JEE Main 2020 Paper 2B (B.Planning) Sep 1 Shift 2 Question Paper with Solutions PDF

Question Paper with Solutions

Conducted by the National Testing Agency (NTA)

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

General Instructions

(i) This paper is Paper 2B (B.Planning.) of JEE (Main) 2020, Session 2 (September), conducted by the National Testing Agency (NTA) in Computer Based Test (CBT) mode on 1 September 2020, Shift 2. The total duration is 3 hours.

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

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

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

(v) Marking scheme (numerical value questions): $+4$ for a correct answer, no negative marking and 0 for an unanswered question.

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

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

1. Let $A = \{1, 2, 3\}$. Define a relation R on A as :

$aRb \Leftrightarrow |a^2 - b^2| \leq 5$.

Then which of the following is not true ? [4 marks]

(A) $R^{-1} = R$, where R^{-1} is the inverse of R.

(B) Range of R is A.

(C) R is reflexive and symmetric.

(D) R is symmetric and transitive.

Correct Answer: (D) R is symmetric and transitive.

Solution:

Concept:

- A relation on A is reflexive when every (a, a) belongs to it, and symmetric when reversing any allowed pair still gives an allowed pair.
- Transitivity requires aRb and bRc to imply aRc for every triple. One counterexample disproves transitivity.

Step 1: List the allowed pairs The squares of the elements of A are $1, 4, 9$. Their distinct absolute differences are $3, 5, 8$. Thus 1 and 2 are related, as are 2 and 3, but 1 and 3 are not related. Every diagonal pair has difference zero. Consequently,

$$R = \{(1, 1), (2, 2), (3, 3), (1, 2), (2, 1), (2, 3), (3, 2)\}.$$

This list includes both orders of each permitted unequal pair, with no pair omitted.

Step 2: Check the first three statements Because $|a^2 - b^2| = |b^2 - a^2|$, reversing a permitted pair preserves the condition; hence $R^{-1} = R$, so (A) is true. Each element occurs as a second coordinate through its diagonal pair, and no second coordinate lies outside A. Therefore the range is exactly A, so (B) is true. The zero differences also establish reflexivity, while the absolute-value identity establishes symmetry, making (C) true.

Step 3: Test the remaining property We have $1R2$ because $|1 - 4| = 3 \leq 5$, and $2R3$ because $|4 - 9| = 5 \leq 5$. However, $|1 - 9| = 8 > 5$, so $1R3$ is false. This directly violates transitivity. Although the symmetry portion of (D) holds, its transitivity portion does not; therefore the combined statement is false.

Step 4: Conclusion R is reflexive and symmetric but not transitive. The statement that is not true is (D). Hence, the correct option is (D).

Quick Tip to Solve: For a threshold relation, test a chain through the middle element: adjacent differences may satisfy the bound while the endpoint difference does not.

2. The locus of the point $z = x + iy\ (x, y \in \mathbf{R}, i = \sqrt{-1})$ satisfying $\arg\left(\frac{z-3}{z+3}\right) = \frac{\pi}{3}$, is : [4 marks]

(A) a circle with radius $= 2\sqrt{3}$

(B) a circle with centre at $(\sqrt{3}, 0)$

(C) a circle with centre at $(0, 2\sqrt{3})$ and radius 3

(D) an ellipse with length of its minor axis $= 3$

Correct Answer: (A) a circle with radius $= 2\sqrt{3}$

Solution:

Concept:

- For a nonzero complex number with argument $\pi/3$, both its real and imaginary parts are positive, and their ratio is $\sqrt{3}$.
- Multiply a complex quotient by the conjugate of its denominator to separate real and imaginary parts. Complete the square to identify its supporting circle.

Step 1: Separate the quotient The denominator excludes $z = -3$, and the argument also excludes $z = 3$, where the numerator vanishes. With $z = x + iy$, rationalisation gives

$$\frac{z-3}{z+3} = \frac{x^2 + y^2 - 9 + 6iy}{(x+3)^2 + y^2}.$$

The real denominator is positive at every permitted point, so it does not affect the argument. The signs of the real and imaginary parts are therefore the signs of $x^2 + y^2 - 9$ and y, respectively.

Step 2: Apply the argument condition Since the given argument is in the first quadrant,

$$\frac{6y}{x^2 + y^2 - 9} = \sqrt{3}, \qquad y > 0, \quad x^2 + y^2 > 9.$$

Rearranging the equality and completing the square gives

$$x^2 + y^2 - 2\sqrt{3}\,y - 9 = 0, \qquad x^2 + (y - \sqrt{3})^2 = 12.$$

Thus the supporting circle has centre $(0, \sqrt{3})$ and radius $\sqrt{12} = 2\sqrt{3}$.

Step 3: Check the choices and the argument branch The argument condition selects the arc of this circle with $y > 0$; the endpoints $z = \pm 3$ are excluded. Merely taking a tangent without checking signs would also admit the wrong argument branch. Among the given descriptions, (A) identifies the correct circle radius. The centre in (B) is on the wrong axis; (C) gives both an incorrect centre and radius; (D) does not describe this circular locus.

Step 4: Conclusion The locus lies on the circle $x^2 + (y - \sqrt{3})^2 = 12$, whose radius is $2\sqrt{3}$, with the arc restriction imposed by the argument. Hence, the correct option is (A).

Quick Tip to Solve: After using the tangent of an argument, check the signs of both components; otherwise an extra arc with argument differing by π can enter the locus.

3. If both the roots of the equation, $x^2 - 2ax + a^2 - 1 = 0 (a \in \mathbf{R})$ lie in the interval $(-2, 2)$, then the equation, $x^2 - \left(a^2 + 1\right) x - \left(a^2 + 2\right) = 0$ has [4 marks]

(A) both roots in $(-3, 0)$

(B) one root in $(0, 2)$ and another root in $(-2, 0)$

(C) one root in $[2, 3)$ and another root in $(-2, 0)$

(D) one root in $(-3, -2)$ and another root in $(0, 2]$

Correct Answer: (C) one root in $[2, 3)$ and another root in $(-2, 0)$

Solution:

Concept:

- A quadratic written as a difference of squares can be factored directly to obtain exact roots.
- Open interval restrictions must hold for both original roots. Once the parameter range is known, use it to bound the roots of the second equation.

Step 1: Find the allowed parameter range The first equation is $(x - a)^2 - 1 = 0$, so its two roots are $a - 1$ and $a + 1$. Requiring the smaller root to exceed -2 and the larger to be less than 2 gives

$$a - 1 > -2 \quad \text{and} \quad a + 1 < 2.$$

Thus $-1 < a < 1$. These inequalities are sufficient as well: the other two endpoint requirements are then automatically satisfied. In particular,

$$0 \leq a^2 < 1.$$

The lower endpoint is attained at $a = 0$, but the upper endpoint is excluded.

Step 2: Factor the second quadratic The second polynomial factors without the quadratic formula:

$$x^2 - (a^2 + 1)x - (a^2 + 2) = (x + 1)(x - a^2 - 2).$$

Indeed, the root sum is $-1 + (a^2 + 2) = a^2 + 1$, and the product is $-(a^2 + 2)$, agreeing with its coefficients. Hence its roots are exactly -1 and $a^2 + 2$.

Step 3: Place both roots in their intervals The negative root -1 lies in $(-2, 0)$, while $0 \leq a^2 < 1$ gives $2 \leq a^2 + 2 < 3$. The positive root is therefore in $[2, 3)$, including 2 when $a = 0$. Option (A) wrongly makes both roots negative. Option (B) excludes the possible value 2 and gives the wrong positive interval. Option (D) puts the negative root below -2, which contradicts its exact value.

Step 4: Conclusion The roots are $-1 \in (-2, 0)$ and $a^2 + 2 \in [2, 3)$. Hence, the correct option is (C).

Quick Tip to Solve: Try a constant root such as -1 before applying the quadratic formula; here it exposes a factor and makes the interval endpoints transparent.

4. If the system of equations

$$2x + y + pz = -1$$

$$3x - 2y + z = q$$

$$5x - 8y + 9z = 5$$

has more than one solution, then $q - p$ is equal to : [4 marks]

(A) 2

(B) -2

(C) 4

(D) -4

Correct Answer: (C) 4

Solution:

Concept:

- More than one solution of a linear system requires a dependent coefficient row together with the same dependency in the constants.
- When two independent rows are known, express the third as their linear combination. Matching all coefficient columns determines the parameter in the coefficient matrix.

Step 1: Find the row dependency Write the third equation as α times the first plus β times the second. Matching the coefficients of x and y requires

$$2\alpha + 3\beta = 5, \qquad \alpha - 2\beta = -8.$$

The second equality gives $\alpha = 2\beta - 8$; substitution into the first gives $7\beta = 21$. Thus $\beta = 3$ and $\alpha = -2$. The first two coefficient rows are independent because their x, y minor is $2(-2) - 3(1) = -7 \neq 0$.

Step 2: Match the remaining coefficient and constants The same row combination must reproduce the coefficient of z. Therefore

$$-2p + 3 = 9 \quad \Longrightarrow \quad p = -3.$$

For consistency, its right-hand side must also be reproduced:

$$-2(-1) + 3q = 5 \quad \Longrightarrow \quad q = 1.$$

If this constant equality failed, the dependent left sides would imply contradictory right sides and there would be no solution, rather than several.

Step 3: Confirm multiplicity and evaluate At these parameter values the third equation is exactly minus twice the first plus three times the second. The first two independent equations impose two constraints on three unknowns, so one variable remains free and there are infinitely many solutions.

This confirms the required condition, rather than only a zero determinant. Finally,

$$q - p = 1 - (-3) = 4.$$

The other values 2, -2, and -4 do not equal this difference; the last would arise from reversing its order.

Step 4: Conclusion $p = -3$, $q = 1$, and hence $q - p = 4$. Hence, the correct option is (C).

Quick Tip to Solve: A zero determinant alone is insufficient: after matching dependent coefficient rows, match their constants to distinguish infinitely many solutions from inconsistency.

5. All the words (with or without meaning) formed using all the five letters of the word GOING are arranged as in dictionary. Then the word OGGIN occurs at the place which is : [4 marks]

(A) $(48)^{\text{th}}$

(B) $(49)^{\text{th}}$

(C) $(50)^{\text{th}}$

(D) $(51)^{\text{th}}$

Correct Answer: (B) $(49)^{\text{th}}$

Solution:

Concept:

- Dictionary order compares letters from left to right; count all words whose first differing letter is smaller than the target letter.
- With repeated letters, the number of distinct permutations is the factorial of the total number divided by factorials of repeated multiplicities.

Step 1: Order the letters and count earlier initial blocks The multiset of letters in GOING is G, G, I, N, O, already in alphabetical order. The target OGGIN starts with O. Every word starting with G, I, or N precedes it, and no other first letter can do so. With initial G fixed, the remaining letters G,I,N,O are distinct, giving $4! = 24$ words. With initial I fixed, the remaining letters G,G,N,O give $4!/2! = 12$ words. With initial N fixed, the remaining letters G,G,I,O also give 12 words. The repeated Gs are indistinguishable, so there is no second separate block for an initial G.

Step 2: Count earlier words in the O block These blocks contain

$$24 + 12 + 12 = 48$$

words. After an initial O, the unused letters are G,G,I,N. Their alphabetically first arrangement is GGIN, precisely the remaining part of OGGIN. At the second position no available letter precedes G; the same is true at the third position after using one G. At the fourth position I is smaller than the sole other unused letter N. Hence no further word in the O block precedes the target.

Step 3: Convert the preceding count to rank A dictionary position is counted from 1, whereas 48 is

the number of earlier words. Add one for the target itself:

$$\text{rank}(\text{OGGIN}) = 48 + 1 = 49.$$

Option (A) confuses the count before the word with its position. Options (C) and (D) add nonexistent earlier arrangements within the O block. Accounting for the two identical Gs is essential in obtaining the correct block sizes.

Step 4: Conclusion OGGIN is the first word of the O block and occupies the 49^{th} place. Hence, the correct option is (B).

Quick Tip to Solve: For a rank problem, keep the count of preceding words separate from the final rank: add one only after every prefix block has been counted.

6. The sum

$-\frac{2}{3} + \frac{2}{9^2} + \frac{10}{9^3} + \frac{18}{9^4} + \frac{26}{9^5} + \ldots\ldots$ **upto infinity, is equal to :** [4 marks]

(A) $-\frac{5}{8}$

(B) $\frac{17}{24}$

(C) $-\frac{11}{24}$

(D) $\frac{5}{8}$

Correct Answer: (A) $-\frac{5}{8}$

Solution:

Concept:

- For $|r| < 1$, $\sum_{n=1}^{\infty} r^n = r/(1-r)$ and $\sum_{n=1}^{\infty} nr^n = r/(1-r)^2$.
- When the numerators form an arithmetic progression and denominators form a geometric progression, split the general term into a multiple of nr^n and a multiple of r^n.

Step 1: Express every term with one formula The first term is $-2/3 = -6/9$. The numerators, when the denominators are $9, 9^2, 9^3, \ldots$, are therefore $-6, 2, 10, 18, 26, \ldots$. They form an arithmetic progression of common difference 8 and nth term $-6 + 8(n-1) = 8n - 14$. Thus the entire series, including its negative first term, is

$$S = \sum_{n=1}^{\infty} \frac{8n - 14}{9^n}.$$

This representation avoids treating the exceptional-looking first term incorrectly.

Step 2: Sum the two convergent series Use $r = 1/9$, whose magnitude is less than 1. Both standard series converge absolutely, so subtraction and multiplication are valid. The needed sums are

$$\sum_{n=1}^{\infty} \frac{1}{9^n} = \frac{1/9}{1 - 1/9} = \frac{1}{8},$$

$$\sum_{n=1}^{\infty} \frac{n}{9^n} = \frac{1/9}{(1 - 1/9)^2} = \frac{9}{64}.$$

Consequently,

$$S = 8\left(\frac{9}{64}\right) - 14\left(\frac{1}{8}\right) = \frac{9}{8} - \frac{14}{8} = -\frac{5}{8}.$$

Step 3: Check the sign and eliminate alternatives The negative first term has magnitude about 0.667, while the later positive terms begin with only $2/81$ and $10/729$. A negative total near -0.63 is therefore consistent with the computed $-5/8 = -0.625$. The positive options (B) and (D) have the wrong sign. The value $-11/24$ in (C) does not agree with the exact evaluation of either convergent component.

Step 4: Conclusion The infinite sum is $-5/8$. Hence, the correct option is (A).

Quick Tip to Solve: Rewrite the first term over the same power pattern as the others; this often reveals the arithmetic progression hidden in the numerators.

7. Let r and s be respectively the remainders when $(12)^{23}$ and $(23)^{12}$ are divided by 5, then $r + s$ is equal to : [4 marks]

(A) 5

(B) 4

(C) 3

(D) 2

Correct Answer: (B) 4

Solution:

Concept:

- Replacing a base by its remainder modulo 5 preserves the remainder of every positive integer power.
- For a base coprime to 5, fourth powers have remainder 1. Reduce exponents by a cycle length of four, then choose remainders from $0, 1, 2, 3, 4$.

Step 1: Reduce the first power Because $12 \equiv 2 \pmod 5$, the remainder r is the least nonnegative residue of 2^{23}. Its powers repeat as $2, 4, 3, 1$, a cycle of length four: indeed $2^4 = 16 \equiv 1 \pmod 5$. Writing $23 = 4 \cdot 5 + 3$ gives

$$12^{23} \equiv (2^4)^5\, 2^3 \equiv 8 \equiv 3 \pmod 5.$$

Thus $r = 3$, rather than 8, since a remainder on division by 5 must be less than 5.

Step 2: Reduce the second power Similarly $23 \equiv 3 \pmod 5$. The powers of 3 have residues $3, 4, 2, 1$, so the same cycle length applies. Since $12 = 4 \cdot 3$,

$$23^{12} \equiv (3^4)^3 \equiv 1 \pmod 5.$$

The exponent being divisible by the cycle length selects the last entry of the cycle, 1; it does not give remainder zero. Hence $s = 1$.

Step 3: Add the actual remainders The problem asks for the ordinary sum of the two remainders, not

for the remainder of that sum. Therefore

$$r + s = 3 + 1 = 4.$$

Option (A) is 5 and cannot follow from the derived pair. Option (C) would omit $s = 1$, while (D) is smaller than r alone. Computing only small residues also avoids constructing either of the enormous original integer powers.

Step 4: Conclusion $r = 3$, $s = 1$, so $r + s = 4$. Hence, the correct option is (B).

Quick Tip to Solve: Make a short residue cycle before reducing the exponent; an exponent divisible by the cycle length uses the last cycle entry, not the first.

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8. Let f be a differentiable function satisfying $f(x + y) = f(x) + f(y) - xy$ for all $x, y \in \mathbf{R}$. If $\lim_{h\to 0} \frac{f(h)}{h} = 3$, then $\sum_{n=1}^{10} f(n)$ is equal to : [4 marks]

(A) $-\frac{55}{2}$

(B) $\frac{275}{2}$

(C) $-\frac{55}{4}$

(D) $\frac{225}{4}$

Correct Answer: (A) $-\frac{55}{2}$

Solution:

Concept:

- The derivative at x is obtained from $\lim_{h\to 0}[f(x + h) - f(x)]/h$. The functional equation expresses this difference using $f(h)$.
- Use $\sum_{n=1}^{N} n = N(N + 1)/2$ and $\sum_{n=1}^{N} n^2 = N(N + 1)(2N + 1)/6$ after finding the function.

Step 1: Find the value at zero and the derivative Set $x = y = 0$ in the given identity. It gives $f(0) = 2f(0)$, so $f(0) = 0$. Next set $y = h$, keeping x fixed:

$$f(x + h) - f(x) = f(h) - xh.$$

For nonzero h, divide by h and take its limit. The given limit is 3, hence

$$f\prime(x) = \lim_{h\to 0}\left(\frac{f(h)}{h} - x\right) = 3 - x.$$

This uses the specified differentiability and introduces no assumption about the shape of f.

Step 2: Recover the function and check the identity Integrating the derivative yields $f(x) = 3x - x^2/2 + C$. The value $f(0) = 0$ forces $C = 0$. As a check,

$$f(x + y) = 3x + 3y - \frac{x^2 + 2xy + y^2}{2} = f(x) + f(y) - xy,$$

exactly as required. Also $f(h)/h = 3 - h/2$ has limit 3, so both the functional equation and the

limiting condition are satisfied.

Step 3: Evaluate the finite sum For $n = 1, \ldots, 10$, substitute the function and sum the linear and quadratic terms separately:

$$\sum_{n=1}^{10} f(n) = 3\sum_{n=1}^{10} n - \frac{1}{2}\sum_{n=1}^{10} n^2.$$

Here $\sum n = 55$ and $\sum n^2 = 385$. Therefore

$$\sum_{n=1}^{10} f(n) = 165 - \frac{385}{2} = -\frac{55}{2}.$$

The positive alternatives have the wrong sign, and $-55/4$ results from an extra factor of two not present in this calculation.

Step 4: Conclusion $f(x) = 3x - x^2/2$ and $\sum_{n=1}^{10} f(n) = -55/2$. Hence, the correct option is (A).

Quick Tip to Solve: In a differentiable addition equation, replace the second argument by h, subtract $f(x)$, and divide by h to expose a derivative directly.

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9. For non-zero real numbers a, b, if $y(x) = \frac{a+bx^{3/2}}{x^{5/4}}, x > 0$ and $y''(5) = 0$, then the ratio $a : b$ is :

[4 marks]

(A) $\sqrt{5} : 3$

(B) $3 : \sqrt{5}$

(C) $\sqrt{5} : \sqrt{3}$

(D) $3 : 1$

Correct Answer: (A) $\sqrt{5} : 3$

Solution:

Concept:

- Rewrite a quotient of powers as a sum, using $x^r/x^s = x^{r-s}$ for $x > 0$. This makes repeated differentiation direct.
- The power rule gives $\frac{d^2}{dx^2}x^r = r(r-1)x^{r-2}$. The condition on the second derivative provides a linear relation between the non-zero constants.

Step 1: Express the function as powers The numerator has two terms, and each must be divided by the entire denominator. Thus

$$y = ax^{-5/4} + bx^{1/4}.$$

In particular, the exponent of the second term is $3/2 - 5/4 = 1/4$, rather than $3/2$. Since $x > 0$, these fractional powers and both derivatives are well-defined.

Step 2: Differentiate twice and impose the condition Termwise differentiation gives

$$y' = -\frac{5a}{4}x^{-9/4} + \frac{b}{4}x^{-3/4}, \qquad y'' = \frac{45a}{16}x^{-13/4} - \frac{3b}{16}x^{-7/4}.$$

At $x = 5$, multiply the equation $y''(5) = 0$ by the positive number $16 \cdot 5^{13/4}$. This yields

$$45a - 3b5^{3/2} = 0, \qquad \frac{a}{b} = \frac{5^{3/2}}{15} = \frac{\sqrt{5}}{3}.$$

Division by b is allowed because the problem declares it non-zero. The reciprocal ratio in (B), the denominator $\sqrt{3}$ in (C), and the rational ratio in (D) do not satisfy this relation.

Step 3: Conclusion Therefore $a : b = \sqrt{5} : 3$. Hence, the correct option is (A).

Quick Tip to Solve: After differentiating fractional powers twice, clear the smaller power of x before substituting; it makes the ratio easy to simplify.

10. The function $f(x) = \sin 2x + 2\cos x, x \in \left(-\frac{3\pi}{4}, \frac{3\pi}{4}\right)$ has : [4 marks]

(A) no critical point.

(B) a point of local maxima and a point of local minima.

(C) a point of local maxima and a point of inflection.

(D) a point of local minima and a point of inflection.

Correct Answer: (C) a point of local maxima and a point of inflection.

Solution:

Concept:

- A critical point of a differentiable function satisfies $f'(x) = 0$. A sign change from positive to negative gives a local maximum; a zero derivative alone does not establish an extremum.
- A point of inflection requires a change in concavity, detected by a sign change of f''. Every candidate must lie inside the specified open interval.

Step 1: Find the stationary points in the interval Differentiate and use $\cos 2x = 1 - 2\sin^2 x$:

$$f'(x) = 2\cos 2x - 2\sin x = -2(2\sin x - 1)(\sin x + 1).$$

Hence $\sin x = 1/2$ or $\sin x = -1$. In $(-3\pi/4, 3\pi/4)$, these give only $x = \pi/6$ and $x = -\pi/2$. The solution $5\pi/6$ is outside the interval and must be discarded.

Step 2: Classify the two stationary points Because $\sin x + 1 \geq 0$, the sign of f', away from its zeros, is opposite to that of $2\sin x - 1$. It changes from positive to negative at $\pi/6$, so this point is a local maximum. Around $-\pi/2$, however, $\sin x < 1/2$ on both sides and $f' > 0$, so there is no local minimum there. Also

$$f''(x) = -4\sin 2x - 2\cos x = -2\cos x(4\sin x + 1).$$

Near $-\pi/2$, the second factor is negative while $\cos x$ changes from negative to positive. Therefore f'' changes from negative to positive, establishing an inflection point. Option (A) misses both stationary points; (B) and (D) incorrectly assert a local minimum.

Step 3: Conclusion The function has a local maximum at $x = \pi/6$ and a stationary point of inflection at $x = -\pi/2$. Hence, the correct option is (C).

Quick Tip to Solve: When a factor such as $\sin x + 1$ vanishes without changing sign, test concavity instead of automatically declaring an extremum.

11. The integral $\int \frac{\cos^5\theta}{\sin\theta(4-3\sin^2 2\theta)}d\theta$ is equal to :

(where C is a constant of integration) [4 marks]

(A) $\frac{1}{5}\log_e\left|\frac{\cos^5\theta}{\sin^5\theta+\cos^5\theta}\right|+C$

(B) $\frac{1}{24}\log_e\left(\frac{\sin^6\theta}{\sin^6\theta+\cos^6\theta}\right)+C$

(C) $\frac{1}{20}\log_e\left|\frac{\sin^5\theta}{\sin^5\theta+\cos^5\theta}\right|+C$

(D) $\frac{1}{6}\log_e\left(\frac{\cos^6\theta}{\sin^6\theta+\cos^6\theta}\right)+C$

Correct Answer: (B) $\frac{1}{24}\log_e\left(\frac{\sin^6\theta}{\sin^6\theta+\cos^6\theta}\right)+C$

Solution:

Concept:

- The substitution $t=\tan\theta$ converts even powers of sine and cosine into rational expressions: $\sin^2 2\theta = 4t^2/(1+t^2)^2$ and $d\theta = dt/(1+t^2)$.
- The identity $(1+t^2)(1-t^2+t^4)=1+t^6$ reduces the resulting rational function to a logarithmic derivative. Work on each interval where the original integrand is defined.

Step 1: Convert the integral to a rational function Where $\cos\theta\neq 0$, put $t=\tan\theta$. Then

$$\frac{\cos^5\theta}{\sin\theta}=\frac{1}{t(1+t^2)^2}, \qquad 4-3\sin^2 2\theta=\frac{4(1-t^2+t^4)}{(1+t^2)^2}.$$

Consequently the integral becomes

$$I=\frac{1}{4}\int\frac{dt}{t(1+t^2)(1-t^2+t^4)}=\frac{1}{4}\int\frac{dt}{t(1+t^6)}.$$

The original condition $\sin\theta\neq 0$ excludes the zero of the logarithm argument.

Step 2: Integrate and express the answer in sine and cosine Use

$$\frac{1}{t(1+t^6)}=\frac{1}{t}-\frac{t^5}{1+t^6}.$$

Therefore

$$I=\frac{1}{4}\log|t|-\frac{1}{24}\log(1+t^6)+C=\frac{1}{24}\log\left(\frac{t^6}{1+t^6}\right)+C.$$

Replacing t by $\tan\theta$ gives

$$I=\frac{1}{24}\log\left(\frac{\sin^6\theta}{\sin^6\theta+\cos^6\theta}\right)+C.$$

This expression extends smoothly across points where $\cos\theta=0$, provided $\sin\theta\neq 0$. The fifth-power logarithms in (A) and (C) have a different derivative. The cosine-numerator expression in (D) differentiates to $-\sin^5\theta/[\cos\theta(\sin^6\theta+\cos^6\theta)]$, which is not the given integrand.

Step 3: Conclusion The integral equals $\frac{1}{24}\log_e\left(\frac{\sin^6\theta}{\sin^6\theta+\cos^6\theta}\right)+C$. Hence, the correct option is (B).

Quick Tip to Solve: With $\sin^2 2\theta$ in a denominator, try $\tan\theta$ and look for the factorisation of $1+t^6$.

12. The area (in sq. units) of the region bounded by the parabola $x = 2y^2$ and the line $x + y = 1$ is : [4 marks]

(A) $\frac{11}{12}$
(B) $\frac{13}{24}$
(C) $\frac{9}{8}$
(D) $\frac{5}{4}$

Correct Answer: (C) $\frac{9}{8}$

Solution:

Concept:

- When both curves are naturally expressed as x in terms of y, horizontal strips give area $\int (x_{\text{right}} - x_{\text{left}})\, dy$.
- The limits of integration are the y-coordinates of the intersection points. The order of subtraction must make the strip width non-negative throughout the bounded region.

Step 1: Find the intersection levels and strip width The line is $x = 1 - y$, while the parabola is $x = 2y^2$. Equating these gives

$$2y^2 = 1 - y, \qquad 2y^2 + y - 1 = (2y - 1)(y + 1) = 0.$$

The intersection levels are $y = -1$ and $y = 1/2$, corresponding to $(2, -1)$ and $(1/2, 1/2)$. For example, at $y = 0$ the line has $x = 1$ and the parabola has $x = 0$. More generally, $1-y-2y^2 = (1-2y)(y+1) \geq 0$ between the two levels, so the line is consistently the right boundary.

Step 2: Integrate the horizontal width The required area is therefore

$$A = \int_{-1}^{1/2} (1 - y - 2y^2)\, dy = \left[y - \frac{y^2}{2} - \frac{2y^3}{3} \right]_{-1}^{1/2}.$$

At the upper limit the antiderivative equals $1/2 - 1/8 - 1/12 = 7/24$; at the lower limit it equals $-1 - 1/2 + 2/3 = -5/6$. Thus

$$A = \frac{7}{24} + \frac{5}{6} = \frac{27}{24} = \frac{9}{8}.$$

This positive value accounts for the full closed region. The other proposed fractions $11/12$, $13/24$, and $5/4$ differ from this exact integral; none results from the correct limits and right-minus-left width.

Step 3: Conclusion The bounded area is $\frac{9}{8}$ square units. Hence, the correct option is (C).

Quick Tip to Solve: For a sideways parabola $x = 2y^2$, integrate with respect to y to avoid splitting the upper and lower square-root branches.

13. Let $y = y(x)$ be the solution of the differential equation $x \log_e x \frac{dy}{dx} + 2y = 2x (x > 1)$. If $\lim_{x \to 1+} y(x) = 1$, then $y\left(e^2\right)$ is equal to : [4 marks]

(A) $\frac{e^2-1}{2}$

(B) $\frac{e^2+1}{2}$

(C) $e^2 - 1$

(D) $e^2 + 1$

Correct Answer: (B) $\frac{e^2+1}{2}$

Solution:

Concept:

- A first-order linear equation $y' + P(x)y = Q(x)$ is solved with integrating factor $\exp(\int P(x)\,dx)$.
- Here $x > 1$ makes $\log x > 0$. A finite limit at $x = 1^+$, where the divided equation is singular, determines the integration constant.

Step 1: Find the integrating factor and integrate Divide by $x \log x$, which is non-zero in the given domain:

$$y' + \frac{2}{x \log x} y = \frac{2}{\log x}.$$

The integrating factor is

$$\exp\left(\int \frac{2}{x \log x}\,dx\right) = (\log x)^2.$$

Multiplying the differential equation by it gives

$$\frac{d}{dx}\{y(\log x)^2\} = 2 \log x.$$

Since $\int \log x\,dx = x \log x - x$, integration yields

$$y(\log x)^2 = 2x \log x - 2x + C.$$

Step 2: Use the limiting value and evaluate at the requested point The hypothesis $y(x) \to 1$ implies $y(x)(\log x)^2 \to 0$ as $x \to 1^+$. Taking this limit in the integrated equation gives $0 = -2 + C$, so $C = 2$. This is consistent with the stated limit: the numerator $2x \log x - 2x + 2$ and denominator $(\log x)^2$ both vanish, and differentiation gives their ratio limit $\lim_{x \to 1^+} x = 1$. Now $\log(e^2) = 2$, so

$$y(e^2) = \frac{4e^2 - 2e^2 + 2}{4} = \frac{e^2 + 1}{2}.$$

Option (A) has the wrong sign on the constant term; (C) and (D) also omit the division by 2.

Step 3: Conclusion Therefore $y(e^2) = (e^2 + 1)/2$. Hence, the correct option is (B).

Quick Tip to Solve: Apply a boundary limit to the integrated equation before dividing by a vanishing integrating factor; it fixes the constant immediately.

14. If $(x_i, y_i), i = 1, 2, 3$ are the vertices of an equilateral triangle such that $(x_1+3)^2 + (y_1-4)^2 = (x_2+3)^2 + (y_2-4)^2 = (x_3+3)^2 + (y_3-4)^2$, then the value of $\frac{y_1+y_2+y_3}{x_1+x_2+x_3}$ is : [4 marks]

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

(B) $-\frac{4}{3}$

(C) $\frac{3}{4}$

(D) $-\frac{3}{4}$

Correct Answer: (B) $-\frac{4}{3}$

Solution:

Concept:

- A point equidistant from all three vertices of a non-degenerate triangle is its circumcentre. The squared-distance formula identifies that point from the given equality.
- In an equilateral triangle the circumcentre and centroid coincide. The centroid coordinates are the arithmetic means of the three vertex coordinates.

Step 1: Identify the point specified by the equal distances Each displayed quantity has the form

$$(x_i - (-3))^2 + (y_i - 4)^2.$$

It is the square of the distance from the vertex (x_i, y_i) to the fixed point $P = (-3, 4)$. Equality for $i = 1, 2, 3$ means that P is equidistant from the three vertices, and hence is their circumcentre. The signs matter: the expression $x_i + 3$ puts the centre at -3, not at $+3$. The vertices of a triangle are non-collinear, so this circumcentre is unique.

Step 2: Use the coincidence of centres For an equilateral triangle, symmetry places its centroid at its circumcentre: each median is also a perpendicular bisector. Therefore

$$\left(\frac{x_1+x_2+x_3}{3}, \frac{y_1+y_2+y_3}{3}\right) = (-3, 4).$$

Thus

$$x_1 + x_2 + x_3 = -9, \qquad y_1 + y_2 + y_3 = 12.$$

The required ratio is

$$\frac{y_1+y_2+y_3}{x_1+x_2+x_3} = \frac{12}{-9} = -\frac{4}{3}.$$

The denominator is non-zero. Option (A) loses its negative sign, while (C) and (D) reverse the requested y-sum to x-sum ratio. There is no need to calculate individual vertices or the side length.

Step 3: Conclusion The required value is $-\frac{4}{3}$. Hence, the correct option is (B).

Quick Tip to Solve: Read equal squared distances as a circumcentre condition, then use the coincidence of centres for an equilateral triangle.

15. If tangent at $\left(\frac{1}{\sqrt{2}}, \frac{1}{\sqrt{2}}\right)$ to the circle $x^2 + y^2 = 1$ is also a tangent to the circle $(x-a)^2 + (y-b)^2 = 1$, then the ordered pair (a, b) can be : [4 marks]

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

(B) $(-\sqrt{2}, 2\sqrt{2})$

(C) $(2, -2\sqrt{2})$

(D) $(-\sqrt{2}, \sqrt{2})$

Correct Answer: (D) $(-\sqrt{2}, \sqrt{2})$

Solution:

Concept:

- The tangent to $x^2 + y^2 = r^2$ at (x_0, y_0) is $xx_0 + yy_0 = r^2$.
- A line is tangent to a circle precisely when its perpendicular distance from the centre equals the radius. For $Ax + By + C = 0$, that distance is $|Aa + Bb + C|/\sqrt{A^2 + B^2}$.

Step 1: Find the fixed tangent line The point $(1/\sqrt{2}, 1/\sqrt{2})$ lies on the unit circle because the sum of its squared coordinates is 1. Substitution into the tangent formula gives

$$\frac{x}{\sqrt{2}} + \frac{y}{\sqrt{2}} = 1, \qquad x + y - \sqrt{2} = 0.$$

The second circle has centre (a, b) and radius 1, regardless of the signs of a and b.

Step 2: Impose the distance condition and test the options For the same line to be tangent to this second circle,

$$\frac{|a + b - \sqrt{2}|}{\sqrt{2}} = 1.$$

Thus $a + b - \sqrt{2} = \pm\sqrt{2}$, giving

$$a + b = 0 \quad \text{or} \quad a + b = 2\sqrt{2}.$$

For (D), $(-\sqrt{2}, \sqrt{2})$, the sum is 0, so its centre is exactly one unit from the line. For (A), the sum is $-2 + \sqrt{2}$, giving distance $\sqrt{2}$, not 1. For (B), the sum is $\sqrt{2}$, placing the centre on the line, so the line is a secant through the centre. For (C), the distance is $(3\sqrt{2} - 2)/\sqrt{2} = 3 - \sqrt{2}$, again not 1. Only (D) meets the tangency criterion.

Step 3: Conclusion The ordered pair can be $(-\sqrt{2}, \sqrt{2})$. Hence, the correct option is (D).

Quick Tip to Solve: For a common tangent problem with a known tangent line, compare centre-to-line distances instead of solving simultaneous circle equations.

16. The foci of a hyperbola coincide with the foci of the ellipse, $\frac{x^2}{16} + \frac{y^2}{9} = 1$. If the eccentricity of the hyperbola is 4, then its equation is : [4 marks]

(A) $\frac{x^2}{7} - \frac{4y^2}{105} = \frac{1}{4}$

(B) $\frac{x^2}{7} - \frac{y^2}{105} = \frac{1}{16}$

(C) $\frac{x^2}{20} - \frac{y^2}{75} = \frac{1}{16}$

(D) $\frac{x^2}{5} - \frac{y^2}{75} = \frac{1}{16}$

Correct Answer: (B) $\frac{x^2}{7} - \frac{y^2}{105} = \frac{1}{16}$

Solution:

Concept:

- For the ellipse $x^2/A^2 + y^2/B^2 = 1$, with $A > B$, the focal distance satisfies $c^2 = A^2 - B^2$.
- For a horizontal hyperbola $x^2/a^2 - y^2/b^2 = 1$, the relations are $c^2 = a^2 + b^2$ and $e = c/a$. Confocal conics share the same centre and foci, not generally the same vertices.

Step 1: Determine the shared foci and the transverse semi-axis The given ellipse has $A^2 = 16$ and $B^2 = 9$. Its major axis is the x-axis, so

$$c^2 = 16 - 9 = 7, \qquad \text{foci } (\pm\sqrt{7}, 0).$$

The desired hyperbola has exactly these foci, so it is horizontal with centre at the origin. Its eccentricity is 4, and hence

$$4 = \frac{\sqrt{7}}{a}, \qquad a = \frac{\sqrt{7}}{4}, \qquad a^2 = \frac{7}{16}.$$

Here a denotes the hyperbola parameter; it is not the ellipse semi-major axis 4.

Step 2: Find the conjugate semi-axis and compare equations Using the hyperbola identity,

$$b^2 = c^2 - a^2 = 7 - \frac{7}{16} = \frac{105}{16}.$$

Its standard equation is

$$\frac{x^2}{7/16} - \frac{y^2}{105/16} = 1.$$

Dividing the equivalent equation $16x^2/7 - 16y^2/105 = 1$ by 16 gives

$$\frac{x^2}{7} - \frac{y^2}{105} = \frac{1}{16}.$$

Option (A), when normalized, has focal square $7/4 + 105/16 = 133/16$, not 7. Options (C) and (D) normalize to semi-axis squares $20/16, 75/16$ and $5/16, 75/16$, respectively, whose sums are also not 7. Therefore they cannot share the stated foci.

Step 3: Conclusion The hyperbola is $\frac{x^2}{7} - \frac{y^2}{105} = \frac{1}{16}$. Hence, the correct option is (B).

Quick Tip to Solve: First compute the common focal distance; eccentricity then determines the hyperbola transverse semi-axis, and the sum relation gives the other one.

17. If the plane $\mathrm{P} : 2x - y + 3z + 5 = 0$ is rotated through 90° about its line of intersection with the plane $5x - 4y - 2z + 1 = 0$, then the equation of the plane P in the new position is : [4 marks]

(A) $27x - 24y - 26z + 13 = 0$

(B) $27x - 24y - 26z - 13 = 0$

(C) $31x + 2y - 20z - 13 = 0$

(D) $31x - 25y + 29z + 13 = 0$

Correct Answer: (B) $27x - 24y - 26z - 13 = 0$

Solution:

Concept:

- A plane through the intersection of two nonparallel planes can be written as a linear combination of their equations. This preserves every point on the common line.
- Planes are perpendicular exactly when their normal vectors have zero dot product. A rotation through 90° about a line in a plane produces a perpendicular plane through the same line.

Step 1: Write the family through the fixed line Put $P = 2x - y + 3z + 5$ and $Q = 5x - 4y - 2z + 1$. Every point of the rotation axis satisfies both $P = 0$ and $Q = 0$, so it also satisfies $P + \lambda Q = 0$. Thus the required plane has equation

$$(2 + 5\lambda)x + (-1 - 4\lambda)y + (3 - 2\lambda)z + 5 + \lambda = 0.$$

Its normal is $(2 + 5\lambda, -1 - 4\lambda, 3 - 2\lambda)$, whereas the original normal is $(2, -1, 3)$.

Step 2: Impose the right-angle condition The new normal must be perpendicular to the original one. Their scalar product is

$$2(2 + 5\lambda) - (-1 - 4\lambda) + 3(3 - 2\lambda) = 14 + 8\lambda.$$

Hence $14 + 8\lambda = 0$, giving $\lambda = -7/4$. Multiplying the plane equation by 4 gives $4P - 7Q = 0$, or

$$-27x + 24y + 26z + 13 = 0.$$

Changing every sign gives $27x - 24y - 26z - 13 = 0$.

Step 3: Check the proposed alternatives The normal $(27, -24, -26)$ has scalar product $54+24-78 = 0$ with the original normal. Option (A) has this normal but its constant has the wrong sign, so it does not contain the fixed line. The normals in (C) and (D) have nonzero scalar products with $(2, -1, 3)$, so neither represents the required right-angle rotation.

Step 4: Conclusion The rotated plane is $27x - 24y - 26z - 13 = 0$. Hence, the correct option is (B).

Quick Tip to Solve: Use the family of planes through the fixed line first; perpendicular normals then give one linear equation for the parameter.

18. The top of two poles, standing 4 m apart on a horizontal plane, are connected by a cable. If the angles of depression from the top of one pole to the bottom of another pole are 30° and 45°, then the minimum length (in m) of the cable is : [4 marks]

(A) $\sqrt{\frac{32\sqrt{3}-16}{3}}$

(B) $\sqrt{\frac{128-32\sqrt{3}}{3}}$

(C) $\sqrt{\frac{122-32\sqrt{3}}{3}}$

(D) $\sqrt{\frac{112-32\sqrt{3}}{3}}$

Correct Answer: (D) $\sqrt{\frac{112-32\sqrt{3}}{3}}$

Solution:

Concept:

- For a pole of height h observed across a horizontal distance d, the angle of depression to the opposite foot satisfies $\tan\theta = h/d$. The horizontal through the pole top is parallel to the ground.
- The shortest cable between two fixed points is the straight segment joining them. Its horizontal component is the pole separation, and its vertical component is the difference of the pole heights.

Step 1: Find the heights of the two poles The two stated angles refer to viewing the opposite foot from the two pole tops. Both horizontal distances are $4\,\text{m}$. Calling the corresponding heights h_1 and h_2,

$$h_1 = 4\tan 30^\circ = \frac{4}{\sqrt{3}}, \qquad h_2 = 4\tan 45^\circ = 4.$$

Their difference, which is the vertical separation between cable endpoints, is $4 - 4/\sqrt{3}$. Adding the heights would incorrectly measure a vertical path through the ground rather than the displacement between the tops.

Step 2: Apply Pythagoras to the cable Let L be the minimum cable length. The straight segment forms the hypotenuse of a right triangle with legs 4 and $4 - 4/\sqrt{3}$. Therefore

$$\begin{aligned} L^2 &= 4^2 + \left(4 - \frac{4}{\sqrt{3}}\right)^2 \\ &= 16 + 16 + \frac{16}{3} - \frac{32}{\sqrt{3}} \\ &= \frac{112 - 32\sqrt{3}}{3}. \end{aligned}$$

Take the positive square root because length is positive. Any sagging or curved cable would have greater length between these same endpoints.

Step 3: Check the scale and the options Numerically the height difference is about $1.69\,\text{m}$, so the cable is about $4.34\,\text{m}$, slightly longer than the horizontal separation. Option (A) is shorter than $4\,\text{m}$ and cannot connect the tops. Options (B) and (C) have different constant terms under the radical and do not equal the squared-distance calculation. Only (D) has the correct value.

Step 4: Conclusion The minimum cable length is $\sqrt{\frac{112 - 32\sqrt{3}}{3}}\,\text{m}$. Hence, the correct option is (D).

Quick Tip to Solve: Find each pole height using the same ground separation, then use the difference of heights for the cable triangle.

19. Let A, B and C be three events such that the probability of occurrence of exactly one of A and B is $\frac{1}{2}$, the probability of occurrence of exactly one of B and C is $\frac{3}{4}$ and the probability of occurrence of exactly one of C and A is $\frac{1}{4}$. If the probability of occurrence of all the three events simultaneously is $\frac{1}{16}$, then the probability that at least one of the three events will occur is : [4 marks]

(A) $\frac{7}{16}$
(B) $\frac{13}{16}$
(C) $\frac{7}{8}$
(D) $\frac{15}{16}$

Correct Answer: (B) $\frac{13}{16}$

Solution:

Concept:

- Exactly one of two events occurs on their symmetric difference. Thus its probability is $P(A) + P(B) - 2P(A \cap B)$.
- Inclusion-exclusion adds the three individual probabilities, subtracts the three pairwise intersection probabilities, and adds the triple-intersection probability once.

Step 1: Add the three pairwise conditions Write $S_1 = P(A) + P(B) + P(C)$ and $S_2 = P(A \cap B) + P(B \cap C) + P(C \cap A)$. Adding the given probabilities of exactly one event in each pair counts each single-event probability twice and each intersection term with coefficient minus two. Hence

$$2S_1 - 2S_2 = \frac{1}{2} + \frac{3}{4} + \frac{1}{4} = \frac{3}{2},$$

so $S_1 - S_2 = 3/4$. It is unnecessary to find the three individual event probabilities: the required combination is already determined.

Step 2: Include the triple intersection Using the supplied value $P(A \cap B \cap C) = 1/16$, inclusion-exclusion immediately yields

$$P(A \cup B \cup C) = \frac{3}{4} + \frac{1}{16} = \frac{13}{16}.$$

The plus sign on the triple intersection is essential: an outcome in all three events has been counted three times in S_1 and subtracted three times in S_2, leaving zero until it is added back once.

Step 3: Check by counting event membership An outcome belonging to exactly one or exactly two of the three events appears in precisely two of the pairwise symmetric differences. Outcomes belonging to none or all three appear in none. Thus their combined probability is half of $3/2$, namely $3/4$, and the all-three probability adds $1/16$. This independent count confirms $13/16$; the alternatives $7/16$, $7/8$, and $15/16$ do not satisfy this identity.

Step 4: Conclusion The probability that at least one event occurs is $13/16$. Hence, the correct option is (B).

Quick Tip to Solve: When all three pairwise exactly-one probabilities are given, halve their sum and add the triple-intersection probability.

20. Let

p **: I have passed JEE (Main),**

q **: My JEE (Main) rank is 100, and**

r **: I will appear in JEE (Advanced)**

be three statements with truth values T, F and T respectively. Then which one of the following has the truth value, F ? [4 marks]

(A) $(\sim p \vee \sim q) \wedge r$

(B) $(p \wedge \sim q) \vee (\sim r)$

(C) $(\sim p \vee q) \wedge (\sim r)$

(D) $(\sim p \wedge q) \vee r$

Correct Answer: (C) $(\sim p \vee q) \wedge (\sim r)$

Solution:

Concept:

- Negation reverses a truth value. A conjunction $u \wedge v$ is true only when both inputs are true; a disjunction $u \vee v$ is true when at least one input is true.
- The supplied values are $p = T$, $q = F$, and $r = T$. Therefore $\sim p = F$, $\sim q = T$, and $\sim r = F$. Treat these as logical data rather than making assumptions about exam eligibility.

Step 1: Evaluate the first two expressions For option (A), first evaluate the parentheses, then the conjunction:

$$(\sim p \vee \sim q) \wedge r = (F \vee T) \wedge T = T \wedge T = T.$$

For option (B), the conjunction inside the first parentheses is true, while the negation of r is false:

$$(p \wedge \sim q) \vee (\sim r) = (T \wedge T) \vee F = T \vee F = T.$$

Neither option has the requested false truth value.

Step 2: Evaluate the remaining expressions For option (C), both entries of the first disjunction are false, and the second conjunct is also false:

$$(\sim p \vee q) \wedge (\sim r) = (F \vee F) \wedge F = F \wedge F = F.$$

For option (D), although the first conjunction is false, the final disjunction contains the true value r:

$$(\sim p \wedge q) \vee r = (F \wedge F) \vee T = F \vee T = T.$$

Thus (C) is the unique false expression.

Step 3: Check the outer connectives The outer connective in (C) is AND. Since $\sim r = F$, the whole expression is false regardless of the first parentheses. In contrast, the outer connective in (D) is OR with $r = T$, forcing that expression to be true. These checks agree with the full substitutions above and guard against interchanging AND and OR while reading the symbols.

Step 4: Conclusion The false statement is $(\sim p \vee q) \wedge (\sim r)$. Hence, the correct option is (C).

Quick Tip to Solve: Write the three negated truth values once, then evaluate parentheses before the outer AND or OR.

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

21. Let $B = \begin{bmatrix} 22 & -26 \\ -6 & 10 \end{bmatrix}$ be the matrix obtained by applying the elementary row operations $R_2 \to R_2 - R_1$, $R_1 \to 2R_1$ and $R_1 \to R_1 - 2R_2$ (in this order only) on a matrix A. Then the sum of all entries of A is _____. [4 marks]

Solution:

Concept:

- An elementary row operation is reversible. To recover the original matrix, undo the last operation first and continue in reverse order.
- Adding a multiple of one row to another leaves the source row unchanged. Inverting a row scaling requires division by the same nonzero factor.

Step 1: Undo the last row replacement The final matrix has rows $R_1 = (22, -26)$ and $R_2 = (-6, 10)$. The last forward operation was $R_1 \to R_1 - 2R_2$. Its inverse is $R_1 \to R_1 + 2R_2$, while the second row remains fixed. Hence the immediately preceding matrix is

$$\begin{pmatrix} 22 + 2(-6) & -26 + 2(10) \\ -6 & 10 \end{pmatrix} = \begin{pmatrix} 10 & -6 \\ -6 & 10 \end{pmatrix}.$$

Use the second row of the current matrix, not a row reconstructed at a later stage.

Step 2: Undo scaling and then the first operation The second forward operation doubled the first row, so divide that row by 2 to obtain

$$\begin{pmatrix} 5 & -3 \\ -6 & 10 \end{pmatrix}.$$

Finally undo $R_2 \to R_2 - R_1$ by replacing R_2 with $R_2 + R_1$. This gives

$$A = \begin{pmatrix} 5 & -3 \\ -1 & 7 \end{pmatrix}.$$

The required sum is therefore $5 - 3 - 1 + 7 = 8$.

Step 3: Verify in the stated forward order Starting with this A, subtracting the first row from the second gives $(-6, 10)$. Doubling the unchanged first row gives $(10, -6)$. Subtracting twice the current second row from it gives $(22, -26)$. Thus the three operations reproduce the supplied B exactly, confirming both the reverse order and the negative signs. The requested answer is a dimensionless sum of matrix entries, so no physical unit is attached.

Step 4: Conclusion The sum of all entries of A is $\boxed{8}$.

Quick Tip to Solve: For successive row operations, reverse both their order and their action; verify the recovered matrix by applying the original sequence.

22. For $b \in \mathbf{N}$, if the limit of the function

$$f(x) = \begin{cases} [5x-4], & x < 4, \\ \dfrac{[x+b]}{2}, & x > 4 \end{cases}$$

when $x \to 4$, exists and $[t]$ denotes the greatest integer $\leq t$, then b is equal to _____. [4 marks]

Solution:

Concept:

- The limit at a point exists when the left-hand and right-hand limits both exist and are equal. The value of the function at that point is not required for this test.
- The greatest-integer function $[t] = \lfloor t \rfloor$ equals the integer n whenever $n \leq t < n+1$. Approaching an integer from below gives the preceding integer, whereas approaching it from above gives that integer itself.

Step 1: Evaluate the left-hand limit Put $x = 4 - h$, where $h > 0$ tends to zero. This uses the branch prescribed for $x < 4$. Its argument is

$$5x - 4 = 5(4-h) - 4 = 16 - 5h.$$

For $0 < h < 1/5$, we have $15 < 16 - 5h < 16$, so its greatest integer is exactly 15. Thus the value is constant sufficiently close to the point on the left, and

$$\lim_{x \to 4^-} f(x) = 15.$$

Substituting $x = 4$ inside the bracket would instead give 16, but that is not the left-hand limit: the argument reaches 16 from below.

Step 2: Evaluate the right-hand limit Put $x = 4 + h$, with $0 < h < 1$, and use the branch for $x > 4$. Since b is a natural number, $b + 4$ is an integer. Hence

$$b + 4 < x + b = b + 4 + h < b + 5, \qquad [x + b] = b + 4.$$

The division by 2 is outside the greatest-integer bracket, so the required one-sided limit is

$$\lim_{x \to 4^+} f(x) = \frac{b+4}{2}.$$

Step 3: Equate the one-sided limits and check The given two-sided limit exists precisely when these two constant one-sided values agree:

$$\frac{b+4}{2} = 15 \quad \Longrightarrow \quad b + 4 = 30 \quad \Longrightarrow \quad b = 26.$$

This is a natural number as required. For this value, the right branch is $[x + 26]/2 = 30/2 = 15$ for every $4 < x < 5$, while the left branch is 15 for every $19/5 < x < 4$. Therefore both sides actually agree throughout sufficiently small punctured neighbourhoods, verifying existence rather than only proposing a candidate.

Step 4: Conclusion Both one-sided limits equal 15 exactly when $\boxed{b = 26}$. The required numerical value is 26; it is dimensionless.

Quick Tip to Solve: For a floor function near an integer, write $x = a - h$ and $x = a + h$ with small positive h. Track which side the bracket's argument approaches from before taking its greatest integer.

23. If $S = \{x \in [0, 4\pi] : \sin 2x - \cos x = 0\}$ and the sum of the elements of S is $k\pi$, then k is equal to _____. [4 marks]

Solution:

Concept:

- Use $\sin 2x = 2 \sin x \cos x$ to factor the equation. A product is zero when at least one factor is zero.
- All distinct solutions must lie in the closed interval $[0, 4\pi]$. Check interval endpoints and avoid counting a solution twice when combining different factors.

Step 1: Factor and solve the cosine factor The given equation becomes

$$2 \sin x \cos x - \cos x = \cos x(2 \sin x - 1) = 0.$$

The first possibility is $\cos x = 0$, which gives $x = \pi/2 + n\pi$ for integral n. In the prescribed interval these are

$$\frac{\pi}{2}, \quad \frac{3\pi}{2}, \quad \frac{5\pi}{2}, \quad \frac{7\pi}{2}.$$

Their sum is $(1 + 3 + 5 + 7)\pi/2 = 8\pi$. Neither endpoint of the interval satisfies this factor.

Step 2: Solve the sine factor The second possibility is $2 \sin x - 1 = 0$, or $\sin x = 1/2$. Over one full turn the solutions are $\pi/6$ and $5\pi/6$; adding 2π supplies the second turn. Thus the four values in the interval are

$$\frac{\pi}{6}, \quad \frac{5\pi}{6}, \quad \frac{13\pi}{6}, \quad \frac{17\pi}{6}.$$

Their sum is $(1 + 5 + 13 + 17)\pi/6 = 6\pi$.

Step 3: Combine the two solution sets None of the cosine-zero values has sine equal to $1/2$, since their sine values are 1 or -1. Hence the two lists are disjoint and all eight values must be included once. Also $x = 0$ and $x = 4\pi$ both give $\sin 2x - \cos x = -1$, so neither is an omitted endpoint solution. The total is

$$\sum_{x \in S} x = 8\pi + 6\pi = 14\pi.$$

Comparing with the definition $k\pi$ gives the requested dimensionless coefficient.

Step 4: Conclusion The sum is 14π, so $\boxed{k = 14}$.

Quick Tip to Solve: Factor before dividing by a trigonometric expression; division by cosine here would lose four valid solutions.

24. If the mean of the numbers $-7, -5, -2, x, 5$ is -1, then the variance of the numbers $x-3, 4x, x+3$ is _____. [4 marks]

Solution:

Concept:

- The arithmetic mean of n numbers is their sum divided by n. Use the first data set to determine the unknown x before forming the second data set.
- The variance of a complete list of n values is $\sigma^2 = \frac{1}{n}\sum(y_i - \bar{y})^2$. Equivalently, it is the mean of the squares minus the square of the mean; the divisor here is n, not $n-1$.

Step 1: Determine the missing number The five numbers are $-7, -5, -2, x, 5$, and their mean is -1. Therefore their sum must be $5(-1) = -5$. Combining the known entries gives $-7-5-2+5 = -9$, so

$$\frac{x-9}{5} = -1 \quad \Longrightarrow \quad x - 9 = -5 \quad \Longrightarrow \quad x = 4.$$

This mean condition applies to the original five-number list only; the new list has a different mean.

Step 2: Form the new data and its mean Substituting $x = 4$ into $x-3, 4x, x+3$ gives $1, 16, 7$. Their arithmetic mean is

$$\bar{y} = \frac{1+16+7}{3} = 8.$$

The deviations from this mean are $-7, 8, -1$, whose sum is zero, as required for deviations about an arithmetic mean. Square each deviation before taking their average.

Step 3: Calculate and independently check the variance The variance is

$$\sigma^2 = \frac{(1-8)^2 + (16-8)^2 + (7-8)^2}{3} = \frac{49+64+1}{3} = 38.$$

As a second calculation, the mean of the squares is $(1+256+49)/3 = 102$, and $102 - 8^2 = 102 - 64 = 38$. Both formulas agree. Taking the square root would give the standard deviation, which is not what is requested; dividing by 2 would instead use a sample-variance convention absent from this question.

Step 4: Conclusion The variance of $x-3, 4x, x+3$ is $\boxed{38}$.

Quick Tip to Solve: After finding the unknown from the first mean, rebuild the new list and calculate its own mean before finding its variance.

25. If the equation of a plane P passing through the point $\hat{i}+\hat{j}+\hat{k}$ is $\vec{r}\cdot(2\hat{i}-\hat{j}+a\hat{k}) = 3$, then the length of the perpendicular from the point $4\hat{i}-\hat{j}+3\hat{k}$ on the plane P is _____. [4 marks]

Solution:

Concept:

- A point lies on a plane precisely when its coordinates satisfy the plane equation. Here the given point has coordinates $(1,1,1)$, so it determines the unknown coefficient a.
- For the plane $Ax+By+Cz+D=0$, the perpendicular distance of (x_0, y_0, z_0) is $d = |Ax_0 + By_0 +$

$Cz_0 + D|/\sqrt{A^2 + B^2 + C^2}$. The denominator is the magnitude of a normal vector.

Step 1: Determine the coefficient of the plane The vector equation is equivalent to $2x - y + az = 3$. Since the plane passes through $(1, 1, 1)$, substitute all three coordinates before finding a distance:

$$2(1) - 1 + a(1) = 3 \quad \Longrightarrow \quad a = 2.$$

Thus the actual plane is $2x - y + 2z - 3 = 0$. Its normal vector is $(2, -1, 2)$, rather than the position vector of either of the given points.

Step 2: Evaluate the perpendicular distance The point from which the perpendicular is drawn is $(4, -1, 3)$. In particular its second coordinate is negative, so the term $-y$ contributes $+1$. Using the distance formula,

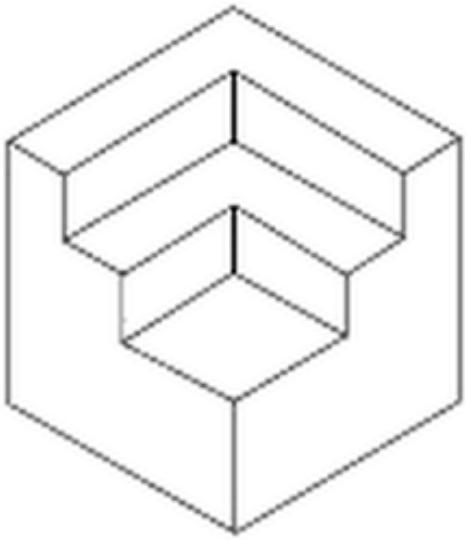
$$d = \frac{|2(4) - (-1) + 2(3) - 3|}{\sqrt{2^2 + (-1)^2 + 2^2}} = \frac{|8 + 1 + 6 - 3|}{\sqrt{9}} = \frac{12}{3} = 4.$$

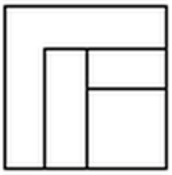
The absolute value makes the result a length, independent of which direction is chosen for the normal. Dividing by its magnitude is essential: the numerator alone depends on the scale of the plane equation.

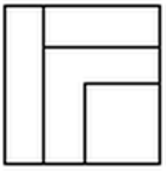
Step 3: Conclusion The required perpendicular length is $\boxed{4}$ units; the numerical answer is 4.

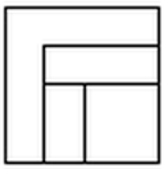
Quick Tip to Solve: First use the point lying on the plane to determine its unknown coefficient; only then insert the other point into the normalized distance formula.

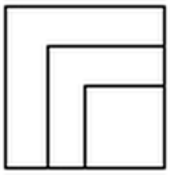
26. The 3 - D figure shows the view of an object. Identify the correct top view from amongst the answer figures. [4 marks]

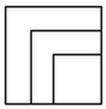


(A) 

(B) 

(C) 

(D) 

Correct Answer: (D) 

Solution:

Concept:

- A top view is the vertical orthographic projection of the object. Height changes appear as boundaries between horizontal terraces; vertical faces do not retain their isometric slant.
- Start with the outside footprint, then trace the exposed edges of each level. A line is retained only when a real edge separates visible surfaces, not merely because two patches have equal height.

Step 1: Trace the footprint and the terraces The object has a square outside footprint. The high strip turns around the rear corner, so its two arms appear as a continuous L-shaped band in plan. Inside that band the next terrace also turns around the same corner. Looking straight down removes the vertical drops, but it does not remove the edges at which those drops begin. Consequently the plan

must contain two successively inset L-shaped boundaries, leaving the lowest corner region at the opening of the two arms.

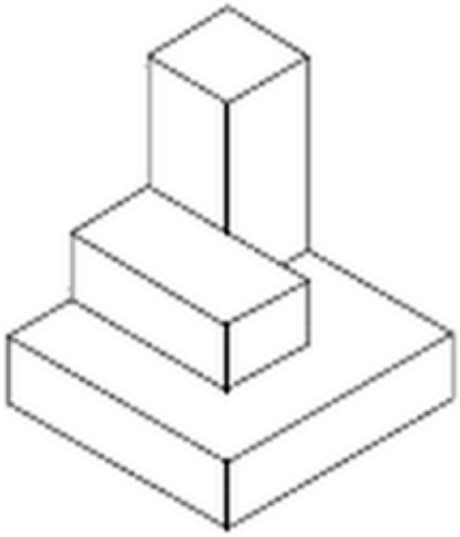
Step 2: Compare the four answer figures Option (D) has the square outer boundary and the two nested L-shaped breaks required by these terraces. In (A), one of the inner vertical divisions runs down into a region that should be a continuous terrace, producing an additional rectangular subdivision. In (B), a horizontal segment continues across to the right in a way that changes the inner step into a crosswise strip. In (C), the middle terrace is again divided by an extra vertical line and the inner turn does not match the uninterrupted L-shaped step. These are differences in visible edges, not changes that can be obtained merely by suppressing height.

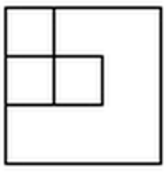
Step 3: Check the projection consistently Keep the orientation of the answer figures fixed while following the outside edges and both inside corners. In (D), each inward turn has the same relation to the outer square as the corresponding ledge of the object. No diagonal line is needed in a top view: the diagonal isometric edges become horizontal or vertical plan edges.

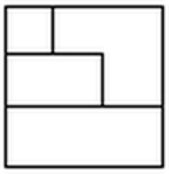
Step 4: Conclusion The top view is the pair of nested L-shaped terraces shown in option (D). Hence, the correct option is (D).

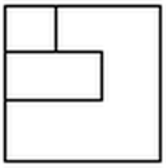
Quick Tip to Solve: For stepped objects, draw the outside footprint mentally and trace each terrace boundary from one outside edge to the other; do not add lines across a continuous horizontal face.

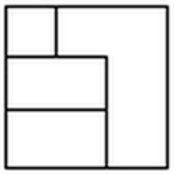
27. The 3 - D figure shows the view of an object. Identify the correct top view from amongst the answer figures. [4 marks]

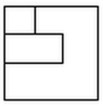


(A) 

(B) 

(C) 

(D) 

Correct Answer: (C) 

Solution:

Concept:

- In a top view, a vertical prism is represented by the shape and location of its horizontal top face. Its height affects visibility, not the size of that footprint.
- An edge between the top of a raised block and an exposed lower surface remains visible in plan. A vertical edge on the side of a block does not automatically become a line dividing its top.

Step 1: Locate the three levels The lowest block provides a square base. Above it is a rectangular block near one corner, with a smaller square column behind it. Seen vertically, the column occupies a square corner region and the next block occupies the adjoining wider rectangular region. The column and the middle block do not produce a line extending across the whole square base: the rest of the base remains one exposed, connected horizontal surface.

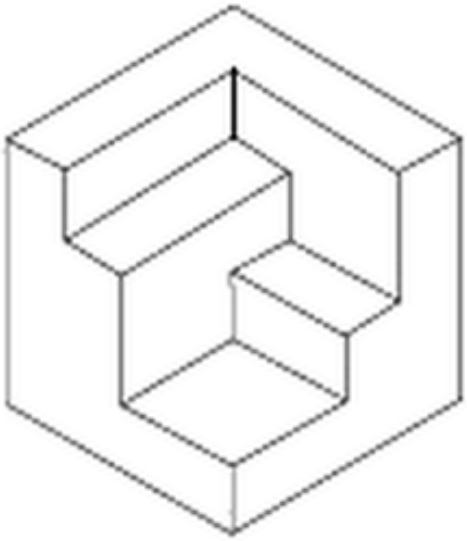
Step 2: Trace the visible boundaries Begin at the top edge of the plan. The little column creates one short vertical division in the corner square. The middle block then has a horizontal top edge and a right edge forming a rectangular outline against the base. Its front edge stops at the outside boundary of that rectangular footprint. The visible lower base surrounds these outlines on the right and below, without a transverse seam joining its opposite edges.

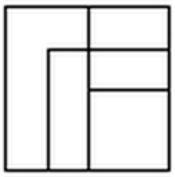
Step 3: Eliminate the additional divisions Option (C) shows precisely the small corner square, the adjacent rectangular top, and the surrounding square base. Option (A) extends the column division downward through the rectangular face, inventing a seam not present on that top. Option (B) extends the lower edge of the raised rectangle across the entire base. Option (D) adds divisions across the lower exposed region as though it consisted of separate horizontal strips. Those extra segments do not correspond to any visible height boundary of this object.

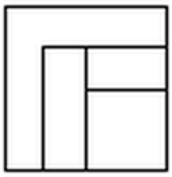
Step 4: Conclusion The correct projection is option (C), with a small corner square above the rectangular ledge and an undivided surrounding base. Hence, the correct option is (C).

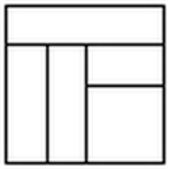
Quick Tip to Solve: Ignore the lengths of the vertical pillars when selecting a top view; compare the footprints of their horizontal faces and check where each boundary must stop.

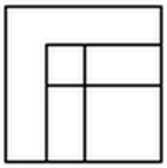
28. The 3 - D figure shows the view of an object. Identify the correct top view from amongst the answer figures. [4 marks]



(A) 

(B) 

(C) 

(D) 

Correct Answer: (B) 

Solution:

Concept:

- A plan view preserves horizontal positions while suppressing vertical distances. Edges at the boundaries of different height levels are projected to their horizontal footprints.
- The junction of a projected edge is as important as its direction: extending a line through a continuous terrace creates a false subdivision.

Step 1: Follow the upper rim The highest portion is a band that turns around the rear corner of the square object. In the plan this is an L-shaped band, with its inner boundary turning once rather than running straight across the entire width. Therefore a candidate must preserve that continuous upper corner band before the lower steps are considered.

Step 2: Place the unequal inner steps Inside the high band, the left-hand raised surface extends toward the front, whereas the right-hand ledge occurs at a lower height and has a shorter exposed

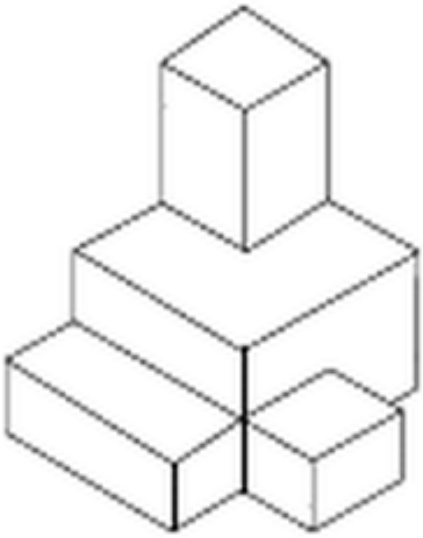
run. Project the long vertical boundary of the left inner region down to the front side of the square. The boundary of the right ledge meets this inner division, forming a horizontal segment only on its right-hand side. It must not cut across the narrow left strip, nor may it extend backward through the highest band.

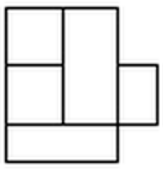
Step 3: Compare the line endings in the options Option (B) has the required outer L-shaped band, the interior vertical division beginning at its inner edge, and the short horizontal segment on the right. Option (A) carries an interior vertical line through the top band, which would incorrectly split its continuous top surface. Option (C) replaces the L-shaped upper band with a full-width straight strip. Option (D) extends a horizontal division into the left inner strip and so introduces a boundary that the shown object does not have. Checking these junctions removes the alternatives without relying on their apparent sizes.

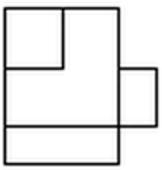
Step 4: Conclusion Option (B) gives the correct top view of the stepped object. Hence, the correct option is (B).

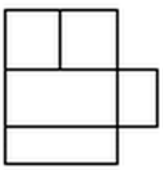
Quick Tip to Solve: After identifying the upper L-shaped rim, check the endpoints of the shorter interior lines; incorrect answers often extend one real edge through a continuous face.

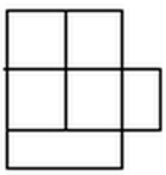
29. The 3 - D figure shows the view of an object. Identify the correct top view from amongst the answer figures. [4 marks]

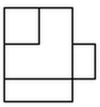


(A) 

(B) 

(C) 

(D) 

Correct Answer: (B) 

Solution:

Concept:

- A vertical orthographic projection retains the horizontal footprint and all visible top-surface boundaries, while collapsing the vertical side faces.
- A tall square column on a wider rectangular platform gives a small square footprint within the platform outline. Its side edge cannot be continued across the rest of that platform unless another height boundary exists.

Step 1: Identify the silhouette in plan The object consists of a larger raised platform, a square column at its rear-left corner, a lower strip projecting toward the front, and a small lower block projecting on the right. Thus the outside footprint is not just a square: it contains a right-hand rectangular projection. The lower front strip extends across the principal width, while the right-hand projection occupies only the adjoining side region.

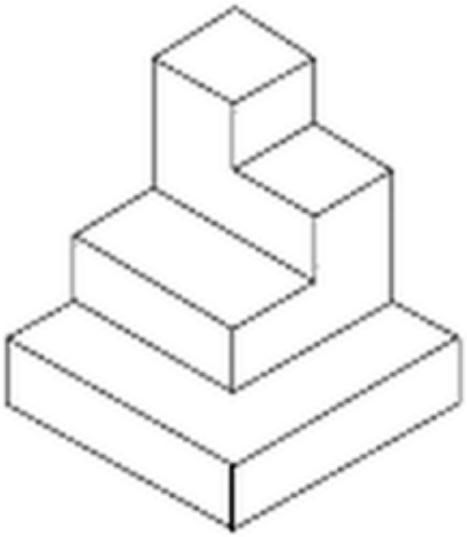
Step 2: Project the column and platform The top of the column forms a small square in the upper-left corner of the plan. Its front boundary stops at the side of that square; its side boundary also stops at the edge of its footprint. The rest of the main platform is one continuous top face, so those two short lines form an L-shaped internal corner rather than a cross extending across the platform. The lower front strip and the side block are separated from the raised platform by their actual ledge boundaries.

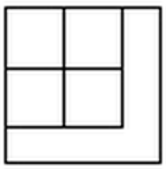
Step 3: Reject invented surface seams Option (B) preserves the corner square and the unbroken L-shaped remainder of the raised platform, together with the front strip and the side projection. Option (A) continues the column-side line downward, splitting the main platform into regions that are at the same uninterrupted level. Option (C) extends the column-front line horizontally across the platform. Option (D) extends both lines and creates a grid of patches. These additional grid edges have no corresponding break on the shown platform.

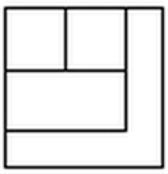
Step 4: Conclusion The required top view is option (B). Hence, the correct option is (B).

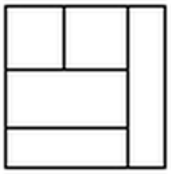
Quick Tip to Solve: Check whether the top of the large platform is continuous around the column; an answer that turns a corner square into a complete grid usually adds nonexistent edges.

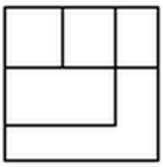
30. The 3 - D figure shows the view of an object. Identify the correct top view from amongst the answer figures. [4 marks]

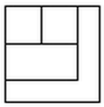


(A) 

(B) 

(C) 

(D) 

Correct Answer: (B) 

Solution:

Concept:

- For a stepped object, the top view records the footprint of each tread and the boundary where the next vertical drop begins. Isometric slopes are converted to horizontal and vertical plan edges.
- Compare the outermost exposed base and the internal step boundaries separately. A visible strip around two adjacent sides becomes an L-shaped region in plan.

Step 1: Trace the exposed base The broad lowest base remains visible along the front and the right side of the raised structure. Therefore its projection is an L-shaped band on those two sides, with a continuous turn around the lower-right corner of the plan. The inner outline of this band must stop before reaching the outer right edge; carrying it right across would divide the base into additional pieces.

Step 2: Trace the two upper steps Above the base is a wide middle tread. Behind it there are two

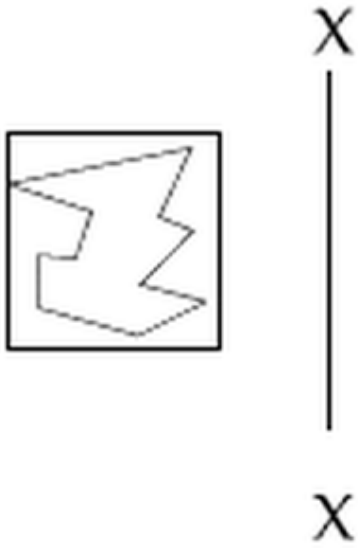
smaller top regions at different heights, one being the tallest column and the other the adjoining lower step. Their projected boundary is a short vertical line across the rear row. That division ends when it meets the long horizontal edge of the middle tread. It does not continue through the middle tread, since that face is continuous across its full width.

Step 3: Match the resulting pattern Option (B) shows an outer L-shaped base band, a single wide middle rectangle, and two rear top regions separated by a short line ending at the middle rectangle. Option (A) wrongly continues that short line through the middle tread and produces four interior cells. Option (C) extends the middle horizontal boundary across the outside base band. Option (D) also carries an upper boundary across the right-side base region, breaking its L-shaped continuity. Only (B) keeps the genuine edges while avoiding these artificial seams.

Step 4: Conclusion The top view is option (B). Hence, the correct option is (B).

Quick Tip to Solve: In a staircase-like solid, follow each tread as one horizontal surface. Its plan region must stay undivided unless the actual solid shows another change of height within it.

31. Which one of the answer figures is the correct mirror image of the problem figure with respect to X - X ? [4 marks]



(A) 

(B) 

(C) 

(D) 

Correct Answer: (C) 

Solution:

Concept:

- Reflection in the vertical line X–X reverses left and right but preserves vertical position. The reflected figure is not rotated: its top edge stays at the top and its bottom edge stays at the bottom.
- Every corner keeps its distance from the mirror line. The order of the notches reverses horizontally, while the sequence of their heights and the lengths of the connecting edges remain unchanged.

Step 1: Reflect the distinctive upper part The problem polygon has a long slanting upper edge and a sharp upper-right corner. After reflection, that sharp corner belongs at the upper left and the long upper edge slopes down toward the right. The original leftmost end of that edge becomes the rightmost end of the reflected upper edge. This immediately fixes the orientation; a rotation or a vertical reversal would place these features at the wrong heights.

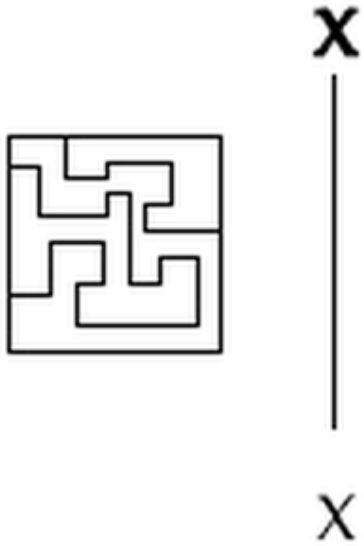
Step 2: Check both irregular sides The original right side contains the sequence of pointed projections and inward turns. These must appear on the left in the reflected polygon, in the same top-to-bottom order. On the original left side, the short sloping edge leads into a small notch and then a nearly vertical lower edge. That exact short notch must appear on the right after reflection. Finally, the low pointed part near the original lower-right area moves to the lower left, keeping the two adjacent lower segments and their relative lengths.

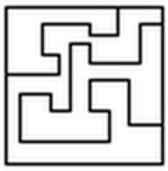
Step 3: Compare the complete outline Option (C) reproduces the reflected upper slope, the two left-side pointed turns and the small right-side inset at their correct heights. Option (A) changes the upper-right inset into a different, longer diagonal connection. Option (B) changes the lower left zigzag, with a deeper inward turn and a differently placed bottom corner. Option (D) replaces the required angular right-hand notch by a sloping, almost curved-looking side. These local differences cannot result from a mirror reflection, which preserves every edge and angle.

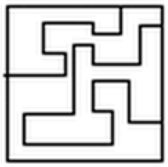
Step 4: Conclusion The reflected outline is shown in option (C). Hence, the correct option is (C).

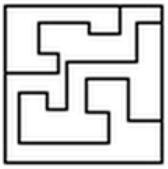
Quick Tip to Solve: For an irregular polygon, check the mirror positions of three landmarks: the highest sharp corner, a distinctive side notch and the lowest point. Keep their heights fixed.

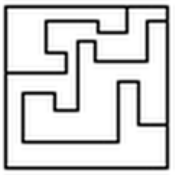
32. Which one of the answer figures is the correct mirror image of the problem figure with respect to X - X ? [4 marks]

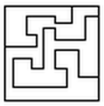


(A) 

(B) 

(C) 

(D) 

Correct Answer: (A) 

Solution:

Concept:

- A mirror on the vertical line X–X reverses the horizontal coordinate of each point. It preserves heights, lengths and the connectivity of the entire pattern.
- For a maze-like line figure, reflect one continuous chain of segments at a time. A short horizontal recess that is on the left of an upright becomes a recess on its right, without changing its vertical level.

Step 1: Reflect the upper chain In the original square, the upper internal line descends from the top near the left, turns right, makes a short upward notch and runs farther right before descending again. In the reflection, the descent must therefore start near the top right. Its first horizontal turn goes left; the short notch then rises at the corresponding height, and the farther run goes left. The horizontal branch reaching the original right border at mid-height must reach the left border instead.

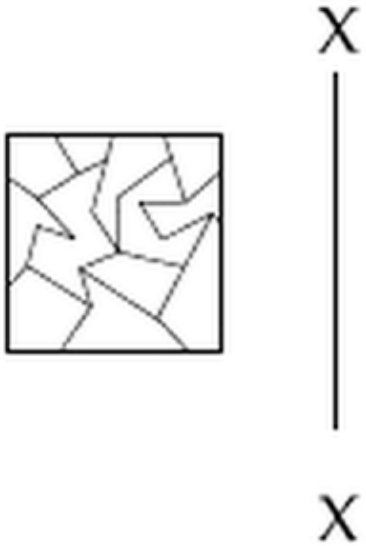
Step 2: Reflect the lower chain independently The lower portion has a broad stepped U-like outline, an inset rectangular turn and a central narrow upright. Move each feature to the opposite side while leaving its height unchanged. In particular the original low horizontal run ending toward the left becomes a low run ending toward the right, and the short elevated corner on the original right appears on the left. This checks the lower pattern independently of the easily confused top notch.

Step 3: Check all four alternatives Option (A) preserves both the upper notch and the complete lower stepped path after their left-right reversal. Option (B) places the lower horizontal recess at the wrong level and changes the width and location of the central lower turn. Option (C) alters the upper chain: its descending turn reaches a lower level before entering the central upright, unlike the reflected source. Option (D) changes the lower inner step, replacing its required rectangular arrangement by a different longer run. None of these changes is permitted by reflection, even though the outer square is the same.

Step 4: Conclusion Option (A) is the correct mirror image with respect to X–X. Hence, the correct option is (A).

Quick Tip to Solve: In a dense line pattern, compare the upper and lower chains separately, checking the level of every short notch; the same overall outline can hide one incorrect internal connection.

33. Which one of the answer figures is the correct mirror image of the problem figure with respect to X - X ? [4 marks]



(A) 

(B) 

(C) 

(D) 

Correct Answer: (D) 

Solution:

Concept:

- A plane mirror reverses the direction perpendicular to its surface. For the vertical line X - X, left and right interchange while the height of each point stays unchanged.
- Reflection preserves lengths, angles, connected lines and the order of junctions. It does not rotate the pattern or move a feature from the top to the bottom.

Step 1: Locate the mirror and fix the orientation The mirror X - X is vertical and lies to the right of the problem square. Its reflected square must therefore have the original right-hand details on its left and the original left-hand details on its right. The top edge stays the top edge and the bottom edge stays the bottom edge.

Step 2: Trace the distinctive corners Begin with the inward-pointing angular feature in the upper-right portion of the problem. In the reflection it lies in the upper-left portion, at the same height. Next follow the broken central line and the sloping segments that meet the lower boundary. Every turn must reverse horizontally, but its vertical order must remain unchanged.

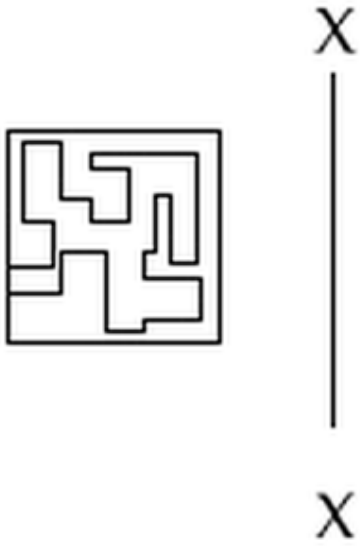
Step 3: Compare the complete line network Option (D) reproduces the reversed angular notch, central zigzag and lower diagonal network together. This complete comparison matters because several options resemble the mirror at one corner. Options (A), (B) and (C) change the arrangement or meeting of some of the internal segments; matching only the outer square cannot make them correct.

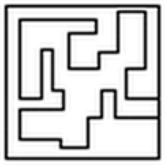
Step 4: Check the reflection rather than a rotation Reading option (D) back through the vertical mirror restores the original arrangement. No upper feature has moved down, and no segment has gained or lost a connection. It therefore satisfies both the local corner checks and the global orientation check.

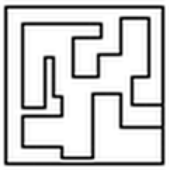
Step 5: Conclusion The horizontally reversed line pattern is the figure in option (D). Hence, the correct option is (D).

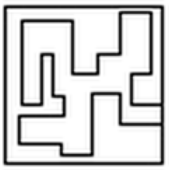
Quick Tip to Solve: Trace one distinctive notch first, then verify every connected segment; a nearly matching corner is insufficient.

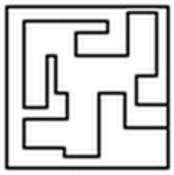
34. Which one of the answer figures is the correct mirror image of the problem figure with respect to X - X ? [4 marks]



(A) 

(B) 

(C) 

(D) 

Correct Answer: (B) 

Solution:

Concept:

- A plane mirror reverses the direction perpendicular to its surface. For the vertical line X - X, left and right interchange while the height of each point stays unchanged.
- Reflection preserves lengths, angles, connected lines and the order of junctions. It does not rotate the pattern or move a feature from the top to the bottom.

Step 1: Reverse left and right The vertical mirror X - X leaves all horizontal levels unchanged. The narrow upright feature near the original right edge must appear near the left edge of the answer. Similarly, the long path near the original upper-left region must move to the upper-right region.

Step 2: Follow the upper part of the path Trace the top horizontal run, its short downward turn and the successive rectangular turns. In a mirror, a turn towards the right becomes a turn towards the left. Option (B) keeps the lengths and sequence of these turns in the reversed arrangement. In particular,

the upper inset is retained rather than shortened or replaced with a different rectangular route.

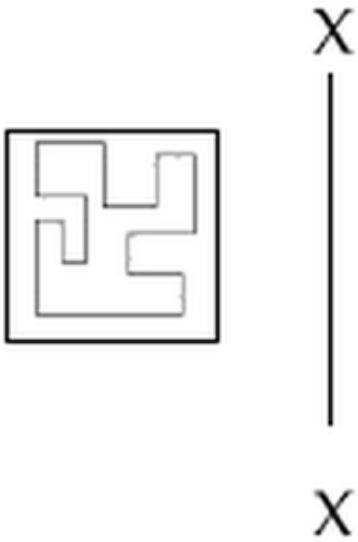
Step 3: Check the lower projections Continue around the lower part of the pattern. The long lower horizontal region and the upright central projection must exchange their lateral positions while retaining their original heights. Option (B) also preserves this lower outline, so the upper and lower checks identify the same figure.

Step 4: Reject the look-alike alternatives Option (A) changes the arrangement of the lower central turns. Option (C) has an altered upper run and inset, although much of the lower outline resembles the answer. Option (D) has a different route through the upper portion. These are changes to the path itself, rather than the required simple reversal, so none represents the full mirror image.

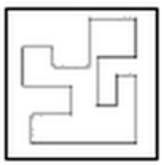
Step 5: Conclusion The entire rectilinear path is reflected correctly in option (B). Hence, the correct option is (B).

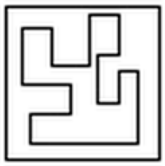
Quick Tip to Solve: For a maze-like mirror question, trace the path from one corner and reverse each left or right turn in sequence.

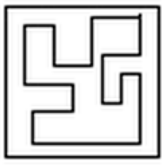
35. Which one of the answer figures is the correct mirror image of the problem figure with respect to X - X ? [4 marks]



(A) 

(B) 

(C) 

(D) 

Correct Answer: (D) 

Solution:

Concept:

- A plane mirror reverses the direction perpendicular to its surface. For the vertical line X - X, left and right interchange while the height of each point stays unchanged.
- Reflection preserves lengths, angles, connected lines and the order of junctions. It does not rotate the pattern or move a feature from the top to the bottom.

Step 1: Identify what the vertical mirror preserves Reflecting in X - X swaps the two sides of the square. The lower horizontal portion remains low, and the upper recess remains high. A figure obtained by turning the paper upside down would fail this condition even if some corners looked similar.

Step 2: Track the upper recess and side notch The broad upper-left part of the original must move to the upper-right part. The narrow notch projecting from the original left side must appear at the corresponding height on the right side. These two features provide independent reference points and prevent a guess based only on the general stepped appearance.

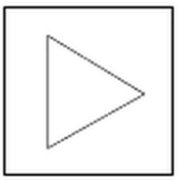
Step 3: Trace the continuous outline Follow the boundary from the upper-left corner of the reflected pattern. Its long inward step, central horizontal stretch, upper-right lobe, right-side notch and long lower run match option (D). The widths and depths of the recesses remain the same; reflection changes their sides, not their proportions.

Step 4: Eliminate the other figures Options (A) and (B) do not give the required horizontally reversed arrangement of the full outline. Option (C) comes closer in overall direction but changes the upper-right portion and its inset. Option (D) alone retains both the wide upper lobe and the correct narrow right-hand notch in the reflected positions.

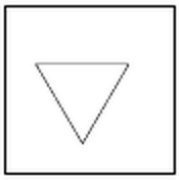
Step 5: Conclusion Option (D) is the complete mirror image with respect to the vertical line X - X. Hence, the correct option is (D).

Quick Tip to Solve: Use two unequal features, such as the broad upper lobe and narrow side notch, to distinguish close mirror-image options.

36. Find the odd figure out of the problem figures given below. [4 marks]

(A) 

(B) 

(C) 

(D) 

Correct Answer: (D) 

Solution:

Concept:

- The shape of a triangle depends on its relative side lengths and angles, not on its size or the direction in which its vertex points.
- An equilateral triangle has three equal sides and three equal angles. A non-equilateral isosceles triangle has only two equal sides.

Step 1: Ignore the outer frames Each option contains a triangle inside a square frame. The frames are common to all four options and do not distinguish the group. We therefore compare the inner triangles, allowing for a change in their size and orientation.

Step 2: Identify the common shape The triangles in (A), (B) and (C) have the same equilateral form. In (A) a vertex points to the right; in (B) a vertex points upwards; in (C) a vertex points downwards. The small size of (B) and the reversed direction of (C) do not change their equal-sided triangular shape.

Step 3: Compare the remaining triangle The triangle in (D) is visibly taller and narrower. Its two sloping sides match one another, but its horizontal base is shorter. It is therefore an isosceles triangle of a different shape, rather than another scaled or rotated equilateral triangle.

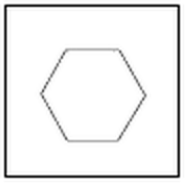
Step 4: Choose the structural difference A rotation changes direction and a scaling changes size, but both preserve angles and side-length ratios. Thus (A), (B) and (C) belong together under those transformations. Option (D) fails the same-shape test. This is a stronger classification than selecting an option only because it points in a different direction.

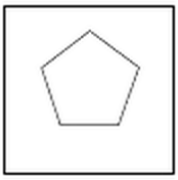
Step 5: Conclusion Option (D) is the odd figure because its inner triangle is not equilateral, unlike the other three. Hence, the correct option is (D).

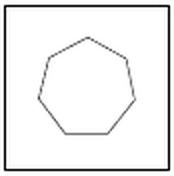
Quick Tip to Solve: When triangles differ in direction and size, compare their angles and side proportions before treating orientation as the rule.

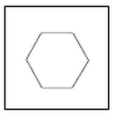
37. Find the odd figure out of the problem figures given below. [4 marks]

(A) 

(B) 

(C) 

(D) 

Correct Answer: (B) 

Solution:

Concept:

- A polygon is classified by the number of straight sides on its boundary. The number of vertices equals the number of sides.
- Parity separates counts into odd numbers and even numbers; a visual classification can depend on this property rather than on apparent size.

Step 1: Identify the shapes inside the frames The square outer frames are the same in all four options, so we count only the sides of the inner polygons. Moving around each boundary once avoids counting a side twice or confusing a vertex with an extra side.

Step 2: Count the sides of every polygon Option (A) is a triangle with 3 sides. Option (B) is a hexagon with 6 sides. Option (C) is a pentagon with 5 sides. Option (D) is a heptagon with 7 sides. Thus the relevant counts, in order, are $3, 6, 5, 7$.

Step 3: Find the common numerical property The counts 3, 5 and 7 are all odd. The count 6 is even. Therefore (A), (C) and (D) share a side-count property which (B) does not. Changing the orientation or size of a polygon would not affect this distinction.

Step 4: Test the selected exception The hexagon in (B) is still a closed polygon, so closure is not the distinguishing condition. Nor is the common outer square relevant. The useful three-against-one classification is odd versus even side count: precisely one inner figure, the hexagon, has an even number of sides.

Step 5: Conclusion Option (B), the six-sided hexagon, is the odd figure. Hence, the correct option is (B).

Quick Tip to Solve: Count the vertices of unfamiliar polygons and test odd versus even counts before searching for a more complicated relation.

38. Find the odd figure out of the problem figures given below. [4 marks]

(A) 

(B) 

(C) 

(D) 

Correct Answer: (D) 

Solution:

Concept:

- A set of disconnected line segments can be classified by the number of segments, independently of their horizontal placement.
- Count each complete stroke once. A sideways displacement changes its position but does not create another segment.

Step 1: Separate the inner lines from the frame All four options have a square border and horizontal strokes inside it. The square border is common and must not be included in the count. We inspect only the separate horizontal segments within each frame.

Step 2: Count the first three arrangements Option (A) contains four horizontal strokes: the upper two, the displaced third and the lowest one. Option (B) also contains four strokes, even though their left ends do not all align. Option (C) again contains four strokes. Their different sideways shifts do not alter the number present.

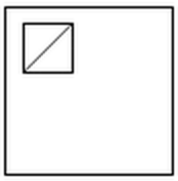
Step 3: Count the final arrangement Option (D) contains five distinct horizontal strokes. Starting at the top and moving down, there are three higher strokes followed by two lower strokes. None of these five strokes is a continuation of another one, since they occupy different heights.

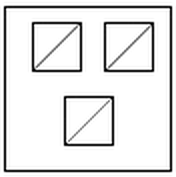
Step 4: Apply the common rule The first three options share the same count of four inner line segments; only (D) has an additional segment. All strokes in all options are horizontal, so direction cannot distinguish the figures. Alignment also varies among the first three. The count is the consistent feature that gives exactly one exception.

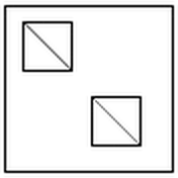
Step 5: Conclusion Option (D) is the odd figure because it has five horizontal strokes, whereas each other option has four. Hence, the correct option is (D).

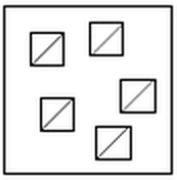
Quick Tip to Solve: Scan from top to bottom and count strokes, ignoring their left-right offsets and the surrounding border.

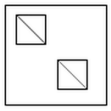
39. Find the odd figure out of the problem figures given below. [4 marks]

(A) 

(B) 

(C) 

(D) 

Correct Answer: (C) 

Solution:

Concept:

- A collection of figures can be grouped by the number of repeated components and by the direction of a repeated internal diagonal.
- A diagonal from bottom left to top right rises towards the right; one from top left to bottom right falls towards the right.

Step 1: Count the inner squares Ignore the common large square frame. Option (A) contains one small square, (B) contains three small squares, (C) contains two small squares and (D) contains five small squares. The counts for (A), (B) and (D) are odd, while that for (C) is even.

Step 2: Inspect the diagonal directions In (A), (B) and (D), each small square has a diagonal running from its bottom-left corner to its top-right corner. In (C), both diagonals run from top left to bottom right. Thus the same option differs in orientation as well as in the count of repeated squares.

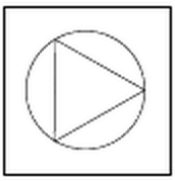
Step 3: Check all components rather than position The small squares occupy different places within their outer frames, but those positions do not provide a common alignment in the first three figures. Their odd number and rising diagonal direction do provide consistent shared features. Both small squares in (C) break the common diagonal-direction rule.

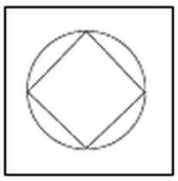
Step 4: Select the single exception Options (A), (B) and (D) form one class under both tests: an odd number of small squares, each with a rising diagonal. Option (C) forms the exception with two squares and falling diagonals. The agreement between these independent observations makes the classification clear.

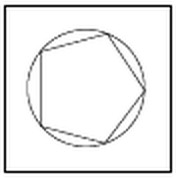
Step 5: Conclusion Option (C) is the odd figure. Its two small squares have falling diagonals, unlike the odd-numbered groups with rising diagonals. Hence, the correct option is (C).

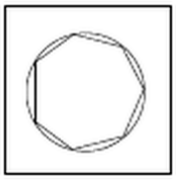
Quick Tip to Solve: Check both the count of repeated shapes and a feature inside each shape; agreement between the two tests confirms the exception.

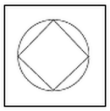
40. Find the odd figure out of the problem figures given below. [4 marks]

(A) 

(B) 

(C) 

(D) 

Correct Answer: (B) 

Solution:

Concept:

- An inscribed polygon has its vertices on a circle. Inscription alone is not a distinguishing property when every option has it.
- The number of vertices and sides is preserved by rotation and scaling, so it is a reliable basis for comparing differently oriented polygons.

Step 1: Identify the common construction Each option shows a polygon inside a circle, enclosed by a square frame. Since the circle and frame appear throughout, we focus on the straight-sided polygon inscribed in the circle rather than on these common surrounding shapes.

Step 2: Count the polygon sides Option (A) contains a triangle, with 3 sides. Option (B) contains a square, drawn like a diamond, with 4 sides. Option (C) contains a pentagon, with 5 sides. Option (D) contains a heptagon, with 7 sides. The curved circle arcs must not be counted as additional polygon sides.

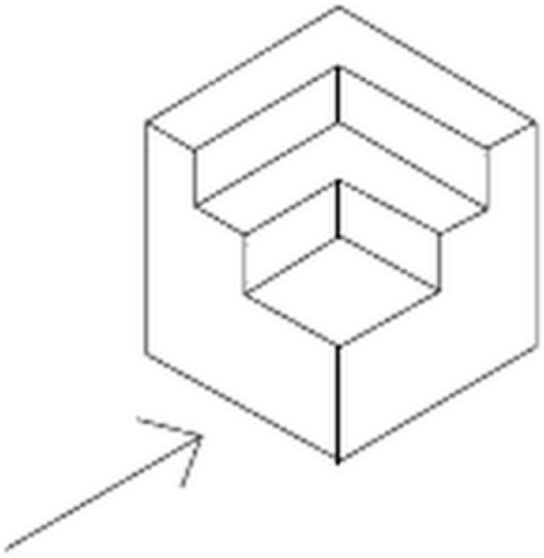
Step 3: Compare the counts The triangle, pentagon and heptagon have the odd side counts $3, 5, 7$. The square has the even side count 4. Thus (A), (C) and (D) share odd parity, whereas (B) does not. The turned orientation of the square does not change its four vertices.

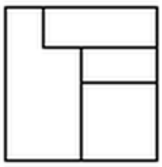
Step 4: Verify the exception All four polygons are closed and all are inscribed in a circle, so neither of those facts singles out an answer. The side-count rule identifies exactly one exception. In particular, the last figure must be counted carefully: it has seven sides, so it belongs with the other odd-sided polygons.

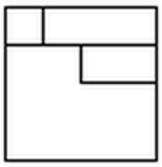
Step 5: Conclusion Option (B), the four-sided square, is the odd figure among the odd-sided inscribed polygons. Hence, the correct option is (B).

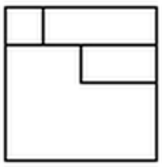
Quick Tip to Solve: Count straight edges around the inscribed polygon; ignore the circle arcs and do not mistake a rotated square for a different shape.

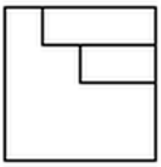
41. The 3 - D figure shows the view of an object. Identify the correct front view in the direction of the arrow, from amongst the answer figures. [4 marks]

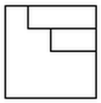


(A) 

(B) 

(C) 

(D) 

Correct Answer: (D) 

Solution:

Concept:

- A front view is an orthographic projection along the arrow: height and horizontal position remain, while depth is collapsed. Parallel edges in the viewing direction project to points.
- Draw or recognise only boundaries and exposed changes of surface visible from that direction. A rear edge hidden by a nearer solid face must not appear as a new solid line.

Step 1: Fix the viewing direction Look along the arrow towards the object, rather than looking down at its top. Mentally flatten the receding direction and keep vertical edges vertical. Compare both the outer silhouette and the internal visible edges; the outline alone can be shared by several answer figures.

Step 2: Trace the two recessed steps The object has a square outside boundary and a stepped recess. Seen along the arrow, its near face gives a continuous descending staircase inside that square: a

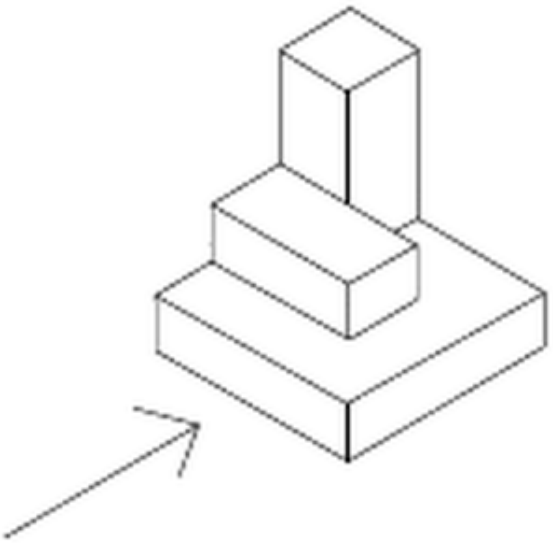
short vertical drop near the left, a horizontal run, a second vertical drop, and the lower horizontal run extending to the right boundary. The two drops terminate at the successive ledge levels; neither continues through the solid lower face.

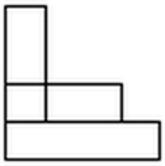
Step 3: Eliminate the other projected patterns Option (D) preserves that continuous stair-shaped visible boundary without adding seams. Option (A) extends an internal vertical edge down through the lower solid region. Options (B) and (C) add a horizontal line across the left strip at the upper ledge level, as though the near upright face were divided there. That line is not a visible edge in the arrow view.

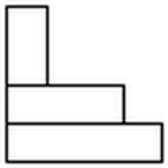
Step 4: Conclusion The projected shape and visible edge arrangement agree with option (D). Hence, the correct option is (D).

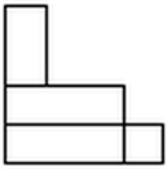
Quick Tip to Solve: Trace the nearest stepped face first, then ask whether each remaining line is a visible edge or a depth edge that disappears in projection.

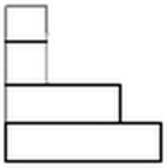
42. The 3 - D figure shows the view of an object. Identify the correct front view in the direction of the arrow, from amongst the answer figures. [4 marks]

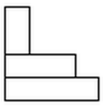


(A) 

(B) 

(C) 

(D) 

Correct Answer: (B) 

Solution:

Concept:

- A front view is an orthographic projection along the arrow: height and horizontal position remain, while depth is collapsed. Parallel edges in the viewing direction project to points.
- Draw or recognise only boundaries and exposed changes of surface visible from that direction. A rear edge hidden by a nearer solid face must not appear as a new solid line.

Step 1: Fix the viewing direction Look along the arrow towards the object, rather than looking down at its top. Mentally flatten the receding direction and keep vertical edges vertical. Compare both the outer silhouette and the internal visible edges; the outline alone can be shared by several answer figures.

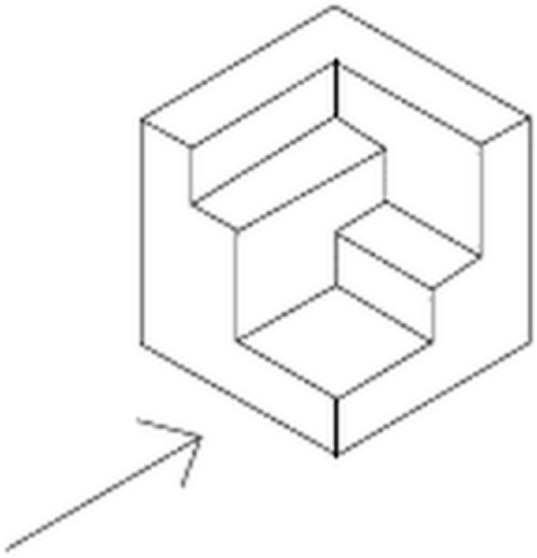
Step 2: Project the base, middle block and upright The broad bottom slab becomes a low horizontal rectangle. The smaller raised block produces a second rectangle above its left portion, and the narrow upright rises from the left end of that block. The upright starts at the top of the middle block, so its right edge stops at that supporting level. It does not create a vertical seam through the middle tier or the base.

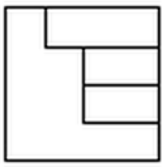
Step 3: Eliminate the other projected patterns Option (B) has exactly these three visible levels. Option (A) continues the upright boundary through the middle tier, introducing an extra seam. Option (C) continues the right boundary of the middle block through the bottom slab. Option (D) divides the upright by an extra horizontal line. None of those divisions is a visible edge of the corresponding solid face.

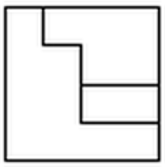
Step 4: Conclusion The projected shape and visible edge arrangement agree with option (B). Hence, the correct option is (B).

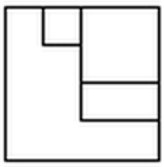
Quick Tip to Solve: Trace the nearest stepped face first, then ask whether each remaining line is a visible edge or a depth edge that disappears in projection.

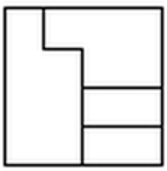
43. The 3 - D figure shows the view of an object. Identify the correct front view in the direction of the arrow, from amongst the answer figures. [4 marks]

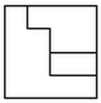


(A) 

(B) 

(C) 

(D) 

Correct Answer: (B) 

Solution:

Concept:

- A front view is an orthographic projection along the arrow: height and horizontal position remain, while depth is collapsed. Parallel edges in the viewing direction project to points.
- Draw or recognise only boundaries and exposed changes of surface visible from that direction. A rear edge hidden by a nearer solid face must not appear as a new solid line.

Step 1: Fix the viewing direction Look along the arrow towards the object, rather than looking down at its top. Mentally flatten the receding direction and keep vertical edges vertical. Compare both the outer silhouette and the internal visible edges; the outline alone can be shared by several answer figures.

Step 2: Follow the recessed boundary through its changes of level Keep the square outer boundary, then follow the visible inside boundary from the upper left towards the lower right. The first short

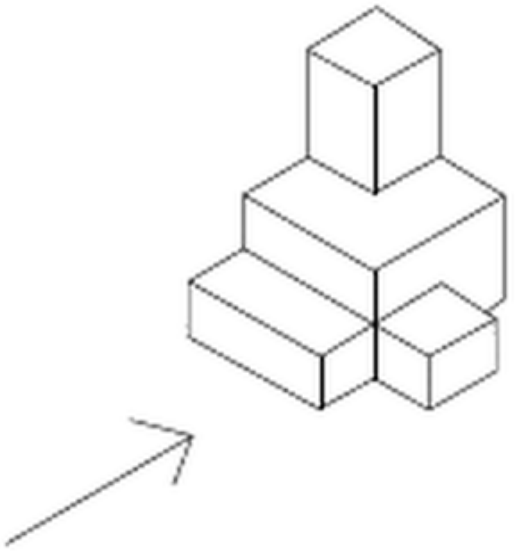
drop is followed by a horizontal ledge and a longer central drop. At its bottom, the low ledge extends to the right outside boundary. A second horizontal edge is visible above that low ledge on the right, marking the thickness of the projecting step.

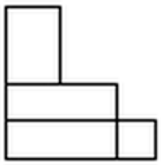
Step 3: Eliminate the other projected patterns Option (B) retains the stepped internal outline and the lower-right horizontal division, while leaving the broad lower-left face undivided. Option (A) converts the recessed outline into a tall rectangular vertical partition. Option (C) inserts a vertical edge through the upper central region. Option (D) extends the central step boundary to the bottom edge, creating a seam across a face that is continuous in this view.

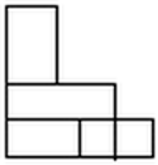
Step 4: Conclusion The projected shape and visible edge arrangement agree with option (B). Hence, the correct option is (B).

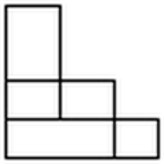
Quick Tip to Solve: Trace the nearest stepped face first, then ask whether each remaining line is a visible edge or a depth edge that disappears in projection.

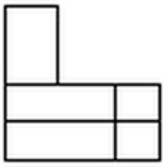
44. The 3 - D figure shows the view of an object. Identify the correct front view in the direction of the arrow, from amongst the answer figures. [4 marks]

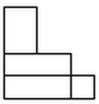


(A) 

(B) 

(C) 

(D) 

Correct Answer: (A) 

Solution:

Concept:

- A front view is an orthographic projection along the arrow: height and horizontal position remain, while depth is collapsed. Parallel edges in the viewing direction project to points.
- Draw or recognise only boundaries and exposed changes of surface visible from that direction. A rear edge hidden by a nearer solid face must not appear as a new solid line.

Step 1: Fix the viewing direction Look along the arrow towards the object, rather than looking down at its top. Mentally flatten the receding direction and keep vertical edges vertical. Compare both the outer silhouette and the internal visible edges; the outline alone can be shared by several answer figures.

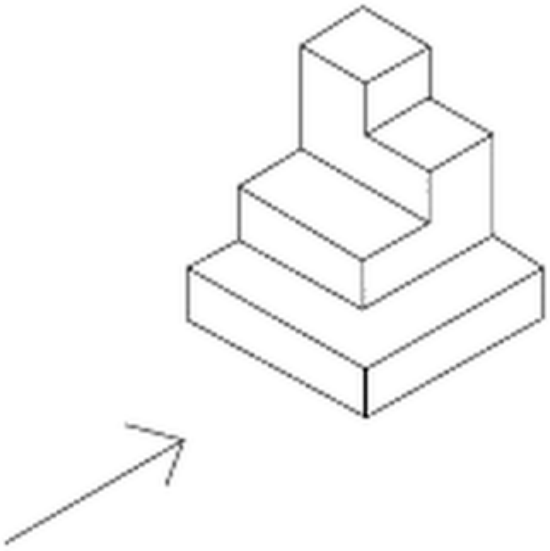
Step 2: Locate the small block in the projected outline The top post forms the highest narrow rectangle at the left of the view. Below it, the main middle tier extends farther to the right. The bottom projects farther still because the small forward block occupies the rightmost low portion in this direction. The visible vertical edge at the right end of the middle tier reaches the base line and separates this small low projection from the main body.

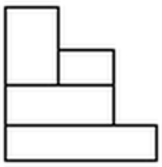
Step 3: Eliminate the other projected patterns Option (A) shows the tall left post, the intermediate tier and the rightmost low projection with the required visible edge. Option (B) adds another vertical subdivision within the bottom tier. Option (C) carries the post boundary through the intermediate tier and changes the bottom division. Option (D) raises the rightmost low projection to the height of the middle tier, losing the third descending level of the outside silhouette.

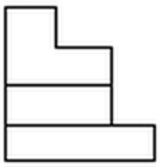
Step 4: Conclusion The projected shape and visible edge arrangement agree with option (A). Hence, the correct option is (A).

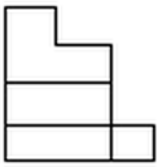
Quick Tip to Solve: Trace the nearest stepped face first, then ask whether each remaining line is a visible edge or a depth edge that disappears in projection.

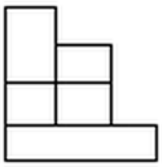
45. The 3 - D figure shows the view of an object. Identify the correct front view in the direction of the arrow, from amongst the answer figures. [4 marks]

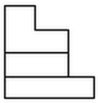


(A) 

(B) 

(C) 

(D) 

Correct Answer: (B) 

Solution:

Concept:

- A front view is an orthographic projection along the arrow: height and horizontal position remain, while depth is collapsed. Parallel edges in the viewing direction project to points.
- Draw or recognise only boundaries and exposed changes of surface visible from that direction. A rear edge hidden by a nearer solid face must not appear as a new solid line.

Step 1: Fix the viewing direction Look along the arrow towards the object, rather than looking down at its top. Mentally flatten the receding direction and keep vertical edges vertical. Compare both the outer silhouette and the internal visible edges; the outline alone can be shared by several answer figures.

Step 2: Identify the stepped upper profile The bottom slab gives the widest low rectangle. The raised middle part is narrower. Above it the upper part has a high left portion and a lower shoulder to its

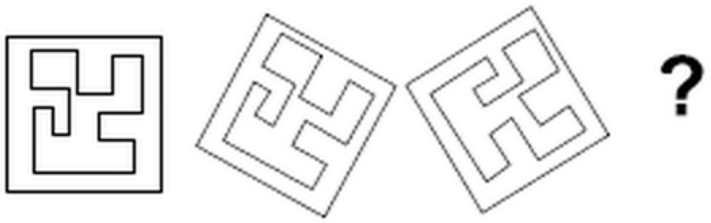
right, so its outline steps down once before meeting the middle tier. The broad faces of the middle and bottom tiers remain continuous; their visible horizontal top edges extend across their respective widths.

Step 3: Eliminate the other projected patterns Option (B) has this stepped upper silhouette and the two uninterrupted horizontal divisions below it. Option (A) puts an additional vertical boundary between the tall part and its shoulder. Option (C) extends the right boundary of the raised part through the bottom slab. Option (D) carries extra vertical divisions through the middle region. Those lines do not correspond to visible edges when the object is projected along the arrow.

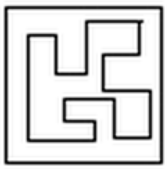
Step 4: Conclusion The projected shape and visible edge arrangement agree with option (B). Hence, the correct option is (B).

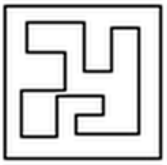
Quick Tip to Solve: Trace the nearest stepped face first, then ask whether each remaining line is a visible edge or a depth edge that disappears in projection.

46. Which one of the answer figure will complete the sequence of the three problem figures ? [4 marks]



(A) 

(B) 

(C) 

(D) 

Correct Answer: (A) 

Solution:

Concept:

- A rigid rotation preserves the internal shape, lengths and connections. Every corner and recess turns through the same angle as the outside frame.
- An upright square can reappear after a quarter-turn even though its asymmetric interior has moved. Distinguish rotation from reflection by tracking the direction of a distinctive bend.

Step 1: Follow the rigid rotation The complete square, including its internal angular path, turns through the same angle at each stage. The first square is upright, the second is turned clockwise by about $30°$, and the third is turned clockwise by about $60°$ relative to the first. Thus the next figure is the original pattern after a clockwise quarter-turn, $90°$. The internal path does not change its shape during this movement.

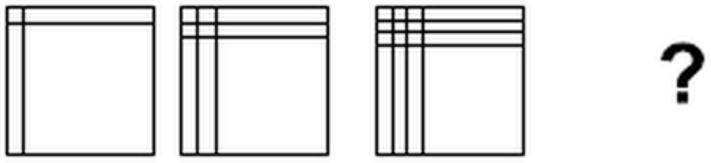
Step 2: Check every answer against the complete pattern Rotate the prominent square-ended upper-left part of the first pattern to the upper-right. At the same time, its short inward recess moves with it, and the lower part of the path becomes the left-hand lower projection. Option (A) preserves these relative connections. Options (B) and (D) change the direction or shape of an internal bend; option (C) has a different arrangement of the upper-right and lower-right portions. They are not rigid quarter-turns of the original.

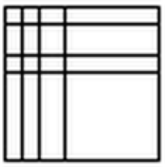
Step 3: Verify the transition consistently Check a second landmark, rather than selecting an option from the square frame alone. Carry a lower bend of the original through the same clockwise quarter-turn and compare its new position with the chosen figure. It agrees without reversing the outline or independently moving any part. This confirms the entire figure obeys the established rotation rule.

Step 4: Conclusion The next figure is the one shown in option (A). Hence, the correct option is (A).

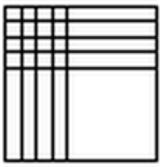
Quick Tip to Solve: Track one distinctive bend and the outside frame through the same rotation, then check a second bend to eliminate near-matching distractors.

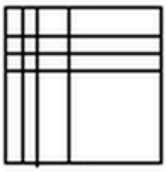
47. Which one of the answer figure will complete the sequence of the three problem figures ? [4 marks]

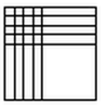


(A) 

(B) 

(C) 

(D) 

Correct Answer: (C) 

Solution:

Concept:

- A visual sequence must follow one consistent operation from each figure to the next; test a proposed rule on both known transitions.
- For a line-building sequence, count horizontal and vertical lines separately, excluding the outside frame. Equal increases in both counts must continue together.

Step 1: Count the lines in the three given squares Ignore the four outside borders and count only the internal straight lines. The first square contains one internal vertical line near the left edge and one internal horizontal line near the top. The second contains two internal vertical lines and two internal horizontal lines. The third contains three of each. Therefore the next square must contain four internal vertical lines and four internal horizontal lines, each set extending across the square.

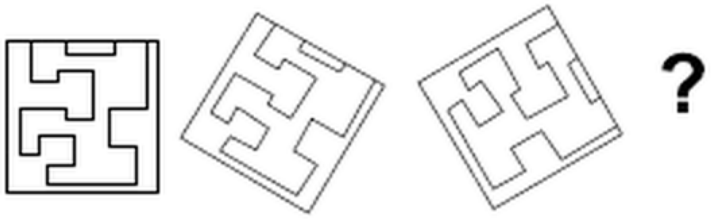
Step 2: Check every answer against the complete pattern Option (C) supplies four internal vertical lines at the left and four internal horizontal lines at the top, producing the next enlarged corner grid. Option (B) has four vertical lines but only three horizontal lines. Options (A) and (D) do not provide the required equal set of four closely and regularly placed lines in both directions. Merely looking for the darkest grid is unreliable: both counts and positions must continue the given construction.

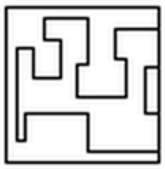
Step 3: Verify the transition consistently The added lines form a matched horizontal and vertical pair at each step, so the line counts run $1, 2, 3, 4$ in both directions. The fourth figure must retain the earlier lines and add one in each direction; changing only the spacing or adding a line in one direction breaks the common rule.

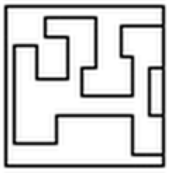
Step 4: Conclusion The next figure is the one shown in option (C). Hence, the correct option is (C).

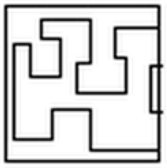
Quick Tip to Solve: Count internal lines in the two directions separately before comparing the small corner grids.

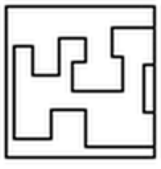
48. Which one of the answer figure will complete the sequence of the three problem figures ? [4 marks]

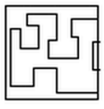


(A) 

(B) 

(C) 

(D) 

Correct Answer: (C) 

Solution:

Concept:

- A rigid rotation preserves the internal shape, lengths and connections. Every corner and recess turns through the same angle as the outside frame.
- An upright square can reappear after a quarter-turn even though its asymmetric interior has moved. Distinguish rotation from reflection by tracking the direction of a distinctive bend.

Step 1: Recognise rotation without changing the path Use the outside square as an orientation marker. It starts upright, then turns clockwise by about 30°, then by about 60° from the original position. The irregular inner outline keeps its same bends, widths and connections while rotating with the square. Continuing the rule gives a clockwise rotation of 90° from the first figure, rather than a reflected or reshaped path.

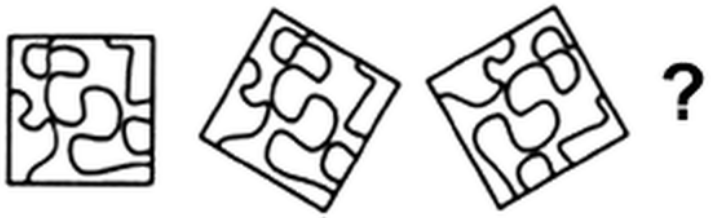
Step 2: Check every answer against the complete pattern Under this quarter-turn, the notched outline has two high inward notches separated by a central downward rectangular return. Its lower central recess rises from the lower horizontal part, while a short rectangular indentation lies on the right. Option (C) keeps these features and their relative lengths. Option (A) changes the long lower-left vertical return, option (B) changes the lower central notch proportions, and option (D) alters the upper-left bend. These are local shape changes, not the same path rotated.

Step 3: Verify the transition consistently Check a second landmark, rather than selecting an option from the square frame alone. Carry a lower bend of the original through the same clockwise quarter-turn and compare its new position with the chosen figure. It agrees without reversing the outline or independently moving any part. This confirms the entire figure obeys the established rotation rule.

Step 4: Conclusion The next figure is the one shown in option (C). Hence, the correct option is (C).

Quick Tip to Solve: Track one distinctive bend and the outside frame through the same rotation, then check a second bend to eliminate near-matching distractors.

49. Which one of the answer figure will complete the sequence of the three problem figures ? [4 marks]



(A) 

(B) 

(C) 

(D) 

Correct Answer: (C) 

Solution:

Concept:

- A visual pattern must preserve every relevant feature of the supplied figures; matching the outer shape alone is insufficient.
- Use identifiable lines, boundaries and their relative positions to test each alternative, and reject an alternative when any visible feature disagrees.

Step 1: Identify the transformation The boundary is the same square throughout, and the curved network inside it is carried along with that boundary. The second square is turned clockwise through one small angular increment relative to the first. The third continues the same clockwise movement. A useful reference is the small loop initially near the upper-left corner: it moves with the figure rather than being replaced by a different curve.

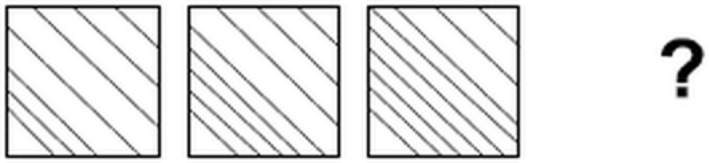
Step 2: Continue the rotation The three orientations correspond to successive clockwise turns of approximately $30°$. The fourth must therefore have the original pattern turned through $90°$. Its boundary is upright again. The small loop initially at the upper left is now at the upper right, and the long bent boundary-adjacent line is transferred to the lower-right region. Follow the whole connected line, not only the outer square.

Step 3: Compare the complete curves Option (C) preserves the original curved network under this quarter-turn, including the small upward loop at the bottom and the bent line along the lower-right part. The lower portions of (A), (B) and (D) contain different continuations or terminations. An upright boundary alone is insufficient: each interior junction and loop must agree with the rotated original.

Step 4: Conclusion The next figure is the original pattern rotated clockwise through a quarter-turn. Hence, the correct option is (C).

Quick Tip to Solve: Track a small closed loop and a long boundary-adjacent curve together; two landmarks distinguish a rotation from a similar-looking altered pattern.

50. Which one of the answer figure will complete the sequence of the three problem figures ? [4 marks]



(A) 

(B) 

(C) 

(D) 

Correct Answer: (D) 

Solution:

Concept:

- A visual pattern must preserve every relevant feature of the supplied figures; matching the outer shape alone is insufficient.
- Use identifiable lines, boundaries and their relative positions to test each alternative, and reject an alternative when any visible feature disagrees.

Step 1: Separate the fixed and changing features All three problem figures have an upright square boundary and parallel diagonals running from upper left to lower right. Neither the slope nor the size of the square changes. The changing feature is the spacing between neighbouring diagonals: close-spaced lines progressively replace the wider gaps. Thus this is a progressive densification sequence, rather than a rotation of the square.

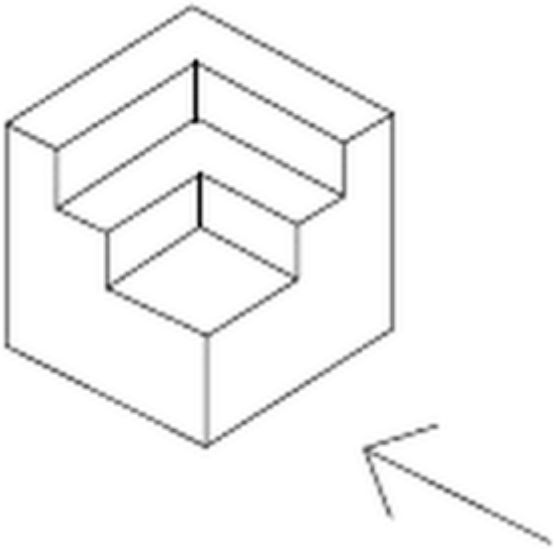
Step 2: Extend the close-spaced region In the first figure, the closely spaced portion is concentrated toward the lower-left corner. In the second it extends farther across the square. In the third it reaches still farther toward the upper-right corner. Continue this same extension: the next square must retain all the already close-spaced lower-left diagonals and introduce the next subdivision toward the upper-right side. A later member cannot reopen an earlier narrow gap.

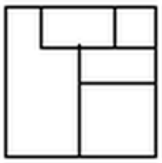
Step 3: Eliminate patterns with misplaced gaps Option (D) continues the close-spaced pattern across the required next region, retaining the common direction and the accumulated subdivisions. Option (A) leaves wide gaps in the lower-left part, which reverses the progression. Option (B) concentrates the extra lines in a different band and also leaves earlier gaps unfilled. Option (C) does not carry the subdivision as far toward the upper-right as the next member requires.

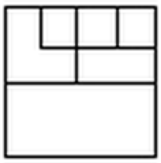
Step 4: Conclusion The diagonals become progressively more closely spaced from the lower-left region toward the upper right. Hence, the correct option is (D).

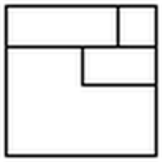
Quick Tip to Solve: Read the gaps between lines as the sequence variable. Check that a proposed next figure retains every subdivision already present.

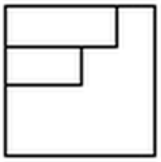
51. The 3 – D figure shows the view of an object. Identify the correct view in the direction of the arrow, from amongst the answer figures. [4 marks]

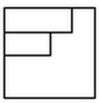


(A) 

(B) 

(C) 

(D) 

Correct Answer: (D) 

Solution:

Concept:

- An orthographic view collapses depth along the line of sight while preserving positions and heights perpendicular to that direction.
- Use identifiable lines, boundaries and their relative positions to test each alternative, and reject an alternative when any visible feature disagrees.

Step 1: Fix the viewing direction The arrow points toward the object from the lower-right side of the drawing. Look horizontally along that direction and project onto a vertical plane perpendicular to the arrow. Heights remain heights in this view, whereas distances along the arrow collapse. Consequently, the receding isometric diagonals must not be copied as sloping edges in the answer.

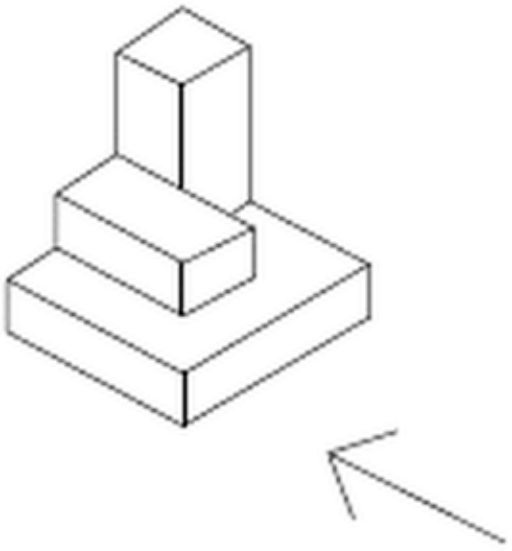
Step 2: Trace the outline and recess The outer solid gives a square outline. Inside it, the recessed levels produce a stepped set of visible horizontal edges. Trace these from the upper level down to the lower level while retaining their positions across the width. From the indicated side, the short vertical connecting edges belong on the left portions of the projected recess, producing the left-hand descending arrangement shown in (D).

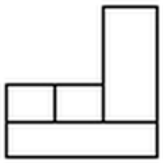
Step 3: Compare the internal edge positions Option (D) has both the square silhouette and the internal step arrangement obtained from the arrow direction. Option (C) places the short lower step toward the right instead, corresponding to a reversed arrangement. Option (A) extends an interior divider downward to the base, although that is not the visible edge pattern from this direction. Option (B) adds a different grid-like division and a full-width lower horizontal edge. These internal lines distinguish the views even though the outer boundaries are alike.

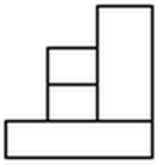
Step 4: Conclusion The square view with the correctly oriented recessed steps is option (D). Hence, the correct option is (D).

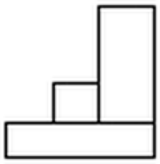
Quick Tip to Solve: For a recessed solid, match the internal visible edges after matching the silhouette; a mirror image can share the same outer square.

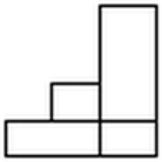
52. The 3 – D figure shows the view of an object. Identify the correct view in the direction of the arrow, from amongst the answer figures. [4 marks]

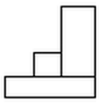


(A) 

(B) 

(C) 

(D) 

Correct Answer: (C) 

Solution:

Concept:

- An orthographic view collapses depth along the line of sight while preserving positions and heights perpendicular to that direction.
- Use identifiable lines, boundaries and their relative positions to test each alternative, and reject an alternative when any visible feature disagrees.

Step 1: Establish which dimensions collapse The arrow directs the observer toward the object from its lower-right side. Imagine viewing along this arrow without looking down onto the top surfaces. Depth along the arrow disappears in an elevation; vertical height and the width perpendicular to the arrow remain. This is why sloping isometric edges do not appear as sloping edges in the required answer.

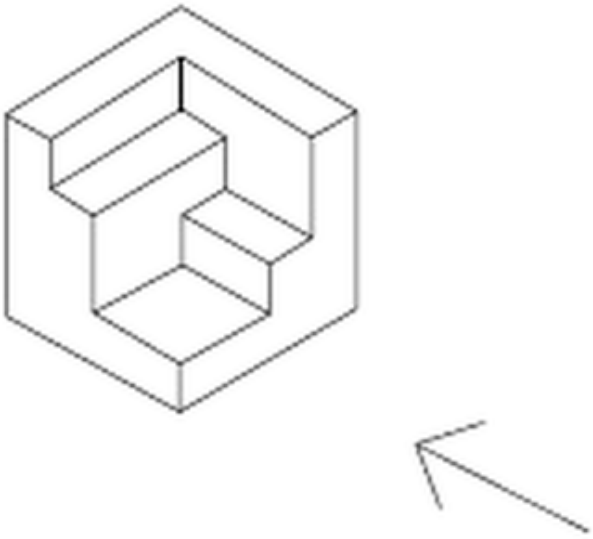
Step 2: Build the projected silhouette Begin with the broad, low rectangular base. Above it, the intermediate rectangular block makes a short raised portion, while the narrow tall block rises on the right of the view. Along the arrow direction, the depth of the intermediate block is superposed rather than shown as an extra width division. The outline therefore consists of a base, a short step above its middle region and a tall upright on the right.

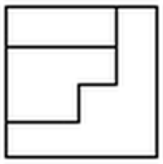
Step 3: Check the visible joints Option (C) gives this outline and the required simple divisions: one horizontal base boundary and the visible edge separating the short raised portion from the tall upright. Option (A) adds an extra vertical subdivision through the short portion. Option (B) divides that portion into two stacked layers although the intermediate block does not have that extra horizontal joint. Option (D) carries the tall block divider through the base; the continuous base does not require that line.

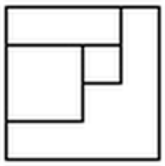
Step 4: Conclusion The correct elevation has the continuous base, one short raised portion and the tall right-hand block shown in (C). Hence, the correct option is (C).

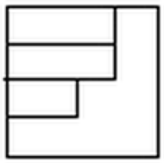
Quick Tip to Solve: Project one layer at a time, and erase depth edges that collapse along the viewing direction before comparing the options.

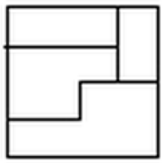
53. The 3 – D figure shows the view of an object. Identify the correct view in the direction of the arrow, from amongst the answer figures. [4 marks]

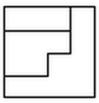


(A) 

(B) 

(C) 

(D) 

Correct Answer: (A) 

Solution:

Concept:

- An orthographic view collapses depth along the line of sight while preserving positions and heights perpendicular to that direction.
- Use identifiable lines, boundaries and their relative positions to test each alternative, and reject an alternative when any visible feature disagrees.

Step 1: Read the arrow before the steps The object contains an inward stepped recess bounded by an outer square solid. The arrow fixes the view from the lower-right side of the isometric drawing. Project along this direction, keeping the outer heights and widths but removing depth. The inner staircase is asymmetric, so reversing the viewing direction would reverse or alter its apparent step positions.

Step 2: Trace the projected stair boundary First trace the outer square. The highest interior horizontal

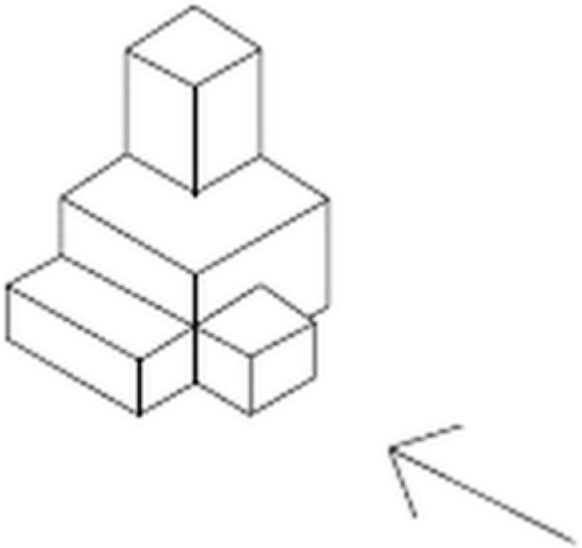
line runs from the left to the inner upright near the right side. Follow the recessed boundary downward: its next horizontal segment is shorter and displaced to the left, and the lowest visible segment extends back toward the left boundary. The resulting internal profile is a descending staircase. A narrow vertical strip remains at the right-hand side of the outer square.

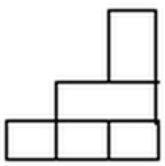
Step 3: Match edges as well as the outline Option (A) reproduces this combination: the long upper horizontal, the descending inner staircase and the right-hand strip all occupy the required positions. Option (B) has a short rectangular subdivision near the upper right and an incorrect lower edge arrangement. Option (C) introduces an additional full horizontal division across the upper-left portion. Option (D) raises the lower step on the wrong side and changes how it meets the right portion. Those are changes to visible edges, not merely stylistic differences.

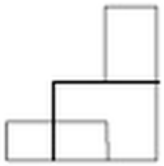
Step 4: Conclusion The indicated view is the descending recessed staircase shown in option (A). Hence, the correct option is (A).

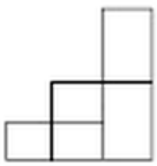
Quick Tip to Solve: Trace a recess as one continuous boundary from its highest edge to its lowest edge, then compare where each segment ends.

54. The 3 – D figure shows the view of an object. Identify the correct view in the direction of the arrow, from amongst the answer figures. [4 marks]

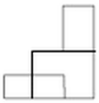


(A) 

(B) 

(C) 

(D) 

Correct Answer: (B) 

Solution:

Concept:

- An orthographic view collapses depth along the line of sight while preserving positions and heights perpendicular to that direction.
- Use identifiable lines, boundaries and their relative positions to test each alternative, and reject an alternative when any visible feature disagrees.

Step 1: Project from the indicated side The arrow approaches from the lower-right direction. The solid consists of a tall narrow upper block, a wider intermediate block and lower projecting blocks. View along the arrow, so depth is superposed and the answer becomes a two-dimensional arrangement of vertical and horizontal edges. Distinguish the silhouette of the combined solid from seams that might only appear in the isometric drawing.

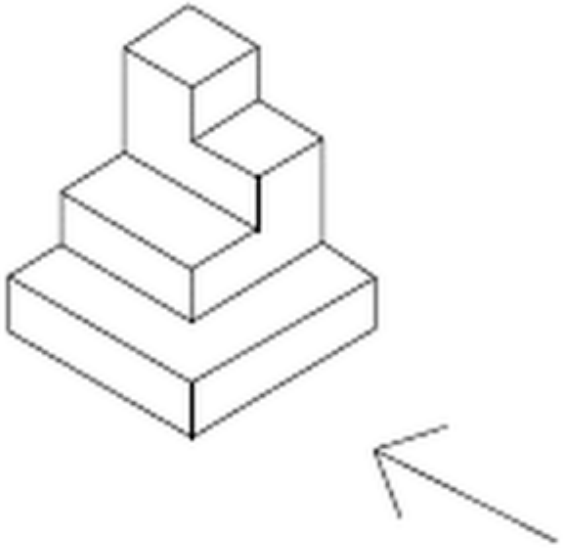
Step 2: Find the visible step outline The tall upper block projects at the right. The intermediate block forms the middle raised rectangle, and a low projecting portion remains at the left. Several faces lie in the same projected plane or are hidden behind nearer faces. Their receding isometric edges do not all survive as visible lines. In particular, the wide middle region must remain a single visible face rather than being divided into separate narrow columns.

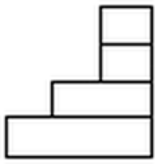
Step 3: Reject superfluous projected edges Option (B) has the required stepped outline and only the visible main boundaries. Option (A) inserts several extra vertical seams, splitting the base and intermediate face into a row of small units. Option (C) extends the vertical line under the tall block too far down through the middle face. Option (D) similarly divides the low and middle regions in a way that does not follow the visible surfaces from the arrow direction. Such extra lines cannot be justified merely because depth edges were visible in the original perspective.

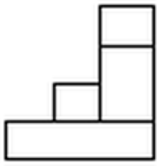
Step 4: Conclusion The elevation retaining the visible outline without extra face divisions is (B). Hence, the correct option is (B).

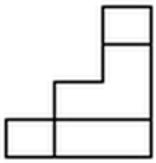
Quick Tip to Solve: Do not project every line of an isometric drawing mechanically: hidden edges and edges between coplanar projected regions may disappear.

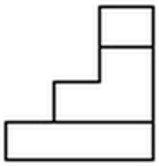
55. The 3 – D figure shows the view of an object. Identify the correct view in the direction of the arrow, from amongst the answer figures. [4 marks]

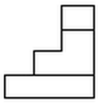


(A) 

(B) 

(C) 

(D) 

Correct Answer: (D) 

Solution:

Concept:

- An orthographic view collapses depth along the line of sight while preserving positions and heights perpendicular to that direction.
- Use identifiable lines, boundaries and their relative positions to test each alternative, and reject an alternative when any visible feature disagrees.

Step 1: Choose the elevation plane Look in the direction of the arrow from the lower-right side. The broad lowest slab projects as a continuous horizontal rectangle. The raised portions above it form a stepped profile, with the greatest height toward the right of the required view. Maintain these relative positions while suppressing distances parallel to the arrow.

Step 2: Keep the genuine level changes Above the base, the middle block gives one short rising step. The upper part includes a further change in level, which produces a horizontal edge across the narrow

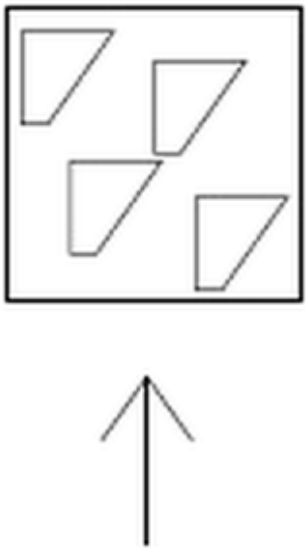
tall region. The final view therefore has an uninterrupted base, a short intermediate step and the tall right-hand region divided once near its top. The face below that upper division is continuous; it is not two separately stacked exposed rectangles.

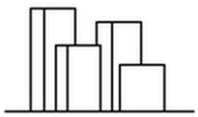
Step 3: Compare the line arrangements Option (D) shows the projected outline together with the single upper horizontal division and the continuous base. Option (A) adds an extra horizontal division in the tall region, so it creates a level boundary not visible in this projection. Option (B) adds an unnecessary vertical seam through the middle step. Option (C) carries a vertical divider through the bottom slab, whereas the low base appears as one continuous face. Matching only the number of rises would miss these incorrect internal edges.

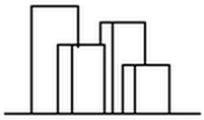
Step 4: Conclusion The correctly projected stepped solid is option (D). Hence, the correct option is (D).

Quick Tip to Solve: After identifying the step silhouette, count internal horizontal boundaries separately; an extra line can make an otherwise similar elevation wrong.

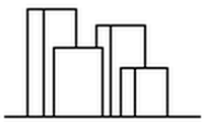
56. The problem figure shows the top view of objects. Looking in the direction of the arrow, identify the correct elevation, from amongst the answer figures. [4 marks]

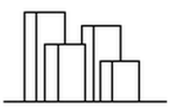


(A) 

(B) 

(C) 

(D) 

Correct Answer: (C) 

Solution:

Concept:

- An orthographic view collapses depth along the line of sight while preserving positions and heights perpendicular to that direction.
- Use identifiable lines, boundaries and their relative positions to test each alternative, and reject an alternative when any visible feature disagrees.

Step 1: Use the plan and the arrow together The square is a plan containing four similarly oriented sloping-sided footprints. The arrow points upward into the plan, so the lower objects are nearer the observer and the upper objects are farther away. In the elevation, left-right position is preserved, but this front-back separation is collapsed. Objects whose footprints overlap horizontally can therefore partly conceal one another.

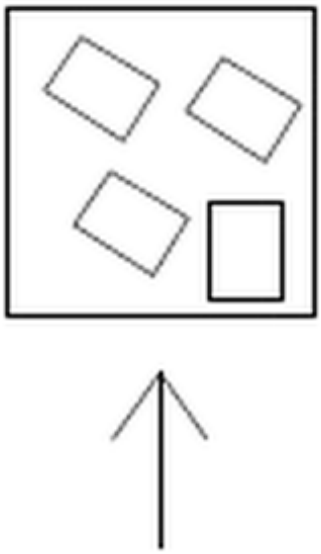
Step 2: Arrange the projected objects Read the four positions from left to right while keeping their depth order. The far upper-left object supplies the left tall portion, while the other offset objects form the central and right portions. Each sloping-sided footprint also fixes which side of its object appears as the narrow vertical face. Thus compare both the horizontal overlap of the silhouettes and the side-face divisions, rather than choosing solely by the number of upright shapes.

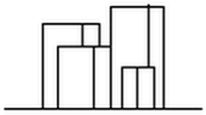
Step 3: Check the overlap and side faces Option (C) preserves the left-right arrangement, the nearer objects in front of the more distant ones, and the visible narrow faces in their correct positions. Option (A) changes the side-face divisions of the middle and right portions. Option (B) changes the left object into an undivided face and shifts the central overlap. Option (D) omits the narrow vertical strip on the second object from the left, the nearer left-middle object; that visible strip is present in (C). These alternatives fail the combination of plan position and orientation even though each contains four upright forms.

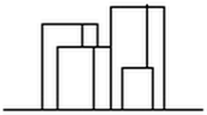
Step 4: Conclusion The elevation consistent with the positions and orientations in the plan is (C). Hence, the correct option is (C).

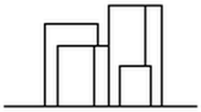
Quick Tip to Solve: In plan-to-elevation questions, use horizontal overlap to determine occlusion, then use each footprint orientation to check its narrow visible side face.

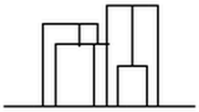
57. The problem figure shows the top view of objects. Looking in the direction of the arrow, identify the correct elevation, from amongst the answer figures. [4 marks]

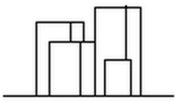


(A) 

(B) 

(C) 

(D) 

Correct Answer: (B) 

Solution:

Concept:

- An elevation looking along the arrow retains left-to-right positions and heights, while depth is projected away. A nearer solid hides any part of a rear edge lying behind it.
- A rectangular prism turned obliquely in plan generally displays a vertical corner inside its projected outline. A prism with a face parallel to the viewing plane presents a plain rectangular face.

Step 1: Read the foreground objects The arrow points upwards, so the two lower objects in the plan are nearer the observer. The lower-right rectangle is aligned with the viewing direction; its elevation must be a small plain rectangle, without a vertical line through its face. The lower-left oblique rectangle produces the wider foreground prism with a visible internal corner.

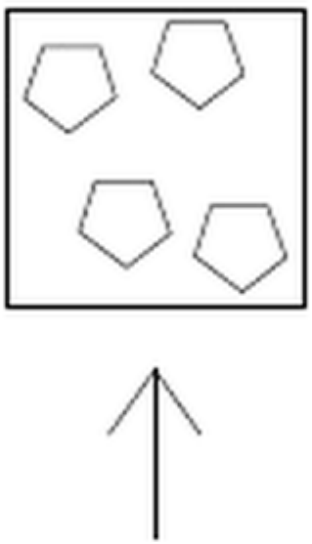
Step 2: Check rear edges and compare the options The two upper oblique rectangles stand behind the foreground objects. Their vertical corner lines must be visible only above the nearer solids. In option (B), the right rear corner is in the correct lateral position and stops at the top of the small front rectangle. Option (A) incorrectly continues that rear edge through the front face; option (C) loses a visible corner on the left rear prism. Option (D) shifts the right rear corner to the wrong lateral

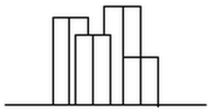
position relative to its plan.

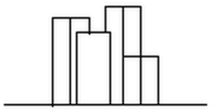
Step 3: Conclusion The arrangement and visible edges agree with elevation (B). Hence, the correct option is (B).

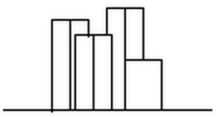
Quick Tip to Solve: For each internal vertical line, locate its corner in the plan and stop the line wherever a nearer solid hides it.

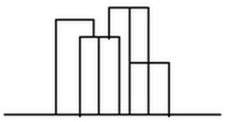
58. The problem figure shows the top view of objects. Looking in the direction of the arrow, identify the correct elevation, from amongst the answer figures. [4 marks]

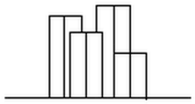


(A) 

(B) 

(C) 

(D) 

Correct Answer: (A) 

Solution:

Concept:

- A front elevation preserves horizontal position but removes the front-to-back separation. Opaque foreground solids hide rear edges.
- Each pentagon in this plan has a vertex directed towards the observer. Its corresponding prism therefore shows a vertical corner line inside the front elevation.

Step 1: Project the nearer pair The arrow is directed upwards. The two pentagons in the lower

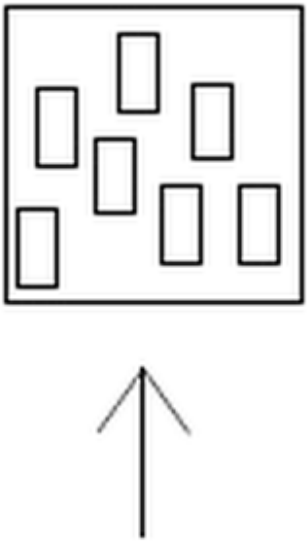
half are therefore in front of the upper pair. Both present a forward-pointing vertex, so both nearer elevations require a visible internal vertical corner. Their outlines must also be placed at the same left-to-right positions as their footprints.

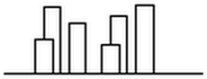
Step 2: Test the visible corners Option (A) retains the visible corner on each foreground pentagonal prism, including the shortest object at the right, while the taller rear objects appear behind them. Option (B) omits the foreground middle corner. Option (C) omits the internal corner of the small right foreground object, and option (D) removes the exposed upper portion of the left rear corner. These missing edges are inconsistent with the pentagonal footprints and the indicated viewing direction.

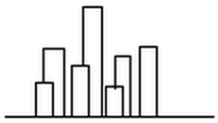
Step 3: Conclusion Only option (A) gives the required visible corners and overlaps. Hence, the correct option is (A).

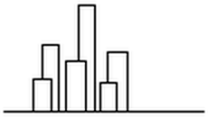
Quick Tip to Solve: A pentagonal footprint pointing a vertex towards you gives an internal vertical edge; check this before comparing heights.

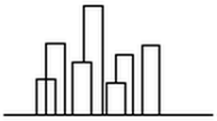
59. The problem figure shows the top view of objects. Looking in the direction of the arrow, identify the correct elevation, from amongst the answer figures. [4 marks]

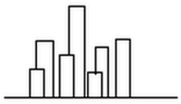


(A) 

(B) 

(C) 

(D) 

Correct Answer: (B) 

Solution:

Concept:

- The viewing arrow fixes which objects are in front. Horizontal coordinates remain unchanged in the elevation, but the depth coordinates collapse.
- A rear vertical edge can be visible above a nearer block, but cannot show through the opaque front face. Count the footprints and retain each object unless it is completely hidden.

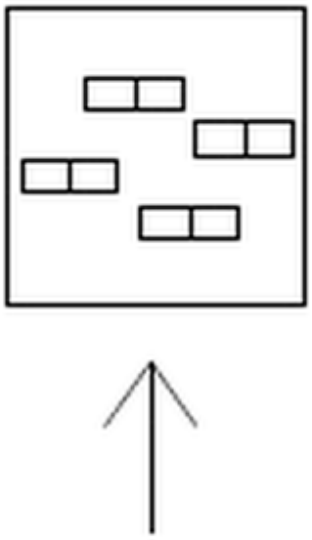
Step 1: Establish the order and overlaps There are seven rectangular footprints. From left to right, the first near block overlaps a taller block behind it; the next nearer block partly covers the tallest central block. Farther right another low front block partly overlaps a rear block, and the last footprint remains separate. All faces are aligned rectangles, so no oblique-prism corner line is required.

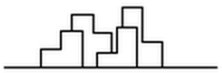
Step 2: Reject the incorrect elevations Option (B) preserves the seven-object sequence and stops the obscured rear lines at the foreground tops. Options (A) and (C) suppress objects or place the tallest member in the wrong position, so their silhouettes cannot match the plan. Option (D) includes a rear line passing through the left foreground rectangle: the edge should disappear behind that opaque block. Thus its visibility is wrong even though its overall heights resemble the correct elevation.

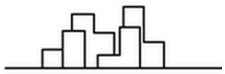
Step 3: Conclusion The correct seven-block elevation, with the hidden edges suppressed, is (B). Hence, the correct option is (B).

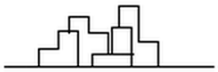
Quick Tip to Solve: Compare the vertical edges below each front block first: an edge visible through a foreground face rules an option out immediately.

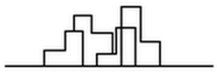
60. The problem figure shows the top view of objects. Looking in the direction of the arrow, identify the correct elevation, from amongst the answer figures. [4 marks]

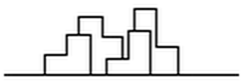


(A) 

(B) 

(C) 

(D) 

Correct Answer: (A) 

Solution:

Concept:

- An elevation is formed by projecting in the arrow direction. Preserve each object's left-to-right extent and its visible stepped profile.
- Overlap is resolved by depth: a lower object in this plan is nearer the observer and masks the portions of a rear object lying behind it.

Step 1: Identify the stepped profiles Each footprint is a long rectangle divided into two parts by a line. The objects are staggered in depth. Looking upwards along the arrow, the lower central object is in front; the left object is also nearer than the upper pair. Trace the projected outline from the far left to the far right while keeping these foreground objects ahead of the rear ones.

Step 2: Compare the continuity of visible edges In option (A), the exposed left object joins the rear stepped profile and the central foreground object masks the appropriate lower rear edges. Its rising and falling outline agrees with the staggered positions. Option (B) introduces an extra exposed lower-left rectangular edge; option (C) retains an inappropriate horizontal division across the front lower region. Option (D) puts the foreground vertical step at the wrong horizontal position. These differences conflict with the plan and its occlusion order.

Step 3: Conclusion The consistent stepped elevation is shown in (A). Hence, the correct option is (A).

Quick Tip to Solve: Trace the outside silhouette first, then inspect the internal lines; the nearest footprint determines which rear segments must disappear.

61. The White House is which one of the following ? [4 marks]

(A) Residence of Prime Minister of Germany

(B) Residence of Prime Minister of France

(C) Residence of Prime Minister of Spain

(D) Residence of President of USA

Correct Answer: (D) Residence of President of USA

Solution:

Concept:

- The White House is the official residence and workplace of the President of the United States of America. It is located in Washington, D.C.
- Building-identification questions require the building's institutional function, rather than simply identifying a capital city or a government office.

Step 1: Identify the building and its occupant The name White House refers to the presidential complex at 1600 Pennsylvania Avenue in Washington, D.C. The head of state and head of the executive branch of the United States is the President. The building is consequently associated with the American presidency and serves as the President's official residence.

Step 2: Compare the four descriptions Option (D), Residence of President of USA, states precisely this function. Options (A), (B) and (C) instead associate the White House with the prime ministers

of Germany, France and Spain. Those are three different European countries and their heads of government do not reside in the White House. The identification therefore follows from both the country and the office, not from the building's colour alone.

Step 3: Conclusion The White House is the residence of the President of the USA. Hence, the correct option is (D).

Quick Tip to Solve: Link White House with Washington, D.C., and the American President to avoid confusing residences of different national leaders.

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62. In the Northern Hemisphere the summer sun rises from which one of the following directions ?

[4 marks]

(A) North East

(B) North West

(C) South East

(D) South West

Correct Answer: (A) North East

Solution:

Concept:

- The Earth's axial tilt makes the Sun's apparent daily path shift northward in Northern Hemisphere summer. Sunrise moves north of due east and sunset north of due west.
- A sunrise direction must lie on the eastern side of the horizon. Summer and winter shift that eastern direction towards north and south respectively.

Step 1: Locate the summer sunrise At the equinox the Sun rises approximately due east. During Northern Hemisphere summer its declination is northward, so the sunrise point lies to the north of the east point for the ordinary latitudes implied in an architectural orientation question. That quadrant is north-east. The question asks for a direction category, rather than a numerical azimuth.

Step 2: Eliminate the other quadrants North-west and south-west, options (B) and (D), lie on the western horizon and cannot describe the usual rising Sun. South-east, option (C), is the winter-side sunrise direction in the Northern Hemisphere. North-east, option (A), is the only eastern direction with the required summer shift. At polar latitudes continuous summer daylight can prevent a daily sunrise, but that special case does not alter the intended directional comparison.

Step 3: Conclusion The Northern Hemisphere summer sunrise is towards the north-east. Hence, the correct option is (A).

Quick Tip to Solve: Remember the pair: northern summer sunrise shifts north of east; northern winter sunrise shifts south of east.

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63. In which of the following States is the Golden Temple located ? [4 marks]

(A) Haryana

(B) Punjab

(C) Assam

(D) Nagaland

Correct Answer: (B) Punjab

Solution:

Concept:

- The Golden Temple, also called Sri Harmandir Sahib, is the famous Sikh shrine in Amritsar. Amritsar is a city in the Indian state of Punjab.
- To identify a monument's state, first recall its city and then map that city to the state. Nearby states must not be substituted for the actual location.

Step 1: Recall the city of the shrine The Golden Temple is associated with Amritsar and its sacred pool, the Amrit Sarovar. This establishes the geographical identification independently of the list of options. Amritsar is in Punjab in north-western India, so the requested state is Punjab rather than a neighbouring state or a north-eastern state.

Step 2: Match the state with the options Punjab is explicitly given in option (B). Haryana, option (A), is a separate state and does not contain Amritsar. Assam and Nagaland, options (C) and (D), are in north-eastern India and likewise are not the location of this shrine. The association Golden Temple–Amritsar–Punjab therefore selects one option unambiguously. The question asks the state, so naming Amritsar alone would not fully answer it.

Step 3: Conclusion The Golden Temple is located in Punjab. Hence, the correct option is (B).

Quick Tip to Solve: Use the location chain Golden Temple, Amritsar, Punjab; recalling both city and state makes monument questions quicker.

64. What is the thickness of a one and a half brick thick wall ? [4 marks]

(A) $9''$

(B) $12''$

(C) $18''$

(D) $13.5''$

Correct Answer: (D) $13.5''$

Solution:

Concept:

- In the conventional inch-based brick-wall terminology used here, a one-brick-thick wall is nominally 9 inches thick and a half-brick wall is 4.5 inches thick.
- A one-and-a-half-brick wall combines the one-brick thickness and a half-brick thickness. The nominal wall thickness refers to the brickwork, without adding a separate plaster layer.

Step 1: Translate the brick-thickness description The fractional expression describes thickness in units of the brick's conventional length. Take one brick as 9 inches and half a brick as 4.5 inches in this traditional convention. A one-and-a-half-brick thickness is therefore obtained by adding those two nominal dimensions; it is not the thickness of one and a half individual flat bricks stacked vertically.

Step 2: Calculate and compare The nominal thickness is $9 + 4.5 = 13.5$ inches. Option (A), 9 inches, describes a one-brick wall. Option (C), 18 inches, corresponds to two bricks in the same nominal convention. Option (B), 12 inches, is not the sum of the given one-brick and half-brick nominal modules. Option (D) alone matches the one-and-a-half-brick description used in the question's imperial answer choices.

Step 3: Conclusion The wall thickness is 13.5 inches. Hence, the correct option is (D).

Quick Tip to Solve: For traditional 9-inch brickwork, multiply the stated brick thickness by 9; one and a half gives 13.5 inches.

65. Which one amongst the following supports the masonry above doors and windows ? [4 marks]

(A) Foundation

(B) Lintel

(C) Slab

(D) Wooden frame

Correct Answer: (B) Lintel

Solution:

Concept:

- A wall above an opening needs a member that bridges the opening and carries the masonry load to the wall on either side.
- A lintel is the horizontal structural member immediately above a door or window; the supported side portions of the wall provide its end bearings.

Step 1: Identify the position of the required support A door or window interrupts the continuity of a masonry wall. The brickwork or stonework above that interruption cannot be supported by the empty opening itself. Its weight must be carried across the opening and then transferred to the solid masonry at its two sides. The question therefore asks for the local spanning member at the head of the opening.

Step 2: Match the function to the component That spanning member is a lintel. It may be made from reinforced concrete, stone, steel or another suitable structural material, but its defining role is to support the masonry above the opening. A foundation transfers the overall building load into the ground, so (A) names a component at a different position. A slab normally forms a floor or roof rather than the named support above a door or window. A wooden frame holds the door or window assembly; it is not the general structural answer for the masonry load above it.

Step 3: Conclusion The masonry above doors and windows is supported by a lintel. Hence, the correct option is (B).

Quick Tip to Solve: Associate the head of a wall opening with a lintel; associate the base of the building with its foundation.

66. The Leaning Tower in Italy is located in which one of the following cities ? [4 marks]

(A) Florence

(B) Venice

(C) Pisa

(D) Rome

Correct Answer: (C) Pisa

Solution:

Concept:

- Architectural-awareness questions are answered by matching the named landmark with its actual geographical location.
- The internationally known Leaning Tower is the bell tower associated with the cathedral complex at Pisa in Italy.

Step 1: Identify the landmark The expression Leaning Tower in this architectural context identifies the Leaning Tower of Pisa. It is a freestanding bell tower, or campanile, rather than a tower in Florence, Venice or Rome. The city name is part of the established name of the monument, so the most direct identification is the landmark-city pair: Leaning Tower – Pisa.

Step 2: Compare the listed cities Option (C), Pisa, reproduces the city in that landmark name and is therefore the required match. Florence is associated with its cathedral and Renaissance architecture, but it is not the location of this famous tower. Venice is associated with canals and its own bell towers; those associations do not relocate the Leaning Tower of Pisa. Rome is the Italian capital and contains many famous monuments, but being the capital does not make it the location of every Italian landmark. Thus (A), (B) and (D) do not answer the location asked for.

Step 3: Conclusion The Leaning Tower is located in Pisa, Italy. Hence, the correct option is (C).

Quick Tip to Solve: Remember the complete name Leaning Tower of Pisa; the landmark itself supplies the required city.

67. Which one of the garden of the following is a terraced garden in Srinagar ? [4 marks]

(A) Nishat

(B) Vrindaban

(C) Buddha

(D) Nehru

Correct Answer: (A) Nishat

Solution:

Concept:

- A terraced garden is organised on successive levels rather than on one continuous flat surface.
- Nishat Bagh is a terraced Mughal garden in Srinagar; matching both the garden type and the city identifies the answer.

Step 1: Use both clues in the question The question does not ask for any well-known garden. It specifies a terraced garden and also specifies Srinagar. Nishat Bagh satisfies this pair of clues: it is a Srinagar garden with a sequence of terraces. The stepped levels are the relevant landscape feature, so the name Nishat is a direct match to the description.

Step 2: Eliminate the other garden names Vrindaban, as a garden name in this list, is not the Srinagar terraced Mughal garden identified by the question; the well-known Brindavan Gardens are associated with the Mysuru region. Buddha and Nehru are names used for parks and gardens in other settings, but neither is the specific Nishat terraced garden of Srinagar. Merely recognising a garden name is insufficient: it must match the place and the stated spatial arrangement. Option (A) is the one that gives the established landmark corresponding to both requirements, while the remaining names fail that combined identification.

Step 3: Conclusion The terraced garden in Srinagar is Nishat Bagh. Hence, the correct option is (A).

Quick Tip to Solve: For garden-identification questions, connect the name with both its city and its layout: Nishat – Srinagar – terraces.

68. What amongst the following is the name of the famous museum in Hyderabad ? [4 marks]

(A) Falaknuma

(B) Salarjung

(C) Gandhi

(D) Nizam

Correct Answer: (B) Salarjung

Solution:

Concept:

- A cultural-landmark question requires the recognised name of the institution, rather than simply a person or a nearby palace.
- The Salar Jung Museum is a celebrated museum in Hyderabad; its name corresponds to the printed option Salarjung.

Step 1: Recognise the institution being asked for The famous Hyderabad museum conventionally identified by this question is the Salar Jung Museum. Its name is printed as Salarjung in option (B). The difference between the spaced institutional name and the joined spelling in the option does not change the identification: both refer to the Salar Jung Museum.

Step 2: Distinguish the distractors carefully Falaknuma is primarily recognised as the name of a Hyderabad palace, so (A) does not identify the museum requested here. Gandhi is a widely occurring commemorative name and does not name the specific famous Hyderabad museum in this question. Nizam refers to the former rulers of Hyderabad and is also associated with other local heritage institutions; that connection alone does not replace the intended Salar Jung landmark. The decisive match is the complete recognised museum name. Therefore (B) answers the question directly, while the other choices give related or general names rather than the institution being identified.

Step 3: Conclusion The required institution is the Salar Jung Museum, printed as Salarjung. Hence, the correct option is (B).

Quick Tip to Solve: Link Hyderabad with the Salar Jung Museum, and distinguish museum names from palace names such as Falaknuma.

69. Which one of the color is made when blue and yellow are mixed ? [4 marks]

(A) Violet

(B) Orange

(C) Green

(D) White

Correct Answer: (C) Green

Solution:

Concept:

- In the conventional artists colour wheel, blue and yellow are primary pigment colours and their mixture produces a secondary colour.
- For the paint or pigment interpretation used in this aptitude question, the relevant pair is blue plus yellow giving green.

Step 1: Identify the colour-mixing convention The options and the blue-yellow pair indicate the ordinary artists pigment-mixing rule. On this colour wheel, mixing two suitable primary pigments yields a secondary colour between them. Blue mixed with yellow therefore gives green. The question asks for the colour identity, rather than for a precise shade, which can vary with the pigments and proportions.

Step 2: Check every proposed result Green is printed in option (C), so it matches the required mixture. Violet is conventionally obtained by mixing blue and red, not blue and yellow, which rules out (A). Orange is conventionally obtained by mixing red and yellow, which rules out (B). White is not the secondary pigment colour formed by the stated pair; ordinary blue and yellow paints do not combine to produce white, so (D) is also unsuitable. This reasoning uses pigment mixing consistently rather than changing to a different model of coloured light halfway through the comparison.

Step 3: Conclusion Under conventional pigment mixing, blue and yellow produce green. Hence, the correct option is (C).

Quick Tip to Solve: Keep the three pigment pairs together: blue plus yellow gives green, red plus yellow gives orange, and red plus blue gives violet.

70. Which one of the following color suggests love and romance ? [4 marks]

(A) Blue

(B) Green

(C) Pink

(D) Brown

Correct Answer: (C) Pink

Solution:

Concept:

- Colour-association questions use familiar visual-design conventions linking colours with moods or ideas.
- Pink is conventionally associated with tenderness, affection and romance, which matches the words love and romance in this question.

Step 1: Identify the emotional association The question asks what the colour suggests, so it tests a conventional design association rather than a physical mixing rule. Among the listed colours, pink is commonly used to communicate gentle affection, tenderness and romantic feeling. These associations fit both parts of the expression love and romance and make pink the intended selection.

Step 2: Compare the alternative associations Blue more commonly suggests calmness, coolness or trust, so it is less appropriate for the particular romantic cue in option (A). Green commonly suggests vegetation, freshness or growth, rather than the specified love-and-romance association, ruling out (B). Brown is commonly linked with earthiness, wood and solidity, so (D) does not match the cue either. Such associations are visual conventions and can vary with context; the task is to select the conventional association best matching the words given. Within these four alternatives, pink supplies that direct match without requiring any change to the question.

Step 3: Conclusion Pink is the colour conventionally associated with love and romance here. Hence, the correct option is (C).

Quick Tip to Solve: For colour-emotion matching, identify the cue first: tenderness and romance point to pink among these four choices.

71. Which one of the following suggests the texture of the skin of the elderly persons ? [4 marks]

(A) Glossy

(B) Wrinkled

(C) Smooth

(D) Soft

Correct Answer: (B) Wrinkled

Solution:

Concept:

- Texture describes the perceived surface character of an object, including folds, roughness, ridges or smoothness.
- Wrinkled describes a surface with folds or creases, making it the characteristic visual texture associated with elderly skin in this question.

Step 1: Identify the relevant surface feature The question asks for the texture suggested by elderly skin. The characteristic visual cue is a network of wrinkles or creases. The word wrinkled directly describes that surface structure, rather than its colour, temperature or a general emotional impression. This makes option (B) the most precise match to the stated recognition task.

Step 2: Separate texture from other surface properties Glossy describes a shiny surface reflecting light strongly; shine is not the characteristic feature being tested, so (A) is unsuitable. Smooth describes a relatively even surface without pronounced folds, making (C) the opposite of the wrinkled appearance intended here. Soft describes how a surface yields to touch rather than the visible creases, so (D) is less specific and does not answer this visual-texture cue. Individual skin appearances vary, but the conventional texture association asked for is unambiguous among these options. The answer follows from the descriptive meaning of wrinkled, not from assuming that every older person has identical skin.

Step 3: Conclusion The intended texture is wrinkled. Hence, the correct option is (B).

Quick Tip to Solve: Choose the word that describes the visible surface pattern: creases and folds indicate a wrinkled texture.

72. Which one of the following is fixed to drain water from a sloping roof ? [4 marks]

(A) Ridge

(B) Eave

(C) J. Bolt

(D) Gutter

Correct Answer: (D) Gutter

Solution:

Concept:

- A sloping roof directs rainwater down its surface towards the lower edge, where it must be collected and discharged safely.
- A gutter is a channel fixed along a roof edge to collect runoff and carry it towards an outlet or downpipe.

Step 1: Trace the path of rainwater Rain falling on a sloping roof runs downhill towards the eaves. A drainage fitting must collect this runoff along the lower roof edge and guide it to a suitable discharge point. The named component designed as this collecting channel is the gutter, which is fixed to the roof-edge drainage arrangement.

Step 2: Distinguish the roof elements Option (D), gutter, therefore performs the requested drainage function. The ridge is the high line where roof slopes meet, so (A) names an upper roof feature rather than the runoff-collecting channel. The eave is the lower projecting edge of the roof; water reaches it, but the edge itself is not the separately fixed drainage channel asked for, ruling out (B). A J. bolt is a fastening used to secure components such as roofing sheets, not a channel to carry water, so (C) is also unsuitable. The distinction is between the roof location, a fastening and the actual drainage fitting.

Step 3: Conclusion A gutter is fixed to collect and drain water from a sloping roof. Hence, the correct option is (D).

Quick Tip to Solve: Follow runoff downhill: the ridge is high, the eave is the lower edge, and the gutter is the collecting channel fixed there.

73. Which one of the following is ideal flooring for a cinema hall ? [4 marks]

(A) Granite

(B) Brick

(C) Marble

(D) Carpet

Correct Answer: (D) Carpet

Solution:

Concept:

- Floor finishes in an auditorium are selected partly for their acoustic behaviour: unwanted reflected sound should be reduced so that speech and dialogue remain clear.
- Soft, porous finishes absorb more incident sound than smooth, hard stone surfaces. Carpet also cushions footfalls and reduces noise from audience movement.

Step 1: Identify the performance needed A cinema hall contains amplified dialogue, music and effects. The flooring should help control excessive reverberation rather than add strong reflections. People may also move along aisles during a screening, so reducing the sound of footsteps is useful. Thus the relevant comparison is acoustic absorption and impact-noise control, rather than hardness or decorative appearance alone.

Step 2: Compare the four finishes Carpet is a soft, fibrous covering with numerous small air spaces. It absorbs part of the incident sound, particularly at higher frequencies, and softens footsteps. Granite and marble are dense, smooth, hard stones that tend to reflect sound; their durability does not make them the best acoustic choice here. Brick is also a comparatively hard finish and does not offer the same cushioning and absorption as carpet. Among the listed choices, carpet best meets the cinema hall requirement.

Step 3: Conclusion Carpet is the ideal flooring among the listed materials because it assists sound absorption and reduces footfall noise. Hence, the correct option is (D).

Quick Tip to Solve: For an auditorium finish, connect soft, porous surfaces with sound absorption and smooth stone surfaces with reflection.

74. Who among the following is the architect of the Punjab Haryana High Court Building ? [4 marks]

(A) Maxwell Fry

(B) Le Corbusier

(C) Louis Kahn

(D) Geoffrey Bawa

Correct Answer: (B) Le Corbusier

Solution:

Concept:

- The Punjab and Haryana High Court is a major public building in the Capitol Complex at Chandigarh.
- Le Corbusier designed the principal monumental buildings of the Capitol Complex, including the High Court. Identify the specific building rather than attributing every Chandigarh building to the same collaborator.

Step 1: Locate the building in its architectural context The question refers to the High Court serving Punjab and Haryana at Chandigarh. It belongs to the city's Capitol Complex, whose monumental government buildings are associated with Le Corbusier. The High Court is recognised for its expressive reinforced-concrete form and large protective roof. These characteristics place it within his modernist work.

Step 2: Distinguish the named architects Le Corbusier is therefore the required architect. Maxwell Fry participated in the wider Chandigarh project, but that association does not make him the designer of the High Court. Louis Kahn is associated with other major institutional projects, including the Indian Institute of Management at Ahmedabad. Geoffrey Bawa is associated especially with Sri Lankan architecture and tropical modernism. Neither of these latter names identifies the Chandigarh High Court. The building-specific attribution selects Le Corbusier from the four options.

Step 3: Conclusion The Punjab and Haryana High Court Building at Chandigarh was designed by Le Corbusier. Hence, the correct option is (B).

Quick Tip to Solve: Associate Chandigarh's Capitol Complex monuments, including the High Court, with Le Corbusier; distinguish them from the wider city team.

75. Which one among the following is used for water conservation ? [4 marks]

(A) Water drainage

(B) Water evaporation

(C) Water harvesting

(D) Water flowing

Correct Answer: (C) Water harvesting

Solution:

Concept:

- Water conservation involves saving available water, limiting avoidable losses and retaining water for later use or groundwater replenishment.
- Water harvesting collects runoff, commonly rainwater, and directs it into storage or recharge systems instead of allowing it to be lost from the site.

Step 1: Identify the action that retains water The question asks for a method used to conserve water. A conservation measure must help make water available when needed, either by storing it or by replenishing an accessible source. Harvesting rainwater from roofs or paved catchments and collecting it in tanks is one example. Routing suitable runoff into recharge structures is another. Both retain a useful part of water that would otherwise leave the site.

Step 2: Reject processes that merely move or lose water Water harvesting directly satisfies this requirement, so select it. Water drainage primarily carries water away and is not, by itself, a conservation technique. Water evaporation changes liquid water into vapour; from the perspective of a local storage system, it is generally a loss to be controlled. Water flowing describes movement alone and says nothing about collection, storage or saving. Such movement may occur inside a harvesting system, but the phrase itself does not name the conservation method requested.

Step 3: Conclusion Water harvesting is used for water conservation through collection, storage or recharge. Hence, the correct option is (C).

Quick Tip to Solve: Look for the option that retains usable water: harvesting names a collection method, while drainage and evaporation usually describe outflow or loss.

Planning (100 marks)

76. Secondary sector of economic activity is associated with : [4 marks]

(A) Agriculture

(B) Manufacturing

(C) Service

(D) Mining

Correct Answer: (B) Manufacturing

Solution:

Concept:

- The primary sector obtains products directly from nature, including agriculture, fishing, forestry and extraction of minerals.
- The secondary sector processes raw materials into manufactured goods. The tertiary sector supplies services that support production and consumption.

Step 1: Apply the sector classification Classify an activity by what it does to the input. Growing crops and extracting minerals obtain materials from natural resources, whereas turning those materials into finished or intermediate goods is manufacturing. Manufacturing adds value through a production process: for example, cotton may be converted into cloth and iron ore into steel products. This transformation is the defining feature of the secondary sector.

Step 2: Classify each offered activity Manufacturing belongs to the secondary sector, so option (B) fits. Agriculture belongs to the primary sector because crops are produced by working with land and biological growth. Mining also belongs to the primary sector because it extracts minerals from nature; using machinery does not change that basic classification. Service belongs to the tertiary sector, covering activities such as transport, trade and communication. The presence of equipment or paid employment is therefore insufficient to decide the sector: the nature of the economic output decides it.

Step 3: Conclusion The secondary sector is associated with manufacturing, which converts raw materials into goods. Hence, the correct option is (B).

Quick Tip to Solve: Use the sequence extract or grow, then manufacture, then provide services to remember primary, secondary and tertiary sectors.

77. Allocation of powers and functions between Union and State governments is given in which schedule of the Constitution of India ? [4 marks]

(A) First Schedule

(B) Third Schedule

(C) Fifth Schedule

(D) Seventh Schedule

Correct Answer: (D) Seventh Schedule

Solution:

Concept:

- India's federal arrangement distributes legislative subjects between the Union and the States through constitutional lists.
- The Seventh Schedule contains the Union List, State List and Concurrent List. These lists organise the principal subject-wise division of legislative competence.

Step 1: Identify the schedule containing the lists The wording points to the constitutional distribution of subjects between two levels of government. The Union List concerns subjects assigned to Parliament, the State List concerns subjects assigned to State legislatures, and the Concurrent List contains subjects on which both may legislate subject to constitutional rules. These three lists occur in the Seventh Schedule. Thus the question is testing the location of the division of powers, rather than the territorial names of the States.

Step 2: Eliminate the remaining schedules The First Schedule lists the States and Union Territories and their territorial descriptions; it does not contain the three legislative lists. The Third Schedule supplies forms of oaths or affirmations for specified public offices. The Fifth Schedule concerns administration and control of Scheduled Areas and Scheduled Tribes. Each therefore has a different constitutional purpose. Among the offered schedules, only the Seventh Schedule supplies the Union, State and Concurrent Lists referred to by the question.

Step 3: Conclusion The relevant distribution is given through the lists in the Seventh Schedule of the Constitution of India. Hence, the correct option is (D).

Quick Tip to Solve: Remember Seventh Schedule as the home of the three lists: Union, State and Concurrent.

78. Which of the following criteria is not the basis of classification of natural resources ? [4 marks]

(A) Exhaustibility

(B) Ownership

(C) Origin

(D) Climate

Correct Answer: (D) Climate

Solution:

Concept:

- Natural resources are commonly classified by origin, exhaustibility, ownership and status of development.
- A question asking which basis is not used requires checking whether each proposed criterion belongs to this standard classification, rather than whether it influences resource availability.

Step 1: Check the established classification criteria Origin separates biotic resources, derived from living things, from abiotic resources such as rocks and metals. Exhaustibility separates renewable resources from non-renewable resources. Ownership distinguishes individual, community, national and international resources. These are recognised classification bases and therefore options (A), (B) and (C) cannot answer a question asking for the exception.

Step 2: Distinguish a controlling factor from a classification basis Climate affects the distribution, productivity and availability of many natural resources. For example, rainfall influences vegetation and surface-water availability. However, climate is not one of the standard bases used in the stated school-level classification of natural resources. A factor can affect a resource without being a named category in this classification scheme. Keeping that distinction in view prevents choosing origin merely because some resources have complex origins. The exception among the four offered criteria is climate.

Step 3: Conclusion Climate is not a basis in the standard classification of natural resources asked here. Hence, the correct option is (D).

Quick Tip to Solve: For the standard resource classification, recall origin, exhaustibility, ownership and development; treat climatic influence as a separate idea.

79. Who amongst the following was involved in design of New Delhi ? [4 marks]

(A) Sir Edwin Lutyens

(B) Le Corbusier

(C) Otto Konigsberger

(D) Patrick Geddes

Correct Answer: (A) Sir Edwin Lutyens

Solution:

Concept:

- Sir Edwin Lutyens was a principal architect involved in the planning and design of New Delhi as the imperial capital.
- Architectural attribution questions require matching the named city or project with the appropriate designer, rather than choosing an architect who worked elsewhere in India.

Step 1: Identify the relevant city-design association New Delhi was planned as a new capital during British rule. Sir Edwin Lutyens was centrally involved in its planning and architectural design, together with other collaborators such as Herbert Baker. Lutyens' association includes the monumental capital ensemble and the building now known as Rashtrapati Bhavan. Consequently, his name directly fits the question, which asks who was involved rather than who alone designed every part of the city.

Step 2: Compare the alternative names Le Corbusier is associated particularly with the modern planning and Capitol Complex of Chandigarh, not the imperial New Delhi project asked about. Otto Koenigsberger is known for planning and architectural work in other settings, including Bhubaneswar. Patrick Geddes contributed important ideas and surveys to town planning, but is not the offered name identifying the principal New Delhi design association. Therefore the direct historical match among the four options is Sir Edwin Lutyens. There is no need to claim that the city was the work of a single person.

Step 3: Conclusion Sir Edwin Lutyens was involved in the design of New Delhi. Hence, the correct option is (A).

Quick Tip to Solve: Keep the major associations separate: Lutyens with New Delhi and Le Corbusier with Chandigarh.

80. Jawaharlal Nehru National Urban Renewal Mission (JNNURM) was launched in : [4 marks]

(A) 1970

(B) 1975

(C) 2005

(D) 2010

Correct Answer: (C) 2005

Solution:

Concept:

- Jawaharlal Nehru National Urban Renewal Mission is abbreviated JNNURM and was launched by the Government of India in 2005.
- The mission concerned urban renewal, infrastructure and basic services. A launch-year question is answered from the programme's inception, not a later project completion or extension date.

Step 1: Recall the programme and its launch JNNURM was launched on 3 December 2005. Its name links it to urban development rather than to an earlier general economic plan. The mission combined attention to urban infrastructure and governance with improvements in services for the urban poor. For this question the decisive information is its launch year; no calculation from its title or from a city's project dates is required.

Step 2: Match the year to the choices The listed year 2005 appears as option (C), so it is the correct match. The dates 1970 and 1975 belong to much earlier periods and are not the inception year of JNNURM. The date 2010 falls after the mission had already been launched and therefore cannot answer when it began. A programme may remain active across several years, and individual projects may be sanctioned or completed later, but those later events do not replace the launch date. Select the year attached to the mission itself, not the life span of one of its projects.

Step 3: Conclusion JNNURM was launched in 2005. Hence, the correct option is (C).

Quick Tip to Solve: Tie the full name JNNURM to its inception year, 2005, and avoid confusing later project dates with the mission launch.

81. Which of the following does not involve community participation ? [4 marks]

(A) Demarcation of dense forests

(B) Urban Basic Services for the poor

(C) Joint Forest Management

(D) Beej Bachao Andolan

Correct Answer: (A) Demarcation of dense forests

Solution:

Concept:

- Community participation means that the people affected by a programme help make decisions, organise activities, or manage local resources. Merely marking an administrative boundary does not necessarily involve such participation.
- The word **not** reverses the selection: identify the activity that is primarily an administrative or technical exercise, rather than a community-based programme.

Step 1: Classify the three participatory programmes Urban Basic Services for the poor involves the intended beneficiaries in identifying and addressing basic local needs. Joint Forest Management brings forest-dependent communities and the forest administration together in protection and management. Beej Bachao Andolan is a people-led movement associated with conserving traditional seeds and agricultural diversity. Therefore options (B), (C), and (D) all have an explicit community component.

Step 2: Identify the contrasting activity Demarcation of dense forests concerns identifying and marking the extent or boundary of a forest area. In the classification used here, it is a survey and administrative function. It is not itself a named scheme for people to organise, participate in service provision, or jointly manage resources. Community consultation may accompany a particular boundary exercise, but that possibility does not turn demarcation itself into one of the participatory programmes listed in the other choices.

Step 3: Conclusion Demarcation of dense forests is the activity that does not, by its stated nature, involve community participation. Hence, the correct option is (A).

Quick Tip to Solve: For a negative participation question, separate people-led or joint-management programmes from technical tasks such as surveying and boundary marking.

82. Out of Mohenjo-daro, Harappa, Lothal and Dholavira, which of the following cities were laid out on grid pattern ? [4 marks]

(A) Mohenjo-daro and Harappa

(B) Mohenjo-daro, Harappa and Dholavira

(C) Harappa and Lothal

(D) Mohenjo-daro, Harappa, Dholavira and Lothal

Correct Answer: (D) Mohenjo-daro, Harappa, Dholavira and Lothal

Solution:

Concept:

- A grid pattern is a network in which the principal streets intersect approximately at right angles, producing regular blocks. It describes the street layout and need not imply that every city has the same division into precincts.
- Mohenjo-daro and Harappa are major examples of planned Indus cities. Lothal and Dholavira also exhibit organised orthogonal street planning, despite differences in their size and internal divisions.

Step 1: Check all four settlements against the criterion Mohenjo-daro had a street network with major routes and intersecting smaller streets forming blocks. Harappa likewise had organised streets and planned urban areas. Lothal had a deliberately laid-out settlement with streets meeting at right angles; its association with maritime trade does not exclude grid planning. Dholavira had a strongly organised layout divided into distinct fortified areas, with an orthogonal street system. Division into separate precincts and the use of a street grid are compatible features, rather than mutually exclusive types of planning.

Step 2: Compare the complete set with the options Option (A) includes only Mohenjo-daro and Harappa and leaves out the planned street layouts at Lothal and Dholavira. Option (B) adds Dholavira but still omits Lothal. Option (C) includes Harappa and Lothal but omits Mohenjo-daro as well as Dholavira. Option (D) is the only list containing all four settlements. The supplied answer key selects (A), but that restriction is inconsistent with the stated criterion: Lothal and Dholavira also have grid or orthogonal street layouts. The answer follows that criterion rather than treating the two best-known examples as the only examples.

Step 3: Conclusion All four listed cities had organised grid or orthogonal street planning. Hence, the correct option is (D). The supplied key excludes Lothal and Dholavira despite their qualifying street layouts; that restriction is inconsistent with the criterion stated in the question.

Quick Tip to Solve: Apply the definition of a grid to every named settlement; differences in fortifications, precincts, or trading functions do not by themselves exclude a right-angled street plan.

83. What is the full form of IOT ? [4 marks]

(A) International Organisation for Trade

(B) Internet of Tweets

(C) Interest on Transactions

(D) Internet of Things

Correct Answer: (D) Internet of Things

Solution:

Concept:

- IoT expands to Internet of Things: a network of physical objects that have connectivity and can collect or exchange data.
- The word things refers to connected devices and objects, such as meters, sensors, appliances, or vehicles. The abbreviation is recognised by its established technical expansion.

Step 1: Match the abbreviation to the technical idea Read IoT as Internet of Things. A connected water meter, for example, can measure consumption and send readings to a monitoring system. A traffic sensor can communicate information about vehicle flow. In each example, a physical object is connected to a network and shares data. This is the feature represented by things in the full form; the phrase does not merely describe people communicating on social media.

Step 2: Eliminate the alternative expansions Option (A), International Organisation for Trade, names a proposed organisation rather than a network of devices. Option (B), Internet of Tweets, restricts the expression to a particular kind of online message and is not the technical expansion. Option (C), Interest on Transactions, is a financial phrase with no connection to connected objects. Only option (D) gives the standard expression and matches the examples of sensors, smart appliances, and other networked physical devices.

Step 3: Conclusion IOT stands for Internet of Things. Hence, the correct option is (D).

Quick Tip to Solve: Associate the T in IoT with physical things such as sensors and smart meters; this immediately separates it from social-media and finance distractors.

84. The Second United Nations Conference on 'Human Settlements Habitat II' was held in : [4 marks]

(A) Vancouver

(B) Kyoto

(C) Istanbul

(D) Quito

Correct Answer: (C) Istanbul

Solution:

Concept:

- Habitat II was the second United Nations Conference on Human Settlements. It was held in Istanbul, Turkey, in 1996.

- Conference numbering is essential: Habitat I, Habitat II, and Habitat III refer to different meetings, cities, and years.

Step 1: Recall the sequence of Habitat meetings The first United Nations Conference on Human Settlements, Habitat I, took place in Vancouver in 1976. The second meeting, Habitat II, took place in Istanbul in 1996. Habitat III was held in Quito in 2016. These conferences dealt with human settlements, housing, and urban development. Since the question explicitly asks for the second conference, the middle city of this sequence is required.

Step 2: Compare each city with its conference Vancouver in option (A) is associated with the first Habitat conference, so it is a plausible but incorrect choice. Istanbul in option (C) is the host of Habitat II and matches the question exactly. Quito in option (D) is associated with the third conference, so choosing it would confuse two successive editions. Kyoto in option (B) is not the host of Habitat II; the city is more commonly associated with the international climate protocol. The number II, rather than merely the broad United Nations connection, decides the answer.

Step 3: Conclusion The Second United Nations Conference on Human Settlements, Habitat II, was held in Istanbul. Hence, the correct option is (C).

Quick Tip to Solve: Remember the Habitat sequence as Vancouver–Istanbul–Quito, corresponding to I–II–III and 1976–1996–2016.

85. The first Sub-urban Railway line in India started its operation in : [4 marks]

(A) 1857

(B) 1984

(C) 1901

(D) 1837

Correct Answer: (A) 1857

Solution:

Concept:

- A suburban railway serves travel between a city and its surrounding settlements, particularly regular commuting. Its history must be distinguished from the dates of other railway milestones.
- The date associated with the first suburban railway operation in this question is 1857. The first passenger railway journey in India is a different milestone, conventionally dated to 1853.

Step 1: Identify the railway milestone being asked The wording specifies the first sub-urban railway line, rather than the first passenger train, the first electric train, or the first metro railway. These developments belong to different stages of the railway system. The relevant year among the given alternatives is 1857. Recognising the type of rail service is necessary before selecting a date; remembering a famous rail anniversary without checking the description can lead to a different event.

Step 2: Check the four supplied dates The year 1857 in option (A) matches the suburban-railway milestone asked for. The year 1984 in option (B) is much later and is associated with the beginning of metro operations in Kolkata, not the earliest suburban railway line. The year 1901 in option (C) is

also later than the nineteenth-century beginning of suburban services. The year 1837 in option (D) belongs to the very early history of railway experiments and freight-related development in India; it is not the suburban-service date requested here. Therefore none of these three alternatives replaces 1857 for this question.

Step 3: Conclusion The first suburban railway line in India started its operation in 1857. Hence, the correct option is (A).

Quick Tip to Solve: Underline the railway type before recalling a year: passenger rail, suburban rail, electric suburban rail, and metro rail have different starting dates.

86. Which of the following cities is not planned on a grid pattern ? [4 marks]

(A) Washington DC

(B) Amsterdam

(C) Barcelona

(D) New York

Correct Answer: (B) Amsterdam

Solution:

Concept:

- A grid street pattern consists mainly of intersecting streets arranged in an approximately rectilinear network. A city can retain a grid while also having diagonal avenues or irregular local exceptions.
- Amsterdam is especially associated with its concentric canal belts and connecting radial routes, whereas the other listed cities are standard examples of grid-based planning.

Step 1: Recognise the grid-based alternatives New York is well known for the rectilinear street-and-avenue grid of Manhattan. Barcelona is associated with the regular blocks of the Eixample plan, including their characteristic chamfered corners. Washington DC combines an orthogonal street grid with major diagonal avenues. The presence of diagonals in Washington does not eliminate its underlying grid, so it should not be selected merely because the pattern is not a completely uniform checkerboard.

Step 2: Identify the distinct organising pattern Amsterdam developed around waterways and is noted for a system of concentric canal belts linked by radial connections. This organising pattern differs from the regular orthogonal grid represented by the other three options. The question asks which city is not planned on a grid pattern in this standard comparison, rather than whether every street throughout a city conforms to one geometry. Consequently options (A), (C), and (D) are eliminated by their well-known grid structures, leaving Amsterdam in option (B).

Step 3: Conclusion Amsterdam is the city that is not planned on a grid pattern in this comparison. Hence, the correct option is (B).

Quick Tip to Solve: Use a city's characteristic organising pattern: Amsterdam suggests canal rings, while Manhattan and Barcelona's Eixample suggest rectangular grids.

87. The largest source of water pollution in India is due to : [4 marks]

(A) Small Scale Industries

(B) Agricultural Run-off

(C) Untreated Sewage

(D) Large Scale Industries

Correct Answer: (C) Untreated Sewage

Solution:

Concept:

- Untreated sewage is wastewater from households and settlements discharged without adequate treatment. It carries organic matter, pathogens, and nutrients into water bodies.
- Pollution sources include domestic wastewater, industrial effluents, and agricultural runoff. The question asks for the largest overall source in India, rather than the most toxic individual discharge.

Step 1: Identify the widespread source Large volumes of sewage are generated continuously wherever people live. When collection and treatment are inadequate, this wastewater reaches rivers, lakes, drains, and other receiving waters. Its organic matter is decomposed by microorganisms, which increases oxygen demand and can reduce dissolved oxygen available to aquatic life. Disease-causing organisms and nutrient loads add further water-quality problems. This broad and persistent domestic wastewater load makes untreated sewage the required answer.

Step 2: Distinguish the other pollution categories Small-scale industries in option (A) and large-scale industries in option (D) can both cause serious pollution, including toxic contamination, but the seriousness of a particular effluent does not make either category the largest overall source asked for here. Agricultural runoff in option (B) transports fertilisers, pesticides, and sediment and is an important diffuse source. Nevertheless, in the general Indian water-pollution comparison used in this question, untreated sewage in option (C) is the dominant source. The distinction is between overall contribution and the hazardousness of one pollutant.

Step 3: Conclusion The largest source of water pollution in India among these choices is untreated sewage. Hence, the correct option is (C).

Quick Tip to Solve: When a pollution question says largest source, compare the overall wastewater burden; do not substitute the most poisonous industrial contaminant.

88. What is indicated by a contour line on a topographical map ? [4 marks]

(A) Height

(B) Administrative Boundary

(C) Vegetation

(D) Water Body

Correct Answer: (A) Height

Solution:

Concept:

- A contour line joins points having the same elevation above a common reference level, usually mean sea level. It therefore represents height on a topographical map.
- The contour interval is the fixed vertical difference between successive contour values. Contour spacing also helps interpret slope, but a single contour is fundamentally a line of equal height.

Step 1: Apply the definition of a contour Imagine points on a hillside that all lie at the same elevation. Joining their map positions gives a contour line. A contour labelled 200, for example, represents points at the indicated elevation, in the map's stated units and reference system. Successive contours show how the land rises or falls. Closely spaced contours generally indicate a steeper slope, while more widely spaced contours indicate a gentler slope. Thus height is the primary quantity encoded by the line.

Step 2: Distinguish contours from other map symbols An administrative boundary in option (B) separates political or administrative areas and need not follow points of equal elevation. Vegetation in option (C) is usually represented through colours, patterns, or conventional symbols rather than contours. A water body in option (D) has its own map outline or symbol; although a shoreline may approximately follow a level, a contour line in general does not mean a water body. Option (A), Height, is the only choice that states the defining property shared by all points on a contour.

Step 3: Conclusion A contour line indicates height, by joining points of equal elevation. Hence, the correct option is (A).

Quick Tip to Solve: Remember contour as equal height: the numbers give elevation, while the spacing between contours helps you infer steepness.

89. The ratio that shows a relationship between the distance on a map and the actual distance on ground is known as : [4 marks]

(A) Direction

(B) Key map

(C) Scale

(D) Isotherm

Correct Answer: (C) Scale

Solution:

Concept:

- A map scale expresses the ratio of a distance measured on the map to the corresponding horizontal distance on the ground.
- Both distances must be expressed in the same unit before their ratio is evaluated; the ratio then has no unit.

Step 1: Identify the relationship described The question connects two measurements of the same separation: its reduced representation on a map and its actual size on the ground. This is a relationship of size, rather than a statement about the compass bearing or the meaning of a symbol. The term used for this size relationship is the scale of the map.

Step 2: Express the ratio and check the alternatives The representative fraction can be written as

$$\text{Scale} = \frac{\text{distance on the map}}{\text{corresponding distance on the ground}}.$$

For example, a scale of $1 : 50{,}000$ means that 1 cm on the map represents 50,000 cm, or 500 m, on the ground. Direction identifies a bearing such as north or south; it does not compare lengths. A key map helps locate a mapped area within a larger region. An isotherm joins locations with the same temperature. None of these three terms denotes the required distance ratio.

Step 3: Conclusion The distance ratio described is the map scale. Hence, the correct option is (C).

Quick Tip to Solve: When comparing map distance with ground distance, look for scale; convert both lengths to the same unit before calculating it.

90. Find the correct match :

(P)	**Dhanbad**	**(I)**	**Textile**
(Q)	**Kandla**	**(II)**	**Mining**
(R)	**Bokaro**	**(III)**	**Port**
(S)	**Surat**	**(IV)**	**Steel Industry**

[4 marks]

(A) (P)-(II), (Q)-(I), (R)-(III), (S)-(IV)

(B) (P)-(I), (Q)-(III), (R)-(II), (S)-(IV)

(C) (P)-(III), (Q)-(II), (R)-(IV), (S)-(I)

(D) (P)-(II), (Q)-(III), (R)-(IV), (S)-(I)

Correct Answer: (D) (P)-(II), (Q)-(III), (R)-(IV), (S)-(I)

Solution:

Concept:

- Matching a place to an economic activity requires its characteristic industrial or transport role.
- Each place must be linked separately before comparing the complete sequence with an option; one correct pair does not validate the whole option.

Step 1: Match the four places to their functions Dhanbad is associated with coal mining in the Jharia coalfield region, so P matches II, Mining. Kandla is a major port on the Gujarat coast, so Q matches III, Port. Bokaro is known for its steel plant and steel production, so R matches IV, Steel Industry. Surat is a major textile and fabric-processing centre, so S matches I, Textile.

Step 2: Compare every proposed sequence The required complete matching is

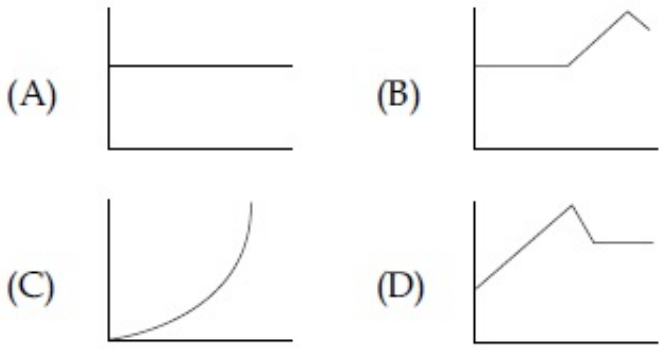
$$P-II, \qquad Q-III, \qquad R-IV, \qquad S-I.$$

Option (A) starts with Dhanbad correctly matched to mining, but then calls Kandla a textile centre, Bokaro a port and Surat a steel centre. Option (B) correctly associates Kandla with a port, but incorrectly assigns Dhanbad to textiles, Bokaro to mining and Surat to steel. Option (C) has the correct Bokaro and Surat pairs but reverses the roles of Dhanbad and Kandla. Only option (D) preserves all four independently established relationships.

Step 3: Conclusion Dhanbad–Mining, Kandla–Port, Bokaro–Steel Industry and Surat–Textile give P–II, Q–III, R–IV, S–I. Hence, the correct option is (D).

Quick Tip to Solve: Anchor the match with Kandla as a port and Bokaro as a steel centre, then check Dhanbad and Surat before choosing the full sequence.

91. Select the indicative graph that best fits the Statement : "Car prices rose steadily, dropped a little and are now holding steady". [4 marks]



(A) (A)

(B) (B)

(C) (D)

(D) Both (C) and (D)

Correct Answer: (C) (D)

Solution:

Concept:

- An indicative time-series graph represents the order of changes rather than exact numerical prices. Read time from left to right and price vertically upward.
- A rising segment means that the price increases, a falling segment means that it decreases, and a horizontal segment means that the price remains constant over that interval.

Step 1: Translate the statement into three successive trends The words "rose steadily" require an initial upward-sloping segment: later prices are consistently higher than earlier ones. The next phrase, "dropped a little", requires a downward movement after that rise. Finally, "are now holding steady" requires a horizontal final segment, because the most recent prices do not change with time. The required sequence is therefore rise, small fall, then a plateau. A graph that satisfies only the first phrase is insufficient; all three changes must occur in the stated order.

Step 2: Compare each labelled graph with the complete sequence Graph (A) is horizontal throughout, so it describes a price that was constant from the beginning and misses both the rise and the drop. Graph (B) begins with a horizontal interval, then rises and ends with a falling segment; it has no final horizontal plateau, so it does not show prices now holding steady. Graph (C) rises throughout with an increasing slope. It shows neither a drop nor a constant final price, and therefore cannot be included in the answer. Graph (D) first rises, then falls over a short segment and finally becomes horizontal. These three successive segments match the statement in full.

Step 3: Match the graph label to the answer-option label The matching figure is graph (D). In the answer list, the third option, labelled (C), contains the graph reference "(D)". The fourth option says "Both (C) and (D)", but that would also include the continuously rising graph (C), which fails the statement. Thus the correct response is the third answer option rather than the fourth, even though

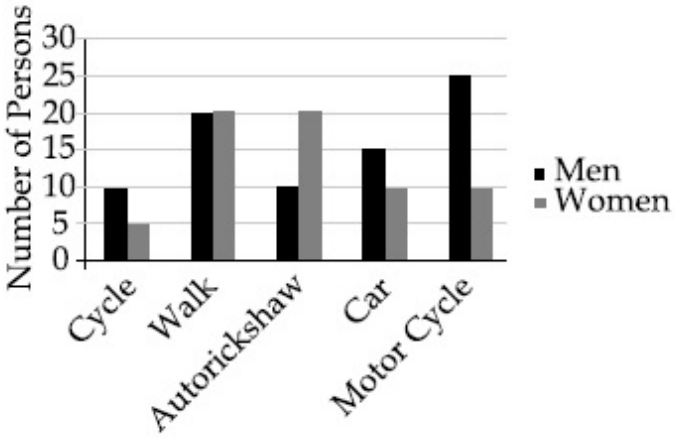
the selected graph itself is labelled (D).

Step 4: Conclusion The graph showing an initial rise, a small drop and a final horizontal segment is listed in the third answer option. Hence, the correct option is (C).

Quick Tip to Solve: Convert each time phrase into a slope sign, in order: positive, negative, then zero. After finding the graph, check its reference against the separate answer-option letters.

92. The diagram above shows the number of men and women using different modes of transport to commute to their work place.

Which of these statements is the correct answer ? [4 marks]



(A) 50% of all those who cycle to their work places are women

(B) More men compared to women use auto-rickshaw for commuting to work place

(C) More women compared to men cycle to their work place

(D) The highest share of persons walk to their work place

Correct Answer: (D) The highest share of persons walk to their work place

Solution:

Concept:

- In a grouped bar chart, the legend identifies each group and the vertical scale gives the corresponding number of persons.
- The total for a mode of transport is the sum of its men and women bars. A claim about the largest overall share must compare these totals.

Step 1: Read the chart using the legend The black bars represent men and the grey bars represent women. The pairs of values, in the order men and women, are: cycle (10, 5), walk (20, 20), autorickshaw (10, 20), car (15, 10), and motorcycle (25, 10). The scale advances in increments of five persons, so the bar heights can be read directly without interpolation.

Step 2: Test the statements against the totals For cycling there are $10 + 5 = 15$ persons, of whom $5/15 = 1/3$, or about 33.3%, are women; this rules out (A). Autorickshaws have 10 men and 20

women, so (B) reverses the actual comparison. Cycling has 10 men and 5 women, so (C) also reverses the comparison. For the overall mode shares, add the two bars:

$$\begin{aligned} \text{Cycle} = 15, \quad \text{Walk} &= 40, \\ \text{Autorickshaw} = 30, \quad \text{Car} &= 25, \\ \text{Motorcycle} = 35. & \end{aligned}$$

Walking has the largest combined count, 40. The tallest individual bar belongs to male motorcycle users, but that is not the largest combined total.

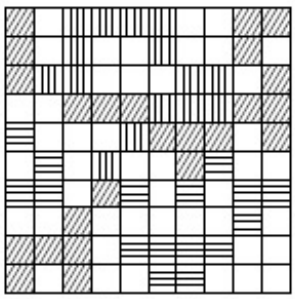
Step 3: Conclusion The highest share of persons walk to their work place. Hence, the correct option is (D).

Quick Tip to Solve: For a statement about all persons in a grouped chart, add the men and women bars first; the tallest single bar can be misleading.

93. One site is divided into 10×10 units as shown in the figure. It has following classification of land area.

Which of the following classification has the highest amount of land ? [4 marks]

(A) Waste land
(B) Forest land
(C) Agriculture land
(D) Unused land



(A) Waste land
(B) Forest land
(C) Agriculture land
(D) Unused land

Correct Answer: (D) Unused land

Solution:

Concept:

- All 100 cells of the 10 by 10 grid have equal area, so a category covering more cells occupies more land.
- The legend identifies waste land by horizontal hatching, forest by vertical hatching, agriculture by diagonal hatching, and unused land by blank cell interiors.

Step 1: Count unused cells row by row Use the outer grid lines only as cell boundaries: a blank cell still has a boundary, so it must not be mistaken for horizontal hatching. Number the rows from the top. The numbers of blank cells in these ten rows are

$$3,\ 6,\ 4,\ 2,\ 4,\ 6,\ 2,\ 8,\ 3,\ 7.$$

Their total is

$$3 + 6 + 4 + 2 + 4 + 6 + 2 + 8 + 3 + 7 = 45.$$

Thus unused land occupies 45 of the 100 equal cells, or 45 percent of the site.

Step 2: Check the other patterns and compare areas Counting by the three remaining patterns gives 24 diagonally hatched agriculture cells, 16 horizontally hatched waste-land cells, and 15 vertically hatched forest cells. The complete check is

$$45 + 24 + 16 + 15 = 100,$$

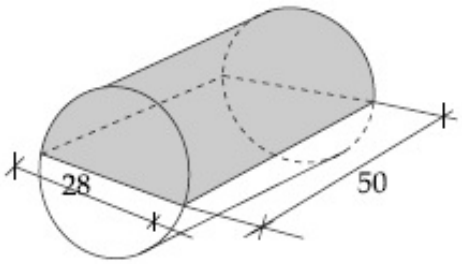
which accounts for the full grid without omissions or double counting. The largest count is 45, for unused land. Waste land therefore cannot be (A), since its count is 16; forest cannot be (B), since its count is 15; and agriculture cannot be (C), since its count is 24. The visual darkness of a hatched patch has no bearing on its area. Counting cell interiors provides a consistent comparison even though the categories occur in several disconnected patches.

Step 3: Conclusion Unused land occupies 45 cells, more than agriculture (24), waste land (16) or forest (15). Hence, the correct option is (D).

Quick Tip to Solve: Count the unhatched cell interiors as well as the patterned ones; ordinary grid boundary lines do not make a blank cell waste land.

94. In the given figure the volume of the shaded portion is :

[4 marks]



(A) 46,200

(B) 30,800

(C) 15,400

(D) 7,700

Correct Answer: (C) 15,400

Solution:

Concept:

- A cylinder of radius r and length h has volume $V = \pi r^2 h$. The radius is half of the diameter.
- A plane through the axis divides a circular cylinder into two equal semicylindrical volumes; the shaded half therefore has half the cylinder volume.

Step 1: Identify the solid and its dimensions The drawing shows a circular cylinder cut lengthwise through its axis. The shaded portion is one half of the cylinder. The marked 28 is the full diameter of the circular end, not its radius, and the length along the cylinder is 50. Thus

$$r = \frac{28}{2} = 14, \qquad h = 50.$$

The volume is measured in cubic units corresponding to the length units in the figure.

Step 2: Calculate the shaded volume and eliminate the distractors Use the area of a semicircular end multiplied by the cylinder length:

$$\begin{aligned} V_{\text{shaded}} &= \frac{1}{2}\pi r^2 h \\ &= \frac{1}{2} \times \frac{22}{7} \times 14^2 \times 50 \\ &= \frac{1}{2} \times 616 \times 50 \\ &= 15{,}400. \end{aligned}$$

The uncut full cylinder would have volume 30,800, so option (B) counts both halves rather than only the shaded portion. Option (D), 7,700, halves the required volume once again and corresponds to a quarter of the full cylinder. Option (A), 46,200, exceeds even the full cylinder volume and cannot represent a portion inside it. Only option (C) equals the semicylindrical volume.

Step 3: Conclusion The shaded volume is $15{,}400$ cubic units. Hence, the correct option is (C).

Quick Tip to Solve: Check whether the marked circular length is a diameter before squaring it, and apply the half-cylinder factor only once.

95. Following table gives the number of families according to family size. What is the average family size ? (Rounded off to one decimal)

S.No.	Family size (persons)	No. of families
1.	3	300
2.	4	200
3.	5	400
4.	6	400

[4 marks]

(A) 4.5

(B) 4.7

(C) 4.9

(D) 5.0

Correct Answer: (B) 4.7

Solution:

Concept:

- Average family size is the total number of persons divided by the total number of families.
- The number of families is the frequency of each size, so the required mean is $\bar{x} = \sum f_i x_i / \sum f_i$, not the unweighted average of the listed sizes.

Step 1: Compute the number of persons in each group There are 300 families of size 3, 200 of size 4, 400 of size 5 and 400 of size 6. Multiply size by frequency for each row:

$$3(300) = 900,$$
$$4(200) = 800,$$
$$5(400) = 2{,}000,$$
$$6(400) = 2{,}400.$$

These products count persons, whereas the original frequencies count families. Their distinction is essential because the requested unit is persons per family.

Step 2: Divide by the number of families and round once The totals are

$$\sum f_i = 300 + 200 + 400 + 400 = 1{,}300,$$

$$\sum f_i x_i = 900 + 800 + 2{,}000 + 2{,}400 = 6{,}100.$$

Therefore

$$\bar{x} = \frac{6{,}100}{1{,}300} = \frac{61}{13} = 4.692307\ldots$$

Rounding to one decimal gives 4.7. The value 4.5 in option (A) is the simple average of 3, 4, 5 and 6, which wrongly gives each category equal weight. Options (C) and (D), 4.9 and 5.0, do not equal the frequency-weighted calculation. Keep the full quotient until the final rounding so that intermediate approximations do not change the required decimal.

Step 3: Conclusion The average family size, rounded to one decimal, is 4.7 persons per family. Hence, the correct option is (B).

Quick Tip to Solve: In a size-frequency table, calculate total persons and total families separately; divide these totals and round only at the end.

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96. Read the given passage and answer the question.

The United Nations (UN) has warned that the global consumption of natural resources could triple to 140 billion tons a year by 2050 unless consumer nations take drastic steps. The UN environment panel called on governments to 'decouple' economic growth from the rapid rate of natural resource consumption. It said the world is already running out of some essential materials including oil, copper and gold, which in turn, will need rising volumes of fuel and water. Decoupling involves transition to a low-carbon, resource efficient green economy that stimulates growth in a way to keep humanity's footprint within planetary.

The term 'decoupling' here would entail : [4 marks]

(A) Birth control measures to reduce resource consumption

(B) Production of cheap materials

(C) Talk less and work more

(D) Promoting growth that stresses on reducing the rate of consumption of natural resources

Correct Answer: (D) Promoting growth that stresses on reducing the rate of consumption of natural resources

Solution:

Concept:

- The meaning of a technical term in a passage must be inferred from its immediate explanation and the relationship described by the author.
- Here decoupling concerns economic growth and the rate of natural-resource consumption: growth should continue while resource use becomes more efficient.

Step 1: Locate the passage explanation The passage calls on governments to decouple economic growth from the rapid rate of natural-resource consumption. It then explains the intended transition as a low-carbon, resource-efficient green economy that stimulates growth while keeping the human footprint within planetary limits. These two statements define the relevant relationship. The central aim is to reduce the resource pressure associated with growth, rather than to stop economic activity altogether.

Step 2: Compare all alternatives with that definition Option (D) directly connects continued growth with reducing the rate of natural-resource consumption, which is exactly the relationship described. Option (A) proposes birth control; although population can affect total demand, the passage does not define decoupling as a population-control policy. Option (B) concerns cheap materials, but low price alone does not establish resource efficiency and is not the stated objective. Option (C), talk less and work more, is a general slogan with no connection to the separation between economic output and resource consumption. Therefore these alternatives either introduce an unstated policy or miss the two quantities being decoupled. The passage supports an economy that produces growth with less pressure on finite resources.

Step 3: Conclusion Decoupling entails promoting growth while reducing the rate of consumption of natural resources. Hence, the correct option is (D).

Quick Tip to Solve: For a passage-defined term, identify the two quantities connected in its explanation and select the option that preserves that relationship.

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97. Read the given passage and answer the question.

The United Nations (UN) has warned that the global consumption of natural resources could triple to 140 billion tons a year by 2050 unless consumer nations take drastic steps. The UN environment panel called on governments to 'decouple' economic growth from the rapid rate of natural resource consumption. It said the world is already running out of some essential materials including oil, copper and gold, which in turn, will need rising volumes of fuel and water. Decoupling involves transition to a low-carbon, resource efficient green economy that stimulates growth in a way to keep humanity's footprint within planetary.

Identify the correct statement : [4 marks]

(A) 140 billion tons of natural resources will be consumed till the end of 2050

(B) Green economy refers to an economy that is based on forest resources

(C) Green economy refers to an economy that produces at lower carbon footprint and is resource efficient

(D) The UN has asked governments to reduce their economic growth

Correct Answer: (C) Green economy refers to an economy that produces at lower carbon footprint and is resource efficient

Solution:

Concept:

- A reading-comprehension answer must preserve the meaning of the passage, including conditions, units of time and the purpose of the proposed policy.
- The passage defines the green economy through two linked features: low carbon emissions and efficient use of natural resources. Decoupling means reducing resource use relative to economic growth.

Step 1: Identify the stated definition The final sentence explicitly links the transition to a green economy with a low-carbon, resource-efficient pattern of growth. Its purpose is to keep the environmental footprint within planetary limits while allowing growth. Option (C) restates these two

defining features without adding a new claim. The passage discusses natural resources generally, not only forests.

Step 2: Test the remaining statements against the passage Option (A) changes an annual rate into a cumulative quantity: the warning is about 140 billion tons a year by 2050, not a total consumed up to that date. It also turns a conditional warning, qualified by the need for drastic steps, into a certainty. Option (B) wrongly restricts a green economy to forest resources. Option (D) confuses decoupling growth from rapid resource consumption with reducing growth itself; the passage instead says the transition should stimulate growth.

Step 3: Conclusion A green economy produces with a lower carbon footprint and uses resources efficiently. Hence, the correct option is (C).

Quick Tip to Solve: Match the option to the passage's actual definition. Check especially whether an annual rate has been changed into a total or a conditional prediction into a certainty.

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98. Statement : The citizens of Narbhada city are facing water shortage.

Given are the two courses of action available to the Municipal corporation.

(I) The Municipal Corporation of Narbhada should immediately take action to prevent all water leakages and theft.

(II) The Municipal Corporation of Narbhada should cut the water supply to its residents by half.

Which of the following options is most appropriate ? [4 marks]

(A) only (I)

(B) only (II)

(C) both (I) and (II)

(D) neither (I) nor (II)

Correct Answer: (A) only (I)

Solution:

Concept:

- A suitable course of action should directly address the stated problem, be feasible for the responsible authority and avoid imposing an unsupported additional hardship.
- Water lost through leakage or theft reduces the quantity available for legitimate use. Preventing those losses conserves the existing supply rather than simply reducing access to it.

Step 1: Evaluate action (I) The stated problem is a shortage of water faced by residents. Preventing leakages and theft tackles avoidable losses in the municipal distribution system. This allows more of the available water to reach authorised users and is within the municipal corporation's responsibilities. It is therefore a direct and appropriate immediate response. The action does not depend on assuming a new source of water or denying essential needs.

Step 2: Evaluate action (II) and compare the choices An automatic reduction of every resident's supply by half has no supporting assessment in the statement. There is no information that half the current supply would meet essential needs, or that such a cut would be proportionate. It could worsen

the hardship already described. Emergency rationing may require evidence in a real situation, but that evidence is not supplied here. Thus action (II), as an unconditional proposal, does not follow. Option (B) accepts only this unsupported cut; option (C) also accepts it, while option (D) incorrectly rejects the useful conservation measure.

Step 3: Conclusion Only action (I), preventing water leakages and theft, is an appropriate course of action on the information given. Hence, the correct option is (A).

Quick Tip to Solve: For a course-of-action question, prefer a measure that removes an identified cause of loss. Do not assume an arbitrary restriction is justified merely because a shortage exists.

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99. In a survey taken for household income in an area, mean annual income of the households came to be Rs 10.0 lakh and the median income was Rs 4.0 lakh per annum. Which of the following statement will explain the difference between mean and median income of the households ? [4 marks]

(A) more than 50% of the households have income around 10.0 lakh

(B) more than 50% of the households have income much higher than 10.0 lakh

(C) few households have income much higher than 10.0 lakh

(D) most of the households have income between 4.0 lakh to 10.0 lakh

Correct Answer: (C) few households have income much higher than 10.0 lakh

Solution:

Concept:

- The arithmetic mean is total income divided by the number of households: $\bar{x} = \frac{\sum x_i}{n}$. Every income enters the total, so very large observations can raise it sharply.
- The median is the middle income after the households are arranged in order. It is less sensitive to the magnitudes of a few unusually high incomes.

Step 1: Interpret the difference between the two averages The mean of Rs 10.0 lakh is much greater than the median of Rs 4.0 lakh. This is consistent with a distribution having a long upper tail: a relatively small number of high-income households contribute a large share of total income. They raise the arithmetic average without moving the central household income by a comparable amount. Thus option (C) supplies the natural explanation. The figures describe a typical skewed income distribution rather than requiring most households to earn the mean.

Step 2: Eliminate the other explanations If more than 50% earned much more than Rs 10.0 lakh, the median would also be above Rs 10.0 lakh, contradicting the stated Rs 4.0 lakh; hence (B) fails. A majority concentrated around Rs 10.0 lakh would ordinarily put the median near that level, so (A) does not explain the large gap. Option (D), placing most households between Rs 4.0 lakh and Rs 10.0 lakh, does not identify the unusually large upper incomes needed to explain the elevated mean. The relevant distinction is sensitivity to extreme observations, which (C) captures directly.

Step 3: Conclusion A few households with incomes much higher than Rs 10.0 lakh can raise the mean well above the median. Hence, the correct option is (C).

Quick Tip to Solve: When mean income greatly exceeds median income, look for a small high-income upper tail. The mean responds to income magnitudes; the median mainly responds to their ordered positions.

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100. Statement I :

Sustainable development means development that takes place without causing damage to the environment.

Statement II :

Sustainable development means development that meets the needs of the present without compromising the needs of the future generation.

Which of these is correct ? [4 marks]

(A) Statement (I) only

(B) Statement (II) only

(C) Both statements (I) and (II)

(D) Neither statement (I) nor (II)

Correct Answer: (C) Both statements (I) and (II)

Solution:

Concept:

- Sustainable development combines environmental protection with the long-term ability of society to meet human needs. Present benefits must not be obtained by exhausting the basis of future well-being.
- The standard intergenerational definition is development that meets present needs without compromising the ability of future generations to meet their needs.

Step 1: Assess Statement I Statement I expresses the environmental-protection aspect of sustainable development: development should take place without damaging the environment. In the general educational sense used in this question, it rules out a pattern of development that degrades ecosystems and destroys the resources on which human life depends. It is a valid description of the environmental objective, though it is shorter and less comprehensive than the full intergenerational definition. It should not be read as a separate claim that sustainable activity can never have any physical environmental effect.

Step 2: Assess Statement II and select the combined verdict Statement II gives the familiar needs-based definition and explicitly includes future generations. It requires present development to preserve the capacity of future people to satisfy their needs, linking current welfare with resource conservation and environmental stewardship. This agrees with the environmental concern expressed in Statement I rather than contradicting it. Therefore both statements are correct in the intended sense. Option (A) would wrongly reject the standard definition; option (B) would wrongly reject the environmental objective; option (D) would reject both valid aspects.

Step 3: Conclusion Both Statement I and Statement II correctly describe sustainable development, with Statement II giving its fuller intergenerational definition. Hence, the correct option is (C).

Quick Tip to Solve: Recognise the standard definition by its balance between present needs and future generations. A compatible statement about protecting the environment can also be correct even if it is less complete.