as a horizontal line across the rectangle, with the broad raised wall visible above it. The notch lies on the side of the slab and does not cut through the near broad face seen along this arrow; it therefore does not produce a visible vertical gap or an extra horizontal band in this view.

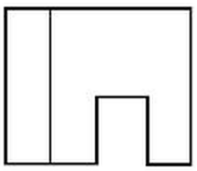
Step 3: Eliminate drawings with missing or added edges Option (A) shows the complete rectangle and the single horizontal boundary at the slab-top level. Option (B) omits this visible change of surface level and draws only an undivided rectangle. Option (C) introduces a second horizontal division that the object does not have in this view. Option (D) adds several horizontal bands, including a line near the top, despite the upright being one uninterrupted broad face. Neither the slab nor the wall supports those extra visible edges.

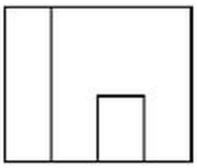
Step 4: Conclusion The required projection is the rectangle with one horizontal division shown in option (A). Hence, the correct option is (A).

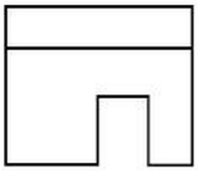
Quick Tip to Solve: Follow the arrow before using the previous view: the same stepped solid may look L-shaped from one end and rectangular from its broad side.

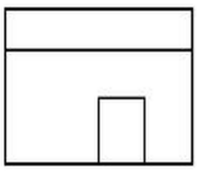
33. The question figure shows the 3D view of an object. Identify the correct top view . [4 marks]

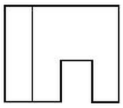


(A) 

(B) 

(C) 

(D) 

Correct Answer: (A) 

Solution:

Concept:

- A top view is an orthographic projection vertically downward. It preserves the left-right and front-back positions of the object while removing its height.
- A raised wall appears as a strip representing its horizontal thickness. An open notch in the base remains an interruption of the outer boundary; it is not closed by a new edge.

Step 1: Project the footprint and its notch Look down on the horizontal platform. Its outline is rectangular except for the rectangular recess cut inward from the front edge. The two sides of the recess and its back edge form a U-shaped interruption of the outline. There is no material across the mouth of that recess, so no horizontal line should join its two front corners. Options (B) and (D) incorrectly close that opening with a line.

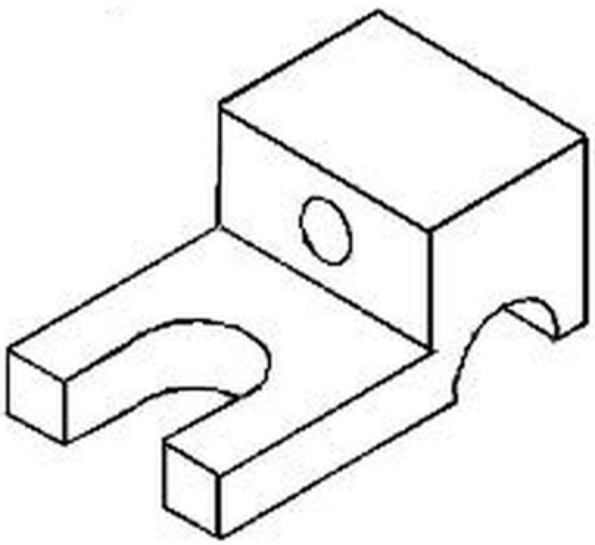
Step 2: Locate the wall relative to the notch Trace the long direction of the upright wall in the isometric figure: it runs along the same horizontal-plane direction as the two sides that extend inward from the mouth of the notch. Thus the wall is beside the notch, not opposite its mouth. When the notch is drawn opening downward as in the options, the wall thickness must form a vertical strip along the left side. Option (C) instead puts that strip across the top, perpendicular to the notch sides; this changes the relationship of the two features. Option (A) preserves the side strip and the open notch, while (B) incorrectly closes the notch.

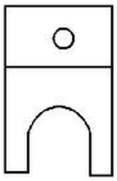
Step 3: Conclusion The upright wall projects as the left-hand strip, parallel to the sides of the open rectangular notch. Hence, the correct option is (A).

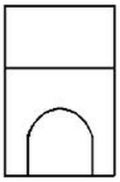
Quick Tip to Solve: In an isometric view, trace parallel edge directions before placing a raised wall in the plan; apparent position on the page can be misleading.

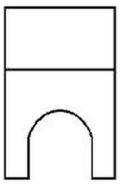
34. The question figure shows the 3D view of an object. Identify the correct top view of the object.

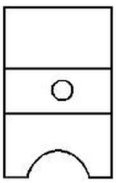
[4 marks]

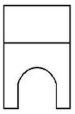


(A) 

(B) 

(C) 

(D) 

Correct Answer: (C) 

Solution:

Concept:

- A top view projects the object vertically onto a horizontal plane. Height is suppressed, but the outline and boundaries between horizontal levels remain in the plan.
- A feature cut in a vertical face does not appear as a circular hole in the horizontal top surface. A notch open at the front remains open in the projected outer boundary.

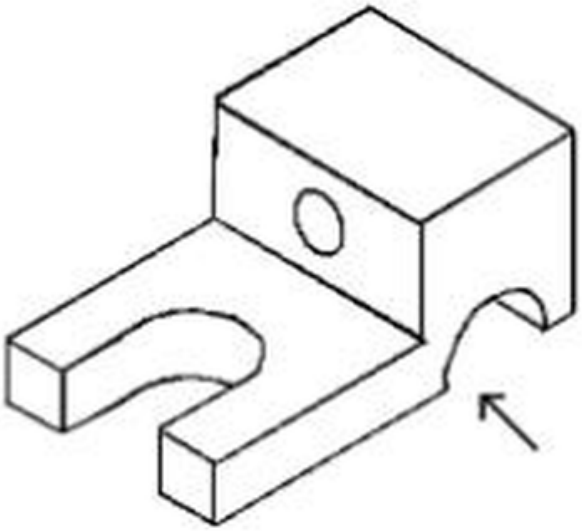
Step 1: Trace the plan of the base The lower portion consists of two projecting arms separated by a rounded recess. From above, the recess is a U-shaped cut opening at the front. The outline therefore follows one arm, curves around the back of the recess and returns along the other arm, with no edge closing its mouth. Option (B) adds a bottom line across the open recess and consequently changes the footprint.

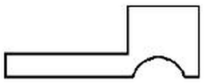
Step 2: Project the raised block The solid raised block at the rear has a rectangular top, producing a rectangular band across the back of the plan. Its circular hole is on a vertical front-facing surface, so it must not appear as a circle on the top surface. This eliminates (A), which places the circle inside the rear band. The curved opening on the side likewise does not turn into the front arch shown in (D); (D) combines elevation features instead of giving the plan. Option (C) alone shows the solid rear band and the open rounded notch without a false circular top hole.

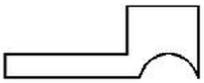
Step 3: Conclusion The correct plan is the rear rectangular band with an open U-shaped recess at the front and no circle on the top surface. Hence, the correct option is (C).

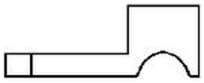
Quick Tip to Solve: When finding a top view, identify which faces are horizontal. Holes on vertical faces must not be copied as circles onto horizontal surfaces.

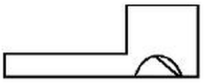
35. The question figure shows the 3D view of an object. Identify the correct view looking in the direction of the arrow. [4 marks]

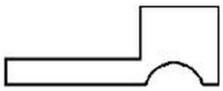


(A) 

(B) 

(C) 

(D) 

Correct Answer: (A) 

Solution:

Concept:

- An arrow specifies the line of sight for an orthographic view. Project parallel to that arrow, retaining height and the horizontal dimension perpendicular to the viewing direction.
- Visible outlines and changes in level survive projection; perspective depth offsets disappear. An opening must retain its position relative to the outside edges of the object.

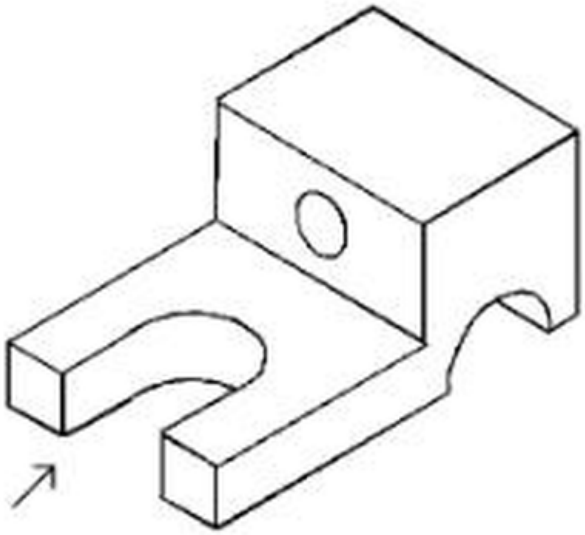
Step 1: Establish the side silhouette The arrow points toward the right-hand side face of the object. From this direction, the low projecting platform is seen on the left and the taller rear block on the right. Their outline is a low horizontal strip rising through one vertical step to the top of the taller block. The circular hole on the perpendicular face is not a circular feature of this side view.

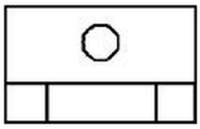
Step 2: Locate the curved opening and reject extra edges The semicircular cut in the bottom of the taller side face is the decisive feature. It is inset from the right outside edge: a short straight segment remains between the end of the curve and that edge. Option (A) preserves this inset curved opening. In (B), the curve reaches the far right corner, incorrectly removing that straight segment. Option (C) adds a vertical line near the left tip of the continuous low platform. Option (D) retains doubled slanting curves from the perspective appearance, although a straight orthographic view collapses the depth offset and shows a single semicircular profile.

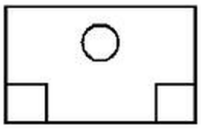
Step 3: Conclusion The side elevation has a low left platform, a high right block and a single inset semicircular cut at the bottom. Hence, the correct option is (A).

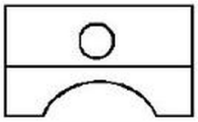
Quick Tip to Solve: After matching the stepped outline, check whether a curved opening touches an outside corner. A short remaining straight edge can distinguish the correct projection.

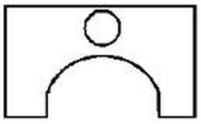
36. The question figure shows the 3D view of an object. Identify the correct view looking in the direction of arrow. [4 marks]

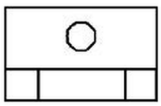


(A) 

(B) 

(C) 

(D) 

Correct Answer: (A) 

Solution:

Concept:

- The indicated arrow gives the viewing direction. A front elevation removes depth while preserving vertical height and lateral width.
- Features on the face perpendicular to the line of sight keep their shape. A horizontal recess is viewed edge-on rather than copied as its curved plan outline.

Step 1: Identify the face and the main boundary The arrow looks along the projecting arms toward the raised rear face containing the circular hole. That face is perpendicular to the viewing direction,

so the hole appears as a circle in the upper portion. Across the full width, the top of the low base gives a horizontal division below the raised face. The front ends of the two arms appear as short rectangular areas at the lower left and lower right.

Step 2: Project the recess and compare the alternatives The rounded U-shaped recess lies in the horizontal base. Its curved outline is apparent from above, but it must not be drawn as a semicircular arch in this front view. The material farther back provides the lower central projected boundary, while the two arm ends retain their short vertical edges. Option (A) shows the circle, the complete horizontal base-level line and those two short divisions. Option (B) omits the middle portion of the horizontal division. Options (C) and (D) incorrectly import a curved cut into the front outline; (D) also loses the correct base-level division.

Step 3: Conclusion The front projection is the rectangular elevation with a circular hole and a lower band divided by the two arm-end edges. Hence, the correct option is (A).

Quick Tip to Solve: Do not transfer every visible curve from an isometric drawing into an elevation. First decide which plane contains the curve and whether it is viewed face-on or edge-on.

37. A man walks 10 km north, then turns to his left and walks 5 km, then turns to his left again and walks 10 km. How far is he from his starting point? [4 marks]

(A) 10 km

(B) 20 km

(C) 15 km

(D) 5 km

Correct Answer: (D) 5 km

Solution:

Concept:

- Distance from the starting point is the magnitude of the net displacement, not the length of the complete route walked. Equal movements in opposite directions cancel when calculating displacement.
- Update the facing direction after each turn: left from north is west, whereas left from west is south. Coordinates provide a direct way to track the final position without confusing successive turns.

Step 1: Track the first two movements Take the starting point as the origin, with east as the positive horizontal direction and north as the positive vertical direction. After walking $10\,\mathrm{km}$ north, the man's position is $(0, 10)$, with coordinates measured in kilometres. He is facing north at this point. His first left turn therefore makes him face west. Walking $5\,\mathrm{km}$ in this direction changes only his horizontal coordinate, giving the position $(-5, 10)$. The first left turn must be interpreted relative to his current northward heading; it does not yet send him south.

Step 2: Apply the next turn and find the separation He is now facing west, so his second left turn makes him face south. The last $10\,\mathrm{km}$ movement is therefore southward, exactly cancelling the first northward movement. His final position is $(-5, 0)$, directly west of his starting point. The straight-line

distance is

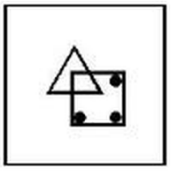
$$d = \sqrt{(-5)^2 + 0^2} = 5\,\text{km}.$$

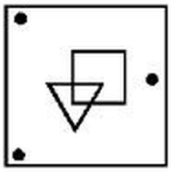
Options (A), (B) and (C) give 10, 20 and $15\,\text{km}$, respectively, none of which equals the remaining westward displacement. Adding the two vertical legs would count distance travelled rather than separation. The total route length is $10 + 5 + 10 = 25\,\text{km}$, but the question asks how far he is from the starting point after the entire walk, so that total is not the required quantity.

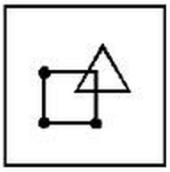
Step 3: Conclusion The man ends $5\,\text{km}$ west of his starting point. His distance from it is therefore $5\,\text{km}$. Hence, the correct option is (D).

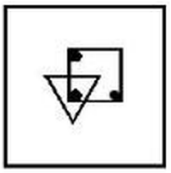
Quick Tip to Solve: Record the new facing direction after each left turn. Here the equal north and south legs cancel, leaving only the $5\,\text{km}$ westward leg.

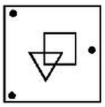
38. Identify the figure which is odd from rest of the figures. [4 marks]

(A) 

(B) 

(C) 

(D) 

Correct Answer: (B) 

Solution:

Concept:

- In an odd-one-out problem, compare the same relationship in every option. A useful invariant is whether the dots belong to the small overlapping figures or lie separately in the surrounding frame.
- Rotating a triangle or changing which corner overlaps a square does not change containment. Count and location of the dots should therefore be checked before using orientation as the distinguishing feature.

Step 1: Identify the shared components Each option contains an outer square frame, an inner square overlapping a triangle, and three dark dots. Hence the number of dots, the presence of a triangle and the presence of two square outlines do not separate one option from the others. The inner figures point or overlap in different directions, so orientation by itself is not a common rule for three choices.

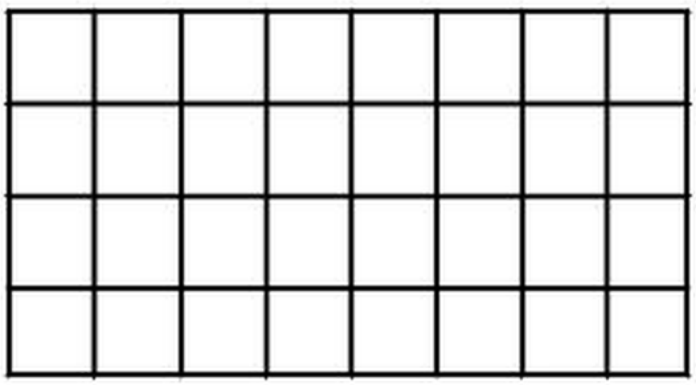
Step 2: Compare where the dots are placed In (A), all three dots lie inside the small inner square near its corners. In (C), the dots are placed on corners of the inner square. In (D), the dots again belong to the inner square or its boundary, including the region where the triangle overlaps. These

three options keep the dots attached to or inside the small square. In (B), all three dots are outside both small overlapping figures and dispersed in the surrounding frame. Thus (A), (C) and (D) share the containment relationship, whereas (B) alone breaks it.

Step 3: Conclusion Only option (B) places all three dots separately outside the small square and triangle. Hence, the correct option is (B).

Quick Tip to Solve: For visual odd-one-out questions, check containment and contact before rotation: a dot inside, on or outside a small figure is often the decisive relationship.

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



(A) 32

(B) 48

(C) 78

(D) 70

Correct Answer: (D) 70

Solution:

Concept:

- A square in a rectangular unit grid has equal numbers of unit intervals along its width and height. Count squares separately by side length so that larger squares are not missed.
- In a grid of m columns and n rows, an axis-aligned square of side k units has $(m-k+1)(n-k+1)$ possible positions, provided $k \leq \min(m, n)$.

Step 1: Count the rows and columns The figure has eight columns and four rows of equal cells. A square can therefore have side length 1, 2, 3 or 4 unit cells; a larger square cannot fit into the four-row height. Since the drawing contains only horizontal and vertical segments, no additional tilted square boundaries are formed.

Step 2: Count each possible size For unit squares there are $8 \times 4 = 32$ positions. For side 2, the left edge has seven possible column positions and the top edge has three row positions, giving $7 \times 3 = 21$.

Similarly, side 3 gives $6 \times 2 = 12$, and side 4 gives $5 \times 1 = 5$. Thus

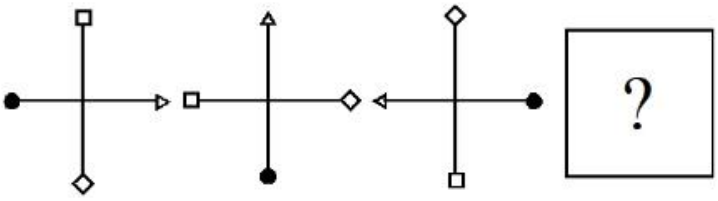
$$N = 32 + 21 + 12 + 5 = 70.$$

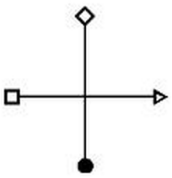
Each square has exactly one size and one upper-left corner, so these groups neither overlap nor omit a position. Option (A), 32, counts only individual cells. Options (B), 48, and (C), 78, do not match the complete size-by-size count.

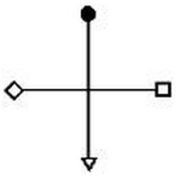
Step 3: Conclusion The figure contains 70 squares of all sizes. Hence, the correct option is (D).

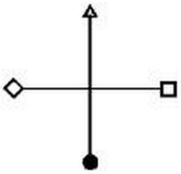
Quick Tip to Solve: In a rectangular grid, list the allowed side lengths first, then multiply the horizontal and vertical starting positions for each size.

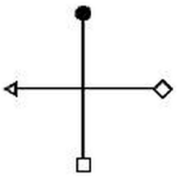
40. [4 marks]

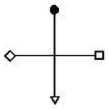


(A) 

(B) 

(C) 

(D) 

Correct Answer: (B) 

Solution:

Concept:

- A visual sequence can be tested by following one distinctive symbol through successive positions. The same transformation must then explain every other symbol.
- A quarter-turn anticlockwise moves the top position to the left, left to bottom, bottom to right and right to top. Symbols keep their identities while their positions change.

Step 1: Read the change between the first three figures In the first figure, the square is at the top, the arrowhead at the right, the diamond at the bottom and the filled dot at the left. In the second, they have moved respectively to left, top, right and bottom. This is a quarter-turn anticlockwise. Applying

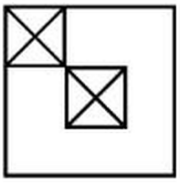
that same movement again produces the third figure: diamond at the top, dot at the right, square at the bottom and arrowhead at the left.

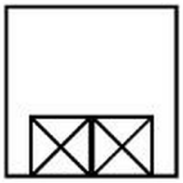
Step 2: Apply the same turn once more From the third figure, move the top diamond to the left, the right-hand dot to the top, the bottom square to the right and the left-hand arrowhead to the bottom. The required fourth figure therefore has dot above, downward-pointing arrow below, diamond left and square right. Option (B) has all four positions. Option (A) has the wrong top and left symbols; option (C) swaps the required top dot and bottom arrow; option (D) leaves the diamond on the right and square below instead of moving them to left and right.

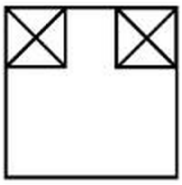
Step 3: Conclusion The missing figure is the quarter-turn anticlockwise continuation, with the filled dot at the top and the arrow at the bottom. Hence, the correct option is (B).

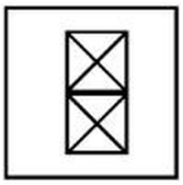
Quick Tip to Solve: Track the filled dot to determine the direction of movement, then verify the square and diamond; one matching symbol alone is not sufficient.

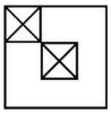
41. Find the odd one when the object is divided vertically through the centre. [4 marks]

(A) 

(B) 

(C) 

(D) 

Correct Answer: (A) 

Solution:

Concept:

- A vertical line through the centre divides an object into matching halves only when every feature on one side has a reflected counterpart at the same height on the other side.
- Reflection preserves size and vertical position but reverses horizontal position. A feature centred on the line may map onto itself if its own pattern is symmetric.

Step 1: Locate the vertical centre line Use the midpoint of the outer square to imagine a vertical line from its upper edge to its lower edge. Compare corresponding features at equal distances to the left and right of this line. The small squares contain both diagonals, so each crossed square is itself symmetric; the deciding information is where these squares are placed.

Step 2: Check the three symmetric arrangements In option (B), the two crossed squares at the bottom occupy matching positions on opposite sides of the centre line. In (C), the crossed squares in the

upper-left and upper-right corners likewise exchange places under reflection. In (D), both crossed squares are stacked along the middle: the centre line bisects each small square, and each diagonal pair maps back onto itself.

Step 3: Find the arrangement that breaks the rule In option (A), one crossed square is at the upper-left corner, while the other is near the centre. Reflecting the upper-left square would require an upper-right square at the same height, but that matching feature is absent. The middle square cannot replace it because its height and position differ. Thus the two vertical halves do not match in (A), whereas they do in (B), (C), and (D).

Step 4: Conclusion Only option (A) lacks symmetry about the vertical line through the centre. Hence, the correct option is (A).

Quick Tip to Solve: For vertical symmetry, compare features at the same height first; an unmatched corner feature immediately rejects symmetry.

42. A man is facing East, turns 90° clockwise, then 180° anti clockwise, and then another 90° clockwise. In which direction is he facing? [4 marks]

(A) West

(B) East

(C) North

(D) South

Correct Answer: (B) East

Solution:

Concept:

- The four cardinal directions occur in clockwise order North, East, South and West. A quarter-turn is 90°, while a half-turn is 180°.
- Clockwise and anticlockwise rotations have opposite signs. For turns about the same position, their signed angles can be added; a full 360° turn leaves the direction unchanged.

Step 1: Track the first two turns Start with the man facing East. A clockwise quarter-turn takes East to South, so after the first instruction he faces South. Now apply the second turn from this new direction, rather than restarting from East. An anticlockwise half-turn takes South through East to North. Thus the intermediate direction after the first two turns is North.

Step 2: Apply the final turn and verify the net angle From North, the final clockwise quarter-turn takes him to East. As a separate check, take clockwise as positive. The combined rotation is

$$90^\circ - 180^\circ + 90^\circ = 0^\circ.$$

A zero net rotation returns him to his initial direction. West would require a net half-turn, South would result if only the first turn were used, and North is merely the direction before the last instruction. None of these is the final direction.

Step 3: Conclusion The man finishes facing East. Hence, the correct option is (B).

Quick Tip to Solve: For several turns at one point, add clockwise angles and subtract anticlockwise angles before applying the net turn to the initial direction.

43. What is the mirror image of PRODUCTION along X-X' axis. [4 marks]



(A) ꓤЯODUCTION
(B) ꟼЯODUCTION
(C) ꟼЯODUCTION
(D) ꟼЯODUCTION

Correct Answer: (D) ꟼЯODUCTION

Solution:

Concept:

- A mirror placed on a horizontal axis reflects top and bottom. Each point remains at the same horizontal position and moves to the opposite side of the axis at equal distance.
- Letter order therefore stays P, R, O, D, U, C, T, I, O, N from left to right, while each letter is flipped vertically. This differs from reversing a word left to right.

Step 1: Read the orientation of the mirror The line X–X' lies horizontally below PRODUCTION. The reflected word must therefore appear below this line. Do not reverse the order of the letters: the P remains the leftmost letter and the N remains the rightmost letter.

Step 2: Transform the distinguishing letters The bowl of P moves from its upper part to its lower part. In R, the bowl also moves down and the slanting leg changes to an upward stroke. U becomes an arch open at the bottom, and the top crossbar of T moves to the bottom. O and the horizontally symmetric shapes C and D keep their familiar outline under this top-to-bottom flip; the diagonal of N reverses its slope.

Step 3: Compare every candidate Option (D) shows all of these changes together, including the lower bowls of P and R, the inverted U, and the bottom crossbar of T. Option (A) also reverses the left-right orientation of letters such as P and D, which a horizontal mirror does not do. Option (B) likewise has reversed sideways outlines and retains an upright U. Option (C) leaves U and T upright even though their top and bottom must exchange. It therefore cannot be the reflection of the complete word.

Step 4: Conclusion The top-to-bottom reflection of PRODUCTION about the horizontal X–X' axis is option (D). Hence, the correct option is (D).

Quick Tip to Solve: Check an asymmetric letter and then U or T: a horizontal mirror preserves letter order but turns U and T upside down.

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



(A) ƎDUTITΓA

(B) ƎDUTIΓΓA

(C) ƎDUTITJA

(D) ∀LTITUDE

Correct Answer: (C) ƎDUTITJA

Solution:

Concept:

- A vertical mirror reverses left and right while preserving height. The image of a word therefore has reversed letter order and horizontally reflected individual letters.
- The letters A, T, I and U in the displayed capital style have vertical symmetry. E, D and L supply the clearest checks because their side-facing strokes must reverse.

Step 1: Reverse the order about the vertical axis The given Y–Y' axis is vertical and lies to the right of ALTITUDE. The E is closest to the mirror, so E is the first reflected letter when the image is read from left to right. The required sequence of letter identities is E, D, U, T, I, T, L, A, with each glyph itself mirrored.

Step 2: Check the non-symmetric outlines The reflected E has its vertical stroke on the right and its three horizontal strokes extending left. The reflected D has its straight stroke on the right and curved side on the left. For L, the upright moves to the right and the short horizontal foot extends left at the bottom. The foot must remain at the bottom because reflection in a vertical line does not exchange top and bottom.

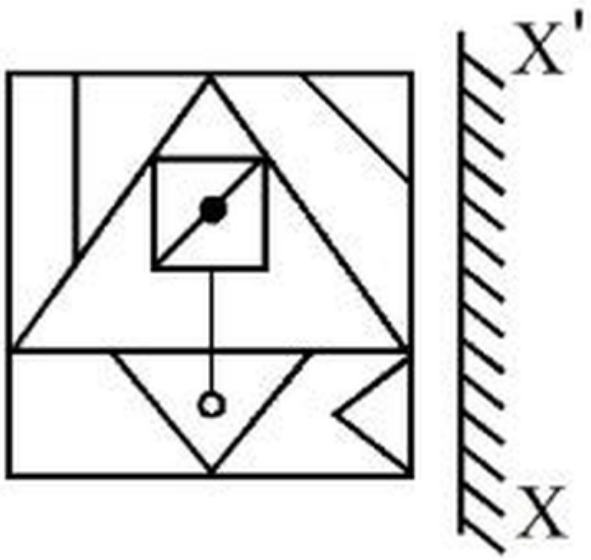
Step 3: Eliminate altered letters Option (C) combines the reversed order with these correct glyphs, including the bottom-left foot of the reflected L. Option (A) places the L-shaped horizontal stroke at the top rather than the bottom. Option (B) turns the T crossbars downward as well as using the wrong L orientation. Option (D) additionally turns A upside down. Such vertical changes are not produced by the given mirror, so these three candidates fail.

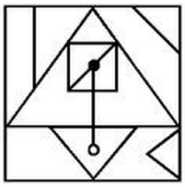
Step 4: Conclusion Option (C) is the horizontal reflection of ALTITUDE about Y–Y'. Hence, the correct

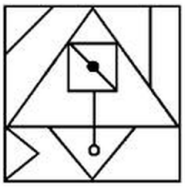
option is (C).

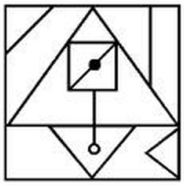
Quick Tip to Solve: In a vertical mirror image, reverse the sequence and check L: its foot changes side but must stay at the bottom.

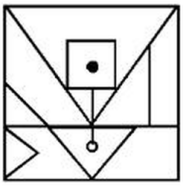
45. Identify the correct mirror image of given figure along XX'-axis. [4 marks]

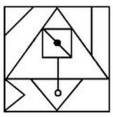


(A) 

(B) 

(C) 

(D) 

Correct Answer: (B) 

Solution:

Concept:

- Reflection in a vertical mirror changes left to right without changing height. Every line, dot and corner must undergo the same transformation.
- A complete pattern is identified by several independent landmarks. Matching only the outer square or its main triangle is insufficient when internal details differ.

Step 1: Reflect the outer landmarks The mirror X–X' is vertical to the right of the square. The short

vertical segment near the upper-left edge must move to the upper-right. The diagonal cutting off the upper-right corner must move to the upper-left. At the lower-right edge, the inward-pointing triangular notch must move to the lower-left edge.

Step 2: Reflect the internal lines The large centred triangle and the central vertical pendant stay centred, because left-right reflection does not move points on their vertical centre line. The small central square also stays in place, but its diagonal changes from a rising line from lower-left to upper-right into a falling line from upper-left to lower-right. The filled dot remains on that reflected diagonal, while the small open circle remains below the centre at the same height.

Step 3: Check all four options Option (B) correctly puts the corner diagonal and notch on the left, the short vertical line on the right, and reverses the central square's diagonal. Option (A) largely keeps the original arrangement, so it is not mirrored. Option (C) moves some upper details but leaves the central diagonal and lower-right notch in their original directions. Option (D) reverses the main triangular arrangement vertically and loses the required central diagonal. These contradictions rule out all except (B).

Step 4: Conclusion All landmarks match the left-right reflection only in option (B). Hence, the correct option is (B).

Quick Tip to Solve: Track three asymmetric landmarks across the mirror, then verify the central diagonal; one matching corner alone can be misleading.

46. Identify the most used building material seen in the facade of the building. [4 marks]



(A) Sand Stone
(B) Granite
(C) Marble
(D) Slate

Correct Answer: (C) Marble

Solution:

Concept:

- A building-material identification question is answered from the exposed facade, rather than from the colour of a plinth or the surrounding ground.
- Marble is a crystalline stone widely used for pale polished facades, intricate carving and decorative inlay. Sandstone, granite and slate have different characteristic architectural uses and appearances.

Step 1: Identify the visible building and surface The photograph shows the tomb of Itimad-ud-Daulah in Agra: a low, pale main pavilion, four slender corner towers and richly decorated facade panels. The extensive light-coloured facing of the pavilion and towers is the material the question asks us to identify. The reddish lower platform occupies a different part of the composition and should not determine the answer.

Step 2: Connect the facade to marble The tomb is distinguished by its white marble facing and delicate surface ornament. The pale stone forms the continuous visible wall surfaces, arches and tower faces, with decorative inlay providing contrasting patterns. Thus marble describes the predominant facade material, even though the building contains other materials and its ornament is not a single uniform colour.

Step 3: Rule out the alternatives Sandstone is common in many Mughal buildings and can occur in their bases, but it does not describe the principal white facing shown here. Granite is a hard igneous stone, often with a visibly granular texture, and is not the characteristic facing of this monument. Slate is typically a dark, thinly splitting stone used as slabs or roofing; it does not account for these pale, elaborately carved facade surfaces. The visible architectural character and identification therefore support marble.

Step 4: Conclusion Marble is the predominant material seen in the facade. Hence, the correct option is (C).

Quick Tip to Solve: Identify the monument, then focus on its main wall facing; a red plinth or contrasting inlay need not be the dominant facade material.

47. Identify the name of the monument. [4 marks]



(A) Tower of Victory

(B) Connaught Place

(C) The Pantheon

(D) The Parthenon

Correct Answer: (D) The Parthenon

Solution:

Concept:

- Monuments can be distinguished by their massing, roof form, column arrangement and structural style. A recognisable combination of features is more reliable than a single column.
- A Greek temple typically presents a rectangular plan, an external colonnade and a triangular pediment. The Parthenon is the celebrated temple on the Acropolis in Athens.

Step 1: Read the main architectural features The image shows the remains of a rectangular temple standing on a raised stone base. Closely spaced fluted columns extend along the front and long side, supporting a straight entablature. The surviving gabled end has the form of a triangular pediment. These features identify a classical Greek temple with an exterior colonnade.

Step 2: Match the temple to the Parthenon The Parthenon is recognised by this rectangular colonnaded form, its Doric columns and its surviving temple ruins on the Acropolis. The photographed building is therefore the Parthenon. Its long side is open between rows of columns, rather than enclosing the circular domed body associated with the similarly named Pantheon.

Step 3: Separate the similar and unrelated choices The Pantheon in Rome has a columned entrance portico attached to a large circular rotunda and dome; that overall form is different from this long rectangular Greek temple. Connaught Place is a modern urban commercial ensemble with curved blocks and colonnades, not an ancient temple ruin. The Tower of Victory is a tall, intricately carved Indian tower, so its vertical massing differs completely. Eliminating these alternatives leaves the Parthenon, consistent with every major feature in the image.

Step 4: Conclusion The monument is the Parthenon in Athens. Hence, the correct option is (D).

Quick Tip to Solve: Distinguish the two names by form: Parthenon means the rectangular Greek temple; Pantheon means the Roman domed rotunda with a portico.

48. Which book by Robert Venturi is considered as pivoted text in the development of post modern architecture? [4 marks]

(A) The timeless way of building

(B) The poetics of space

(C) Complexity and contradiction in architecture

(D) Architecture : Form, Space and Order

Correct Answer: (C) Complexity and contradiction in architecture

Solution:

Concept:

- Robert Venturi challenged the severe simplification associated with orthodox modern architecture. His writing supported complexity, historical references and the coexistence of apparently contradictory architectural ideas.
- Identifying an architectural theory book requires matching both its author and its intellectual contribution. A familiar title about buildings is insufficient if it belongs to a different writer or theoretical tradition.

Step 1: Identify the work associated with Venturi Robert Venturi wrote *Complexity and Contradiction in Architecture*, published in 1966. Its argument valued richness, ambiguity and layered meaning in architecture rather than reducing every design to a single pure formal idea. This makes it a foundational text in the development of postmodern architectural thinking. Both the named author and the historical role specified in the question therefore point to the same title.

Step 2: Eliminate the other authors and titles *The Timeless Way of Building* is associated with Christopher Alexander and his approach to patterns and the quality of built environments. *The Poetics of Space* is by Gaston Bachelard and concerns the experience and imagination of inhabited spaces. *Architecture: Form, Space and Order* is by Francis D. K. Ching and explains architectural elements and ordering principles. These are significant works, but none is the Venturi book named by the question. Option (C) alone meets both the authorship test and the connection with postmodern architecture.

Step 3: Conclusion The book is *Complexity and Contradiction in Architecture* by Robert Venturi. Hence, the correct option is (C).

Quick Tip to Solve: Pair Venturi with complexity and contradiction; pair Alexander with patterns, Bachelard with poetic space, and Ching with form and spatial order.

49. Which material is used traditionally to make Sandpaper? [4 marks]

(A) Brick

(B) Silica

(C) Iron

(D) Rubber

Correct Answer: (B) Silica

Solution:

Concept:

- Sandpaper is a coated abrasive: hard particles attached to a flexible backing remove small amounts of material by rubbing.
- The abrasive grains must be harder than the surface being smoothed. Silica, commonly occurring as quartz sand, provides hard mineral grains suitable for this traditional use.

Step 1: Identify the working component Separate the backing from the material that actually does the cutting. The paper or cloth carries many small abrasive grains. When the sheet is rubbed over wood or another surface, the exposed grain edges scratch down high spots and produce a smoother finish. Thus the question asks for the traditional abrasive, rather than a cushioning material or a structural building product.

Step 2: Compare the four materials Silica is the appropriate hard mineral abrasive among the choices. Brick is a manufactured masonry unit and is not the conventional name for the abrasive coating of sandpaper. Iron is a metal, rather than the traditional sand coating meant here. Rubber is relatively flexible and is useful as a pad or backing component; it does not provide the hard cutting grains required for the stated purpose. Modern abrasive papers may use other minerals, but that does not change the traditional identification asked in this question.

Step 3: Conclusion Silica is traditionally used as the abrasive material in sandpaper. Hence, the correct option is (B).

Quick Tip to Solve: For abrasive-material questions, identify the hard grains that cut the surface, rather than the flexible backing that holds them.

50. The 'Sagrada Familia' in Barcelona, a masterpiece of unique design and organic forms, was designed by: [4 marks]

(A) Antoni Gaudi

(B) Santiago Calatrava

(C) Renzo Piano

(D) Zaha Hadid

Correct Answer: (A) Antoni Gaudi

Solution:

Concept:

- Architectural awareness questions often require matching a landmark with the architect most closely associated with its design.
- The Sagrada Familia in Barcelona is the celebrated basilica associated with Antoni Gaudi. Its nature-inspired forms are characteristic of his architectural work.

Step 1: Use the landmark and design clues The question gives both the building name and its city: Sagrada Familia, Barcelona. It also mentions organic forms, meaning forms inspired by natural structures and growth. Gaudi used this approach in the basilica, including branching, tree-like columns and an unusually sculptural treatment of the building. These clues identify the architect much more specifically than the general fact that the building has an unusual design.

Step 2: Eliminate the other architects Santiago Calatrava is known for expressive structural and engineering-led designs, but he is not the architect associated with the Sagrada Familia. Renzo Piano is a major contemporary architect whose works include the Centre Pompidou as a co-designer; that is a different landmark. Zaha Hadid is associated with fluid contemporary forms, but similarity in descriptive words does not make her the designer of this Barcelona basilica. The named building and its architectural history determine the answer, so Antoni Gaudi is the matching choice.

Step 3: Conclusion The Sagrada Familia is associated with the design of Antoni Gaudi. Hence, the correct option is (A).

Quick Tip to Solve: Memorise the linked trio Barcelona–Sagrada Familia–Gaudi; the organic, nature-inspired forms provide a useful confirming clue.

51. Pointed arches and flying buttresses were the prominent architectural style introduced in:

[4 marks]

(A) Romanesque

(B) Renaissance

(C) Gothic

(D) Baroque

Correct Answer: (C) Gothic

Solution:

Concept:

- Architectural styles can be recognised from recurring structural elements as well as ornament.
- Pointed arches and flying buttresses are characteristic Gothic elements. Together with ribbed vaulting, they enabled tall church interiors and large window openings.

Step 1: Identify the structural combination A pointed arch has two curved sides meeting at an apex, rather than the semicircular profile associated especially with Romanesque architecture. A flying buttress transfers outward thrust across an open space to an external support. The combination allows the walls to carry less lateral load and makes a taller, lighter-looking interior with larger glazed openings possible. This combination is the familiar identifying vocabulary of Gothic cathedral architecture.

Step 2: Distinguish the alternatives Romanesque architecture is more commonly recognised by round arches, heavy masonry and relatively small openings. Renaissance architecture draws strongly on classical orders, proportion and revived Greek and Roman forms. Baroque architecture emphasises dramatic spatial effects, movement and rich treatment of surfaces. Although later buildings can reuse earlier elements, the question asks for the style prominently associated with the listed structural features. Among these four choices, that identification is Gothic rather than any of the other historical styles.

Step 3: Conclusion Pointed arches and flying buttresses are prominent features of Gothic architecture. Hence, the correct option is (C).

Quick Tip to Solve: Pair Gothic with pointed arches, ribbed vaults and flying buttresses; contrast this cluster with the round arches of Romanesque buildings.

52. **"Acoustical Design" deals with:** [4 marks]

(A) Structure of building

(B) Sound in the building

(C) Ventilation of the building

(D) Facade design

Correct Answer: (B) Sound in the building

Solution:

Concept:

- Acoustics is the study of sound, including its production, transmission, reflection and absorption.
- Acoustical design applies these principles to buildings so that speech or music is heard appropriately and unwanted noise is controlled.

Step 1: Relate the term to building performance In a room, sound can travel directly from its source to a listener or reach the listener after reflecting from walls, ceilings and other surfaces. The selection of room shape and finishes affects reverberation, echoes and clarity. Acoustical design considers these effects, along with sound insulation between spaces. An auditorium, classroom or recording room therefore needs acoustical decisions suited to its intended activity.

Step 2: Separate acoustics from the other services The structure of a building primarily concerns safe load carrying through members such as beams, columns and foundations. Ventilation concerns the movement and renewal of air and the removal of indoor pollutants or heat. Facade design concerns the external envelope and appearance, although a facade can also contribute to sound insulation. These fields may interact during a real project, but their defining subject is different. The word acoustical specifically identifies sound as the primary concern, which matches only the second option.

Step 3: Conclusion Acoustical design deals with sound in the building. Hence, the correct option is (B).

Quick Tip to Solve: Connect acoustics with hearing: echo, reverberation, speech clarity and noise insulation all point to the sound performance of a space.

53. **What is the primary purpose of using a 'mullion' in window design?** [4 marks]

(A) For decoration

(B) To enhance ventilation

(C) To support the glass within the window frame

(D) To block sunlight

Correct Answer: (C) To support the glass within the window frame

Solution:

Concept:

- A mullion is a vertical member dividing a window opening into separate lights or glazed units.
- Besides separating the units visually, the mullion provides a framing and support function. Its

primary role is functional rather than merely ornamental.

Step 1: Identify the member within the opening A window opening may be too wide to be treated as one undivided glazed panel. A mullion provides an intermediate vertical framing member between adjacent parts. The glass is held within the framed glazing units, and the mullion helps support and subdivide that assembly. It should be distinguished from a transom, which is a horizontal dividing member. This structural and framing role is the feature being tested.

Step 2: Match the role to the options Supporting the glass within the window frame is the closest description among the choices. A mullion can contribute to the visual rhythm of a facade, but decoration is not its primary defining purpose. Ventilation depends mainly on whether and how the window sashes or other openings can be opened; a vertical divider does not itself create ventilation. Blocking sunlight is primarily the role of shading devices such as louvers, fins or overhangs. A mullion may cast a small shadow, but that incidental effect does not define the component.

Step 3: Conclusion A mullion supports and divides the glazed window assembly. Hence, the correct option is (C).

Quick Tip to Solve: Remember the orientation first: mullion is vertical, transom is horizontal; both belong to the framing and subdivision of an opening.

54. The usable area of floor is called: [4 marks]

(A) Carpet area

(B) Plinth area

(C) Surface area

(D) Built-up area

Correct Answer: (A) Carpet area

Solution:

Concept:

- Carpet area denotes the usable floor area of an interior, as distinguished from the larger area occupied by the building construction.
- Plinth area and built-up area include the footprint of enclosing construction such as walls, so they are not simply the usable floor surface referred to here.

Step 1: Interpret usable floor area The question asks for a name, not for a numerical area calculation. In standard architectural terminology, carpet area refers to the floor area available for use inside the premises. The intuitive idea is the floor that can be used or covered, rather than the full outer dimensions of the building measured across its walls. Detailed measurement rules can distinguish particular enclosed spaces, but the central usable-versus-built distinction resolves this general aptitude question.

Step 2: Compare the competing area terms Plinth area is generally measured as the covered built-up area at floor level, including wall thicknesses within the outer dimensions. Built-up area likewise goes beyond the net usable interior and includes construction components. Surface area is a general

geometrical term that could apply to walls, roofs or many other surfaces; it does not specifically name the usable floor area of a building. Carpet area is therefore the only term among the four that directly answers the wording. Do not substitute a larger construction-area measure merely because all of these quantities can be expressed in square metres.

Step 3: Conclusion The usable floor area is called carpet area. Hence, the correct option is (A).

Quick Tip to Solve: When usable interior floor is the clue, choose carpet area; when outer building dimensions and wall thicknesses enter, consider built-up or plinth area.

55. Name the place where 'Statue of Unity' is situated. [4 marks]

(A) Gandhinagar, Gujarat

(B) Kadi, Gujarat

(C) Anand, Guajarat

(D) Kewadia, Gujarat

Correct Answer: (D) Kewadia, Gujarat

Solution:

Concept:

- The Statue of Unity is the monumental statue of Sardar Vallabhbhai Patel in Gujarat.
- Its location is associated with Kevadia, also written as Kewadia, near the Sardar Sarovar Dam in the Narmada region. The locality is also known as Ekta Nagar.

Step 1: Identify the specific locality All four options name places in Gujarat, so knowing only the state does not decide the answer. The Statue of Unity stands near Kevadia and the Sardar Sarovar Dam. The spelling Kewadia in the fourth option refers to that same locality. This geographic association is the key fact: the landmark is linked with the Narmada setting rather than with the state capital or another well-known city.

Step 2: Reject the other Gujarat locations Gandhinagar is the state capital, but the statue is not situated there. Kadi and Anand are also Gujarat locations, yet neither is the locality of the Statue of Unity. The spelling variation in Kewadia should not distract from the familiar place name Kevadia. In landmark-location questions, use the closest relevant locality supplied by the options rather than selecting a prominent city from the same state. Here the fourth choice is the precise match, whereas the other choices share only the state and not the site of the monument.

Step 3: Conclusion The Statue of Unity is situated at Kewadia (Kevadia), Gujarat. Hence, the correct option is (D).

Quick Tip to Solve: Link Statue of Unity with Kevadia, the Narmada region and Sardar Sarovar Dam; simply recalling Gujarat does not distinguish these options.

56. What is the proportional relationship in classical architecture, represented as 1.628? [4 marks]

(A) Fibonacci sequence

(B) Symmetry ratio

(C) Golden ratio

(D) Modular scale

Correct Answer: (C) Golden ratio

Solution:

Concept:

- The golden ratio is the proportion obtained when a segment is divided so that the whole-to-larger-part ratio equals the larger-to-smaller-part ratio.
- Writing this positive ratio as ϕ, its value is $\phi = (1+\sqrt{5})/2 \approx 1.618$. It is widely discussed in relation to proportion in art and architecture.

Step 1: Derive the characteristic proportion Let the larger and smaller parts have positive lengths a and b. The golden-section condition is $(a+b)/a = a/b = \phi$. Since $b/a = 1/\phi$, this gives $\phi = 1 + 1/\phi$, or $\phi^2 - \phi - 1 = 0$. The positive solution is $(1+\sqrt{5})/2$, approximately 1.618. The printed 1.628 is close to this familiar value but is not its correct numerical approximation; the named architectural proportion intended by the choices is the golden ratio.

Step 2: Compare the descriptions The Fibonacci sequence is a sequence of numbers, not itself the name of a single proportional relationship, although ratios of successive terms approach the golden ratio. A symmetry ratio does not identify the golden-section division, and symmetry can exist without it. A modular scale is a system of related dimensions that may use various chosen ratios, so it is not uniquely represented by this particular characteristic value. Thus the conceptual identification is the golden ratio, while keeping its correct value distinct from the number printed in the question.

Step 3: Conclusion The intended proportional relationship is the golden ratio, whose correct value is approximately 1.618 rather than the printed 1.628. Hence, the correct option is (C).

Quick Tip to Solve: Use the defining equation $\phi^2 = \phi + 1$ to recognise the golden ratio and to check a questionable decimal approximation.

57. Rings of the wooden log represents: [4 marks]

(A) Strength of wood

(B) Age of the wood

(C) Colour of wood

(D) Defects of wood

Correct Answer: (B) Age of the wood

Solution:

Concept:

- Growth rings are concentric layers of secondary wood produced by the vascular cambium. Seasonal differences in growth make successive layers visible in a cut trunk.
- In trees with a clear annual growth cycle, one earlywood and latewood pair constitutes an annual ring. Counting these rings estimates the age of the stem at the level where it is cut.

Step 1: Identify what a ring records During a favourable growing season the tree produces relatively rapid growth, followed by slower growth when conditions change. The difference in cell size and density creates a visible boundary in the wood. Repetition of this cycle leaves a sequence of concentric rings around the pith. Thus the rings are primarily a record of elapsed growth cycles rather than a direct measurement of a mechanical property.

Step 2: Compare the four interpretations Age is therefore the relevant information obtained by counting annual rings, so option (B) matches the question. Strength depends on factors including species, density, grain direction, moisture and defects; simply counting rings does not give strength. Colour depends on species and heartwood or sapwood characteristics. Defects such as knots and shakes may be visible in a log, but the normal concentric growth rings are not themselves a count of those defects.

Step 3: Conclusion The rings of a wooden log represent the age of the wood or tree. Hence, the correct option is (B).

Quick Tip to Solve: For timber questions, connect annual rings with age; distinguish ring count from strength, colour and knots.

58. Which ancient civilization is credited with inventing the arch, a fundamental structural element in architecture? [4 marks]

(A) Greek

(B) Roman

(C) Egyptian

(D) Mesopotamian

Correct Answer: (D) Mesopotamian

Solution:

Concept:

- A true arch spans an opening using wedge-shaped units arranged along a curve. Its load is carried mainly through compression towards supports on either side.
- The earliest development of the arch is associated with ancient Mesopotamia. Roman architecture later developed and employed arches extensively in major engineering works.

Step 1: Identify the earliest origin The question asks which civilization is credited with inventing the arch, rather than which civilization made the arch a dominant feature of monumental architecture. Early examples of true arches occur in ancient Mesopotamian construction. This historical distinction is decisive: the invention and the later widespread application of a structural technique need not belong to the same civilization.

Step 2: Distinguish invention from extensive use Mesopotamian is the matching choice, option (D). Roman is a tempting alternative because Roman aqueducts, bridges, amphitheatres and vaults made systematic use of arches, but this represents extensive development and adoption rather than the earliest invention. Greek monumental architecture is principally associated with the post-and-lintel system. Egyptian monuments likewise do not establish Egypt as the standard answer for the earliest invention of the true arch. These associations separate the distractors from the requested origin.

Step 3: Conclusion Ancient Mesopotamian civilization is credited with the invention of the arch. Hence, the correct option is (D). The key gives Roman, but the wording asks for the invention rather than the later extensive Roman use; the historically earlier Mesopotamian origin supports Mesopotamian.

Quick Tip to Solve: When Rome appears beside Mesopotamia, check whether the question asks for widespread use or the early invention of the arch.

59. Which architectural structure in Paris is known for its iconic wrought iron lattice work and was completed in 1889? [4 marks]

(A) Notre Dame Cathedral

(B) Louvre Museum

(C) Eiffel Tower

(D) Arc de Triumph

Correct Answer: (C) Eiffel Tower

Solution:

Concept:

- A landmark can be identified by combining its location, construction material, structural form and completion date.
- The Eiffel Tower in Paris is a wrought-iron lattice tower completed in 1889 for the international exposition. Its open metal framework is its identifying structural feature.

Step 1: Combine the identifying clues The given structure is in Paris, uses wrought iron in lattice work, and was completed in 1889. The Eiffel Tower fits all three clues together. The word lattice describes the open network of metal members rather than a solid masonry wall. It is therefore more useful here than merely recognising that all four choices are well-known Parisian landmarks.

Step 2: Eliminate the masonry alternatives Notre Dame Cathedral is a medieval Gothic cathedral distinguished by stone architecture, pointed arches and flying buttresses, not an 1889 iron lattice tower. The Louvre Museum is a palace and museum complex rather than the specified lattice structure. The Arc de Triumph, conventionally called the Arc de Triomphe, is a monumental masonry triumphal arch. Neither its form nor its material matches the description. Option (C), the Eiffel Tower, alone satisfies the combined date and structural-material clues.

Step 3: Conclusion The structure is the Eiffel Tower. Hence, the correct option is (C).

Quick Tip to Solve: Use the combination Paris, wrought-iron lattice and 1889 to identify the Eiffel Tower immediately.

60. 'Char bagh' concept is an important characteristic of which Garden style? [4 marks]

(A) Chinese Garden

(B) Mughal Garden

(C) Japanese Garden

(D) French Garden

Correct Answer: (B) Mughal Garden

Solution:

Concept:

- Char bagh means four gardens: it describes a garden divided into four principal parts by intersecting axes, paths or water channels.

- The Persian-derived char bagh layout became a characteristic feature of Mughal garden design, combining axial symmetry, geometry and water.

Step 1: Recognise the four-part composition In a char bagh layout, two main axes divide the garden into four quarters. Paths and water channels define the organisation, and the intersection provides a strong centre. Repetition and symmetry give the composition an ordered appearance. The term therefore refers to a recognisable planning system, rather than merely to any garden containing four plants or four ornamental features.

Step 2: Match the layout to the garden tradition Mughal gardens are strongly associated with this Persian-derived four-part arrangement, so option (B) is the appropriate answer. Chinese gardens commonly use varied sequences of scenic spaces and naturalistic composition. Japanese gardens have their own traditions of symbolic landscapes, rocks and carefully composed views. French formal gardens can also be geometrical and axial, but geometric order alone does not make the specifically named char bagh a French concept. The distinctive term and four-quarter organisation identify the Mughal tradition.

Step 3: Conclusion The char bagh concept is an important characteristic of Mughal gardens. Hence, the correct option is (B).

Quick Tip to Solve: Remember char as four: four quarters divided by axes and channels point to a Mughal char bagh.

61. If a room is painted with dark colour, what will be the appeareance of the room? [4 marks]

(A) Room will appear smaller than the original room size

(B) Room will appear larger then the original room size

(C) Room will look brighter and appear larger than the original size.

(D) Room will look brighter

Correct Answer: (A) Room will appear smaller than the original room size

Solution:

Concept:

- Surface colour affects the amount of visible light reflected into an interior and hence its perceived brightness and spaciousness.
- Under comparable lighting conditions, dark finishes generally reflect less light than light finishes. Dark enclosing surfaces commonly produce a more compact or enclosed visual impression.

Step 1: Relate dark paint to light reflection A dark wall absorbs a greater proportion of incident light and reflects less back into the room than a pale wall under similar conditions. Consequently, the interior generally looks less bright. This changes the visual impression of its enclosing surfaces; it does not alter the actual length, width, height or floor area of the room.

Step 2: Select the perceived spatial effect The conventional interior-design effect tested here is that dark-coloured enclosing surfaces make a room appear smaller and more enclosed, matching option (A). Option (B) asserts the opposite spatial effect. Option (C) claims both greater brightness

and greater apparent size, neither of which follows from uniformly dark painting under comparable illumination. Option (D) also incorrectly predicts greater brightness. Particular accent walls and carefully designed lighting can create special effects, but the question asks for the usual general effect of painting a room dark.

Step 3: Conclusion The room will generally appear smaller than its original size. Hence, the correct option is (A).

Quick Tip to Solve: Separate physical dimensions from visual impression: dark enclosing finishes usually reduce perceived brightness and spaciousness.

62. The ground floor plan of a building has 3 entrances. If each entrance can be connected by stairs or an elevator externally, in how many ways can a person enters the building through the entrance? [4 marks]

(A) 03

(B) 06

(C) 09

(D) 12

Correct Answer: (B) 06

Solution:

Concept:

- When a task requires one choice from each of two independent sets, the multiplication principle gives $N = m \times n$, where m and n are the respective numbers of choices.
- An entry route here is specified by both the selected entrance and the selected access method. Stairs and elevator are two distinct methods for each entrance.

Step 1: Count the alternatives for one entrance There are three distinct entrances. For any fixed entrance, a person may use either stairs or an elevator externally. These are two alternatives, not successive stages that the person must both use. Thus entrance 1 provides two routes, entrance 2 provides two routes, and entrance 3 provides two routes. The same counting rule applies to each entrance.

Step 2: Combine the entrance and method choices Label the entrances 1, 2 and 3. The six entry possibilities are 1 by stairs, 1 by elevator, 2 by stairs, 2 by elevator, 3 by stairs and 3 by elevator. Equivalently,

$$N = 3 \times 2 = 6.$$

Option (A), 03, counts entrances but ignores the method. Option (C), 09, would require three methods per entrance, which are not given. Option (D), 12, would require an additional independent factor of two, also absent. Counting exits or both entry and return journeys would answer a different question.

Step 3: Conclusion There are 6 distinct entrance-and-access-method combinations. Hence, the correct option is (B). The supplied key gives 03, counting entrances alone; including the two access alternatives explicitly stated in the question gives 6 instead.

Quick Tip to Solve: Represent each route as an ordered pair (entrance, method), then multiply three entrances by two access methods.

63. Given below are two statements:

Statement I: The concept of "form follows function" suggest that a building's design should primarily consider its use.

Statement II: The concept of "form follows functions" means that aesthetics should take precedence over functionality.

In the light 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: (C) Statement I is true but Statement II is false

Solution:

Concept:

- Form follows function is a design principle in which the organisation and physical expression of a building respond to its intended purpose.
- Functional requirements include activities, circulation, access, accommodation and environmental needs. The principle gives these requirements priority in determining form without requiring all aesthetic concerns to disappear.

Step 1: Evaluate Statement I Statement I says that the design should primarily consider the use of the building. This expresses the essential meaning of form follows function: a school, hospital and warehouse have different functional requirements, so their planning and forms should respond to those differences. The statement correctly identifies use as a principal design driver and is therefore true.

Step 2: Evaluate Statement II and select the combination Statement II says aesthetics should take precedence over functionality. This reverses the priority expressed by the principle: under form follows function, visual form responds to functional needs rather than overriding them. The statement is therefore false. This does not mean that a functional building cannot be beautiful; it means beauty is not the stated reason for sacrificing the intended use. Option (A) wrongly accepts Statement II, option (B) wrongly rejects Statement I, and option (D) reverses both truth values. Option (C) correctly combines true I with false II.

Step 3: Conclusion Statement I is true but Statement II is false. Hence, the correct option is (C).

Quick Tip to Solve: Read follows as responds to: the building form responds to its function, so an aesthetics-first reversal is false.

64. Given below are two statements:

Statement I: The sun has a maximum altitude of 90° on Tropic of Capricorn on 22nd June at 12 noon and gradually decreases thereafter till 22nd December.

Statement II: The tilt of earth on axis of 23.5° has no role to play in the change of altitude of sun on Tropic of Capricorn.

In the light 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: (B) Both Statement I and Statement II are false

Solution:

Concept:

- At local solar noon, solar altitude is $h = 90^\circ - |\phi - \delta|$, where ϕ is latitude and δ is the solar declination.
- The Tropic of Capricorn is at approximately 23.5° south. Earth's axial tilt causes declination to vary between approximately 23.5° north and 23.5° south during the year.

Step 1: Check the dates and altitude in Statement I Take southern latitude as negative, so Capricorn has $\phi = -23.5^\circ$. Around 22 June, the Sun has northern declination $\delta = +23.5^\circ$. Hence

$$h = 90^\circ - |-23.5^\circ - 23.5^\circ| = 43^\circ.$$

Around 22 December, declination is approximately -23.5°, giving $h = 90^\circ$. Thus June is not the overhead-Sun maximum at Capricorn; the maximum occurs around the December solstice. From June towards December the noon altitude increases overall. Statement I is false.

Step 2: Check the role of tilt in Statement II The approximately 23.5° axial tilt is precisely what produces the annual north-south change in the overhead Sun's position and therefore the change in noon solar altitude at Capricorn. Saying that this tilt has no role is false. Both statements are false, which is option (B). Options (A) and (C) incorrectly accept Statement I, while option (D) incorrectly accepts Statement II. The distinction between the two tropics is essential: the June overhead Sun is associated with Cancer, not Capricorn.

Step 3: Conclusion Both Statement I and Statement II are false. Hence, the correct option is (B). The supplied key treats Statement I as true, but Capricorn has its overhead Sun near the December solstice, so the printed June claim in Statement I is false as well as Statement II.

Quick Tip to Solve: June overhead Sun: Cancer; December overhead Sun: Capricorn. Use signed latitude and declination to check the noon altitude.

65. Given below are two statements:

Statement I: 'Granite' is the hardest stone.

Statement II: 'Marble' is a soft stone.

In the light 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: (D) Statement I is false but Statement II is true

Solution:

Concept:

- Hardness is resistance to scratching and differs from strength, toughness and resistance to weathering. A stone may be a durable building material without being the hardest stone.
- Granite is a hard igneous building stone, but its minerals have different hardnesses. Marble is principally calcite and is relatively soft compared with granite and quartz-rich stone.

Step 1: Assess the claim about granite Statement I makes an absolute claim: granite is the hardest stone. Granite is hard and durable, but that does not establish the superlative. Its principal minerals include quartz, feldspar and mica; quartz has Mohs hardness 7, feldspar about 6, and mica is softer. Other stones and minerals can be harder. Consequently, the general claim that granite is the hardest stone is false. Do not confuse its common use for paving and worktops with being the hardest material.

Step 2: Assess marble and combine the results Marble is a metamorphic rock consisting mainly of calcite, whose Mohs hardness is about 3. It is readily carved and polished and is relatively soft in the building-stone comparison used here. Statement II is therefore true. The required combination is false for I and true for II. Option A wrongly accepts the absolute granite claim, B wrongly rejects the marble statement, and C reverses both truth values.

Step 3: Conclusion Statement I is false and Statement II is true. Hence, the correct option is (D).

Quick Tip to Solve: Treat words such as hardest as absolute claims; distinguish hardness from the durability of a building stone.

66. Given below are two statements:

Statement I : "Wind speed" should be considered while designing tall buildings.

Statement II : "Buildings" should be rigid in an earthquake high risk zone.

In the light of 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: (C) Statement I is true but Statement II is false

Solution:

Concept:

- Tall buildings experience lateral wind forces; the design wind speed helps determine pressure, lateral displacement and occupant comfort.
- Earthquake resistance requires a suitable load path, strength and ductility. A blanket demand for rigidity alone does not ensure seismic safety.

Step 1: Check the wind-speed statement Wind acts on the exposed surfaces of a tall building and produces lateral force and overturning moment. Wind pressure depends strongly on speed; for otherwise comparable conditions its dynamic component varies approximately with the square of wind speed. Height, terrain and the shape of the building also affect the response. The structural designer must therefore consider the appropriate design wind speed and check both safety and movement. Statement I is true.

Step 2: Check the earthquake statement Earthquake shaking imposes ground motion and cyclic deformation. A safe building needs adequate strength, detailing and ductile behaviour so it can dissipate energy without sudden brittle failure. Merely making a building rigid can attract large forces and does not provide this deformation capacity. Although stiffness must be designed and drift controlled, the unrestricted assertion that buildings should be rigid is not the correct seismic design principle. Statement II is false. Thus A wrongly accepts II, B wrongly rejects I, and D reverses the correct evaluations.

Step 3: Conclusion Statement I is true but Statement II is false. Hence, the correct option is (C).

Quick Tip to Solve: For wind remember lateral pressure and sway; for earthquakes remember strength together with ductility, rather than rigidity alone.

67. Match the LIST-I with LIST-II

LIST-I (Building)		LIST-II (Shape)	
A.	Sanchi Stupa	I.	Cylinder
B.	Circular Column	II.	Triangular Surfaces
C.	Pyramid	III.	Dome
D.	Palaces	IV.	Cuboids

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

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

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

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

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

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

Solution:

Concept:

- Architectural forms can be associated with familiar three-dimensional solids by identifying their dominant mass or surface.
- A cylindrical column has a circular cross-section, a dome is a rounded covering, and a pyramid has triangular lateral faces.

Step 1: Match the three distinctive geometries The main hemispherical mass of Sanchi Stupa is associated with a dome, so A matches III. A circular column extends a circular cross-section along its height and is therefore cylindrical: B matches I. A pyramid has triangular lateral surfaces meeting at its apex, so C matches II. Its base need not be triangular; the relevant description here is the set of sloping side faces. These identifications use the visible geometric feature named in each entry.

Step 2: Complete and check the matching code The remaining association is palaces with cuboids, D-IV, referring to the simplified rectangular volumes used to describe their built mass. It does not mean that every decorative part of a palace is a cuboid. Together the matches are A-III, B-I, C-II and D-IV. Only option B contains all four. Option A makes the stupa cuboidal and the column domical, C makes the stupa cylindrical and the column cuboidal, and D assigns triangular surfaces to the stupa. Each therefore contradicts a direct shape identification.

Step 3: Conclusion The matching is A-III, B-I, C-II, D-IV. Hence, the correct option is (B).

Quick Tip to Solve: Anchor a form-matching question with a distinctive pair such as circular column-cylinder, then verify every remaining pair.

68. Match the LIST-I with LIST-II

LIST-I		LIST-II	
A.	Column and Beam	I.	Aesthetics
B.	Trees and Plants	II.	Services
C.	Building form	III.	Landscape
D.	Water supply	IV.	Structures

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

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

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

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

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

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

Solution:

Concept:

- Building design includes structural systems, landscape, visual form and services. Classify each component by its main function.
- Load-bearing elements belong to structures; planting belongs to landscape; appearance belongs to aesthetics; utilities belong to services.

Step 1: Match physical support and outdoor planting Columns and beams form a structural framework: beams transfer loads to their supports, and columns carry loads towards the foundations. Thus A matches IV, Structures. Trees and plants are living elements used to organize and improve outdoor spaces, provide shade and contribute to the site environment. They are therefore part of landscape, giving B-III. Their environmental and visual benefits do not change their primary classification in this list.

Step 2: Match visual form and water distribution Building form means the shape, proportions and arrangement of the built mass. In the offered categories it is associated with aesthetics, so C-I. Water supply is a utility system involving the provision, storage and distribution of water and is classified under building services, so D-II. The complete code is A-IV, B-III, C-I, D-II. Option B alone gives these four links. A assigns columns and beams to services, C assigns them to landscape, and D assigns them to aesthetics; all three miss their load-bearing role. Checking water supply against services confirms the selected code.

Step 3: Conclusion The matching is A-IV, B-III, C-I, D-II. Hence, the correct option is (B).

Quick Tip to Solve: Ask what each component primarily does: support loads, organize planting, shape appearance, or deliver a utility.

69. Match the LIST-I with LIST-II

LIST-I		LIST-II	
A.	Sun Temple	I.	Tirupati
B.	Shiva Temple	II.	Pushkar
C.	Balaji Temple	III.	Modhera
D.	Brahma Temple	IV.	Ujjain

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

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

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

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

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

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

Solution:

Concept:

- Monument-location matching requires the association of a named temple with the place represented in the list.
- Use the familiar specific temple at each listed location, rather than assuming a generic temple name has only one example in India.

Step 1: Identify the Sun and Shiva temples The Sun Temple in the offered set of places is at Modhera in Gujarat, giving A-III. The Shiva Temple association is Ujjain, Madhya Pradesh, known for the Mahakaleshwar temple dedicated to Shiva, giving B-IV. India has several Sun and Shiva temples, so these matches are determined by the locations provided in List II. Neither the presence of other temples elsewhere nor a different famous example changes these matches within this question.

Step 2: Identify Balaji and Brahma and test the code Balaji refers here to Lord Venkateswara at Tirupati, more precisely the Tirumala temple complex associated with Tirupati in Andhra Pradesh. Hence C-I. The well-known Brahma Temple is at Pushkar in Rajasthan, so D-II. Combining all four gives A-III, B-IV, C-I and D-II, exactly option A. Option B puts the Sun Temple at Ujjain and Balaji at Modhera; C puts the Sun Temple at Pushkar and Brahma at Modhera; D puts the Sun Temple at Tirupati and Shiva at Modhera. These alternatives fail the landmark-location associations.

Step 3: Conclusion The matching is A-III, B-IV, C-I, D-II. Hence, the correct option is (A).

Quick Tip to Solve: Start with the distinctive Brahma-Pushkar or Sun Temple-Modhera pair, then check the other temple locations.

70. Match the LIST-I with LIST-II

LIST-I (Construction equipments)		LIST-II (Functions)	
A.	Buldozer	I.	Used for transporting smaller loads over short distances at site.
B.	Crane	II.	Mixes cement, sand and aggregate with water to produce concrete.
C.	Concrete Mixer	III.	Used to transport concrete to different location at site.
D.	Wheel Barrow	IV.	Used to level and move debris from the site.

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

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

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

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

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

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

Solution:

Concept:

- Construction equipment is classified by its primary operation: earthmoving, lifting, mixing or small-load transport.
- Identify the working action of the machine before comparing the Roman-numbered descriptions; the descriptions are deliberately shuffled.

Step 1: Identify the earthmoving and mixing machines A bulldozer uses its broad blade to push earth, debris or loose material and to help level a site. Its matching function is IV, so A-IV. A concrete mixer combines cement, sand, aggregate and water into a reasonably uniform concrete mix. This is function II, giving C-II. Mixing is distinct from moving already mixed concrete: the latter task does not describe the principal operation of a concrete mixer.

Step 2: Identify the lifting and short-distance transport machines A wheelbarrow carries smaller loads over short distances around a construction site, giving D-I. A crane lifts and moves suspended loads; it can move concrete in a suitable bucket to the required location on site, matching the available function III and giving B-III. This does not mean a crane is limited to concrete transport. The full code is A-IV, B-III, C-II, D-I, which is option D. A and B wrongly identify the bulldozer function and the mixer function. C wrongly assigns small-load transport to the bulldozer and earthmoving to the mixer. Testing all four associations avoids selecting a code on the basis of just one machine.

Step 3: Conclusion The matching is A-IV, B-III, C-II, D-I. Hence, the correct option is (D).

Quick Tip to Solve: Separate making concrete from transporting it; then pair the bulldozer with pushing debris and the wheelbarrow with small loads.

71. 'SDG' stands for: [4 marks]

(A) Sequential Design Goals

(B) Systematic Development Goals

(C) Strategic Development Goals

(D) Sustainable Development Goals

Correct Answer: (D) Sustainable Development Goals

Solution:

Concept:

- SDG is the standard abbreviation for Sustainable Development Goals in the United Nations development framework.
- Sustainability connects social well-being, economic development and environmental protection; it is broader than a design method or a planning sequence.

Step 1: Expand the abbreviation in its development context Read the three letters as S for Sustainable, D for Development, and G for Goals. The Sustainable Development Goals form the internationally recognized set of goals associated with the 2030 Agenda. They address interconnected concerns such as poverty, health, education, water, energy, sustainable communities and climate action. In a planning-awareness question this established development meaning is the relevant one, rather than a newly constructed expansion that happens to use the same initials.

Step 2: Compare every printed alternative Sequential Design Goals, option A, changes both the established first word and the development context. Systematic Development Goals, option B, preserves Development Goals but replaces Sustainable with Systematic. Strategic Development Goals, option C, likewise substitutes Strategic, which is a general descriptive word rather than the official expansion. Option D gives Sustainable Development Goals exactly. The shared letters alone cannot distinguish the alternatives because all four expansions were built to fit SDG; recalling the established full name resolves the question.

Step 3: Conclusion SDG stands for Sustainable Development Goals. Hence, the correct option is (D).

Quick Tip to Solve: For SDG, retain Sustainable as the first word; systematic and strategic are plausible distractors but are not the established expansion.

72. GRIHA stands for: [4 marks]

(A) Green Rating for Integrated Habitat Assessment

(B) Glare Rating for Integrated Heat Assessment

(C) Green Rating for Insulation Heat Assessment

(D) Glare Rating for Insulation Heat Assessment

Correct Answer: (A) Green Rating for Integrated Habitat Assessment

Solution:

Concept:

- GRIHA is an Indian green-building rating system whose established full name is Green Rating for Integrated Habitat Assessment.
- The name refers to assessment of a habitat or building in an integrated environmental framework, rather than a single measure of glare or heat.

Step 1: Recall the established full name Expand GRIHA as Green Rating for Integrated Habitat Assessment. The key words are Green, Rating, Integrated, Habitat and Assessment; the connecting word for appears in the full title. The rating concerns the environmental performance of the built environment through a broader assessment framework. It is not simply a glare index or an insulation test. Recognizing the full institutional name is necessary here because several alternatives retain the same initial letters while replacing its meaning.

Step 2: Eliminate the altered expansions Option A reproduces Green Rating for Integrated Habitat Assessment exactly. Option B replaces Green with Glare and Habitat with Heat, turning the title into an unrelated phrase. Option C keeps Green Rating but substitutes Insulation Heat for Integrated Habitat; those terms restrict the phrase to thermal considerations and do not give the recognized name. Option D changes both the opening word and the middle terms. Therefore only A preserves every substantive word in the correct order. Checking Habitat as well as Green prevents confusion between the two alternatives that begin with Green Rating.

Step 3: Conclusion GRIHA stands for Green Rating for Integrated Habitat Assessment. Hence, the correct option is (A).

Quick Tip to Solve: Remember the pair Integrated Habitat: it distinguishes GRIHA from distractors about insulation, glare or heat.

73. ECBC stands for: [4 marks]

(A) Electricity Conservation Building Code

(B) Electricity Consumption Building Code

(C) Energy Conversion Building Code

(D) Energy Conservation Building Code

Correct Answer: (D) Energy Conservation Building Code

Solution:

Concept:

- ECBC is the standard abbreviation of Energy Conservation Building Code. Its subject is the efficient use of energy in buildings rather than the conversion of one form of energy into another.
- A building energy code addresses energy performance through such features as the building envelope, lighting and building services. Conservation means reducing avoidable energy use while providing the intended conditions.

Step 1: Expand the abbreviation accurately Read the four letters in order: E represents Energy, C represents Conservation, B represents Building and the final C represents Code. The full expression is therefore Energy Conservation Building Code. The first word matters because building performance concerns energy use broadly; replacing it with Electricity does not reproduce the name. The question asks for the official expansion, so a phrase that merely sounds relevant to building efficiency is insufficient.

Step 2: Eliminate the altered expansions Option (A) changes Energy to Electricity, while option (B) changes both Energy and Conservation to Electricity and Consumption. Neither is the recognised title. Option (C) retains Energy but substitutes Conversion for Conservation. Energy conversion describes a physical transformation, whereas conservation in this title concerns efficient energy use. Option (D) preserves all four words in their proper order and is the only exact expansion.

Step 3: Conclusion ECBC stands for Energy Conservation Building Code. Hence, the correct option is (D).

Quick Tip to Solve: For ECBC, pair the first two letters with Energy Conservation; Electricity and Conversion are the distractor substitutions.

74. 'HRIDAY' stands for: [4 marks]

(A) Heritage City in Developed Association Yojana

(B) High Residential in Densified Augmented Yojana

(C) Heritage City Development and Augmentation Yojana

(D) Hermitage Centre of Development and Association Yojana

Correct Answer: (C) Heritage City Development and Augmentation Yojana

Solution:

Concept:

- HRIDAY expands to Heritage City Development and Augmentation Yojana, a programme associated with the conservation and development of urban heritage.
- The words Heritage City identify the setting, while Development and Augmentation describe improvements to the heritage environment and supporting urban infrastructure.

Step 1: Identify the full programme name Associate HRIDAY with heritage cities rather than with housing density or a single religious establishment. The recognised expansion is Heritage City Development and Augmentation Yojana. In this name, Development and Augmentation refer to improving the urban setting and services around a city heritage resource, with conservation central to its purpose. Treat the programme title as a complete phrase rather than trying to substitute a similar-sounding word for each letter.

Step 2: Compare the alternatives word for word Option (A) introduces Developed Association, which does not occur in the programme name. Option (B) describes high residential density and contains no reference to heritage cities, so it belongs to a different subject altogether. Option (D) substitutes Hermitage Centre and Association for Heritage City and Augmentation. A hermitage is not equivalent to the historic urban areas covered by this scheme. Only option (C) reproduces the recognised full name without either substitution.

Step 3: Conclusion HRIDAY stands for Heritage City Development and Augmentation Yojana. Hence, the correct option is (C).

Quick Tip to Solve: Remember HRIDAY as a heritage-city programme: the central phrase is Development and Augmentation.

75. What is the architectural term for a semi circular or polygonal recess, often found at the end of a church nave? [4 marks]

(A) Atrium

(B) Apse

(C) Cloister

(D) Ambulatory

Correct Answer: (B) Apse

Solution:

Concept:

- An apse is a semicircular or polygonal recess at the end of a church, often associated with the sanctuary and altar.
- Architectural elements are distinguished by both form and position. A recess at the termination of a nave is different from an entrance court, a covered courtyard walk or a circulation aisle.

Step 1: Use the shape and location together The question supplies two identifying clues: the feature is semicircular or polygonal, and it forms a recess at the end of a church nave. These are the characteristic features of an apse. The term identifies the terminal architectural space, not simply any curved route in a church. In a conventional church plan it commonly projects beyond the main body and gives a defined setting to the sanctuary or altar.

Step 2: Distinguish the other church spaces An atrium is a court or open central space and does not specifically name the terminal recess. A cloister is a covered walk, typically arranged around a courtyard, particularly in monastic buildings. An ambulatory is a passage or aisle used for circulation, often around the choir or apse. Its proximity to an apse can make it tempting, but it denotes the route around the space rather than the recess itself. Thus only Apse matches the combination of shape, form and location stated.

Step 3: Conclusion The architectural term is Apse. Hence, the correct option is (B).

Quick Tip to Solve: Use the distinction apse = end recess, ambulatory = circulation passage around it to avoid confusing neighbouring church elements.

Planning (100 marks)

76. Which of the following city is facing 'water crisis' and approaching towards 'Zero Day'? [4 marks]

(A) Hyderabad

(B) Bengaluru

(C) Indore

(D) Pune

Correct Answer: (B) Bengaluru

Solution:

Concept:

- In urban water discussions, Day Zero describes the critical point at which normal municipal water supplies may no longer meet the available demand and severe restrictions become necessary.
- The city associated with the water-crisis warning in this question is Bengaluru. The answer is a contextual identification, rather than a claim that every other listed city has unlimited water.

Step 1: Recognise the city linked to the warning Bengaluru experienced widely discussed urban water stress, including shortages in water-dependent neighbourhoods and concern about depleted local groundwater. The expression approaching Zero Day in the question refers to this crisis context. Rapid growth increases the quantity of water required, while dependence on groundwater and pressure on local water resources can make a city vulnerable when supplies are stressed. These clues identify Bengaluru among the four choices.

Step 2: Select the contextual match The options name Hyderabad, Bengaluru, Indore and Pune. Water management is relevant to every one of them, but the question asks which city is associated with this particular warning. Hyderabad in (A), Indore in (C) and Pune in (D) do not match that intended reference. Do not infer that these cities can never face shortages; that stronger statement is neither required nor justified. The named city corresponding to the warning here is Bengaluru in (B).

Step 3: Conclusion The city referred to is Bengaluru. Hence, the correct option is (B).

Quick Tip to Solve: For a city-and-event MCQ, identify the city connected with the stated crisis; do not turn the answer into a permanent ranking of water scarcity.

77. Identify the aspect that deals with the 'Demography' of a town. [4 marks]

(A) Per capita income

(B) Crime rate

(C) Sex ratio

(D) Social security

Correct Answer: (C) Sex ratio

Solution:

Concept:

- Demography studies human population: its size, composition, distribution and changes through births, deaths and migration.
- Sex ratio measures the relative numbers of females and males in a population. It is therefore a population-composition indicator rather than an income, crime or welfare indicator.

Step 1: Identify what demography measures To classify the alternatives, ask whether each one describes the people making up a population or a different social and economic condition. Demographic structure includes features such as age composition and sex composition. Sex ratio directly describes the latter by comparing the female and male components of a population. In the commonly used Indian convention it is expressed as the number of females per thousand males. Its essential feature is that it compares population groups.

Step 2: Separate the other urban indicators Per capita income in (A) is an economic measure obtained by relating income to population; having population in its calculation does not make it an indicator of population composition. Crime rate in (B) concerns recorded criminal activity and public safety. Social security in (D) concerns protection and welfare arrangements. Those indicators may all be useful in studying a town, but none as directly expresses demographic structure as the sex ratio in (C).

Step 3: Conclusion Sex ratio is the aspect that deals directly with the demography of a town. Hence, the correct option is (C).

Quick Tip to Solve: Classify sex ratio and age structure as demographic; classify income as economic and crime as a public-safety indicator.

78. Bharatiya Sakshya Adhiniyam 2023 has replaced: [4 marks]

(A) Indian Eviction Act, 1870

(B) Indian Education Act, 1872

(C) Indian Emergency Act, 1870

(D) Indian Evidence Act, 1872

Correct Answer: (D) Indian Evidence Act, 1872

Solution:

Concept:

- Bharatiya Sakshya Adhiniyam, 2023 is the legislation concerning the law of evidence. Sakshya refers to evidence, which identifies the subject of the enactment.
- The earlier law replaced in this field was the Indian Evidence Act, 1872. The question tests the name and year of that predecessor, not the general subject of criminal punishment.

Step 1: Identify the legal subject Read the name Bharatiya Sakshya Adhiniyam as the law governing evidence. Evidence law concerns matters such as what information may be presented and considered in judicial proceedings and how facts may be established. This points directly to an earlier Evidence Act. It does not point to legislation about removing occupants from property, administering education or declaring an emergency. The subject word is the most decisive clue in matching the two enactments.

Step 2: Match both the name and the year Option (D) gives Indian Evidence Act, 1872, which is the predecessor asked for. Option (A) instead says Eviction and supplies 1870; it changes the subject and does not identify the relevant law. Option (B) retains 1872 but substitutes Education, so the year alone cannot make it correct. Option (C) says Emergency and 1870, again describing a different subject. Correct identification requires the complete title together with its year, and only (D) supplies both correctly.

Step 3: Conclusion Bharatiya Sakshya Adhiniyam, 2023 replaced the Indian Evidence Act, 1872. Hence, the correct option is (D).

Quick Tip to Solve: Associate Sakshya with evidence, then check the predecessor year 1872; a matching year with the wrong subject is still incorrect.

79. Which famous ranges are located on the coastline along Arabian Sea? [4 marks]

(A) Eastern Ghat

(B) Western Ghat

(C) Aravalli Ranges

(D) Vindhya Ranges

Correct Answer: (B) Western Ghat

Solution:

Concept:

- The Arabian Sea lies to the west of peninsular India. The Western Ghats run broadly parallel to the western coastal plain.
- The Eastern Ghats are associated with the eastern side of the peninsula, whereas the Aravalli and Vindhya ranges are inland systems rather than ranges running along the Arabian Sea coast.

Step 1: Locate the coastline first Orient the Indian peninsula before selecting a range. Its western coast faces the Arabian Sea and its eastern coast faces the Bay of Bengal. The mountain system that extends near and broadly parallel to the western coastal belt is the Western Ghats, also known as the Sahyadri. The question uses coastline in this broad geographic sense: the ranges lie inland of the coastal plain rather than forming a continuous mountain edge directly at the sea.

Step 2: Check each range against its setting The Eastern Ghats in (A) are on the eastern side of peninsular India, so they correspond to the wrong coast. The Aravalli ranges in (C) extend through northwestern India and do not form the long western coastal mountain system. The Vindhya ranges in (D) are inland in central India. The Western Ghats in (B) alone match both the Arabian Sea side and the coast-parallel arrangement. Locating the sea therefore eliminates the nearest distractor, Eastern Ghat, immediately.

Step 3: Conclusion The ranges along the Arabian Sea side are the Western Ghats. Hence, the correct option is (B).

Quick Tip to Solve: Pair Arabian Sea with western coast and Western Ghats; pair Bay of Bengal with the eastern side of the peninsula.

80. Given below are two statements:

Statement I: Urban green spaces can help to reduce air pollution and improve public health.

Statement II: Urban green spaces are solely for aesthetic purposes and have no functional benefits.

In the light of 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: (C) Statement I is true but Statement II is false

Solution:

Concept:

- Urban green spaces provide functional environmental and public-health benefits in addition to their visual and recreational value.
- Trees and other vegetation can intercept some airborne particles, provide shade and support cooler local conditions. Green spaces also create opportunities for physical activity and psychological restoration.

Step 1: Evaluate Statement I on its own Statement I says green spaces can help reduce air pollution and improve public health. The word can is appropriate: the size, location, vegetation and management of a green space influence its effects. Vegetation can capture some particulate matter, while shade and cooling reduce heat exposure. Accessible parks also support walking and recreation. These functions support the statement without requiring the false claim that a park eliminates every pollutant. Statement I is therefore true.

Step 2: Test the absolute claim in Statement II Statement II says green spaces are solely aesthetic and have no functional benefits. Solely and no make this an absolute denial of every environmental or health function. The pollution-interception, cooling and recreation benefits already identified contradict that denial. Aesthetic appeal is one benefit, but it does not exclude practical functions. Statement II is therefore false. Option (A) incorrectly treats it as true; (B) incorrectly rejects Statement I; and (D) reverses both evaluations. The true-false combination is (C).

Step 3: Conclusion Statement I is true, whereas Statement II is false. Hence, the correct option is (C).

Quick Tip to Solve: When a statement says solely or no benefits, look for one valid counterexample; shade or recreation already disproves the absolute claim.

81. Given below are two statements:

Statement I: In general, city of Delhi is considered to be planned in radial concentric design.

Statement II: City of Mumbai is planned in linear design.

In the light 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:

- A radial-concentric urban pattern combines roads radiating from a centre with circumferential routes connecting those radial roads. The classification describes the broad arrangement, rather than requiring every street to follow a perfect circle.
- A linear urban pattern extends predominantly along a major axis, such as a coast, transport corridor or narrow strip of developable land. Natural constraints can make this pattern especially pronounced.

Step 1: Assess the Delhi statement The planned central area of New Delhi uses prominent radial avenues, roundabouts and connections around major focal points. In the broad classification used in this question, Delhi is consequently associated with a radial-concentric arrangement. The statement does not claim that every settlement or street in the entire National Capital Territory follows the same pattern. Statement I is therefore true in the stated general sense.

Step 2: Assess the Mumbai statement Mumbai developed on a narrow coastal peninsula, with major movement corridors and suburban growth extending principally along its length. This restricted geography encourages an elongated, linear development pattern. Mumbai is accordingly a standard example of linear urban form, so Statement II is true. The combination is true and true: option B rejects both correct descriptions, while C and D each reject one of them.

Step 3: Conclusion Both statements are true. Hence, the correct option is (A).

Quick Tip to Solve: For urban-form questions, connect the street network to geography: Delhi has radial focal avenues, while Mumbai has a long, narrow coastal growth axis.

82. Given below are two statements:

Statement I: Constitutional amendments empowers village panchayat.

Statement II: Village panchayats were formed under 73rd Amendment Act.

In the light 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:

- The Constitution (Seventy-third Amendment) Act, 1992 gave constitutional recognition to Panchayati Raj institutions by inserting Part IX and the Eleventh Schedule. Its provisions came into force in 1993.
- Village panchayats form the village tier of rural local government. Constitutional recognition supplies an institutional framework for democratic representation, regular elections and decentralisation.

Step 1: Evaluate constitutional empowerment Statement I refers to constitutional amendments empowering village panchayats. The Seventy-third Amendment established a constitutional framework for rural local self-government, including elected panchayats, a normal five-year term and representation through reserved seats. It also enabled state legislation concerning powers and responsibilities. This supports the substance of Statement I; the amendment is directly connected with strengthening rural local institutions.

Step 2: Interpret the institutional reference in Statement II The Seventy-third Amendment provides the constitutional framework for panchayats at village, intermediate and district levels, subject to its stated qualifications. Read in that institutional sense, Statement II is true and both statements match option A. Panchayats and village councils existed before this amendment: the statement should not be understood as saying that village councils first appeared in Indian history in 1992. Options B, C and D do not express the intended constitutional classification.

Step 3: Conclusion Both statements are true in the context of the constitutional Panchayati Raj framework. Hence, the correct option is (A).

Quick Tip to Solve: Remember the association: the 73rd Amendment concerns rural panchayats; the 74th concerns urban municipalities.

83. What was the name of Sri Lanka in ancient India? [4 marks]

(A) Java

(B) Ceylon

(C) Burma

(D) Kampuchea

Correct Answer: (B) Ceylon

Solution:

Concept:

- Ceylon is the former English name of the island country now called Sri Lanka. A geographical-name question should match the place itself, rather than merely another country in the same broad Asian region.
- The word ancient in this question is imprecise: older Indian traditions also use names such as Lanka. Among the four supplied choices, Ceylon is the only name associated with Sri Lanka.

Step 1: Identify the island named in the question Sri Lanka lies just south of the Indian peninsula, across the Palk Strait and Gulf of Mannar. The name Ceylon was used for this island before the country adopted the name Sri Lanka in 1972. Thus the name-place association needed to distinguish the supplied options is Sri Lanka and Ceylon. The wording does not make Java, Burma or Kampuchea alternative historical names of the same island.

Step 2: Eliminate the names of other places Java is an island in Indonesia and is not Sri Lanka. Burma is the former English name commonly used for Myanmar, a mainland Southeast Asian country. Kampuchea is associated with Cambodia, another mainland Southeast Asian country. These three alternatives name different places. Ceylon alone identifies Sri Lanka, although it is more accurately described as its former English name than as its name in ancient Indian literature.

Step 3: Conclusion Among the listed options, Sri Lanka corresponds to Ceylon. Hence, the correct option is (B).

Quick Tip to Solve: Match each old name with its modern place: Ceylon–Sri Lanka, Burma–Myanmar and Kampuchea–Cambodia; Java is an Indonesian island.

84. Which of the followings is not correct land use as per the master plan? [4 marks]

(A) Residential

(B) Transport

(C) Commercial

(D) Recreational

Correct Answer: All four options are legitimate master-plan land-use functions.

Solution:

Concept:

- A master plan allocates urban land among functional categories, such as residential, commercial, industrial, recreational, public facilities, and transport or circulation uses. Exact terminology can differ between planning documents.
- A transport use is still a land use: roads, railway land, terminals, depots and related facilities occupy land and are represented in spatial planning. It cannot be excluded merely because its function involves movement.

Step 1: Check the four supplied categories Residential land accommodates housing and associated neighbourhood activities. Commercial land accommodates shops, offices and business activities. Recreational land provides parks, playgrounds, open spaces and leisure facilities. These are all recognised master-plan functions. Transport or transportation land likewise provides the circulation network and transport facilities required to connect the other functions. It is not an activity that exists independently of physical land allocation.

Step 2: Resolve the negative wording honestly The question asks which listed use is not correct. All four options describe legitimate land-use functions, so the literal question supplies no uniquely defensible exclusion. The supplied answer key selects B, Transport, but that selection contradicts the inclusion of transportation and circulation within master-plan land-use planning. A difference between the words transport and transportation does not make the function invalid. Selecting B without explaining this issue would teach an incorrect planning distinction.

Step 3: Conclusion All four listed functions can be master-plan land uses; no option is correct as the question is written. The supplied key selects (B), but transport is also a recognised land-use function.

Quick Tip to Solve: In a negative land-use question, test whether the option occupies planned land: roads and terminals count just as housing, shops and parks do.

85. Name the person responsible for 'White Revolution' in India. [4 marks]

(A) Verghese Kurien

(B) Jawahar Lal Nehru

(C) Indira Gandhi

(D) Mother Terresa

Correct Answer: (A) Verghese Kurien

Solution:

Concept:

- The White Revolution concerns the expansion and organisation of milk production and dairy cooperatives in India. It is associated with Operation Flood and the development of a farmer-owned dairy system.
- Dr Verghese Kurien is widely recognised as the father of the White Revolution in India. His leadership connected cooperative milk procurement, processing and marketing with producers and consumers.

Step 1: Identify the sector and its leading organiser The word white refers to milk in this context. The question is therefore asking about the dairy-development movement, rather than a political revolution or a programme in another agricultural product. Verghese Kurien was central to the cooperative dairy movement associated with Amul and led the institutional effort behind Operation Flood. These contributions explain why his name is attached to the White Revolution.

Step 2: Distinguish the other public figures Jawaharlal Nehru was the first Prime Minister of independent India, and Indira Gandhi was also a Prime Minister, but neither is the person conventionally identified as the father of the White Revolution. Mother Teresa is known for humanitarian and charitable service rather than organising Indian dairy development. The relevant distinction is the specific contribution to milk cooperatives and dairy organisation, not the general prominence of the person.

Step 3: Conclusion The person associated with the White Revolution is Dr Verghese Kurien. Hence, the correct option is (A).

Quick Tip to Solve: Associate White Revolution with milk, Operation Flood, Amul and Verghese Kurien; this cluster separates it from other agricultural revolutions.

86. What is the full form of HUDCO? [4 marks]

(A) Housing and Urban Development Center

(B) Heritage and Urban Development Corporation Limited

(C) Housing and Urban Development Corporation Limited

(D) Health and Urban Development Center

Correct Answer: (C) Housing and Urban Development Corporation Limited

Solution:

Concept:

- HUDCO expands to Housing and Urban Development Corporation Limited. Its name combines the sectors housing and urban development with its organisational designation.
- An acronym-expansion question requires each component to match the institutional name. Similar-sounding words such as heritage or health cannot replace housing, and center cannot replace corporation.

Step 1: Expand each substantive part of the name Read the abbreviation as a reference to housing and urban development. The initial H stands for Housing, while UD denotes Urban Development. The CO component comes from Corporation. The complete institutional name retains Limited, so the expansion is Housing and Urban Development Corporation Limited. Its subject matter concerns financing and supporting housing and urban infrastructure rather than a health or heritage agency.

Step 2: Compare every proposed expansion Option A begins with the correct sectors but ends with Center, which is not the institution's corporate designation. Option B keeps Corporation Limited but substitutes Heritage for Housing, changing the institution's name. Option D substitutes Health for Housing and also ends with Center. Option C is the only alternative that preserves both the correct sectoral wording and the complete corporate designation; therefore it matches every part of the required expansion.

Step 3: Conclusion HUDCO stands for Housing and Urban Development Corporation Limited. Hence, the correct option is (C).

Quick Tip to Solve: Check both ends of the HUDCO expansion: it begins with Housing and ends with Corporation Limited, which eliminates the near-matching alternatives.

87. Select which of the followings does not represent the 'Vedic Town Plan'. [4 marks]

(A) Varataka

(B) Padmaka

(C) Prastara

(D) Dandaka

Correct Answer: (A) Varataka

Solution:

Concept:

- Traditional Indian town-planning classifications include named layouts such as Dandaka, Prastara and Padmaka. Their names identify plan types rather than modern administrative classes of settlements.
- The question is a negative identification task: retain names belonging to the traditional list and select the remaining name. Similar spelling alone is not evidence that an unfamiliar term belongs to the classification.

Step 1: Recognise the established plan names Dandaka is one of the recognised traditional settlement-plan types and is associated with a comparatively elongated arrangement. Prastara is also a traditional plan name, commonly discussed in connection with regular, grid-like layouts. Padmaka is another recognised form, whose name evokes the lotus. Consequently options B, C and D are members of the traditional town-planning vocabulary invoked by the question.

Step 2: Select the name outside the supplied classification Varataka, as printed in option A, is not one of the recognised Vedic town-plan types represented by the other three names. It is therefore the choice that satisfies does not represent. Selecting Padmaka because a lotus sounds decorative would be a mistake: symbolic names are part of this historical terminology. Likewise, the distinct physical forms associated with Prastara and Dandaka do not prevent both from belonging to the same traditional classification.

Step 3: Conclusion Varataka does not represent the stated traditional town-plan classification. Hence, the correct option is (A).

Quick Tip to Solve: For this list, retain Padmaka, Prastara and Dandaka as traditional plan names; the question asks for the outsider, not the most familiar layout.

88. A person starts moving from a point 'A' towards south direction for 200 mts, then he returns back to point 'A' by taking 180° turn. Identify the primary design element he made after completing his journey. [4 marks]

(A) A point

(B) A vertical line

(C) A horizontal line

(D) A diagonal line

Correct Answer: (B) A vertical line

Solution:

Concept:

- A point records a location, while a line records an extended path. Returning to the starting location gives zero displacement, but it does not erase the line traced during the journey.
- On a conventional plan, north is upward and south downward. A path lying along the north–south axis is therefore represented by a vertical line. Reversing direction retraces the same segment.

Step 1: Trace the outward and return paths Starting at A, the person moves 200 metres south along a straight segment. A turn through 180 degrees reverses the direction of travel, so the return journey is north along that same segment until the person reaches A again. The two legs occupy the same set of points; they do not create two separated lines or enclose an area. The total distance travelled is 400 metres, while the final displacement is zero.

Step 2: Identify the element traced rather than the endpoint The journey leaves a line segment aligned north–south. With north at the top of the page, this segment is vertical, giving option B. Option A describes only the common starting and finishing position and overlooks the extended path. A horizontal line would require east–west motion, while a diagonal line would require an oblique direction such as northeast–southwest. Neither of those directions occurs in the stated journey.

Step 3: Conclusion The traced primary design element is a vertical line. Hence, the correct option is (B).

Quick Tip to Solve: Separate path from displacement: retracing a north–south segment gives zero final displacement but still traces a vertical line.

89. When was the Planning Commission of India launched ? [4 marks]

(A) 1948

(B) 2015

(C) 1994

(D) 1952

Correct Answer: The Planning Commission was established on 15 March 1950; no listed option is correct.

Solution:

Concept:

- The Planning Commission was the institution established by the Government of India to assess resources, formulate Five-Year Plans and recommend priorities for national development.
- Its establishment date must be distinguished from the commencement of the First Five-Year Plan and from its replacement by NITI Aayog. These are separate events in the history of Indian planning.

Step 1: Identify the establishment date The Planning Commission was established by a Government of India resolution on 15 March 1950. Therefore the year required by the question is 1950. The First Five-Year Plan began in 1951; the date of a plan does not replace the date on which its planning institution was constituted.

Step 2: Compare all four years Option (A), 1948, predates the establishment of the Planning Commission. Option (B), 2015, is associated with the formation of NITI Aayog, which replaced the Planning Commission. Option (C), 1994, is much later than the Commission's establishment. Option (D), 1952, also comes after the institution was established and is not its launch year. None of the four printed options gives 1950, so selecting the nearest year would be historically incorrect.

Step 3: Conclusion The Planning Commission of India was established on 15 March 1950. None of options (A)–(D) is correct. The official answer key dropped this question and awarded bonus marks to all candidates.

Quick Tip to Solve: Keep three dates separate: Planning Commission, 1950; First Five-Year Plan, 1951; NITI Aayog, 2015.

90. Match the LIST-I with LIST-II

LIST-I		LIST-II	
A.	Mangrove	I.	Jaisalmer, Rajasthan
B.	Backwaters	II.	Dholavira, Gujarat
C.	Thar Desert	III.	Alapuzha, Kerala
D.	Rann of Kutch	IV.	Sundarban, West Bengal

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

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

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

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

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

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

Solution:

Concept:

- Match each landscape to the place characteristically associated with it, using vegetation, coastal water systems, desert geography and salt-marsh geography.
- A matching code is correct only if all four associations agree; a single correct pair does not establish the whole option.

Step 1: Match the wetland landscapes Mangroves grow in tidal coastal environments. The Sundarban delta of West Bengal is renowned for its extensive mangrove forest, giving A–IV. Backwaters are interconnected coastal lagoons, lakes and canals; Alapuzha (Alappuzha) in Kerala is a characteristic backwater destination, giving B–III. The Kerala association concerns backwaters rather than the desert or the saline Rann.

Step 2: Match the dry landscapes Jaisalmer lies in western Rajasthan in the Thar Desert, so C–I. Dholavira is located on Khadir island in the Rann of Kutch region of Gujarat, so D–II. Thus the complete sequence is A–IV, B–III, C–I, D–II. Option (A) incorrectly sends mangroves to Kerala backwaters and the Thar to the Sundarban. Option (B) gets A and C right but exchanges the backwaters and Rann destinations. Option (D) does not preserve any of these characteristic landscape-place matches.

Step 3: Conclusion The correct matching is A–IV, B–III, C–I, D–II. Hence, the correct option is (C).

Quick Tip to Solve: Anchor the two deserts first: Thar–Jaisalmer and Rann–Dholavira; then distinguish Sundarban mangroves from Kerala backwaters.

91. Match the LIST-I with LIST-II

LIST-I		LIST-II	
A.	Population	I.	Fertility
B.	Communication	II.	Demand
C.	Agriculture	III.	Accessibility
D.	Housing	IV.	Density

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

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

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

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

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

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

Solution:

Concept:

- Population, communication, agriculture and housing each have a characteristic planning indicator or requirement in the supplied matching list.
- Population density measures concentration of people; accessibility measures ease of reaching places; soil fertility supports farming; housing demand expresses the need for dwellings.

Step 1: Connect people and movement to their indicators Population is matched with density (IV), since population density expresses the number of people per unit area and helps describe settlement concentration. Communication is matched with accessibility (III), since transport and communication connections enable people and services to reach one another. This gives A–IV and B–III; neither demand nor soil fertility is the intended direct indicator of communication.

Step 2: Connect farming and housing to their requirements Agriculture is matched with fertility (I): productive soil and its nutrient-supplying capacity are central to crop growth. Housing is matched with demand (II): the requirement for dwellings guides housing provision and planning. Therefore C–I and D–II. Combining the four gives A–IV, B–III, C–I, D–II. Option (A) wrongly matches agriculture to demand and housing to density. Option (C) interchanges the population and communication indicators. Option (D) assigns demand to population and accessibility to housing instead of the direct pairs intended by the list.

Step 3: Conclusion The correct sequence is A–IV, B–III, C–I, D–II. Hence, the correct option is (B).

Quick Tip to Solve: Use the direct indicator pairs: population–density, communication–accessibility, agriculture–fertility and housing–demand.

92. Match the LIST-I with LIST-II

LIST-I		LIST-II	
A.	Mawlynnong	I.	Port city
B.	Vishakhapatnam	II.	Steel city
C.	Ladakh	III.	Cleanest village in Asia
D.	Jamshedpur	IV.	Frozen desert

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

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

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

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

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

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

Solution:

Concept:

- Place-identity matching uses the best-known geographic or economic description in the supplied list rather than assuming every description applies to every settlement.
- Mawlynnong is associated with village cleanliness, Visakhapatnam with a major seaport, Ladakh with a cold desert, and Jamshedpur with the steel industry.

Step 1: Identify the village and coastal city Mawlynnong in Meghalaya is popularly recognised as the cleanest village in Asia; it therefore matches III. Visakhapatnam (spelt Vishakhapatnam in the question) is a major port city on the Bay of Bengal coast of Andhra Pradesh, so it matches I. These establish A–III and B–I and already exclude options that describe Mawlynnong as a port or steel city.

Step 2: Identify the desert and industrial city Ladakh is a high-altitude cold desert, corresponding to the description frozen desert (IV) used in the list. Its cold arid environment distinguishes it from a coastal port or a steel-producing city. Jamshedpur in Jharkhand is closely associated with the iron and steel industry and is known as the Steel City, giving D–II. The full matching is A–III, B–I, C–IV, D–II. Option (B) makes several incompatible assignments, including Ladakh as a port. Option (C) exchanges geographic and industrial identities. Option (D) preserves the port and desert pairs but incorrectly exchanges the village-cleanliness and steel-city identities.

Step 3: Conclusion The correct matching is A–III, B–I, C–IV, D–II. Hence, the correct option is (A).

Quick Tip to Solve: Fix Visakhapatnam–port and Jamshedpur–steel first; Mawlynnong–clean village and Ladakh–cold desert complete the code.

93. Match the LIST-I with LIST-II

LIST-I (Schemes)		LIST-II (Objectives)	
A.	**Smart city**	**I.**	**Affordable housing**
B.	**P.M. Jandhan Yojana**	**II.**	**Primary education**
C.	**PMAY**	**III.**	**IoT**
D.	**Sarvshiksha Abhiyan**	**IV.**	**Bank account opening**

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

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

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

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

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

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

Solution:

Concept:

- Government-scheme matching distinguishes the main policy objective of a programme from a supporting technology or an unrelated public service.
- Financial inclusion, affordable housing, elementary education and technology-enabled urban management belong to different programmes in the given list.

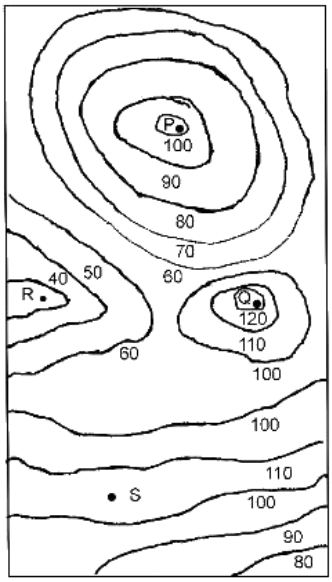
Step 1: Match the social programmes to their direct aims Pradhan Mantri Jan Dhan Yojana promotes financial inclusion through access to bank accounts and related banking services, so B–IV. Pradhan Mantri Awas Yojana (PMAY) concerns affordable housing, so C–I. Sarva Shiksha Abhiyan concerns universal elementary education, which corresponds to primary education (II) in the question; therefore D–II. Bank account opening must not be confused with a housing or education objective.

Step 2: Complete and verify the urban-technology pair Smart-city services use information and communication technologies, including the Internet of Things (IoT), for connected infrastructure and improved urban management. In this supplied list the intended match is Smart city–IoT, A–III. IoT is a technology supporting smart services rather than a complete definition of every smart-city objective. The complete code is A–III, B–IV, C–I, D–II. Option (B) assigns education to PMAY and bank accounts to the education programme. Option (C) incorrectly gives primary education to Jan Dhan. Option (D) likewise fails the direct financial-inclusion, housing and schooling associations.

Step 3: Conclusion The correct matching is A–III, B–IV, C–I, D–II. Hence, the correct option is (A).

Quick Tip to Solve: Expand the names first: Jan Dhan–banking, Awas–housing and Shiksha–education; the smart-city technology pair then follows.

94. In reference to the given diagram, find out that which is placed at the highest level. [4 marks]



(A) R

(B) Q

(C) S

(D) P

Correct Answer: (B) Q

Solution:

Concept:

- A contour line joins points at the same elevation. Its written value gives height, whereas its position near the top of the page does not.
- Compare the numbered contours surrounding each labelled point. For closed contours whose values increase inward, the innermost region is the higher ground.

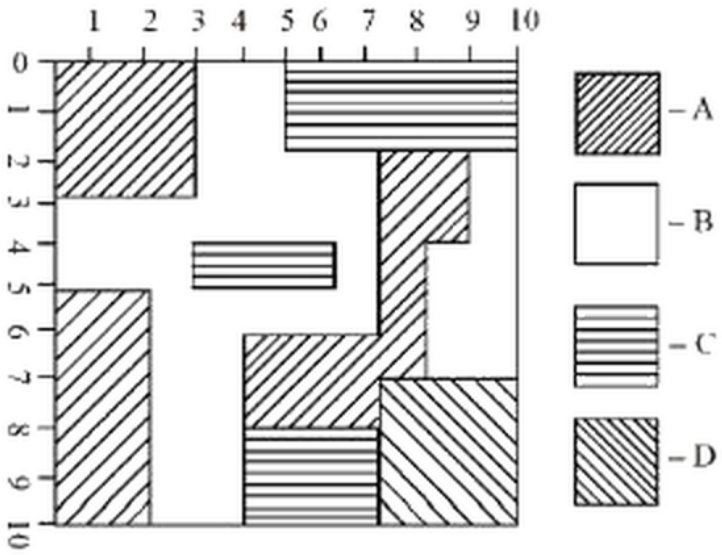
Step 1: Read the elevations around the four points The nested contours around P increase inward through 60, 70, 80 and 90 to the small contour labelled 100. The separate closed contours around Q increase from 100 through 110 to the inner contour labelled 120. Thus Q lies on the higher of these two hilltops. The small enclosure near R carries the much smaller value 40. S lies between contours labelled 100 and 110, so its elevation is between these values and below the summit region enclosed by Q's 120 contour.

Step 2: Compare heights rather than page positions The contour information puts Q above the other three points: its inner contour is 120, whereas S lies between 100 and 110, P is surrounded by the 100 contour, and R is near the 40 contour. There is no need to estimate an exact summit height to identify the highest location; the surrounding contour values already separate Q from the alternatives. Option (A), R, corresponds to low ground. Option (C), S, is lower than Q. Option (D), P, is drawn higher on the page but has lower contour values. Only option (B) agrees with the elevation evidence.

Step 3: Conclusion Q is placed at the highest level, in the region of the contour labelled 120. Hence, the correct option is (B).

Quick Tip to Solve: On a contour map, rank the printed contour values around the points; never rank their vertical positions on the page.

95. The figure shows an area of 10 km $\times$ 10 km with different land uses. Which land use covers the second largest area? [4 marks]



(A) C

(B) A

(C) B

(D) D

Correct Answer: (B) A

Solution:

Concept:

- The map covers a square of side 10 km, so its total area is $10 \times 10 = 100\,\text{km}^2$. One interval on either numbered axis represents 1 km.
- Match each hatch pattern with the legend, then add the areas of all disconnected patches carrying that pattern. Unshaded land is category B.

Step 1: Add the patches of land use A Use the top-left corner as the origin, with horizontal coordinate increasing rightward and vertical coordinate increasing downward. The upper-left A rectangle is $3 \times 3 = 9$. The lower-left A rectangle is $2 \times 5 = 10$. Split the central stepped A region into non-overlapping rectangles: the strip from horizontal coordinate 7 to 8 and vertical coordinate 2 to 7 has area 5; the extension from 8 to 9 and 2 to 4 has area 2; the block from 4 to 7 and 6 to 8 has area 6. Hence

$$A = 9 + 10 + 5 + 2 + 6 = 32\,\text{km}^2.$$

Step 2: Calculate the other land uses and rank them Horizontal hatching denotes C. Its top rectangle has area $5 \times 2 = 10$, its middle rectangle has area $3 \times 1 = 3$, and its bottom rectangle has area $3 \times 2 = 6$. Thus $C = 19\,\text{km}^2$. The reverse-diagonal hatching of D fills the bottom-right 3×3 square,

giving $D = 9\,\text{km}^2$. The unshaded remainder is

$$B = 100 - (32 + 19 + 9) = 40\,\text{km}^2.$$

Therefore the decreasing order is $B > A > C > D$. Option (A), C, is third; option (C), B, is largest; and option (D), D, is smallest. The second-largest land use is A, which appears as option (B).

Step 3: Conclusion Land use A covers $32\,\text{km}^2$, the second-largest area after B. Hence, the correct option is (B).

Quick Tip to Solve: Add disconnected patches with the same hatching before ranking them, and find the unshaded category by subtracting all shaded areas from the total.

96. What is the full form of UNICEF? [4 marks]

(A) United Nations Iconic Childcare Economic Federation

(B) United Nations International Children's Fellowship

(C) United Nations International Children's Education Fund

(D) United Nations Children's Fund

Correct Answer: (D) United Nations Children's Fund

Solution:

Concept:

- UNICEF is the United Nations organisation concerned with the rights, well-being and development of children, including health, nutrition, education and protection.
- The organisation retains its familiar acronym even though its official name was shortened from its original emergency-relief name. The current name and the historic expansion must be distinguished.

Step 1: State the official name The official name of UNICEF is United Nations Children's Fund. It was originally established as the United Nations International Children's Emergency Fund in 1946. When its name was shortened to United Nations Children's Fund, the established acronym UNICEF was retained. Thus the presence of letters associated with the older name does not make a different modern expansion correct.

Step 2: Eliminate the incorrect expansions Option (A), United Nations Iconic Childcare Economic Federation, is not the organisation's name and invents an economic federation. Option (B) ends in Fellowship rather than Fund, so it is incorrect. Option (C) substitutes Education for Emergency and is neither the original name nor the present official name. UNICEF supports education among many child-focused activities, but that activity does not change its name. Option (D) exactly states the present official name, United Nations Children's Fund, and is therefore the correct choice among the supplied alternatives.

Step 3: Conclusion UNICEF is the United Nations Children's Fund. Hence, the correct option is (D).

Quick Tip to Solve: Remember that UNICEF kept its historic acronym: the current official name is United Nations Children's Fund, without International or Emergency.

97. Identify the city ruled by 'Begums-the Queens.' [4 marks]

(A) Hyderabad

(B) Murshidabad

(C) Bhopal

(D) Aligarh

Correct Answer: (C) Bhopal

Solution:

Concept:

- A city's political history can provide a distinctive identification clue. Here the clue is a succession of women rulers known as Begums, rather than the geographical location or modern size of the city.
- Bhopal is associated with the rule of the Begums during the nineteenth and early twentieth centuries. The title Begum denotes a woman of high rank in the relevant Indo-Islamic political tradition; the question uses it specifically for ruling queens.

Step 1: Connect the title with the historical ruling line Recall the succession associated with Bhopal: Qudsia Begum, Sikandar Begum, Shah Jahan Begum and Sultan Jahan Begum. These women exercised authority as rulers of the princely state, making the expression "the Begums of Bhopal" a characteristic historical association. The clue concerns their political rule, rather than merely the presence of noblewomen in a royal household. Therefore, Bhopal directly matches both the title and the reference to queens.

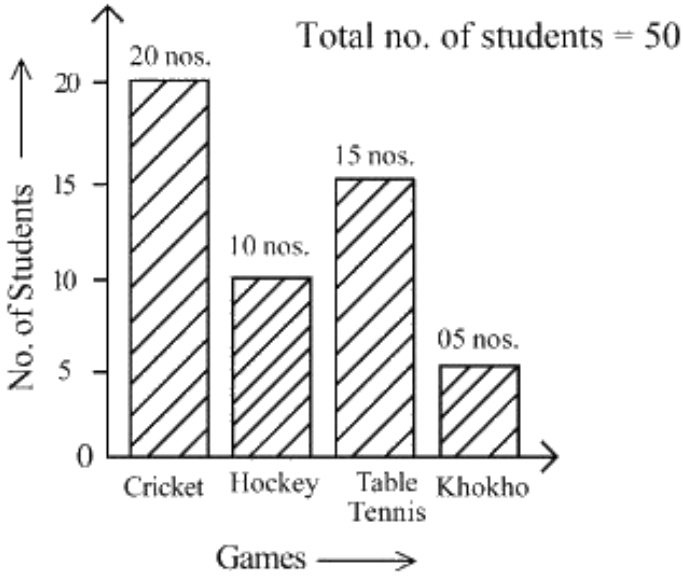
Step 2: Distinguish the other cities Hyderabad is chiefly associated with the Nizams, so it does not match this famous succession of Begum rulers. Murshidabad is associated with the Nawabs of Bengal; although women bearing the title Begum occurred in such aristocratic settings, that is not the ruling line identified here. Aligarh is especially associated with its educational and historical institutions and is not the city conventionally identified by this succession of queens. Thus the four options are separated by their characteristic historical associations, and option (C) alone provides the intended city.

Step 3: Conclusion The city ruled by the celebrated succession of Begums is Bhopal, in present-day Madhya Pradesh. Hence, the correct option is (C).

Quick Tip to Solve: Associate Bhopal with its Begum rulers and Hyderabad with its Nizams; matching the ruling title to the city quickly separates these options.

98. As per the given bar chart, what is the total percentage of students who prefer to play cricket?

[4 marks]



(A) 15%

(B) 20%

(C) 30%

(D) 40%

Correct Answer: (D) 40%

Solution:

Concept:

- A bar chart gives a category's frequency through the height of its bar. The cricket bar is labelled 20 students; this is a count, not a percentage.
- The percentage in a category is its frequency divided by the total population, multiplied by 100. Here the chart explicitly states that the total number of students is 50.

Step 1: Read the cricket count and the stated total The bar above Cricket reaches 20 on the vertical axis and is labelled 20 nos. The total printed above the chart is 50 students. Thus the numerator is 20 and the denominator is 50. Do not use the cricket bar's height directly as a percentage, because the vertical axis measures the number of students.

Step 2: Convert the cricket count into a percentage Let p be the percentage of students who prefer cricket. Applying the frequency-to-percentage formula gives

$$p = \frac{\text{students preferring cricket}}{\text{stated total students}} \times 100 = \frac{20}{50} \times 100 = 40\%.$$

The fraction $20/50 = 2/5$ is also 0.4, which confirms the percentage.

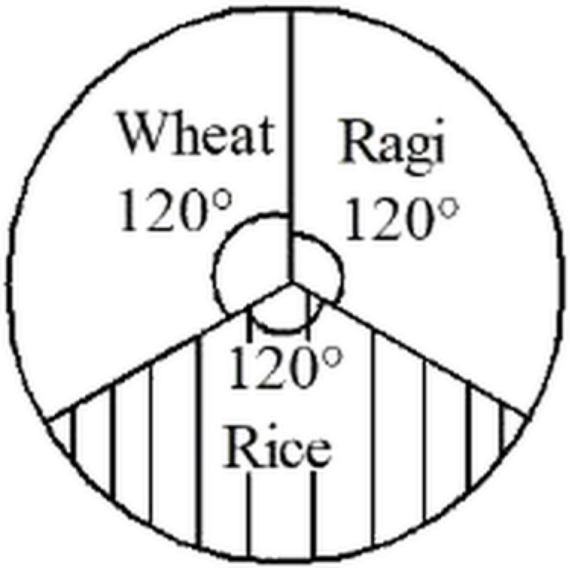
Step 3: Check the alternatives against the data For a total of 50, the proposed percentages 15, 20 and 30 correspond respectively to 7.5, 10 and 15 students, none of which equals the cricket count of 20. Only 40 percent represents 20 students. The four visible bars sum to 45 students, which differs from

the expressly stated total of 50; the requested percentage uses that stated total rather than silently replacing it with the bar sum.

Step 4: Conclusion Using the chart's stated total of 50 students, the percentage preferring cricket is 40%. Hence, the correct option is (D).

Quick Tip to Solve: Read the vertical-axis unit before calculating. A bar height of 20 students becomes a percentage only after division by the stated total of 50.

99. As per pie chart, identify the percentage (%) of shaded portion. [4 marks]



(A) 22.22%

(B) 45.55%

(C) 33.33%

(D) 11.11%

Correct Answer: (C) 33.33%

Solution:

Concept:

- A complete pie chart represents the whole population or quantity by a circle of $360°$. The share of any sector equals its central angle divided by $360°$.
- Multiplying a sector's share by 100 expresses it as a percentage. Shading identifies the required sector; its printed angle provides the numerical information.

Step 1: Identify the shaded sector The lower sector labelled Rice is shaded with vertical lines. Its central angle is printed as $120°$. The Wheat and Ragi sectors are unshaded and are also labelled $120°$, so all three sectors represent equal shares. The required share is one sector, not the combined unshaded part.

Step 2: Calculate the shaded percentage If θ is a sector's central angle, its percentage is $100\theta/360°$.

Substituting the shaded angle gives

$$\text{shaded percentage} = \frac{120^\circ}{360^\circ} \times 100 = \frac{100}{3}\% = 33.333\ldots\%.$$

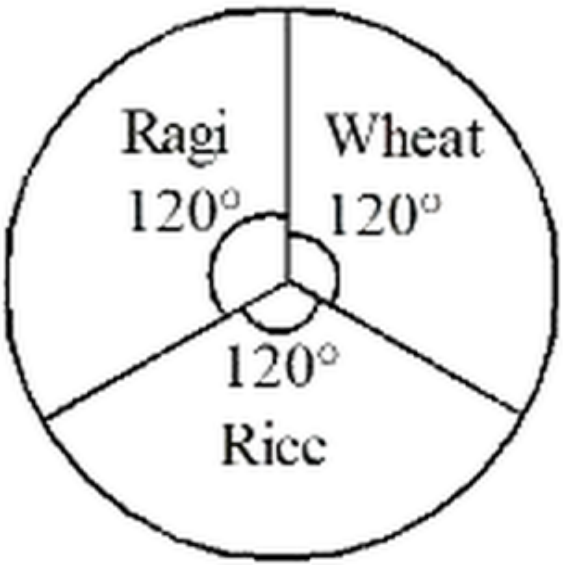
To two decimal places this is 33.33%. The degree units cancel in the ratio; the result is a percentage of the full circle.

Step 3: Compare the proposed answers Option (C) is the two-decimal representation of one third. A share of 22.22 percent would require an angle of approximately 80°, 45.55 percent would require approximately 164°, and 11.11 percent would require approximately 40°. None equals the printed 120°. The equal three-way division also confirms directly that the shaded sector must occupy one third of the circle.

Step 4: Conclusion The shaded portion represents 33.33% of the whole pie chart. Hence, the correct option is (C).

Quick Tip to Solve: When a pie chart has three equal sectors, each is one third of the whole. Confirm the printed angle is 120° before selecting 33.33%.

100. As per the pie chart, what would be the total percentage of Ragi and Wheat if 8% of rice is replaced by Ragi and 3% of Wheat is replaced by Rice and 7% of Ragi is replaced by Wheat? [4 marks]



(A) 71.66%

(B) 69.66%

(C) 62.66%

(D) 65.66%

Correct Answer: No listed option follows from literal relative percentages: $68\frac{1}{3}\%$. Option (A) is the likely intended percentage-point interpretation.

Solution:

Concept:

- Each 120° sector represents $120/360 = 1/3$ of the total. Rice, Ragi and Wheat therefore each initially occupy $33\frac{1}{3}\%$.
- A percentage of a crop is calculated from that crop's share. This differs from a percentage-point change in its share of the entire total.
- A transfer between Ragi and Wheat cannot change their combined share. Only transfers to or from Rice affect the requested combined total.

Step 1: Find the original combined share Ragi and Wheat together occupy two of the three equal sectors, or 240°. Their initial combined percentage is therefore

$$\frac{240}{360} \times 100 = 66\frac{2}{3}\%.$$

The diagram labels angles, not rounded percentages; retain the exact one-third shares during the calculation.

Step 2: Apply the literal relative percentages Taking the stated percentages of the original crop shares, the transfer from Rice to Ragi adds 8% of $33\frac{1}{3}\%$, namely $8/3$ percentage points. The transfer from Wheat to Rice removes 3% of $33\frac{1}{3}\%$, namely 1 percentage point. The Ragi-to-Wheat transfer remains inside the requested combined group and cancels from its total. Hence

$$(R+W)_{\text{final}} = \frac{200}{3} + \frac{8}{3} - 1 = \frac{205}{3}\% = 68\frac{1}{3}\%.$$

This value is absent from all four choices. The result for the combined group is unchanged if the last internal transfer uses Ragi's updated share.

Step 3: Identify the likely intended interpretation If the numbers 8, 3 and 7 instead represent percentage points of the whole, the combined share would be

$$66\frac{2}{3} + 8 - 3 = 71\frac{2}{3}\%.$$

This is approximately the value offered by option (A), 71.66%, when truncated to two decimals; ordinary rounding gives 71.67%. Options (B), (C) and (D) agree with neither the literal result nor this percentage-point calculation. Thus option (A) reveals the likely intended interpretation, but it requires treating percentages of named crops as shares of the whole. That interpretation is not stated clearly in the question and should not replace the literal calculation without explanation.

Step 4: Conclusion Literal percentages of the original crop shares give a combined Ragi-and-Wheat share of $68\frac{1}{3}\%$, so none of the listed options is correct on that reading. Option (A), 71.66%, is the likely intended answer only under a percentage-point interpretation with truncation; the wording is ambiguous.

Quick Tip to Solve: Combine the two requested crops first so their internal transfer cancels. Then check whether each stated percentage is of a crop's share or of the entire total.