JEE Main 2017 Paper 2 (B.Arch/B.Plan) Apr 2 Single sitting (Offline) Question Paper with Solutions PDF

Question Paper with Solutions

Conducted by the Central Board of Secondary Education (CBSE)

Time Allowed: 3 Hours **Maximum Marks: 390**

General Instructions

(i) This paper is Paper 2 (B.Arch/B.Plan.) of JEE (Main) 2017, Annual (offline), conducted by the Central Board of Secondary Education (CBSE) in pen and paper mode on 2 April 2017, Single sitting. The total duration is 3 hours.

(ii) The paper has 82 questions: Mathematics (30), Aptitude Test (50), Drawing Test (2), in that order. Maximum marks: 390.

(iii) Each multiple choice question (MCQ) has four options, of which only one is correct.

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

(v) The Drawing Test questions are answered on the drawing sheet; marks for each are indicated against it.

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

Mathematics (120 marks)

1. If A and B be two finite sets such that the total number of subsets of A is 960 more than the total number of subsets of B, then $n(A) - n(B)$ (where $n(X)$ denotes the number of elements in set X) is equal to : [4 marks]

(A) 2

(B) 3

(C) 4

(D) 6

Correct Answer: (C) 4

Solution:

Concept:

- A set containing k elements has 2^k subsets, including the empty set and the set itself.
- Every positive integer is uniquely a power of two times an odd integer. This separates the smaller cardinality from the difference of cardinalities.

Step 1: Express the subset counts using cardinalities Write $m = n(A)$, $n = n(B)$. The stated excess is positive, so $m > n$. Therefore

$$2^m - 2^n = 960.$$

Put $d = m - n$, where d is a positive integer. Factoring the smaller power gives

$$2^n(2^d - 1) = 960.$$

This uses counts of subsets, rather than incorrectly treating 960 as a difference between numbers of elements.

Step 2: Separate the power of two and the odd factor Since $d \geq 1$, the integer $2^d - 1$ is odd. On the other hand,

$$960 = 64 \times 15 = 2^6 \times 15.$$

Unique factorisation now forces $2^n = 2^6$ and $2^d - 1 = 15$. Consequently $n = 6$, $2^d = 16$, and $d = 4$. In particular $m = 10$. Checking the original statement gives $2^{10} - 2^6 = 1024 - 64 = 960$. The alternatives $d = 2, 3, 6$ would require the odd factors 3, 7, 63 respectively, whereas the required odd factor is 15; thus none can satisfy the same equation with an integral smaller cardinality.

Step 3: Conclusion Thus the difference between the two cardinalities is 4. Hence, the correct option is (C).

Quick Tip to Solve: Factor out the smaller power of two; the remaining factor is odd, so the exponent of two in the given difference immediately identifies the smaller set size.

2. If λ_1 and λ_2 are the two values of λ such that the roots α and β of the quadratic equation, $\lambda(x^2 - x) + x + 5 = 0$ satisfy $\frac{\alpha}{\beta} + \frac{\beta}{\alpha} + \frac{4}{5} = 0$, then $\frac{\lambda_1}{\lambda_2^2} + \frac{\lambda_2}{\lambda_1^2}$ is equal to : [4 marks]

(A) 536

(B) 512

(C) 504

(D) 488

Correct Answer: (D) 488

Solution:

Concept:

- For $ax^2 + bx + c = 0$, the sum and product of roots are $-b/a$ and c/a, provided $a \neq 0$.
- Use $u^3 + v^3 = (u + v)^3 - 3uv(u + v)$ to evaluate a symmetric cubic expression without calculating either root individually.

Step 1: Convert the condition on roots into an equation for the parameter The equation is $\lambda x^2 + (1 - \lambda)x + 5 = 0$. Since it is quadratic, $\lambda \neq 0$; its root product $5/\lambda$ is also nonzero, so the displayed root ratios are defined. Vieta gives

$$\alpha + \beta = \frac{\lambda - 1}{\lambda}, \qquad \alpha\beta = \frac{5}{\lambda}.$$

Thus

$$\frac{\alpha}{\beta} + \frac{\beta}{\alpha} = \frac{(\alpha + \beta)^2 - 2\alpha\beta}{\alpha\beta} = \frac{(\lambda - 1)^2}{5\lambda} - 2.$$

Equating this to $-4/5$ gives $(\lambda - 1)^2 = 6\lambda$, hence $\lambda^2 - 8\lambda + 1 = 0$.

Step 2: Use the sum and product of the two parameter values The two values λ_1, λ_2 therefore have sum 8 and product 1. Both are nonzero, as required by the original equation. Combining the fractions over a common denominator yields

$$\frac{\lambda_1}{\lambda_2^2} + \frac{\lambda_2}{\lambda_1^2} = \frac{\lambda_1^3 + \lambda_2^3}{(\lambda_1\lambda_2)^2}$$
$$= 8^3 - 3(1)(8) = 512 - 24 = 488.$$

In particular 512, option (B), omits the mixed-product correction in the sum-of-cubes identity. Options (A) and (C), 536 and 504, also disagree with the exact symmetric evaluation; finding decimal approximations to the parameter values is unnecessary.

Step 3: Conclusion The required value is 488. Hence, the correct option is (D).

Quick Tip to Solve: First find the equation satisfied by the parameter; then use its root sum and product to simplify a symmetric expression.

3. If $(x+iy)^2 = 7+24i$, then a value of $\left(7+\sqrt{-576}\right)^{\frac{1}{2}} - \left(7-\sqrt{-576}\right)^{\frac{1}{2}}$ is : [4 marks]

(A) $-3i$

(B) $2i$

(C) 6

(D) $-6i$

Correct Answer: (D) $-6i$

Solution:

Concept:

- For real x, y, $(x+iy)^2 = x^2 - y^2 + 2xyi$; compare real and imaginary parts to find a complex square root.
- A nonzero complex number has two square roots, opposite in sign. The wording a value allows a value obtained from those square-root choices.

Step 1: Find the square roots from real and imaginary parts Comparing $(x+iy)^2 = 7+24i$ gives $x^2 - y^2 = 7$ and $2xy = 24$. Also

$$(x^2+y^2)^2 = 7^2 + 24^2 = 625.$$

Since $x^2 + y^2 \geq 0$, it equals 25. Adding and subtracting yields $x^2 = 16$ and $y^2 = 9$. The condition $xy = 12 > 0$ requires matching signs, so the two square roots of $7+24i$ are $4+3i$ and $-4-3i$. Similarly, the roots of its conjugate $7-24i$ are $4-3i$ and $-4+3i$.

Step 2: Choose the roots and compare the proposed values Take $\sqrt{-576} = 24i$. A permitted choice for the two outer square roots is $-4-3i$ and $-4+3i$, giving

$$(-4-3i) - (-4+3i) = -6i.$$

Both choices check on squaring: $(-4-3i)^2 = 7+24i$ and $(-4+3i)^2 = 7-24i$. The possible differences from the two root pairs are $6i, -6i, 8, -8$; choosing the other sign for the inner square root merely interchanges the conjugates and gives the same set. Thus $-3i$, $2i$, and 6 are not possible differences. If all outer square roots were required to be principal, the difference would instead be $6i$; the question asks for a value, so the listed attainable value is selected.

Step 3: Conclusion One value of the expression is $-6i$. Hence, the correct option is (D).

Quick Tip to Solve: When a complex radical asks for a value, retain both opposite square roots and test the candidate by squaring before subtracting.

4. Let S be the set of all real values of 'a' for which the following system of linear equations

$$ax + 2y + 5z = 1$$

$$2x + y + 3z = 1$$

$$3y + 7z = 1$$

is consistent. Then the set S is : [4 marks]

(A) equal to $\mathbf{R}$

(B) equal to $\mathbf{R} - \{1\}$

(C) equal to $\{1\}$

(D) an empty set

Correct Answer: (A) equal to $\mathbf{R}$

Solution:

Concept:

- A linear system is consistent if it has at least one solution. A single explicit solution valid for every parameter proves consistency for the entire parameter set.
- A zero determinant means the unique-solution test is inconclusive: the system may still have infinitely many solutions rather than no solution.

Step 1: Find a solution independent of the parameter The parameter a occurs only as the coefficient of x in the first equation. Try $x = 0$, which removes that dependence. The second and third equations become

$$y + 3z = 1, \qquad 3y + 7z = 1.$$

Multiply the first by 3 and subtract the second to obtain $2z = 2$. Thus $z = 1$, and then $y = 1 - 3 = -2$. Substitute into the first original equation:

$$a(0) + 2(-2) + 5(1) = 1.$$

It holds for every real a. The second original left side is $-2 + 3 = 1$, and the third is $-6 + 7 = 1$, confirming the whole system.

Step 2: Check the special parameter without excluding it For additional confirmation, twice the first equation minus the second and third gives

$$2(a - 1)x = 0.$$

If $a \neq 1$, this forces $x = 0$ and gives the solution already found. If $a = 1$, the first equation is exactly half the sum of the other two: their left sides sum to $2x + 4y + 10z$, and their right sides sum to 2. There is therefore no contradictory equation at the exceptional parameter either. A zero determinant there must not be mistaken for inconsistency. Option (B) wrongly excludes $a = 1$; option

(C) wrongly excludes every other value, and option (D) contradicts the explicit solution valid for all real parameters.

Step 3: Conclusion The system is consistent for every real a, so $S = \mathbf{R}$. Hence, the correct option is (A).

Quick Tip to Solve: Before classifying determinants, look for a fixed solution that sets the parameter-bearing variable to zero; it can prove consistency for every parameter at once.

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5. For all real numbers x, y and z, the determinant

$$\begin{vmatrix} 2x & xy - xz & y \\ 2x + z + 1 & xy - xz + yz - z^2 & 1 + y \\ 3x + 1 & 2xy - 2xz & 1 + y \end{vmatrix}$$ **is equal to :** [4 marks]

(A) zero

(B) $(x - y)(y - z)(z - x)$

(C) $(x - yz)(y - z)$

(D) $(y - xz)(z - x)$

Correct Answer: (B) $(x - y)(y - z)(z - x)$

Solution:

Concept:

- A common factor in every entry of one column may be taken outside a determinant.
- Replacing a row by itself minus another row leaves the determinant unchanged. A row with a zero entry can make cofactor expansion short.

Step 1: Factor the middle column and simplify rows Every entry of the middle column contains $y - z$, because $xy - xz = x(y - z)$ and $xy - xz + yz - z^2 = (x + z)(y - z)$. Therefore the determinant D is

$$D = (y - z)\begin{vmatrix} 2x & x & y \\ 2x + z + 1 & x + z & 1 + y \\ 3x + 1 & 2x & 1 + y \end{vmatrix}.$$

Apply $R_2 \leftarrow R_2 - R_1$ and $R_3 \leftarrow R_3 - R_1$, then $R_3 \leftarrow R_3 - R_2$. These additions do not change the determinant. The resulting rows are $(2x, x, y)$, $(z + 1, z, 1)$, and $(x - z, x - z, 0)$.

Step 2: Expand the simplified determinant and identify the factors Take $x - z$ out of the last row and expand along that row, keeping the opposite signs of its first two cofactors:

$$\begin{aligned} D &= (y - z)(x - z)\left[(x - yz) - \{2x - y(z + 1)\}\right] \\ &= (y - z)(x - z)(y - x) \\ &= (x - y)(y - z)(z - x). \end{aligned}$$

The last equality changes the signs of both $x - z$ and $y - x$, so their product keeps its sign. The derivation uses no division by $x - z$ or $y - z$, and remains valid when those factors vanish. The determinant is not identically zero: at $(x, y, z) = (1, 2, 0)$ it is 2. At the same values options (C) and

(D) give 2 and -2, so that one check alone cannot reject (C); the full factorisation does, and for example $(2, 3, 1)$ gives 2 rather than the -2 predicted by (C).

Step 3: Conclusion The determinant equals $(x-y)(y-z)(z-x)$. Hence, the correct option is (B).

Quick Tip to Solve: First expose common factors hidden in polynomial entries; then subtract rows before expanding a three-by-three determinant.

6. An urn contains 5 red, 4 black and 3 white marbles. Then the number of ways in which 4 marbles can be drawn from it so that at most 3 of them are red, is : [4 marks]

(A) 455

(B) 460

(C) 490

(D) 495

Correct Answer: (C) 490

Solution:

Concept:

- Choosing r objects from n distinct available objects without regard to order gives $\binom{n}{r}$ selections.
- The complement of at most three red marbles in a selection of four is all four are red. Counting this complement avoids several separate cases.

Step 1: Count all unrestricted selections There are $5+4+3=12$ marbles in total. A draw of four is an unordered selection, so each group is counted once by

$$\binom{12}{4} = \frac{12 \cdot 11 \cdot 10 \cdot 9}{4 \cdot 3 \cdot 2 \cdot 1} = 495.$$

The black and white marbles are included among these twelve. As usual for this type of selection problem, individual physical marbles are distinct, even when they have the same colour; we count choices of marbles rather than merely patterns of colours.

Step 2: Subtract exactly the forbidden selections The allowed red counts are 0, 1, 2 and 3. Since exactly four marbles are selected, a forbidden group must contain four red marbles and no other marble. The number of such groups is

$$\binom{5}{4} = 5.$$

Hence the desired count is $495 - 5 = 490$. No groups with three red marbles should be removed: at most three explicitly includes them. A direct check using the seven non-red marbles is

$$\begin{aligned}\binom{5}{0}\binom{7}{4} + \binom{5}{1}\binom{7}{3} + \binom{5}{2}\binom{7}{2} + \binom{5}{3}\binom{7}{1} &= 35 + 175 + 210 + 70 \\ &= 490.\end{aligned}$$

Option (D), 495, includes the five forbidden all-red groups. Options (A) and (B), 455 and 460, remove

too many allowed selections and disagree with both the complement calculation and the case-by-case check.

Step 3: Conclusion The required number of ways is 490. Hence, the correct option is (C).

Quick Tip to Solve: For at most three red in a draw of four, subtract the all-red selections from all selections instead of adding four separate red-count cases.

7. If the digits at ten's and hundred's places in $(11)^{2016}$ are x and y respectively, then the ordered pair (x, y) is equal to : [4 marks]

(A) $(1, 6)$

(B) $(6, 1)$

(C) $(8, 1)$

(D) $(1, 8)$

Correct Answer: (B) $(6, 1)$

Solution:

Concept:

- The last three decimal digits of an integer are its remainder modulo 1000; these determine its units, tens and hundreds digits.
- Use the binomial theorem on $11^{2016} = (1 + 10)^{2016}$. Every term containing 10^j, with $j \geq 3$, is divisible by 1000.

Step 1: Retain only the terms affecting the last three digits The binomial expansion gives

$$11^{2016} = 1 + 2016(10) + \binom{2016}{2}10^2 + \sum_{j=3}^{2016}\binom{2016}{j}10^j.$$

The sum on the right contributes only multiples of 1000, so it cannot change the requested digits. Notice that the quadratic term must be checked before it is discarded; divisibility by 100 alone would not be enough.

Step 2: Compute the remainder and read the two places Evaluate the remaining coefficient:

$$\binom{2016}{2} = \frac{2016 \cdot 2015}{2} = 2,031,120.$$

This coefficient is divisible by 10, making its product with 100 divisible by 1000. Consequently,

$$11^{2016} \equiv 1 + 20,160 \equiv 161 \pmod{1000}.$$

Thus the units digit is 1, the tens digit is 6, and the hundreds digit is 1. The ordered pair asks for tens first, not hundreds first. Option (A) reverses these requested places, while options (C) and (D) introduce a digit 8 that the remainder does not contain.

Step 3: Conclusion The tens and hundreds digits are $x = 6$ and $y = 1$, so $(x, y) = (6, 1)$. Hence, the

correct option is (B).

Quick Tip to Solve: For digits through the hundreds place, work modulo 1000 and retain only the first three terms of $(1+10)^n$.

8. Let a_1, a_2, a_3, a_4, a_5 be a G.P. of positive real numbers such that the A.M. of a_2 and a_4 is 117 and the G.M. of a_2 and a_4 is 108. Then the A.M. of a_1 and a_5 is : [4 marks]

(A) 108

(B) 117

(C) 144.5

(D) 145.5

Correct Answer: (D) 145.5

Solution:

Concept:

- For positive terms in a G.P., equally spaced terms have the same geometric mean: $a_2a_4 = a_3^2$ and $a_1a_5 = a_3^2$.
- Write the five terms as $a/r^2, a/r, a, ar, ar^2$, with $a > 0$ and common ratio $r > 0$. Then $(r + r^{-1})^2 = r^2 + r^{-2} + 2$.

Step 1: Use the given means to identify the middle term Because all terms are positive, the geometric mean has no sign ambiguity. The conditions give

$$a_3 = \sqrt{a_2a_4} = 108, \qquad a_2 + a_4 = 2(117) = 234.$$

Set $a = a_3 = 108$. With the symmetric G.P. representation,

$$108\left(r + \frac{1}{r}\right) = 234, \qquad r + \frac{1}{r} = \frac{13}{6}.$$

There is no need to find which of r and $1/r$ is the common ratio, since reversing the progression leaves the required average unchanged.

Step 2: Find the average of the outer terms Squaring the last relation and removing its cross term yields

$$r^2 + \frac{1}{r^2} = \left(\frac{13}{6}\right)^2 - 2 = \frac{97}{36}.$$

Therefore the arithmetic mean requested is

$$\frac{a_1 + a_5}{2} = \frac{108}{2}\left(r^2 + \frac{1}{r^2}\right) = 54 \cdot \frac{97}{36} = \frac{291}{2} = 145.5.$$

The values 108 and 117 refer to the supplied geometric and arithmetic means of the inner pair, so options (A) and (B) do not answer the outer-pair question. Option (C), 144.5, differs from the exact evaluated average.

Step 3: Conclusion The A.M. of a_1 and a_5 is 145.5. Hence, the correct option is (D).

Quick Tip to Solve: Centre a five-term G.P. on its middle term; square the inner-pair ratio sum to obtain the outer-pair ratio sum.

9. If the sum of the first 15 terms of the series $3 + 7 + 14 + 24 + 37 + \ldots$ is 15 k, then k is equal to : [4 marks]

(A) 122

(B) 81

(C) 119

(D) 126

Correct Answer: (A) 122

Solution:

Concept:

- The first differences of $3, 7, 14, 24, 37, \ldots$ are $4, 7, 10, 13, \ldots$, an arithmetic progression with common difference 3.
- Use $\sum_{n=1}^{N} n = N(N+1)/2$ and $\sum_{n=1}^{N} n^2 = N(N+1)(2N+1)/6$ after deriving the general term.

Step 1: Derive the general term from its increments Let t_n denote the nth term. The increment from t_n to t_{n+1} is $3n + 1$, so

$$t_n = 3 + \sum_{j=1}^{n-1}(3j+1) = 3 + \frac{3n(n-1)}{2} + (n-1) = \frac{3n^2 - n + 4}{2}.$$

This gives $3, 7, 14, 24, 37$ for the first five indices, confirming that the index shift and constant term agree with the displayed sequence. Treating the original terms themselves as an arithmetic progression would be incorrect: their first differences are not constant.

Step 2: Sum the first fifteen terms and divide by fifteen Using the general term,

$$S_{15} = \frac{1}{2}\left(3\sum_{n=1}^{15} n^2 - \sum_{n=1}^{15} n + 4 \cdot 15\right).$$

Here

$$\sum_{n=1}^{15} n = 120, \qquad \sum_{n=1}^{15} n^2 = \frac{15 \cdot 16 \cdot 31}{6} = 1240.$$

Hence

$$S_{15} = \frac{3(1240) - 120 + 60}{2} = 1830, \qquad k = \frac{1830}{15} = 122.$$

As a direct check on the alternatives, 15 times options (B), (C) and (D) gives 1215, 1785 and 1890, respectively; none equals the computed sum.

Step 3: Conclusion The sum is $1830 = 15(122)$, so $k = 122$. Hence, the correct option is (A).

Quick Tip to Solve: When first differences form an A.P., derive a quadratic formula for the terms before applying the standard summation formulae.

10. $\lim_{x\to 0} \frac{\log(\sin 7x+\cos 7x)}{\sin 3x}$ **equals :** [4 marks]

(A) $\frac{7}{3}$

(B) $\frac{14}{3}$

(C) $\frac{1}{3}$

(D) $\frac{1}{3}\log 7$

Correct Answer: (A) $\frac{7}{3}$

Solution:

Concept:

- The standard limits are $\lim_{u\to 0}\log(1+u)/u = 1$ and $\lim_{t\to 0}\sin t/t = 1$, with angles in radians and $\log$ the natural logarithm.
- Near zero, $\cos t - 1 = -2\sin^2(t/2)$ is of second order, whereas $\sin t$ has a nonzero first-order contribution.

Step 1: Put the logarithm into its standard form Set $u(x) = \sin 7x + \cos 7x - 1$. Then $u(x) \to 0$, and the logarithm has a positive argument in a sufficiently small neighbourhood of zero because that argument tends to 1. Factor the expression as

$$\frac{\log(\sin 7x + \cos 7x)}{\sin 3x} = \frac{\log(1+u(x))}{u(x)}\,\frac{u(x)}{x}\,\frac{x}{\sin 3x}.$$

The first factor tends to 1; the third tends to $1/3$. It remains to determine the linear contribution of $u(x)$.

Step 2: Evaluate the linear contribution and combine the limits Separate the two trigonometric terms:

$$\frac{u(x)}{x} = \frac{\sin 7x}{x} + \frac{\cos 7x - 1}{x}.$$

The sine term tends to 7. For the cosine term, the half-angle identity gives

$$\frac{\cos 7x - 1}{x} = -2\frac{\sin^2(7x/2)}{x} \longrightarrow 0.$$

Therefore the required limit is

$$1\cdot(7+0)\cdot\frac{1}{3} = \frac{7}{3}.$$

Option (B) incorrectly doubles the linear term, option (C) loses the factor 7 from the inner angle, and option (D) treats the inner angle multiplier as a constant logarithmic factor. None follows from the local expansion around argument 1.

Step 3: Conclusion The limit equals $\frac{7}{3}$. Hence, the correct option is (A).

Quick Tip to Solve: For a logarithm whose argument tends to 1, subtract 1 inside the argument and retain its linear term; the cosine contributes none here.

11. If the function $f : \mathbf{R} \to \mathbf{R}$, defined by

$$f(x) = \begin{cases} ax, & x < 2 \\ ax^2 - bx + 3, & x \geq 2 \end{cases}$$

is differentiable, then the value of $f'(-3) + f'(3)$ is equal to : [4 marks]

(A) 3

(B) 4

(C) $\frac{15}{2}$

(D) 0

Correct Answer: (A) 3

Solution:

Concept:

- Differentiability at the joining point requires continuity there and equality of the left and right derivatives. Away from the joining point, each polynomial branch is differentiable.
- The derivatives of the two branches are a for $x < 2$ and $2ax - b$ for $x > 2$. Determine the constants using the join at $x = 2$.

Step 1: Impose continuity and matching derivatives at the join The limiting value from the left is $2a$, while the value at 2, supplied by the second branch, is $4a - 2b + 3$. Continuity requires

$$2a = 4a - 2b + 3, \qquad 2b = 2a + 3.$$

The left derivative at the join is a, and the right derivative is $4a - b$. Equating them gives

$$a = 4a - b, \qquad b = 3a.$$

Both equations are necessary: matching slopes alone would not exclude a jump in the function.

Step 2: Determine the constants and evaluate the requested derivatives Substitute $b = 3a$ into the continuity equation:

$$6a = 2a + 3, \qquad a = \frac{3}{4}, \qquad b = \frac{9}{4}.$$

Since $-3 < 2$, use the derivative of the linear branch at -3. Since $3 > 2$, use the derivative of the quadratic branch at 3:

$$f'(-3) = a = \frac{3}{4}, \qquad f'(3) = 6a - b = \frac{18}{4} - \frac{9}{4} = \frac{9}{4}.$$

Thus

$$f'(-3) + f'(3) = \frac{3}{4} + \frac{9}{4} = 3.$$

This selects option (A). The values 4, $15/2$ and 0 do not equal the sum obtained from the correct branches and the uniquely determined constants.

Step 3: Conclusion The required derivative sum is 3. Hence, the correct option is (A).

Quick Tip to Solve: At a piecewise join, first match the function values, then the slopes; afterward select the branch using the point where each derivative is requested.

12. The sum of the abscissae of the points where the curves, $y = kx^2 + (5k+3)x + 6k + 5$, $(k \in \mathbf{R})$, touch the x-axis, is equal to : [4 marks]

(A) $-\frac{19}{3}$

(B) $-\frac{10}{3}$

(C) $\frac{5}{3}$

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

Correct Answer: (B) $-\frac{10}{3}$

Solution:

Concept:

- A genuine quadratic $Ax^2 + Bx + C$ touches the x-axis when its discriminant $B^2 - 4AC$ is zero, giving one repeated root.
- The abscissa of that contact point is the repeated root $-B/(2A)$. Here $A = k$, so the exceptional case $k = 0$ must be checked separately.

Step 1: Find all parameter values giving tangency If $k = 0$, the curve reduces to the line $y = 3x + 5$, which crosses rather than touches the x-axis, so it is not a tangency case. For $k \neq 0$, impose zero discriminant:

$$(5k+3)^2 - 4k(6k+5) = 0.$$

Expand and simplify:

$$25k^2 + 30k + 9 - 24k^2 - 20k = 0, \qquad k^2 + 10k + 9 = (k+1)(k+9) = 0.$$

Thus the required curves occur at $k = -1$ and $k = -9$. These are both genuine quadratics.

Step 2: Find the contact abscissae and add them For either tangency parameter, the repeated root is

$$x = -\frac{5k+3}{2k}.$$

At $k = -1$, this gives $x = -1$; indeed the curve becomes $y = -(x+1)^2$. At $k = -9$, it gives

$$x = -\frac{-42}{-18} = -\frac{7}{3},$$

and the curve is $y = -(3x+7)^2$. These square forms independently confirm contact rather than crossing. Therefore the sum of the contact abscissae is

$$-1 - \frac{7}{3} = -\frac{10}{3}.$$

The sum -10 of the parameter values is not the requested quantity. Of the displayed choices, only option (B) equals the sum of the two contact coordinates; $-19/3$, $5/3$ and $-4/3$ do not.

Step 3: Conclusion The sum of the abscissae is $-\frac{10}{3}$. Hence, the correct option is (B).

Quick Tip to Solve: Zero discriminant determines the parameter values; substitute each one into the repeated-root formula before summing the contact coordinates.

13. Water is running into an underground right circular conical reservoir, which is 10 m deep and radius of its base is 5 m. If the rate of change in the volume of water in the reservoir is $\frac{3}{2}\pi$ $m^3/min.$, then the rate (in m/min) at which water rises in it, when the water level is 4 m, is : [4 marks]

(A) $\frac{3}{8}$

(B) $\frac{1}{8}$

(C) $\frac{1}{4}$

(D) $\frac{3}{2}$

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

Solution:

Concept:

- The water forms a cone similar to the full reservoir. If its depth is h metres and surface radius is r metres, the ratio r/h remains constant.
- For a cone, $V = \frac{1}{3}\pi r^2 h$. A related-rates problem requires expressing the volume in terms of the changing depth before differentiating with respect to time.

Step 1: Relate the water radius to its depth The full cone has radius 5 m and height 10 m. Similarity gives

$$\frac{r}{h} = \frac{5}{10} = \frac{1}{2}, \qquad r = \frac{h}{2}.$$

Consequently the volume of the water, rather than the volume of the entire reservoir, is

$$V = \frac{1}{3}\pi\left(\frac{h}{2}\right)^2 h = \frac{\pi h^3}{12}.$$

The radius changes as the level changes, so it would be incorrect to substitute the reservoir radius directly into the water-volume formula.

Step 2: Differentiate and substitute the given level Differentiating with respect to time t, measured in minutes, gives

$$\frac{dV}{dt} = \frac{\pi h^2}{4}\frac{dh}{dt}.$$

At $h = 4$, the horizontal water surface has radius 2 m and area 4π square metres. Therefore

$$\frac{3}{2}\pi = 4\pi\frac{dh}{dt}, \qquad \frac{dh}{dt} = \frac{3}{8}\ \text{m/min}.$$

The positive sign means the water level is rising. Options (B), (C) and (D) do not satisfy the inflow relation at this depth.

Step 3: Conclusion The water rises at $\boxed{\frac{3}{8}\ \text{m/min}}$ when its depth is 4 m. Hence, the correct option is (A).

Quick Tip to Solve: For any reservoir, divide the volume inflow rate by the horizontal water-surface area at the stated level to obtain the rate of rise.

14. The integral $\int \frac{x+2}{(x^2+3x+3)\sqrt{x+1}}\,dx$ is equal to :
(where C is a constant of integration) [4 marks]

(A) $\frac{1}{\sqrt{3}}\tan^{-1}\left[\frac{x}{\sqrt{3(x+1)}}\right]+C$

(B) $\frac{2}{\sqrt{3}}\tan^{-1}\left[\frac{x}{\sqrt{3(x+1)}}\right]+C$

(C) $\frac{2}{\sqrt{3}}\cot^{-1}\left[\frac{x}{\sqrt{x+1}}\right]+C$

(D) $\frac{1}{\sqrt{3}}\cot^{-1}\left[\frac{x\sqrt{3}}{\sqrt{x+1}}\right]+C$

Correct Answer: (B) $\frac{2}{\sqrt{3}}\tan^{-1}\left[\frac{x}{\sqrt{3(x+1)}}\right]+C$

Solution:

Concept:

- Choose a substitution whose derivative contains the numerator and the square-root factor. Here $u = x/\sqrt{x+1}$ produces a multiple of $(x+2)/(x+1)^{3/2}$.
- The standard formula is $\int du/(u^2+a^2) = a^{-1}\tan^{-1}(u/a)+C$, where $a>0$. The real integrand requires $x>-1$.

Step 1: Transform the denominator and differential Put $u = x/\sqrt{x+1}$. Differentiating by the product rule yields

$$\frac{du}{dx} = \frac{1}{\sqrt{x+1}} - \frac{x}{2(x+1)^{3/2}} = \frac{x+2}{2(x+1)^{3/2}}.$$

Also

$$u^2+3 = \frac{x^2+3x+3}{x+1}.$$

Thus the original differential expression is

$$\frac{(x+2)\,dx}{(x^2+3x+3)\sqrt{x+1}} = \frac{2\,du}{u^2+3}.$$

This identity keeps the factor of two that distinguishes the first two options.

Step 2: Integrate and compare the options Using $a=\sqrt{3}$, we obtain

$$\int \frac{2\,du}{u^2+3} = \frac{2}{\sqrt{3}}\tan^{-1}\left(\frac{u}{\sqrt{3}}\right)+C.$$

Substitution back gives

$$\frac{2}{\sqrt{3}}\tan^{-1}\left(\frac{x}{\sqrt{3(x+1)}}\right)+C.$$

Option (A) has half the required coefficient. The inverse-cotangent expressions in (C) and (D) have negative derivatives because their arguments increase on $x>-1$; the given integrand is positive there. They therefore cannot be antiderivatives of this integrand.

Step 3: Conclusion The integral is $\boxed{\frac{2}{\sqrt{3}}\tan^{-1}\left(\frac{x}{\sqrt{3(x+1)}}\right)+C}$, on $x > -1$. Hence, the correct option is (B).

Quick Tip to Solve: When a numerator contains the derivative pattern of a quotient involving a square root, try that quotient as the new variable and track its constant factor.

15. The integral $\int_{\pi/24}^{5\pi/24} \frac{dx}{1+\sqrt[3]{\tan 2x}}$ is equal to : [4 marks]

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

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

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

(D) $\frac{\pi}{18}$

Correct Answer: (B) $\frac{\pi}{12}$

Solution:

Concept:

- For an integrable function, $\int_a^b f(x)\,dx = \int_a^b f(a+b-x)\,dx$. Pairing these integrands often removes radicals.
- On the given interval, $2x$ lies between $\pi/12$ and $5\pi/12$, so $\tan 2x$ and its real cube root are positive and finite.

Step 1: Reflect the variable about the interval midpoint Let I denote the given integral and set $a = \pi/24$, $b = 5\pi/24$. Their sum is $a + b = \pi/4$. The reflected argument satisfies

$$\tan\big(2(a+b-x)\big) = \tan(\pi/2 - 2x) = \cot 2x.$$

Writing $t = \sqrt[3]{\tan 2x} > 0$, the reflection property gives

$$I = \int_a^b \frac{dx}{1+1/t} = \int_a^b \frac{t}{1+t}\,dx.$$

This is the same integral value expressed using a complementary integrand.

Step 2: Add the paired expressions Adding the original expression and the reflected expression produces

$$2I = \int_a^b \left(\frac{1}{1+t} + \frac{t}{1+t}\right)dx = \int_a^b 1\,dx.$$

Therefore

$$2I = b - a = \frac{4\pi}{24} = \frac{\pi}{6}, \qquad I = \frac{\pi}{12}.$$

Options (A) and (C) are at least the full interval length, which is impossible since the integrand is strictly less than one. Option (D) fails the exact complementary-sum identity above. No explicit antiderivative of the cube-root expression is necessary.

Step 3: Conclusion The integral equals $\boxed{\pi/12}$. Hence, the correct option is (B).

Quick Tip to Solve: Add the limits first: a sum of $\pi/4$ suggests reflecting x so that $\tan 2x$ changes into its reciprocal.

16. If the line, $y = mx$, bisects the area of the region $\{(x, y) : 0 \le x \le \frac{3}{2},\ 0 \le y \le 1 + 4x - x^2\}$, then m equals : [4 marks]

(A) $\frac{9}{8}$
(B) $\frac{13}{3}$
(C) $\frac{13}{6}$
(D) $\frac{39}{16}$

Correct Answer: (C) $\frac{13}{6}$

Solution:

Concept:

- The total area between a nonnegative curve $y = f(x)$, the x-axis and two vertical boundaries is $\int f(x)\,dx$.
- A line bisects this region when the area of the portion below it equals half the total. The proposed line must also remain within the region over the interval used in the calculation.

Step 1: Calculate the total area Here $f(x) = 1 + 4x - x^2$ is positive throughout $[0, 3/2]$. Hence

$$A = \int_0^{3/2} (1 + 4x - x^2)\,dx = \left[x + 2x^2 - \frac{x^3}{3}\right]_0^{3/2} = \frac{39}{8}.$$

Half this area is $39/16$. If the line lies below the curve on the full interval, the area underneath it is the triangle with base $3/2$ and height $3m/2$.

Step 2: Find the slope and verify the position of the line The bisecting condition is

$$\frac{1}{2}\left(\frac{3}{2}\right)\left(\frac{3m}{2}\right) = \frac{39}{16}, \qquad \frac{9m}{8} = \frac{39}{16}, \qquad m = \frac{13}{6}.$$

For this value, the vertical separation between curve and line is

$$g(x) = 1 + \frac{11}{6}x - x^2.$$

This concave quadratic attains its minimum on the closed interval at an endpoint: $g(0) = 1$ and $g(3/2) = 3/2$. Both are positive, so the triangular-area calculation is valid. The portion below the line increases strictly with positive slope until it fills the region; thus the bisecting slope is unique. Consequently the other three proposed slopes cannot give equal halves.

Step 3: Conclusion The required slope is $\boxed{m = 13/6}$. Hence, the correct option is (C).

Quick Tip to Solve: After finding a slope from a triangular area, verify that the line remains below the bounding curve; otherwise the triangle is not the actual portion of the region.

17. The order and the degree of the differential equation of all ellipses with centre at the origin, major axis along x-axis and eccentricity $\frac{\sqrt{3}}{2}$ are, respectively : [4 marks]

(A) 1, 1

(B) 2, 1

(C) 1, 2

(D) 2, 2

Correct Answer: (A) 1, 1

Solution:

Concept:

- For an ellipse with semiaxes $a > b > 0$ and major axis along the x-axis, $x^2/a^2 + y^2/b^2 = 1$ and $e^2 = 1 - b^2/a^2$.
- The order is the highest derivative present. The degree is the power of the highest-order derivative after writing the differential equation as a polynomial in its derivatives.

Step 1: Use the fixed eccentricity to reduce the family Given $e = \sqrt{3}/2$, we have

$$\frac{b^2}{a^2} = 1 - e^2 = 1 - \frac{3}{4} = \frac{1}{4}, \qquad b^2 = \frac{a^2}{4}.$$

Substitution into the ellipse equation gives

$$\frac{x^2}{a^2} + \frac{4y^2}{a^2} = 1, \qquad x^2 + 4y^2 = a^2.$$

The centre and orientation are fixed and the eccentricity fixes the axis ratio. Only the scale parameter a^2 remains arbitrary; the two semiaxes are not independent parameters.

Step 2: Eliminate the parameter and identify order and degree Differentiating once with respect to x eliminates the constant a^2:

$$2x + 8y\frac{\mathrm{d}y}{\mathrm{d}x} = 0, \qquad x + 4y\frac{\mathrm{d}y}{\mathrm{d}x} = 0.$$

The highest derivative is the first derivative, so the order is 1. That derivative occurs to the first power and no radicals or denominators involving derivatives remain, so the degree is 1. Options (B) and (D) wrongly require a second derivative. Option (C) assigns degree two merely because the original ellipse equation contains squares; the degree of a differential equation concerns derivatives, not coordinate powers.

Step 3: Conclusion The order and degree are $\boxed{1, 1}$, respectively. Hence, the correct option is (A).

Quick Tip to Solve: Count independent arbitrary constants after applying all geometric restrictions; fixed eccentricity leaves only one scale parameter in this ellipse family.

18. If an equilateral triangle, having centroid at the origin, has a side along the line, $x + y = 2$, then the area (in sq. units) of this triangle is : [4 marks]

(A) 6

(B) $6\sqrt{3}$

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

(D) $3\sqrt{6}$

Correct Answer: (B) $6\sqrt{3}$

Solution:

Concept:

- In an equilateral triangle, the centroid and incentre coincide. The perpendicular distance from this common centre to any side is the inradius r.
- For side length s, the altitude is $h = \sqrt{3}s/2$, the inradius is $r = h/3$, and the area is $\sqrt{3}s^2/4 = 3\sqrt{3}r^2$.

Step 1: Find the distance of the centroid from the side The given side is on $x + y - 2 = 0$. The perpendicular distance of the origin from a line $Ax + By + C = 0$ is $|C|/\sqrt{A^2 + B^2}$. Thus

$$r = \frac{|-2|}{\sqrt{1^2 + 1^2}} = \sqrt{2}.$$

Because the triangle is equilateral, this distance is its inradius, rather than its full altitude. The centroid divides each median in the ratio $2 : 1$, with the shorter segment running from the centroid to the side.

Step 2: Recover the side and area The altitude is therefore $h = 3r = 3\sqrt{2}$. Using $h = \sqrt{3}s/2$,

$$s = \frac{2h}{\sqrt{3}} = 2\sqrt{6}.$$

The area is

$$\Delta = \frac{1}{2}sh = \frac{1}{2}(2\sqrt{6})(3\sqrt{2}) = 6\sqrt{3} \quad \text{square units.}$$

Equivalently, $3\sqrt{3}r^2 = 3\sqrt{3} \cdot 2 = 6\sqrt{3}$. Options (A), (C) and (D) do not agree with either independent area expression. In particular, taking the centroid-to-side distance as the full altitude would lose the factor of three in the height and produce an incorrect area.

Step 3: Conclusion The area is $\boxed{6\sqrt{3}}$ square units. Hence, the correct option is (B).

Quick Tip to Solve: For an equilateral triangle centred at a known point, first calculate its distance from the side; this immediately gives the inradius and hence the area.

19. The equation of the circle, which is the mirror image of the circle, $x^2 + y^2 - 2x = 0$, in the line, $y = 3 - x$ is : [4 marks]

(A) $x^2 + y^2 - 6x - 8y + 24 = 0$

(B) $x^2 + y^2 - 8x - 6y + 24 = 0$

(C) $x^2 + y^2 - 4x - 6y + 12 = 0$

(D) $x^2 + y^2 - 6x - 4y + 12 = 0$

Correct Answer: (D) $x^2 + y^2 - 6x - 4y + 12 = 0$

Solution:

Concept:

- A reflection maps a circle to a circle with the same radius. Its centre is reflected in the mirror line.
- The reflection of (h, k) in $ax + by + c = 0$ is $(h - 2ad, k - 2bd)$, where $d = (ah + bk + c)/(a^2 + b^2)$.

Step 1: Identify the centre and radius Complete the square in the given equation rather than reflecting individual points on the circumference. We obtain

$$x^2 + y^2 - 2x = 0 \quad \Longrightarrow \quad (x - 1)^2 + y^2 = 1.$$

Thus the original centre is $C = (1, 0)$, and the radius is 1. Reflection is an isometry, so the reflected radius remains 1; only the centre changes.

Step 2: Reflect the centre in the given line The mirror is $x + y - 3 = 0$. Here $a = b = 1$, $c = -3$, and

$$d = \frac{1 + 0 - 3}{1^2 + 1^2} = -1.$$

Consequently,

$$C' = (1 - 2(1)(-1),\ 0 - 2(1)(-1)) = (3, 2).$$

As a geometric check, the midpoint of C and C' is $(2, 1)$, which lies on the mirror. The joining segment has slope 1, perpendicular to the mirror of slope -1.

Step 3: Form and compare the image equation Use the reflected centre and unchanged radius:

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

Expanding gives

$$x^2 + y^2 - 6x - 4y + 12 = 0.$$

Option (A) has centre $(3, 4)$, option (B) has centre $(4, 3)$, and option (C) has centre $(2, 3)$. None is the reflected centre $(3, 2)$, so these alternatives fail even before their constants are checked.

Step 4: Conclusion The mirror-image circle is $x^2 + y^2 - 6x - 4y + 12 = 0$. Hence, the correct option is (D).

Quick Tip to Solve: Reflect the centre, retain the radius, and check that the midpoint of the two centres lies on the mirror line.

20. The product of the perpendiculars drawn from the foci of the ellipse, $\frac{x^2}{9}+\frac{y^2}{25}=1$ upon the tangent to it at the point $\left(\frac{3}{2},\frac{5\sqrt{3}}{2}\right)$, is : [4 marks]

(A) 9

(B) $\frac{189}{13}$

(C) 18

(D) $3\sqrt{13}$

Correct Answer: (A) 9

Solution:

Concept:

- For $x^2/b^2+y^2/a^2=1$, with $a>b$, the foci are $(0,\pm c)$, where $c^2=a^2-b^2$.
- The tangent at (x_1,y_1) is $xx_1/b^2+yy_1/a^2=1$. Distance from (u,v) to $Ax+By+C=0$ is $|Au+Bv+C|/\sqrt{A^2+B^2}$.

Step 1: Locate the foci The larger denominator is under y^2, so the major axis is vertical. Here $a=5$, $b=3$, and

$$c=\sqrt{25-9}=4.$$

The foci are therefore $F_1=(0,4)$ and $F_2=(0,-4)$. The supplied point lies on the ellipse because $(3/2)^2/9=1/4$ and $(5\sqrt{3}/2)^2/25=3/4$.

Step 2: Write the tangent equation Insert $x_1=3/2$ and $y_1=5\sqrt{3}/2$ in the tangent formula:

$$\frac{x}{6}+\frac{\sqrt{3}\,y}{10}=1.$$

Multiplying by 30 gives the convenient form

$$5x+3\sqrt{3}\,y-30=0.$$

Its normalising denominator is $\sqrt{25+27}=2\sqrt{13}$. Both distances must use this same denominator.

Step 3: Multiply the two perpendicular distances The two positive distances are

$$d_1=\frac{|12\sqrt{3}-30|}{2\sqrt{13}},\qquad d_2=\frac{|-12\sqrt{3}-30|}{2\sqrt{13}}.$$

Since $30>12\sqrt{3}$, their product is

$$d_1d_2=\frac{(30-12\sqrt{3})(30+12\sqrt{3})}{52}=\frac{900-432}{52}=9.$$

Thus $189/13$, 18, and $3\sqrt{13}$ do not equal the computed product. As a useful independent check, the focal-distance product for any tangent to this ellipse is its smaller squared semiaxis, $b^2=9$.

Step 4: Conclusion The product of the two perpendicular distances is 9. Hence, the correct option is (A).

Quick Tip to Solve: Identify the smaller semiaxis first: the product of focal perpendiculars to an ellipse tangent equals its square.

21. Which one of the following points does not lie on the normal to the hyperbola, $\frac{x^2}{16} - \frac{y^2}{9} = 1$ drawn at the point $(8, 3\sqrt{3})$? [4 marks]

(A) $\left(13, -\frac{1}{\sqrt{3}}\right)$

(B) $\left(12, \frac{1}{\sqrt{3}}\right)$

(C) $(11, \sqrt{3})$

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

Correct Answer: (D) $(10, \sqrt{3})$

Solution:

Concept:

- The normal is perpendicular to the tangent at the specified point, so its slope is the negative reciprocal of the tangent slope.
- Implicit differentiation of $x^2/16 - y^2/9 = 1$ gives $dy/dx = 9x/(16y)$. Test every candidate in the normal equation.

Step 1: Calculate the tangent and normal slopes The point $(8, 3\sqrt{3})$ is on the hyperbola, since $64/16 - 27/9 = 4 - 3 = 1$. Differentiating the equation gives

$$\frac{2x}{16} - \frac{2y}{9}\frac{dy}{dx} = 0, \qquad \frac{dy}{dx} = \frac{9x}{16y}.$$

At the specified point,

$$m_t = \frac{72}{48\sqrt{3}} = \frac{\sqrt{3}}{2}, \qquad m_n = -\frac{2}{\sqrt{3}}.$$

Use the normal slope, rather than the tangent slope, because the question explicitly asks about a normal.

Step 2: Write the normal in a testable form The point-slope equation is

$$y - 3\sqrt{3} = -\frac{2}{\sqrt{3}}(x - 8).$$

Multiplication by $\sqrt{3}$ and rearrangement yield

$$2x + \sqrt{3}\,y - 25 = 0.$$

This form avoids fractions when substituting the four candidate points and makes the test exact.

Step 3: Check all four points For option (A), the left side is $26 - 1 - 25 = 0$, so that point lies on the normal. For (B), it is $24 + 1 - 25 = 0$, also on the normal. For (C), it is $22 + 3 - 25 = 0$, again on the normal. For (D), however,

$$2(10) + \sqrt{3}(\sqrt{3}) - 25 = 20 + 3 - 25 = -2 \neq 0.$$

Thus (D) is the sole point that fails the line equation. The negative wording of the question requires selecting this failing point rather than one of the three points satisfying it.

Step 4: Conclusion The point $(10, \sqrt{3})$ does not lie on the normal. Hence, the correct option is (D).

Quick Tip to Solve: For a question asking which point does not lie on a line, evaluate one simplified line expression at every option.

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22. If the shortest distance between the lines $x + 2\lambda = 2y = -12z$, $x = y + 4\lambda = 6z - 12\lambda$ is $4\sqrt{2}$ units, then a value of λ is : [4 marks]

(A) 2

(B) $\sqrt{2}$

(C) $2\sqrt{2}$

(D) $\frac{\sqrt{2}}{2}$

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

Solution:

Concept:

- For lines through $\vec{a}_1, \vec{a}_2$ with directions $\vec{u}, \vec{v}$, the shortest distance is $|(\vec{a}_2 - \vec{a}_1) \cdot (\vec{u} \times \vec{v})|/|\vec{u} \times \vec{v}|$.
- A common value in a symmetric line equation supplies a parameter; constant offsets determine a point on that line.

Step 1: Extract points and direction vectors For the first line, let $x + 2\lambda = 2y = -12z = t$. Then

$$(x, y, z) = (-2\lambda, 0, 0) + t(1, 1/2, -1/12).$$

We can use the proportional integer direction $\vec{u} = (12, 6, -1)$. For the second line, put $x = y + 4\lambda = 6z - 12\lambda = s$. This gives

$$(x, y, z) = (0, -4\lambda, 2\lambda) + s(1, 1, 1/6).$$

Use $\vec{v} = (6, 6, 1)$. Thus the displacement between the chosen base points is $(2\lambda, -4\lambda, 2\lambda)$.

Step 2: Evaluate the scalar triple product The cross product is

$$\vec{u} \times \vec{v} = (12, -18, 36) = 6(2, -3, 6),$$

with magnitude

$$|\vec{u} \times \vec{v}| = \sqrt{144 + 324 + 1296} = 42.$$

The scalar product with the base-point displacement is

$$(2\lambda, -4\lambda, 2\lambda) \cdot (12, -18, 36) = 24\lambda + 72\lambda + 72\lambda = 168\lambda.$$

The directions are not parallel because their cross product is nonzero.

Step 3: Use the given distance and test the choices It follows that

$$d = \frac{|168\lambda|}{42} = 4|\lambda|.$$

Equating this to $4\sqrt{2}$ gives $|\lambda| = \sqrt{2}$. Both signs solve the distance condition, but the question asks for a value and lists the positive one. The other options give distances 8, $8\sqrt{2}$, and $2\sqrt{2}$, respectively, none equal to the prescribed distance.

Step 4: Conclusion A permissible value is $\lambda = \sqrt{2}$. Hence, the correct option is (B).

Quick Tip to Solve: Keep the absolute value in a skew-line distance calculation; the resulting parameter can have either sign.

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23. The perpendicular distance from the point $(3, 1, 1)$ on the plane passing through the point $(1, 2, 3)$ and containing the line, $\vec{r} = \hat{i} + \hat{j} + \lambda(2\hat{i} + \hat{j} + 4\hat{k})$, is : [4 marks]

(A) $\frac{1}{\sqrt{11}}$

(B) $\frac{4}{\sqrt{41}}$

(C) 0

(D) $\frac{3}{\sqrt{11}}$

Correct Answer: (C) 0

Solution:

Concept:

- Two nonparallel vectors lying in a plane determine its normal through their cross product.
- The distance from (x_0, y_0, z_0) to $Ax + By + Cz + D = 0$ is $|Ax_0 + By_0 + Cz_0 + D|/\sqrt{A^2 + B^2 + C^2}$.

Step 1: Identify two directions in the plane The given line passes through $A = (1, 1, 0)$ and has direction $\vec{u} = (2, 1, 4)$. The additional point is $P = (1, 2, 3)$. Since both A and P lie in the required plane, the vector

$$\overrightarrow{AP} = (0, 1, 3)$$

is another direction in that plane. It is not a multiple of $\vec{u}$, so together the two directions specify a unique plane.

Step 2: Find the plane equation Taking the cross product gives a normal vector:

$$\vec{n} = (2, 1, 4) \times (0, 1, 3) = (-1, -6, 2).$$

The plane through A is therefore

$$-(x - 1) - 6(y - 1) + 2z = 0,$$

or

$$-x - 6y + 2z + 7 = 0.$$

Check the additional point: $-1 - 12 + 6 + 7 = 0$. Also $\vec{n} \cdot \vec{u} = -2 - 6 + 8 = 0$, verifying that the entire given line is parallel to the plane and, because A lies on it, is contained in it.

Step 3: Evaluate the distance from the requested point For $Q = (3, 1, 1)$, the plane expression is

$$-3 - 6 + 2 + 7 = 0.$$

Hence

$$d = \frac{|-3-6+2+7|}{\sqrt{1+36+4}} = \frac{0}{\sqrt{41}} = 0.$$

The point itself lies on the plane. All the other listed distances are positive, so options (A), (B), and (D) cannot apply. A nonzero normal vector does not imply a nonzero point-to-plane distance; it is the numerator that decides membership.

Step 4: Conclusion The perpendicular distance is 0, because $(3, 1, 1)$ lies on the plane. Hence, the correct option is (C).

Quick Tip to Solve: After finding a plane, test point membership before calculating its distance; a zero numerator ends the calculation.

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24. Three vectors $\vec{a}$, $\vec{b}$ and $\vec{c}$ are such that $|\vec{a}| = 1$, $|\vec{b}| = 2$, $|\vec{c}| = 4$ and $\vec{a} + \vec{b} + \vec{c} = \vec{0}$. Then the value of $4\vec{a} \cdot \vec{b} + 3\vec{b} \cdot \vec{c} + 3\vec{c} \cdot \vec{a}$ is equal to : [4 marks]

(A) -68

(B) -26

(C) -34

(D) 27

Correct Answer: (B) -26

Solution:

Concept:

- Squaring a vector sum uses $|\vec{a} + \vec{b}|^2 = |\vec{a}|^2 + |\vec{b}|^2 + 2\vec{a} \cdot \vec{b}$.
- From $\vec{a} + \vec{b} = -\vec{c}$, one obtains $\vec{c} \cdot (\vec{a} + \vec{b}) = -|\vec{c}|^2$. Real vector magnitudes must also satisfy the triangle inequality.

Step 1: Obtain the formal scalar product The zero-sum equation implies $\vec{a} + \vec{b} = -\vec{c}$. Squaring both sides yields

$$1^2 + 2^2 + 2\vec{a} \cdot \vec{b} = 4^2.$$

Thus the stated data algebraically require

$$2\vec{a} \cdot \vec{b} = 11, \qquad \vec{a} \cdot \vec{b} = \frac{11}{2}.$$

This identity follows directly from the given sum and must be used with its positive sign; substituting a negative scalar product would not satisfy the squared equation.

Step 2: Simplify the requested expression Group the two terms with the same coefficient:

$$\begin{aligned} 4\vec{a} \cdot \vec{b} + 3\vec{b} \cdot \vec{c} + 3\vec{c} \cdot \vec{a} &= 4\vec{a} \cdot \vec{b} + 3\vec{c} \cdot (\vec{a} + \vec{b}) \\ &= 4\left(\frac{11}{2}\right) - 3|\vec{c}|^2 \\ &= 22 - 48 = -26. \end{aligned}$$

The other listed values, -68, -34, and 27, do not equal this formal simplification.

Step 3: Check consistency of the vector premise There is a defect in the stated magnitudes: real Euclidean vectors cannot satisfy all of them. Indeed,

$$|\vec{c}| = |\vec{a} + \vec{b}| \leq |\vec{a}| + |\vec{b}| = 3,$$

whereas the question specifies $|\vec{c}| = 4$. Equivalently, the computed dot product $11/2$ exceeds the Cauchy–Schwarz bound $|\vec{a}||\vec{b}| = 2$. Therefore no actual real-vector configuration exists. The value -26 is the intended algebraic consequence of the supplied equations, rather than a value attained by a realizable configuration.

Step 4: Conclusion The literal real-vector premise has no realizable configuration, so none of the options is attained by such vectors. Formal manipulation of the inconsistent supplied equations yields -26, the intended option (B).

Quick Tip to Solve: Group equal dot-product coefficients before substituting, and independently check that proposed magnitudes obey the triangle inequality.

25. Two numbers are selected at random (without replacement) from the first six positive integers. If X denotes the smaller of the two numbers, then the expectation of X, is : [4 marks]

(A) $\frac{14}{3}$

(B) $\frac{13}{3}$

(C) $\frac{7}{3}$

(D) $\frac{5}{3}$

Correct Answer: (C) $\frac{7}{3}$

Solution:

Concept:

- For a discrete random variable, the expectation is the probability-weighted sum $E(X) = \sum_x xP(X = x)$. Here X is the smaller selected integer, not their sum or their average.
- Selecting two distinct integers without replacement makes the $\binom{6}{2} = 15$ unordered pairs equally likely. For minimum k, the other integer can be any of $k + 1, \ldots, 6$.

Step 1: Count pairs for each possible minimum The minimum can be $1, 2, 3, 4, 5$; it cannot be 6 because the second integer must be distinct and larger. The numbers of pairs for these five values are respectively $5, 4, 3, 2, 1$. Thus

$$P(X = k) = \frac{6 - k}{15}, \qquad k = 1, 2, 3, 4, 5.$$

The counts sum to 15, so all pairs have been included exactly once. Ordered sampling would double both every count and the denominator and give the same probabilities.

Step 2: Form and evaluate the weighted sum Multiply each possible minimum by its probability,

rather than averaging the five minima equally:

$$E(X) = \frac{1\cdot 5 + 2\cdot 4 + 3\cdot 3 + 4\cdot 2 + 5\cdot 1}{15}$$
$$= \frac{5+8+9+8+5}{15} = \frac{35}{15} = \frac{7}{3}.$$

The distribution favours small minima, which is why the result is below the ordinary average $7/2$ of the six integers. Options (A) and (B) even exceed that ordinary average; option (D) does not equal the calculated weighted sum.

Step 3: Conclusion The expectation of the smaller number is $\boxed{7/3}$. Hence, the correct option is (C).

Quick Tip to Solve: For the minimum of two distinct numbers from $1, \ldots, n$, count $n-k$ pairs with minimum k; do not give all possible minima equal probability.

26. If A and B are two independent events such that $P(A) = \frac{3}{10}$ and $P(A \cup B) = \frac{4}{5}$, then $P(A \cap B)$ is equal to : [4 marks]

(A) $\frac{1}{5}$
(B) $\frac{1}{10}$
(C) $\frac{3}{14}$
(D) $\frac{3}{35}$

Correct Answer: (C) $\frac{3}{14}$

Solution:

Concept:

- The addition law is $P(A \cup B) = P(A) + P(B) - P(A \cap B)$. The intersection must be subtracted because outcomes common to both events were counted twice.
- For independent events, $P(A \cap B) = P(A)P(B)$. Independence does not mean the events are disjoint; their intersection need not be zero.

Step 1: Determine the probability of the second event Let $b = P(B)$. Substitute the given probability of A and the independence formula into the union law:

$$\frac{4}{5} = \frac{3}{10} + b - \frac{3}{10}b = \frac{3}{10} + \frac{7}{10}b.$$

Hence

$$\frac{7}{10}b = \frac{4}{5} - \frac{3}{10} = \frac{1}{2}, \qquad b = \frac{5}{7}.$$

This lies between zero and one, as a probability must. Simply adding the individual probabilities would miss the nonzero overlap.

Step 2: Calculate and check the intersection Now multiply the probabilities, using independence once more:

$$P(A \cap B) = \frac{3}{10} \cdot \frac{5}{7} = \frac{3}{14}.$$

Substituting back verifies the given union:

$$\frac{3}{10}+\frac{5}{7}-\frac{3}{14}=\frac{21+50-15}{70}=\frac{56}{70}=\frac{4}{5}.$$

The intersection is smaller than either individual probability, another useful consistency check. Options (A), (B), and (D) are respectively $1/5, 1/10, 3/35$; none equals $3/14$, and each fails the union relation with the independent-event product. The required quantity is the intersection, not the intermediate value $5/7$.

Step 3: Conclusion The probability is $\boxed{P(A\cap B)=3/14}$. Hence, the correct option is (C).

Quick Tip to Solve: With independence and a known union, first solve $P(A\cup B)=P(A)+(1-P(A))P(B)$, then multiply to obtain the intersection.

---

27. A bag contains three coins, one of which has head on both sides, another is a biased coin that shows up heads 90% of the time and the third one is an unbiased coin. A coin is taken out from the bag at random and tossed. If it shows up a head, then the probability that it is the unbiased coin, is : [4 marks]

(A) $\frac{5}{12}$
(B) $\frac{5}{24}$
(C) $\frac{1}{3}$
(D) $\frac{3}{8}$

Correct Answer: (B) $\frac{5}{24}$

Solution:

Concept:

- Bayes' theorem reverses a conditional probability: $P(C_i \mid H)=P(C_i)P(H \mid C_i)/P(H)$, where H denotes observing a head.
- The three coins are equally likely to be selected, but are not equally likely after observing a head. The total probability of a head sums the contributions from all three coins.

Step 1: Calculate the probability of the observed head Write D, B, U for the double-headed, biased, and unbiased coins. Their selection probabilities are each $1/3$, whereas

$$P(H \mid D)=1, \quad P(H \mid B)=\frac{9}{10}, \quad P(H \mid U)=\frac{1}{2}.$$

Therefore

$$P(H)=\frac{1}{3}\left(1+\frac{9}{10}+\frac{1}{2}\right)=\frac{1}{3}\cdot\frac{24}{10}=\frac{4}{5}.$$

Each contribution refers to selecting a particular coin and then obtaining a head, so these mutually exclusive routes can be added.

Step 2: Condition on the observed outcome The joint probability of selecting the unbiased coin and

seeing a head is $P(U \cap H) = (1/3)(1/2) = 1/6$. Divide by the total head probability:

$$P(U \mid H) = \frac{1/6}{4/5} = \frac{1}{6} \cdot \frac{5}{4} = \frac{5}{24}.$$

The answer is below the prior probability $1/3$, since a head is less likely for the unbiased coin than for either other coin. Option (C) ignores the new evidence. Option (A) is twice the required result and results from omitting the factor $1/2$ in the numerator. Option (D) is not the normalized unbiased-coin contribution. The three posterior weights are in the ratio $1 : 0.9 : 0.5 = 10 : 9 : 5$, confirming the numerator 5 out of 24.

Step 3: Conclusion The probability that the selected coin is unbiased, given a head, is $\boxed{5/24}$. Hence, the correct option is (B).

Quick Tip to Solve: With equal prior coin probabilities, posterior probabilities after a head are proportional to the head probabilities $1, 0.9, 0.5$. Normalize these weights.

28. The value of $\frac{1}{\cos 285^\circ} + \frac{1}{\sqrt{3}\sin 255^\circ}$, is : [4 marks]

(A) $2\sqrt{2}$

(B) $\frac{4\sqrt{2}}{\sqrt{3}}$

(C) $\frac{2\sqrt{2}}{3}$

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

Correct Answer: (B) $\frac{4\sqrt{2}}{\sqrt{3}}$

Solution:

Concept:

- Reduce angles using $\cos(360^\circ - \theta) = \cos\theta$ and $\sin(180^\circ + \theta) = -\sin\theta$. Keeping the quadrant signs is essential before taking reciprocals.
- The angle-addition formulae give $\cos 75^\circ = (\sqrt{6} - \sqrt{2})/4$ and $\sin 75^\circ = (\sqrt{6} + \sqrt{2})/4$. These exact values permit rationalization without decimal rounding.

Step 1: Reduce the angles with their signs The angle $285^\circ = 360^\circ - 75^\circ$ is in the fourth quadrant, where cosine is positive, while $255^\circ = 180^\circ + 75^\circ$ is in the third quadrant, where sine is negative. Therefore the expression becomes

$$\frac{1}{\cos 75^\circ} - \frac{1}{\sqrt{3}\sin 75^\circ} = \frac{4}{\sqrt{6} - \sqrt{2}} - \frac{4}{\sqrt{3}(\sqrt{6} + \sqrt{2})}.$$

Both denominators are nonzero, so taking their reciprocals is valid.

Step 2: Rationalize and simplify the sum Using $(\sqrt{6}-\sqrt{2})(\sqrt{6}+\sqrt{2})=4$, obtain

$$\begin{aligned}\frac{4}{\sqrt{6}-\sqrt{2}}-\frac{4}{\sqrt{3}(\sqrt{6}+\sqrt{2})} &= \sqrt{6}+\sqrt{2}-\frac{\sqrt{6}-\sqrt{2}}{\sqrt{3}} \\ &= \sqrt{6}+\sqrt{2}-\sqrt{2}+\frac{\sqrt{2}}{\sqrt{3}} \\ &= \frac{3\sqrt{2}+\sqrt{2}}{\sqrt{3}}=\frac{4\sqrt{2}}{\sqrt{3}}.\end{aligned}$$

The two standalone $\sqrt{2}$ terms cancel. This value is approximately 3.266; options (A), (C), and (D) are approximately $2.828, 0.943, 0.318$, respectively, and therefore cannot represent the same exact number.

Step 3: Conclusion The value is $\boxed{4\sqrt{2}/\sqrt{3}}$. Hence, the correct option is (B).

Quick Tip to Solve: Reduce the angles first, marking the negative sine at 255°. The conjugate denominators at 75° then rationalize using a product of 4.

29. An observer standing at a point P on the top of a hill near the sea-shore notices that the angle of depression of a ship moving towards the hill in a straight line at a constant speed is 30°. After 45 minutes, this angle becomes 45°. If T (in minutes) is the total time taken by the ship to move to a point in the sea where the angle of depression from P of the ship is 60°, then T is equal to : [4 marks]

(A) $45(1+\sqrt{3})$

(B) $45\left(1+\frac{2}{\sqrt{3}}\right)$

(C) $45\left(2+\frac{1}{\sqrt{3}}\right)$

(D) $45\left(1+\frac{1}{\sqrt{3}}\right)$

Correct Answer: (D) $45\left(1+\frac{1}{\sqrt{3}}\right)$

Solution:

Concept:

- An angle of depression from a horizontal line equals the angle of elevation from the ship. If the hill height is h and the horizontal ship distance is x, then $\tan\theta = h/x$.
- At constant speed along the same straight approach, elapsed times are proportional to horizontal distances travelled. The required total time starts at the first observation, not the second.

Step 1: Express the three ship distances in terms of height Let the observer be vertically above the shore reference point, at height h. For the successive depression angles $30^\circ, 45^\circ, 60^\circ$, the corresponding

horizontal distances from that reference point are

$$x_1 = \frac{h}{\tan 30^\circ} = \sqrt{3}h,$$
$$x_2 = \frac{h}{\tan 45^\circ} = h,$$
$$x_3 = \frac{h}{\tan 60^\circ} = \frac{h}{\sqrt{3}}.$$

These decrease in the correct order because the ship approaches the hill. The first 45 minutes cover distance $(\sqrt{3}-1)h$.

Step 2: Use the ratio of the travelled distances If the speed is v, then

$$v = \frac{(\sqrt{3}-1)h}{45}.$$

The complete journey from the first position to the 60° position covers $(\sqrt{3} - 1/\sqrt{3})h = 2h/\sqrt{3}$. Consequently

$$T = 45\frac{2/\sqrt{3}}{\sqrt{3}-1} = 45\frac{2}{3-\sqrt{3}}$$
$$= 45\frac{3+\sqrt{3}}{3} = 45\left(1+\frac{1}{\sqrt{3}}\right).$$

The unknown height cancels, as expected. This is about 70.98 minutes, consisting of the initial 45 minutes plus about 25.98 minutes. Options (A), (B), and (C) give different ratios and do not satisfy both distance intervals at one constant speed.

Step 3: Conclusion The total elapsed time is $\boxed{45(1+1/\sqrt{3}) \text{ minutes}}$. Hence, the correct option is (D).

Quick Tip to Solve: Convert each angle to $x = h\cot\theta$, then divide the total distance by the first 45-minute distance. The height cancels automatically.

30. Which one of the following statements is a tautology ? [4 marks]

(A) $(p \vee q) \to q$

(B) $p \vee (p \to q)$

(C) $p \vee (q \to p)$

(D) $p \to (p \to q)$

Correct Answer: (B) $p \vee (p \to q)$

Solution:

Concept:

- A tautology is true for every assignment of truth values to its variables. To test an implication, use the equivalence $p \to q \equiv \neg p \vee q$.
- The law of excluded middle states $p \vee \neg p \equiv \mathrm{T}$. One false assignment is sufficient to reject a

proposed tautology, but a selected tautology must be established for all assignments.

Step 1: Simplify the statement in option (B) Replace its implication by a disjunction:

$$p \vee (p \to q) \equiv p \vee (\neg p \vee q) \equiv (p \vee \neg p) \vee q \equiv \mathrm{T} \vee q \equiv \mathrm{T}.$$

Associativity allows us to group p and its negation. Since one of these is true for every assignment, the entire statement is true whatever value q has. This proves option (B), rather than merely checking it in a few favourable cases.

Step 2: Reject the other three statements Take the assignment $p = \mathrm{T}, q = \mathrm{F}$. Option (A), $(p \vee q) \to q$, becomes $\mathrm{T} \to \mathrm{F}$, which is false. Option (D), $p \to (p \to q)$, has a false inner implication and is also $\mathrm{T} \to \mathrm{F}$. For option (C), instead take $p = \mathrm{F}, q = \mathrm{T}$: then $q \to p$ is false, so $p \vee (q \to p)$ is false. Thus every remaining option has an explicit counterexample. In contrast, the simplification of (B) contains no restriction on either variable, completing the required all-cases check.

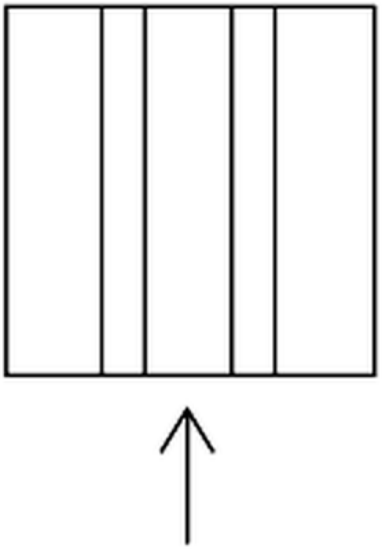
Step 3: Conclusion The tautology is $\boxed{p \vee (p \to q)}$. Hence, the correct option is (B).

Quick Tip to Solve: Rewrite each implication as $\neg p \vee q$. A disjunction containing both p and $\neg p$ is immediately true for every truth assignment.

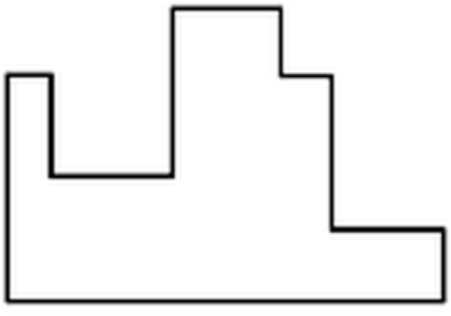
Aptitude Test (200 marks)

31. Directions : (For Q. No. 31 to 33). The problem figure shows the top view of an object. Identify the correct elevation from amongst the answer figures looking in the direction of the arrow.

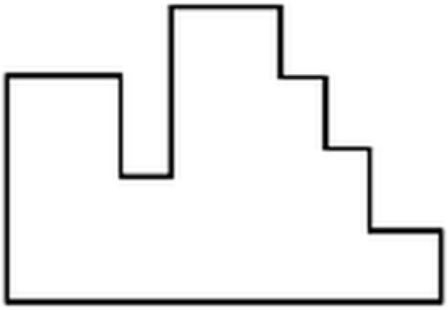
JEE-Main_2017-04-02_Single-Sitting_Paper-2_Q031_Stem-Fig.png [4 marks]



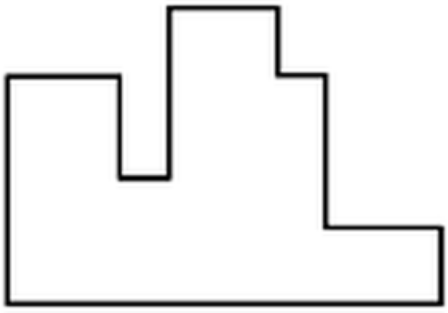
(A) JEE-Main_2017-04-02_Single-Sitting_Paper-2_Q031_Opt1.png



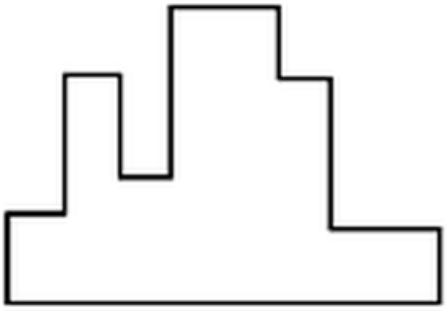
(B) JEE-Main_2017-04-02_Single-Sitting_Paper-2_Q031_Opt2.png



(C) JEE-Main_2017-04-02_Single-Sitting_Paper-2_Q031_Opt3.png

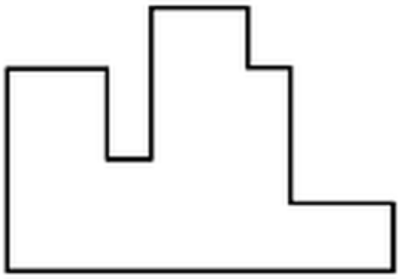


(D) JEE-Main_2017-04-02_Single-Sitting_Paper-2_Q031_Opt4.png



Correct Answer: (C)

JEE-Main_2017-04-02_Single-Sitting_Paper-2_Q031_Opt3.png



Solution:

Concept:

- An elevation is an orthographic projection onto a vertical plane. Looking along the arrow removes depth but preserves the left-to-right positions of vertical edges.
- The heights cannot be read numerically from a plan alone; among the offered elevations, compare the sequence of projected widths and the positions where the height changes.

Step 1: Read the viewing direction The arrow points upward on the page, so the lower horizontal

edge of the plan is the near edge. Look straight along this arrow, keeping the left side of the plan on the left of the elevation. Do not rotate the plan sideways or read it from the opposite direction.

Step 2: Match the vertical divisions From left to right, the rectangular plan has five strips: a broad strip, a narrow strip, a broad middle strip, a narrow strip and a broad final strip. Each full-depth division has a definite horizontal position. In option (C), the raised left portion occupies the first broad strip, the narrow recess occupies the second, the highest central portion occupies the third, and the next drop occupies the fourth before the low right portion fills the fifth.

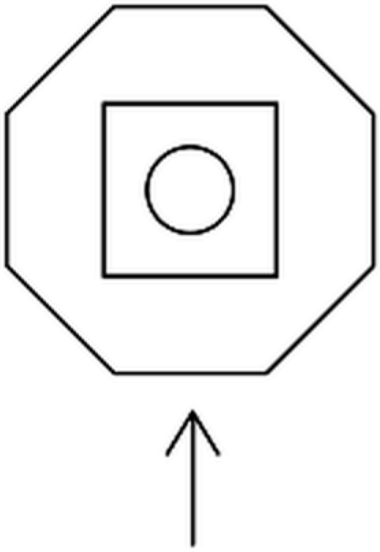
Step 3: Eliminate the other outlines Option (A) begins with a narrow raised portion and a broad recess, so its first two widths do not match the plan. Option (B) adds a further step near the right, introducing an additional division not present in the given five-strip arrangement. Option (D) introduces a separate low strip at the extreme left before the raised portion; this also adds a boundary absent from the plan. Only (C) preserves the given ordering and widths of the divisions.

Step 4: Conclusion The elevation whose horizontal edge positions agree with the top view is (C). Hence, the correct option is (C).

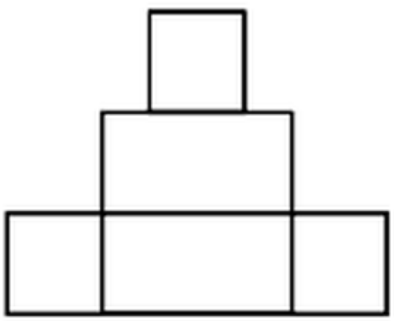
Quick Tip to Solve: Before comparing heights, project every plan division parallel to the arrow and match the resulting left-to-right strip widths.

32. Directions : (For Q. No. 31 to 33). The problem figure shows the top view of an object. Identify the correct elevation from amongst the answer figures looking in the direction of the arrow.

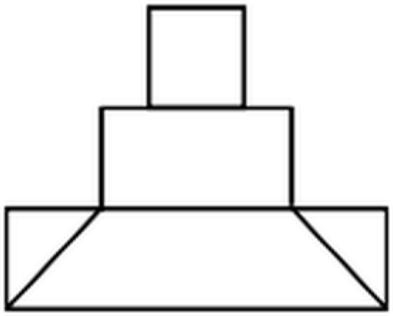
JEE-Main_2017-04-02_Single-Sitting_Paper-2_Q032_Stem-Fig.png [4 marks]



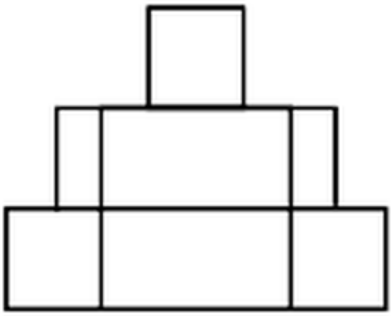
(A) JEE-Main_2017-04-02_Single-Sitting_Paper-2_Q032_Opt1.png



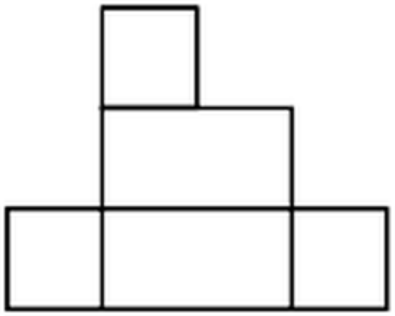
(B) JEE-Main_2017-04-02_Single-Sitting_Paper-2_Q032_Opt2.png



(C) JEE-Main_2017-04-02_Single-Sitting_Paper-2_Q032_Opt3.png

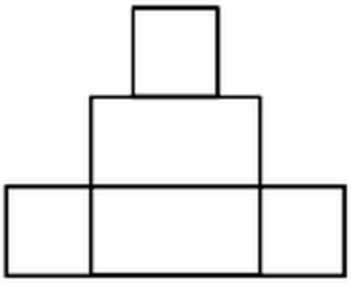


(D) JEE-Main_2017-04-02_Single-Sitting_Paper-2_Q032_Opt4.png



Correct Answer: (A)

JEE-Main_2017-04-02_Single-Sitting_Paper-2_Q032_Opt1.png



Solution:

Concept:

- A top view records the footprint of each visible level. A circular footprint can belong to a vertical cylinder, whose front elevation is a rectangle.
- A concentric octagon, square and circle indicate successively smaller centred components. The elevation must preserve their common centre and their relative widths.

Step 1: Identify the three footprints The outer boundary is an octagon, the next boundary is a

square, and the smallest boundary is a circle. All three share the same centre. The arrow views the object from below the plan, so the elevation should be symmetric about the central vertical axis. Its bottom component must be widest, its square middle component narrower, and its cylindrical upper component narrowest.

Step 2: Project the octagonal base For an octagonal prism, the near horizontal face and the two adjacent chamfered faces give vertical edges in elevation, rather than oblique lines descending across the base. The outer octagon therefore projects as a broad rectangular lower tier with vertical subdivisions. The square above it projects as a narrower centred rectangle, while the circular cylinder projects as the narrow upper rectangle. This is the arrangement in option (A).

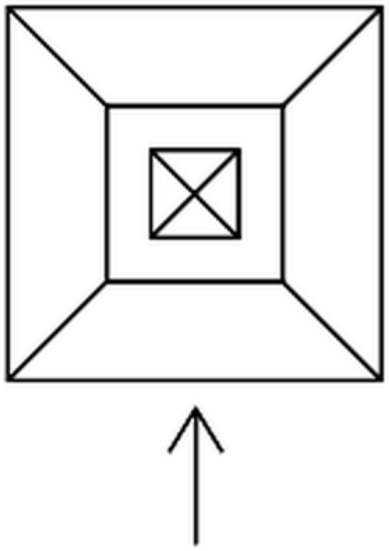
Step 3: Compare all alternatives Option (B) draws sloping edges through the base, corresponding to a tapered lower component rather than the vertical-sided octagonal footprint with the displayed tier arrangement. Option (C) adds extra vertical boundaries across the middle tier that would require additional visible divisions in the plan. Option (D) shifts the narrow top component to the left of the common centre, whereas the given circle is centred in the square. These discrepancies leave only (A).

Step 4: Conclusion The centred three-tier elevation with the appropriate vertical base edges is (A). Hence, the correct option is (A).

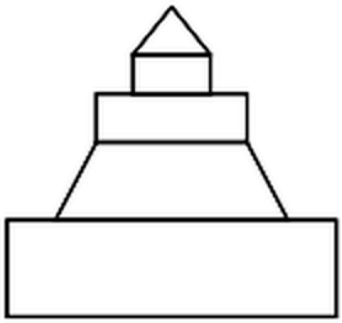
Quick Tip to Solve: For concentric plan shapes, check the common centre first; then distinguish vertical prism edges from the sloping edges of a taper.

33. Directions : (For Q. No. 31 to 33). The problem figure shows the top view of an object. Identify the correct elevation from amongst the answer figures looking in the direction of the arrow.

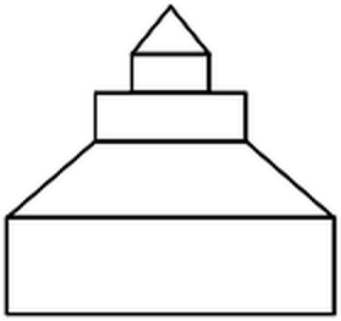
JEE-Main_2017-04-02_Single-Sitting_Paper-2_Q033_Stem-Fig.png [4 marks]



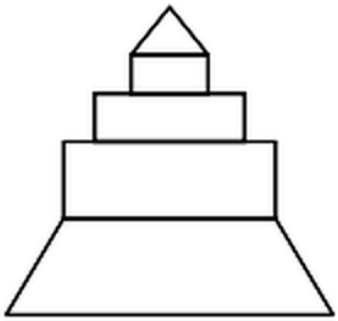
(A) JEE-Main_2017-04-02_Single-Sitting_Paper-2_Q033_Opt1.png



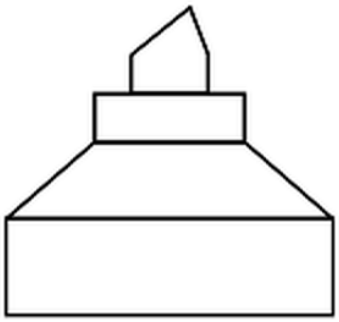
(B) JEE-Main_2017-04-02_Single-Sitting_Paper-2_Q033_Opt2.png



(C) JEE-Main_2017-04-02_Single-Sitting_Paper-2_Q033_Opt3.png

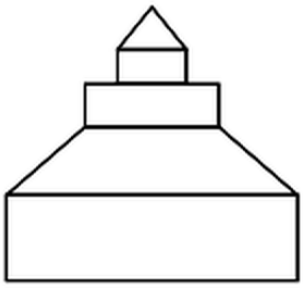


(D) JEE-Main_2017-04-02_Single-Sitting_Paper-2_Q033_Opt4.png



Correct Answer: (B)

JEE-Main_2017-04-02_Single-Sitting_Paper-2_Q033_Opt2.png



Solution:

Concept:

- In an orthographic elevation, a square frustum has a trapezoidal profile and a square pyramid has a triangular profile.
- The widths in an elevation must match the corresponding footprints in the plan, while sloping face boundaries and horizontal ledges must remain consistent.

Step 1: Interpret the nested boundaries The large outer square joins the next smaller square by diagonal corner lines. These are the edges of a square tapered component, whose lower footprint reaches the large square and whose upper footprint reaches the inner square. The smallest central square contains diagonals meeting at its centre, indicating the apex of a square pyramid. The entire arrangement is centred.

Step 2: Build the projected outline Viewed along the arrow, the wide lower footprint projects across the full width. The taper above the lower rectangular base narrows directly to the width of the central square tier. Above that tier is a narrower central block and a triangular pyramid cap. Option (B) has this wide rectangular bottom, the full-width taper rising inward to the square tier, and the symmetric pointed cap at the centre.

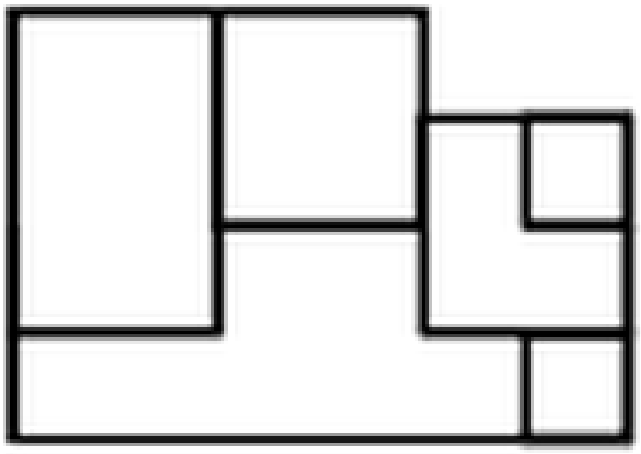
Step 3: Reject mismatching details Option (A) places the lower ends of its sloping sides inside the width of the bottom base, creating an additional exposed ledge that the given outer-square-to-inner-square taper does not show. Option (C) puts a vertical rectangular stage between the taper and the square tier, changing the sequence of projected surfaces. Option (D) has an asymmetric sloping cap instead of the centred symmetric pyramid indicated by the small square and its crossing diagonals. Thus (B) alone matches all the distinguishing features.

Step 4: Conclusion The correct projected profile is the centred tapered assembly in (B). Hence, the correct option is (B).

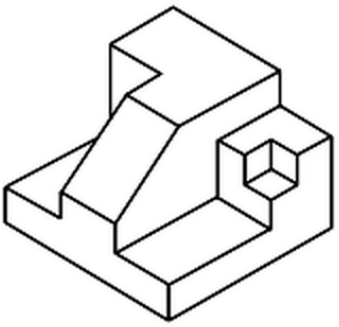
Quick Tip to Solve: Use corner-to-corner diagonals to recognise a taper, and crossed diagonals inside the smallest square to recognise a pyramid cap.

34. Directions : (For Q. No. 34 to 36). Identify the correct 3-D figure from amongst the answer figures, which has the same elevation, as given in the problem figure on the left.

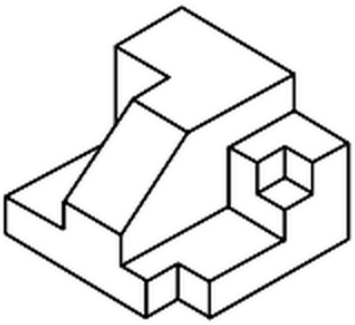
JEE-Main_2017-04-02_Single-Sitting_Paper-2_Q034_Stem-Fig.png [4 marks]



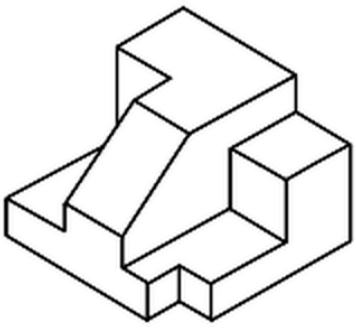
(A) JEE-Main_2017-04-02_Single-Sitting_Paper-2_Q034_Opt1.png

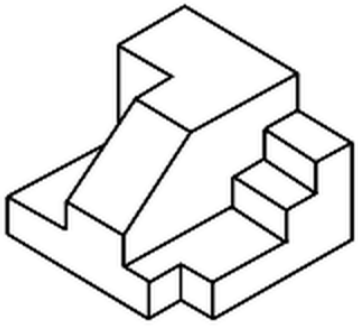


(B) JEE-Main_2017-04-02_Single-Sitting_Paper-2_Q034_Opt2.png

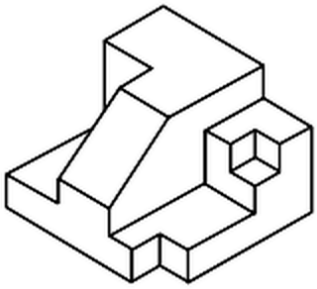


(C) JEE-Main_2017-04-02_Single-Sitting_Paper-2_Q034_Opt3.png



(D) JEE-Main_2017-04-02_Single-Sitting_Paper-2_Q034_Opt4.png 

Correct Answer: (B)

JEE-Main_2017-04-02_Single-Sitting_Paper-2_Q034_Opt2.png 

Solution:

Concept:

- An elevation collapses depth but preserves heights and the horizontal locations of visible edges. A recess is identified by its internal corner lines, not just by the outside silhouette.
- To distinguish similar isometric options, compare independent features: the large sloping block, the small right-hand recess and the notch in the base.

Step 1: Separate the elevation into features The elevation has a tall left and central portion and a lower right-hand portion. Within the right-hand portion, a small corner subdivision appears near the top. A further vertical division occurs at the lower right edge of the base. These small lines are decisive because the main ramp and upper block are almost identical in the four alternatives.

Step 2: Locate the matching recesses Option (B) has the high main block with the inclined face. Its smaller right-hand block contains a square corner recess, whose edges account for the small upper subdivision. The front corner of the base also has a rectangular notch, giving the extra lower vertical edge shown in the elevation. Both details occur together in the required positions when the depth of the isometric view is collapsed.

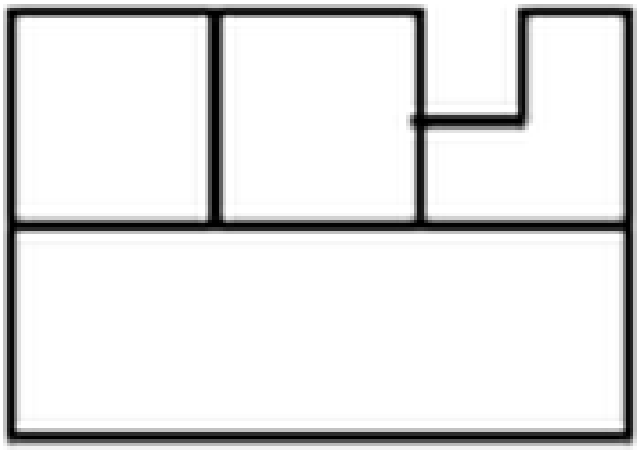
Step 3: Check why the other solids fail Option (A) contains the upper square recess but leaves the front edge of the base continuous, so it cannot provide the lower notch division. Option (C) includes a base notch but the smaller right block is solid and has no upper corner recess. Option (D) has a stepped open ledge on the right instead of the displayed square recess with its corner edges. Matching only the overall height would miss these differences; matching both small subdivisions selects (B).

Step 4: Conclusion The solid containing both the upper corner recess and the base notch is (B). Hence, the correct option is (B).

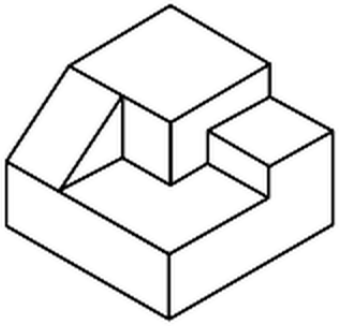
Quick Tip to Solve: With nearly identical solids, mark the smallest internal edges in the elevation and use them to test each recess and base notch.

35. Directions : (For Q. No. 34 to 36). Identify the correct 3-D figure from amongst the answer figures, which has the same elevation, as given in the problem figure on the left.

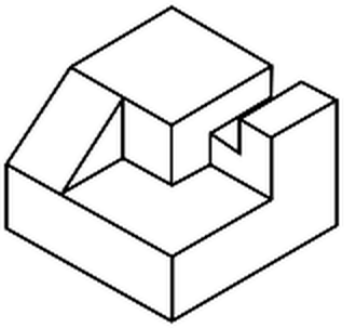
JEE-Main_2017-04-02_Single-Sitting_Paper-2_Q035_Stem-Fig.png [4 marks]



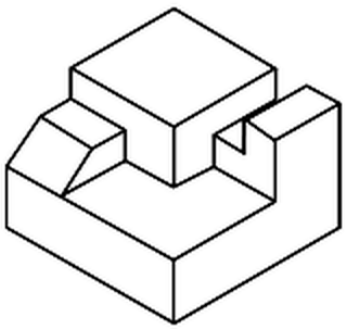
(A) JEE-Main_2017-04-02_Single-Sitting_Paper-2_Q035_Opt1.png

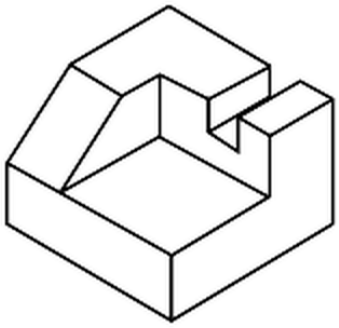


(B) JEE-Main_2017-04-02_Single-Sitting_Paper-2_Q035_Opt2.png

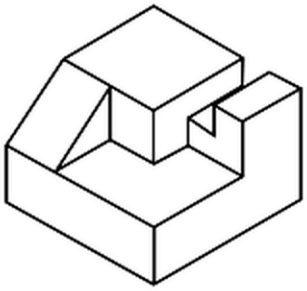


(C) JEE-Main_2017-04-02_Single-Sitting_Paper-2_Q035_Opt3.png



(D) JEE-Main_2017-04-02_Single-Sitting_Paper-2_Q035_Opt4.png 

Correct Answer: (B)

JEE-Main_2017-04-02_Single-Sitting_Paper-2_Q035_Opt2.png 

Solution:

Concept:

- Orthographic projection preserves the relative levels of surfaces and the positions of vertical divisions, even though the depth of the object disappears.
- A notch in the upper edge produces a down-and-up change in the elevation. Its height must be compared with the main upper block and the intervening ledge.

Step 1: Read the required height sequence The base is a wide rectangle with a straight horizontal top line. Above it, the left and middle portions reach the same upper level. The right-hand region first falls to an intermediate ledge and then rises again at its far end. The middle upper face has a clear vertical division, while no extra horizontal step interrupts the left upper part.

Step 2: Project the matching solid Option (B) has a ramp rising to the high central block. On the right, the narrower raised block contains an inner notch: its inner portion is lower, while its outer end reaches the upper level. Projecting these surfaces produces the required drop and rise on the right. The top block itself remains intact, giving the plain high middle portion in the elevation.

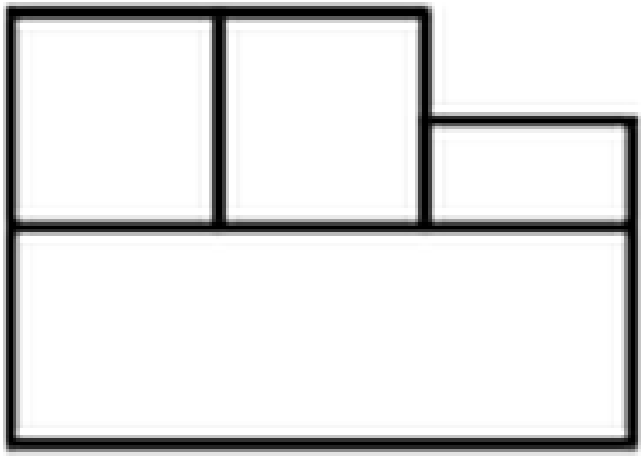
Step 3: Use the small differences to eliminate options Option (A) has a simple lower right block rather than the tall terminal portion and its notch, so the right edge does not rise to the required height. Option (C) inserts a horizontal step above the ramp on the left, adding a line and changing the left height sequence. Option (D) removes a corner from the main high block, introducing an additional recess and an internal subdivision in that upper region. Those extra or missing changes do not appear in the given elevation. Option (B) supplies precisely the shown combination.

Step 4: Conclusion The elevation belongs to the solid in (B). Hence, the correct option is (B).

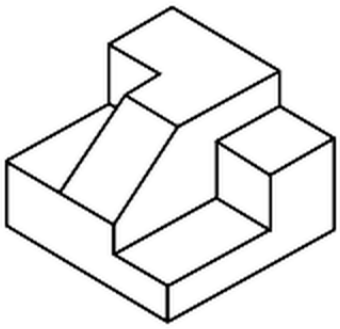
Quick Tip to Solve: Compare the upper outline as a sequence of levels from left to right, then check whether any extra notch would introduce an unwanted edge.

36. Directions : (For Q. No. 34 to 36). Identify the correct 3-D figure from amongst the answer figures, which has the same elevation, as given in the problem figure on the left.

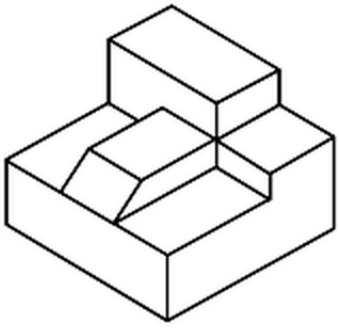
JEE-Main_2017-04-02_Single-Sitting_Paper-2_Q036_Stem-Fig.png [4 marks]



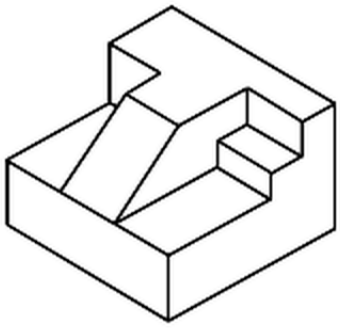
(A) JEE-Main_2017-04-02_Single-Sitting_Paper-2_Q036_Opt1.png

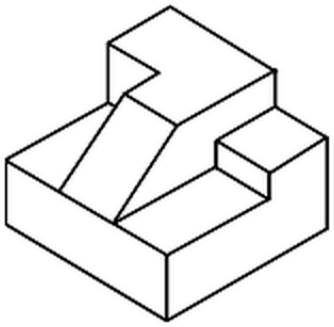


(B) JEE-Main_2017-04-02_Single-Sitting_Paper-2_Q036_Opt2.png

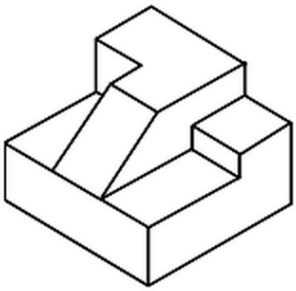


(C) JEE-Main_2017-04-02_Single-Sitting_Paper-2_Q036_Opt3.png



(D) JEE-Main_2017-04-02_Single-Sitting_Paper-2_Q036_Opt4.png 

Correct Answer: (D)

JEE-Main_2017-04-02_Single-Sitting_Paper-2_Q036_Opt4.png 

Solution:

Concept:

- An elevation is obtained by projecting all points in one viewing direction; depth is suppressed while vertical levels remain unchanged.
- The visible junction of a ramp with a base is significant: a ramp ending above the base introduces a vertical riser, whereas a ramp reaching the base does not.

Step 1: List the edges to be reproduced The given elevation has one broad rectangular base. Above the base, two adjacent portions on the left reach the same high level, separated by a vertical edge. The right portion is a single lower rectangle with a flat top. There is no extra step in that right portion and no additional raised strip immediately above the base.

Step 2: Trace the solid in option D In option (D), the inclined face rises directly from the base to the tall rear block. Its lower end reaches the base level without a separate vertical riser. The main upper mass supplies the high region and its central projected division, while the smaller right-hand block supplies the one lower, flat-topped region. After depth is removed, these edges give the displayed two-level upper arrangement on a continuous rectangular base.

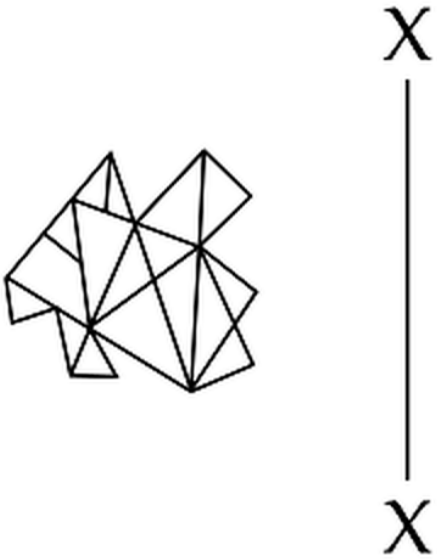
Step 3: Rule out the altered surfaces Option (A) terminates the ramp above the base, leaving a short vertical riser beneath its lower end and changing the projected junction. Option (B) has a separate low ramp in front of the main high block, introducing an extra intermediate platform and a different internal division. Option (C) turns the right-hand portion into an open step with a high back edge, rather than the single plain lower rectangle required. Those features would create additional edges or levels. Only option (D) avoids them while retaining the correct upper division.

Step 4: Conclusion The solid that gives the stated elevation is (D). Hence, the correct option is (D).

Quick Tip to Solve: Check where a ramp actually meets the base; a small riser can distinguish two otherwise almost identical isometric drawings.

37. Directions : (For Q. No. 37 to 40). Which one of the answer figures is the correct mirror image of the problem figure with respect to X - X ?

JEE-Main_2017-04-02_Single-Sitting_Paper-2_Q037_Stem-Fig.png [4 marks]



(A) JEE-Main_2017-04-02_Single-Sitting_Paper-2_Q037_Opt1.png 

(B) JEE-Main_2017-04-02_Single-Sitting_Paper-2_Q037_Opt2.png 

(C) JEE-Main_2017-04-02_Single-Sitting_Paper-2_Q037_Opt3.png 

(D) JEE-Main_2017-04-02_Single-Sitting_Paper-2_Q037_Opt4.png 

Correct Answer: (D) JEE-Main_2017-04-02_Single-Sitting_Paper-2_Q037_Opt4.png 

Solution:

Concept:

- A reflection in the vertical line $X - X$ reverses left and right, while preserving the height of every vertex and the shape and size of every component.
- For a vertical mirror $x = a$, a point (x, y) has image $(2a - x, y)$. Thus every line segment and every intersection must be checked, not just the outside boundary.

Step 1: Reverse the positions of the distinctive parts The large four-sided lobe at the upper right of the problem figure must appear at the upper left. Its internal near-vertical segment remains a near-vertical segment. The narrow triangular peak at the upper left moves to the upper right, while

the small projecting triangle near the lower left moves to the lower right. None of these changes involves turning the figure upside down.

Step 2: Trace the internal connections Follow the two main interior junctions and the long diagonals meeting at them. The lower main vertex stays at the bottom, but moves to the other side. Each straight connection in the original must remain straight in the image, and the small subdivision near the upper-left sloping boundary must reappear near the upper-right sloping boundary.

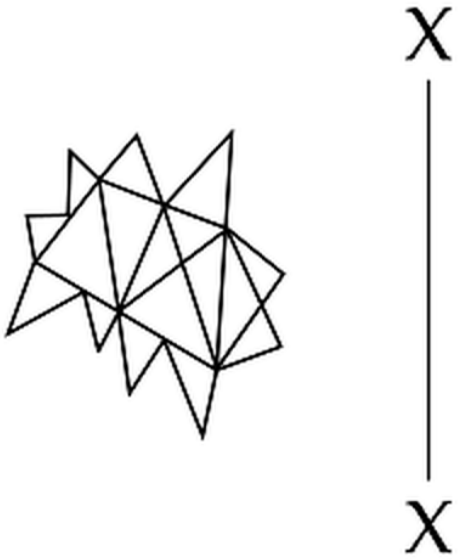
Step 3: Eliminate the altered figures Option (B) omits the small internal subdivisions in the upper-right portion, so its outline alone is insufficient. Option (C) contains additional cross-connections, including a transverse line in the right-hand projection. Option (A) alters the interior connection from the upper-left main junction: its segment bends at the crossing instead of following the required straight diagonal. Option (D) preserves the outline, subdivisions and straight connections together.

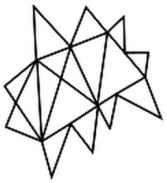
Step 4: Conclusion The complete left-right reflection of the problem figure is (D). Hence, the correct option is (D).

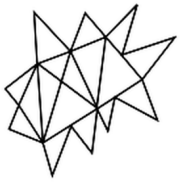
Quick Tip to Solve: For a dense line figure, compare one outer lobe and then trace a long straight diagonal through its crossings; a matching outline can conceal a wrong connection.

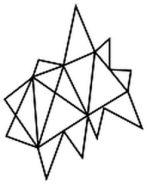
38. Directions : (For Q. No. 37 to 40). Which one of the answer figures is the correct mirror image of the problem figure with respect to X - X ?

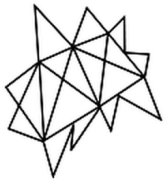
JEE-Main_2017-04-02_Single-Sitting_Paper-2_Q038_Stem-Fig.png [4 marks]



(A) JEE-Main_2017-04-02_Single-Sitting_Paper-2_Q038_Opt1.png 

(B) JEE-Main_2017-04-02_Single-Sitting_Paper-2_Q038_Opt2.png 

(C) JEE-Main_2017-04-02_Single-Sitting_Paper-2_Q038_Opt3.png 

(D) JEE-Main_2017-04-02_Single-Sitting_Paper-2_Q038_Opt4.png 

Correct Answer: (A) JEE-Main_2017-04-02_Single-Sitting_Paper-2_Q038_Opt1.png 

Solution:

Concept:

- A reflection in the vertical line $X - X$ reverses left and right, while preserving the height of every vertex and the shape and size of every component.
- For a vertical mirror $x = a$, a point (x, y) has image $(2a - x, y)$. Thus every line segment and every intersection must be checked, not just the outside boundary.

Step 1: Locate the reflected outline The tall triangular point on the upper right of the problem figure must move to the upper left, at the same height. The stepped pair of small projections on the upper left moves to the upper right. The long downward point remains downward, and the projecting triangle at the far left becomes a projecting triangle at the far right.

Step 2: Check the junctions and small triangles The central fan of straight segments must reverse its handedness. In particular, the small lower projections retain their heights and order after left and right are interchanged. The prominent near-vertical interior line on the left of the original moves to the right of the reflected figure. Option (A) has this complete arrangement, including the upper-left tall point and the upper-right small step.

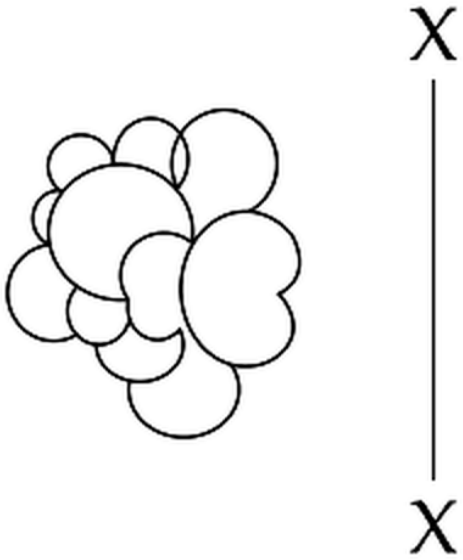
Step 3: Compare the distractors Option (B) changes the upper-right outline into two large projecting triangular tips, unlike the reflected small step. Option (C) changes the upper-left outline: the tall peak is displaced and the required left sloping connection is replaced. Option (D) includes extra interior connections from the central upper junction towards the far-right edge and changes the lower small triangular arrangement. These differences cannot be produced by reflection, which preserves connections.

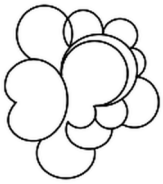
Step 4: Conclusion Only option (A) preserves every projection and internal connection after left-right reversal. Hence, the correct option is (A).

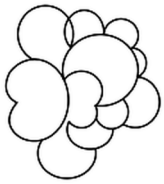
Quick Tip to Solve: Start with the tallest point and the smallest stepped projection; these asymmetrical features distinguish the correct mirror image quickly.

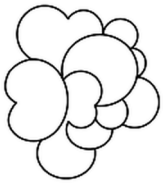
39. Directions : (For Q. No. 37 to 40). Which one of the answer figures is the correct mirror image of the problem figure with respect to X - X ?

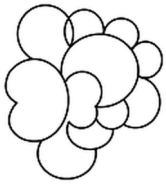
JEE-Main_2017-04-02_Single-Sitting_Paper-2_Q039_Stem-Fig.png [4 marks]

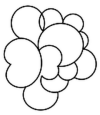


(A) JEE-Main_2017-04-02_Single-Sitting_Paper-2_Q039_Opt1.png 

(B) JEE-Main_2017-04-02_Single-Sitting_Paper-2_Q039_Opt2.png 

(C) JEE-Main_2017-04-02_Single-Sitting_Paper-2_Q039_Opt3.png 

(D) JEE-Main_2017-04-02_Single-Sitting_Paper-2_Q039_Opt4.png 

Correct Answer: (B) JEE-Main_2017-04-02_Single-Sitting_Paper-2_Q039_Opt2.png 

Solution:

Concept:

- A reflection in the vertical line $X - X$ reverses left and right, while preserving the height of every vertex and the shape and size of every component.
- For a vertical mirror $x = a$, a point (x, y) has image $(2a - x, y)$. Thus every line segment and every intersection must be checked, not just the outside boundary.

Step 1: Reflect the major curved lobes The large double-lobed shape on the right of the original must appear on the left of the answer. Its inward notch moves from the outer right edge to the outer left edge. The large rounded lobe at the bottom remains at the bottom. The large rounded lobe near the

upper right moves to the upper left without changing its curved boundary.

Step 2: Preserve the overlap boundaries A mirror image reverses the whole drawing, including the lines indicating which rounded shapes overlap. The large central rounded region must therefore move to the right of the double-lobed shape. The smaller central lobe must lie to its lower left. The small rounded regions along the original left edge appear in corresponding positions along the answer right edge.

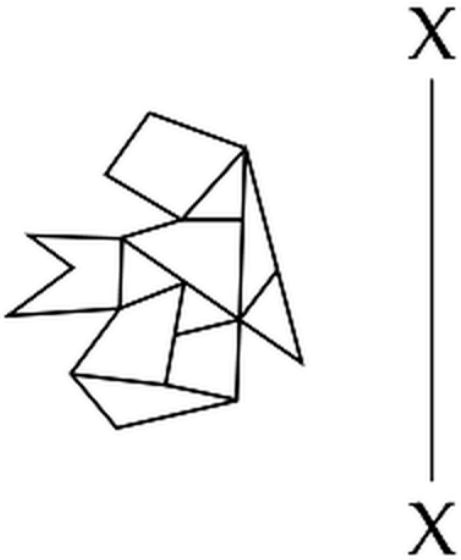
Step 3: Reject the incorrect overlap patterns Option (A) adds a second concentric-looking arc around the large central region and does not reproduce the required central overlap. Option (C) merges the two upper lobes into a single notched outline, removing the original crossing of their arcs. Option (D) gives a differently projecting small right-hand lobe, rather than the small partly hidden region in the original. Option (B) alone retains both the individual curved outlines and their overlap order.

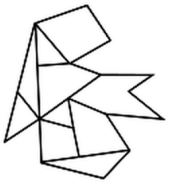
Step 4: Conclusion Option (B) is the correct vertical-mirror image, including the curved overlap details. Hence, the correct option is (B).

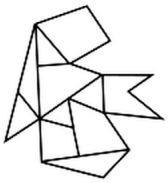
Quick Tip to Solve: For overlapping circles or lobes, check the small hidden arcs after checking the large outline; reflection preserves every overlap boundary.

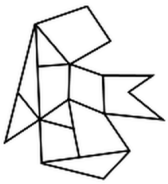
40. Directions : (For Q. No. 37 to 40). Which one of the answer figures is the correct mirror image of the problem figure with respect to X - X ?

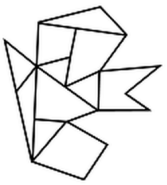
JEE-Main_2017-04-02_Single-Sitting_Paper-2_Q040_Stem-Fig.png [4 marks]



(A) JEE-Main_2017-04-02_Single-Sitting_Paper-2_Q040_Opt1.png 

(B) JEE-Main_2017-04-02_Single-Sitting_Paper-2_Q040_Opt2.png 

(C) JEE-Main_2017-04-02_Single-Sitting_Paper-2_Q040_Opt3.png 

(D) JEE-Main_2017-04-02_Single-Sitting_Paper-2_Q040_Opt4.png 

Correct Answer: (B) JEE-Main_2017-04-02_Single-Sitting_Paper-2_Q040_Opt2.png 

Solution:

Concept:

- A reflection in the vertical line $X - X$ reverses left and right, while preserving the height of every vertex and the shape and size of every component.
- For a vertical mirror $x = a$, a point (x, y) has image $(2a - x, y)$. Thus every line segment and every intersection must be checked, not just the outside boundary.

Step 1: Reflect the three conspicuous projections The upper quadrilateral on the left of the problem figure must become an upper quadrilateral on the right. The notched flag pointing left must point right, and the narrow triangular projection on the right must move to the left. The broad lower polygon remains at the bottom; a horizontal mirror would move it upwards and is therefore inappropriate.

Step 2: Keep the internal divisions The flag in the original has a vertical segment at its attachment, separating it from the adjacent central triangle. That separator must still be present in the reflected right-hand flag. The two principal central junctions must be connected diagonally, with the surrounding triangular subdivisions reversed left-to-right. The lower quadrilateral also retains its sloping internal divider.

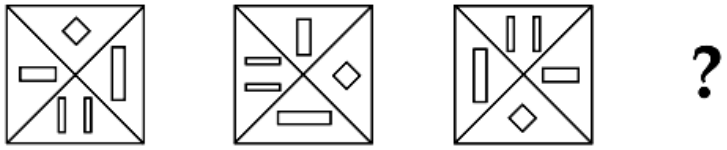
Step 3: Eliminate the alternatives Option (A) lacks the vertical separator at the left edge of the right-hand flag. Option (C) retains a flag separator but changes the central diagonal arrangement into a vertical central connection, so its interior does not match. Option (D) moves the upper quadrilateral to the bottom and the lower parts to the top; this is not reflection in the given vertical line. Option (B) retains the upper, central and lower features at their original heights with their handedness reversed.

Step 4: Conclusion The image in option (B) satisfies both the outer-boundary and internal-line tests. Hence, the correct option is (B).

Quick Tip to Solve: In mirror-image questions, first exclude upside-down figures, then check an internal separator that an otherwise convincing option may omit.

41. Directions : (For Q. No. 41 and 42). Which one of the answer figures will complete the sequence of the three problem figures ?

JEE-Main_2017-04-02_Single-Sitting_Paper-2_Q041_Stem-Fig.png [4 marks]



(A) JEE-Main_2017-04-02_Single-Sitting_Paper-2_Q041_Opt1.png 

(B) JEE-Main_2017-04-02_Single-Sitting_Paper-2_Q041_Opt2.png 

(C) JEE-Main_2017-04-02_Single-Sitting_Paper-2_Q041_Opt3.png 

(D) JEE-Main_2017-04-02_Single-Sitting_Paper-2_Q041_Opt4.png 

Correct Answer: (B) JEE-Main_2017-04-02_Single-Sitting_Paper-2_Q041_Opt2.png 

Solution:

Concept:

- In a figure sequence, one transformation must explain all the consecutive figures. Here the four sectors are formed by the two diagonals of a square.
- The symbols move one sector clockwise at each stage, and the rectangular bars also rotate through $90°$. Relative length and the number of bars are preserved.

Step 1: Track the diamond and the paired bars The diamond occupies the top sector in the first figure, the right sector in the second and the bottom sector in the third. It must therefore occupy the left sector in the fourth. The two thin bars move from bottom to left to top, so next they belong in the right sector. Their orientation becomes horizontal there.

Step 2: Track the unequal single bars The long single bar moves from the right sector to the bottom sector and then to the left sector. Consequently, it must next lie horizontally in the top sector. The shorter single bar moves from left to top to right, so it must next lie vertically in the bottom sector. This distinguishes a true quarter-turn of all symbols from a mere cyclic change of their positions.

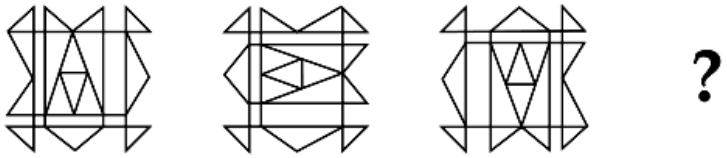
Step 3: Choose the figure satisfying every condition Option (B) has the diamond on the left, two horizontal thin bars on the right, the longer horizontal single bar at the top and the shorter vertical single bar at the bottom. Option (A) places the single bars in the correct sectors but with incorrect orientations. Option (C) also fails the orientation of the long upper bar. Option (D) places the diamond on the right and the paired bars on the left, contrary to the established clockwise movement.

Step 4: Conclusion The fourth figure must be the arrangement shown in option (B). Hence, the correct option is (B).

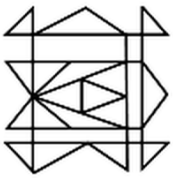
Quick Tip to Solve: Track the diamond first, then distinguish the two single bars by length; checking position alone leaves a tempting incorrect option.

42. Directions : (For Q. No. 41 and 42). Which one of the answer figures will complete the sequence of the three problem figures ?

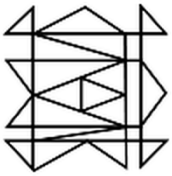
JEE-Main_2017-04-02_Single-Sitting_Paper-2_Q042_Stem-Fig.png [4 marks]



(A) JEE-Main_2017-04-02_Single-Sitting_Paper-2_Q042_Opt1.png 

(B) JEE-Main_2017-04-02_Single-Sitting_Paper-2_Q042_Opt2.png 

(C) JEE-Main_2017-04-02_Single-Sitting_Paper-2_Q042_Opt3.png 

(D) JEE-Main_2017-04-02_Single-Sitting_Paper-2_Q042_Opt4.png 

Correct Answer: (A) JEE-Main_2017-04-02_Single-Sitting_Paper-2_Q042_Opt1.png 

Solution:

Concept:

- A rotational sequence preserves the number of lines and their connections. Here each complete design turns clockwise through 90° to give the next design.
- The internal triangular motif points up, right and down in the three given figures. Its next direction is left, while the outer projections and parallel framing lines must turn with it.

Step 1: Establish the quarter-turn rule Observe the central motif rather than the many overlapping lines: its pointed end is upward in the first drawing, rightward in the second and downward in the third. A further clockwise quarter-turn makes it leftward. The pair of framing lines also alternates between vertical and horizontal, consistently with rotation of the complete design.

Step 2: Rotate the outer boundary as well In the third figure the upper central outline forms an outward peak. After the next turn this peak must appear on the right. The inward notch on its right

edge moves to the lower edge. Each small triangular corner projection rotates with the frame, and each original interior line has one corresponding line in the fourth figure; rotation neither adds spokes nor changes a notch into a peak.

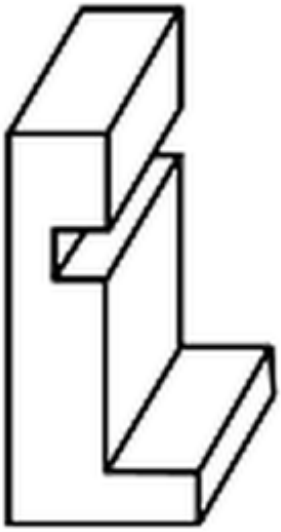
Step 3: Match the complete rotated figure Option (A) has the left-pointing central motif, the outward peak on the right, the upward-pointing notch in the lower outline, and the correct corner triangles. Option (B) inserts extra radiating diagonals at the left central junction. Option (C) keeps the wrong top and bottom boundary shapes instead of the required rotated peak and notch. Option (D) contains extra diagonal divisions across the upper and lower strips. These additions are not part of a rigid quarter-turn.

Step 4: Conclusion The sequence is completed by option (A), the next clockwise quarter-turn of the design. Hence, the correct option is (A).

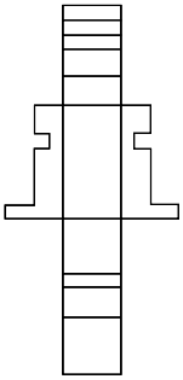
Quick Tip to Solve: Use the central arrow to determine the turn, then verify one exterior notch and the number of internal lines to reject embellished distractors.

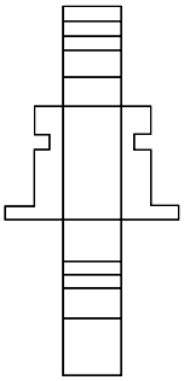
43. Directions : (For Q. No. 43 to 45). Which one of the answer figures shows the correct view of the 3-D problem figure after the problem figure is opened up ?

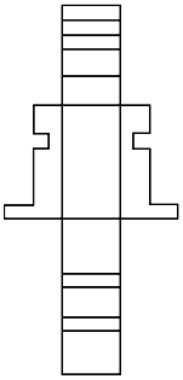
JEE-Main_2017-04-02_Single-Sitting_Paper-2_Q043_Stem-Fig.png [4 marks]

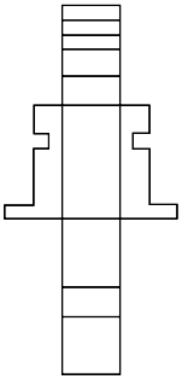


(A) JEE-Main_2017-04-02_Single-Sitting_Paper-2_Q043_Opt1.png

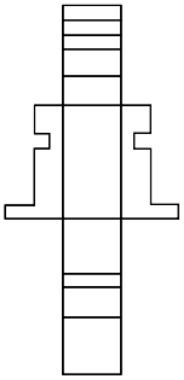


(B) JEE-Main_2017-04-02_Single-Sitting_Paper-2_Q043_Opt2.png 

(C) JEE-Main_2017-04-02_Single-Sitting_Paper-2_Q043_Opt3.png 

(D) JEE-Main_2017-04-02_Single-Sitting_Paper-2_Q043_Opt4.png 

Correct Answer: (A)

JEE-Main_2017-04-02_Single-Sitting_Paper-2_Q043_Opt1.png 

Solution:

Concept:

- A uniform solid can be opened into two identical end profiles and a band of rectangular lateral faces. Each rectangle in the band has the same depth as the prism.
- Walking around the boundary of an end profile determines the order and widths of the rectangles. Every change of direction requires a fold, including both corners of a recess.

Step 1: Identify the end profile The solid has a tall upright, a projecting foot at the bottom and a small inward notch near the top. The two matching stepped pieces in each proposed development are the end faces. The long central strip must wrap around all the edges of this profile. Its subdivisions cannot be chosen merely to give a similar total strip length: their individual lengths must match successive edges.

Step 2: Trace the folds around the notch Start at the large rectangular face joining the two end profiles, then follow the boundary towards the lower projecting foot and around the upright. The short edges of the foot and the two short edges at the upper recess each require their own narrow rectangular panels. In (A), these panels occur in the correct sequence, with the long return panel after the short stepped panels. Folding along these lines closes the band against both end profiles.

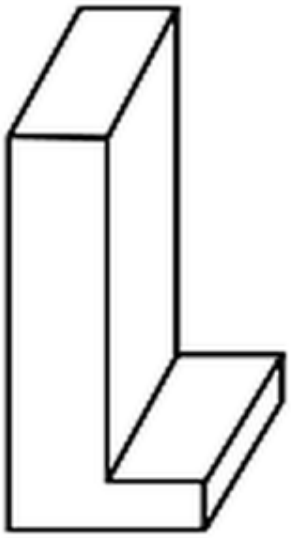
Step 3: Eliminate the other developments Option (B) changes the subdivision positions below the central face, so the long return panel begins before the corresponding stepped edges have been covered. Option (C) introduces an additional division in that return region and does not match the same edge sequence. Option (D) omits the separate narrow panels required by the upper recess. Thus their fold lines cannot all coincide with the corners of the given solid.

Step 4: Conclusion The rectangular band and stepped end faces in (A) reconstruct the given solid. Hence, the correct option is (A).

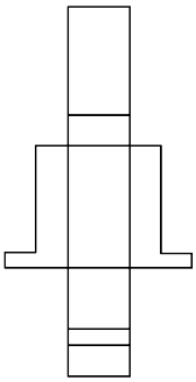
Quick Tip to Solve: For a notched prism, trace one complete end-face perimeter and mark every corner; the strip must have a matching fold at each corner, including inward ones.

44. Directions : (For Q. No. 43 to 45). Which one of the answer figures shows the correct view of the 3-D problem figure after the problem figure is opened up ?

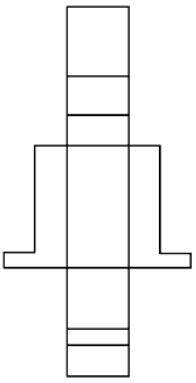
JEE-Main_2017-04-02_Single-Sitting_Paper-2_Q044_Stem-Fig.png [4 marks]



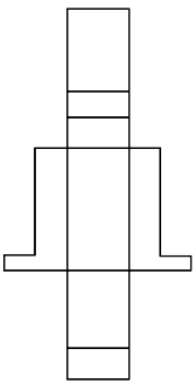
(A) JEE-Main_2017-04-02_Single-Sitting_Paper-2_Q044_Opt1.png

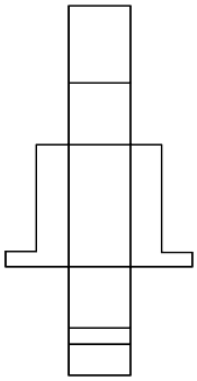


(B) JEE-Main_2017-04-02_Single-Sitting_Paper-2_Q044_Opt2.png

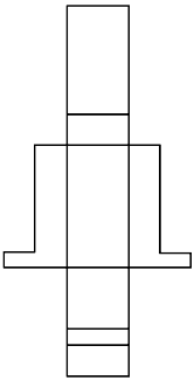


(C) JEE-Main_2017-04-02_Single-Sitting_Paper-2_Q044_Opt3.png



(D) JEE-Main_2017-04-02_Single-Sitting_Paper-2_Q044_Opt4.png 

Correct Answer: (A)

JEE-Main_2017-04-02_Single-Sitting_Paper-2_Q044_Opt1.png 

Solution:

Concept:

- The net of a right prism contains two identical end faces and a lateral strip whose panel widths follow the perimeter of an end face.
- For an L-shaped profile, distinguish the long outer vertical edge, the shorter inner vertical edge, the top thickness, the projecting horizontal arm and the thin base edge.

Step 1: Read the L-shaped profile The given object is a uniform extrusion of an L-shaped end face. The tall upright rises above a short horizontal foot. Two identical L-shaped profiles are therefore needed at the sides of the developed band. Their placement is common to the options, so the decisive information is the sequence of transverse lines across the band.

Step 2: Match each panel with an edge Take the central rectangular panel as the face adjoining the long upright edges of the two L-shaped profiles. On opening the rest of the surface, the panels must turn over the top thickness, down the opposite vertical side, and around the projecting foot. The foot creates a long horizontal face and a short vertical thickness face; these are separate panels. In (A), the upper and lower subdivisions occur at the appropriate distances from the shared central panel.

Step 3: Test the alternative fold positions In (B), the upper part is split into extra shorter panels rather than preserving the uninterrupted long side required by the upright. In (C), a lower division is missing, merging two faces which must meet at a corner of the foot. In (D), the upper division is shifted and the widths no longer correspond to the upright and top edge. Folding these alternatives would place a crease inside a flat face or leave a required corner without a crease.

Step 4: Conclusion Only development (A) has the correct sequence of lateral faces for the L-shaped

solid. Hence, the correct option is (A).

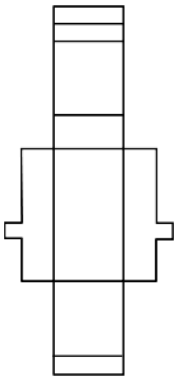
Quick Tip to Solve: When two nets have the same outline, ignore their total length at first and compare the distances between fold lines with the individual edges of the end profile.

45. Directions : (For Q. No. 43 to 45). Which one of the answer figures shows the correct view of the 3-D problem figure after the problem figure is opened up ?

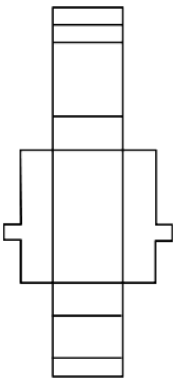
JEE-Main_2017-04-02_Single-Sitting_Paper-2_Q045_Stem-Fig.png [4 marks]

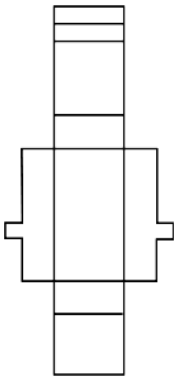


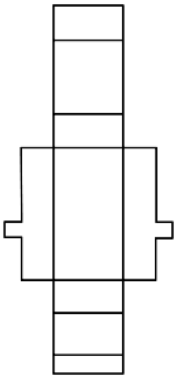
(A) JEE-Main_2017-04-02_Single-Sitting_Paper-2_Q045_Opt1.png



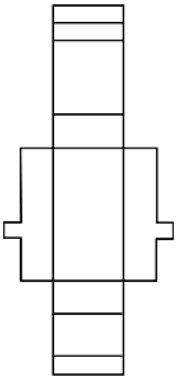
(B) JEE-Main_2017-04-02_Single-Sitting_Paper-2_Q045_Opt2.png



(C) JEE-Main_2017-04-02_Single-Sitting_Paper-2_Q045_Opt3.png 

(D) JEE-Main_2017-04-02_Single-Sitting_Paper-2_Q045_Opt4.png 

Correct Answer: (B)

JEE-Main_2017-04-02_Single-Sitting_Paper-2_Q045_Opt2.png 

Solution:

Concept:

- Opening a prism preserves its end profile and unfolds the lateral faces into rectangles. Each step in the profile produces another change of face direction.
- A projecting middle ledge has both an upper and a lower surface. Its two short thickness edges must remain distinct in the developed band.

Step 1: Identify the additional ledge Unlike a simple L-shaped profile, the solid has a horizontal projection partway up the upright. Below that projection the profile returns to the main vertical side. This creates a pair of short horizontal edges and a short vertical edge around the ledge, in addition to the long faces of the upright. The two end pieces in the net show this same projection.

Step 2: Follow the lateral surface in order Begin with the central face joining the two profiles and trace the boundary successively around the upright, over its top, and then around the middle

projection. Every straight boundary edge requires a rectangular panel with the same corresponding length. Option (B) preserves the long panel and the narrow panels in the correct order above the central face, and also retains the separate lower subdivisions needed to return around the projecting step.

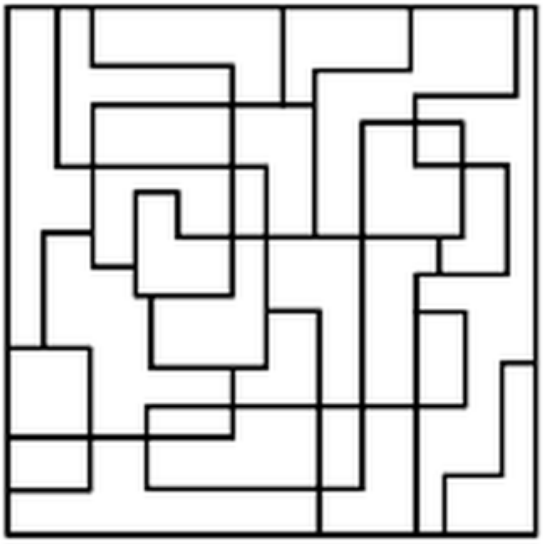
Step 3: Reject the incorrect panel sequences Option (A) merges lower portions of the strip that must be divided at a corner of the profile; a single flat rectangle cannot turn around that corner. Option (C) similarly lacks the required lower subdivision after the first short panel. Option (D) has a different upper-panel arrangement, so its creases do not track the top and upright edges correctly. These errors remain even though the two end profiles look similar in all four choices.

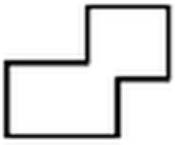
Step 4: Conclusion The unfolded surface in (B) has the required panels and their correct order around the stepped profile. Hence, the correct option is (B).

Quick Tip to Solve: Treat a projecting ledge as a sequence of separate boundary edges. Count its top, outer thickness and underside before choosing the development.

46. Directions : (For Q. No. 46). One of the following answer figures is hidden in the problem figure in the same size and direction. Select the correct one.

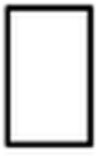
JEE-Main_2017-04-02_Single-Sitting_Paper-2_Q046_Stem-Fig.png [4 marks]



(A) JEE-Main_2017-04-02_Single-Sitting_Paper-2_Q046_Opt1.png 

(B) JEE-Main_2017-04-02_Single-Sitting_Paper-2_Q046_Opt2.png 

(C) JEE-Main_2017-04-02_Single-Sitting_Paper-2_Q046_Opt3.png 

(D) JEE-Main_2017-04-02_Single-Sitting_Paper-2_Q046_Opt4.png 

Correct Answer: (B) JEE-Main_2017-04-02_Single-Sitting_Paper-2_Q046_Opt2.png 

Solution:

Concept:

- An embedded figure is identified by tracing its complete boundary through the given network. Extra intersecting lines may be ignored, but a missing boundary segment cannot be supplied.
- The required figure must retain its size and direction. Translation within the network is allowed; rotation, reflection and stretching are not.

Step 1: Identify the distinctive outline Figure (B) has a broad horizontal cap and a narrow stem descending on the right. Its boundary has six corners: from the upper-left corner it goes right, down the long right edge, left across the foot, up the inner edge, left along the underside of the cap, and finally up to the starting point. The inward corner is therefore on the left side of the descending stem. This direction distinguishes it from a rotated or reflected L-shaped outline.

Step 2: Trace the boundary in the network Look near the centre-right of the square network. Begin on the long horizontal line slightly above the centre, at the vertical line close to the middle of the square. Move right to the next long vertical line, follow that line down to the horizontal line about three-quarters of the way down the square, and turn left to the neighbouring vertical line. Move up that shorter vertical segment, then left along the short horizontal segment, and finally up to the starting point. These six segments reproduce the cap, right-hand stem and inward corner of (B). Lines crossing the traced outline do not invalidate it.

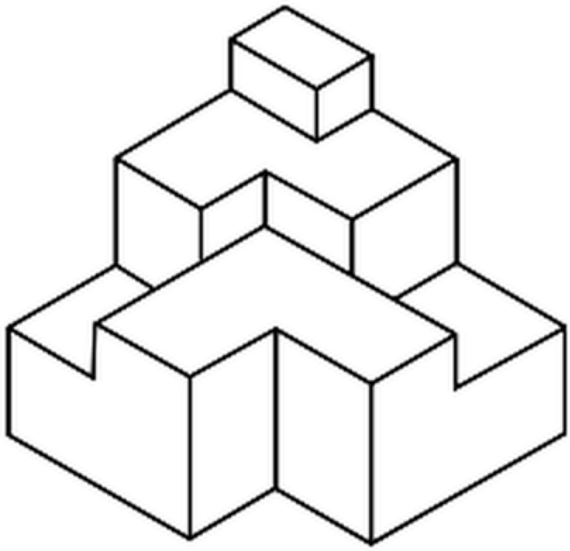
Step 3: Compare the other outlines Option (A) requires the offset extensions of a horizontal zigzag outline; it does not have the same cap-and-stem boundary. Option (C) requires two downward legs with a notch between them, rather than one right-hand stem. Option (D) is a simple tall rectangle and lacks the inward corner. Tracing similar-looking fragments is insufficient: the full closed outline must have the same side lengths and turning sequence. The continuous six-segment trace just identified matches (B) without turning or resizing it.

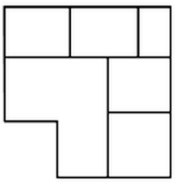
Step 4: Conclusion The hidden figure in its stated size and direction is (B). Hence, the correct option is (B).

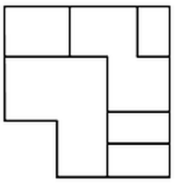
Quick Tip to Solve: Start from the inward corner of an L-shaped candidate, then trace all six sides without lifting your attention; ignore crossing lines but never invent a missing segment.

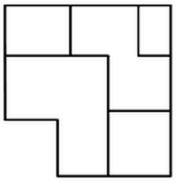
47. **Directions : (For Q. No. 47 to 50). The 3-D figure shows the view of an object. Identify the correct top view from amongst the answer figures.**

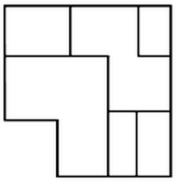
JEE-Main_2017-04-02_Single-Sitting_Paper-2_Q047_Stem-Fig.png [4 marks]

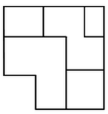


(A) JEE-Main_2017-04-02_Single-Sitting_Paper-2_Q047_Opt1.png 

(B) JEE-Main_2017-04-02_Single-Sitting_Paper-2_Q047_Opt2.png 

(C) JEE-Main_2017-04-02_Single-Sitting_Paper-2_Q047_Opt3.png 

(D) JEE-Main_2017-04-02_Single-Sitting_Paper-2_Q047_Opt4.png 

Correct Answer: (C) JEE-Main_2017-04-02_Single-Sitting_Paper-2_Q047_Opt3.png 

Solution:

Concept:

- A top view is an orthographic projection: vertical height is suppressed, while the horizontal footprint and visible boundaries between levels are retained.
- A vertical wall seen obliquely becomes a boundary line in plan. A surface edge hidden underneath a higher platform must not be continued through that platform.

Step 1: Fix the outer footprint Looking vertically down, the base has a square-like outline with a rectangular recess cut into the near side. That recess remains visible in plan; it cannot be filled merely because higher blocks lie behind it. All candidate plans show this general outline, so the internal level

boundaries must decide the answer.

Step 2: Project the upper platforms The topmost small block occupies part of the rear strip. The intermediate tier wraps around the raised central platform, and the platform nearer the observer follows the same re-entrant shape as the base. Project the edges parallel to the two horizontal directions of the isometric drawing. This gives the stepped inner boundary and the right-hand divisions shown in (C). The long internal vertical boundary ends at the correct level-change line, rather than being extended through a continuous top surface.

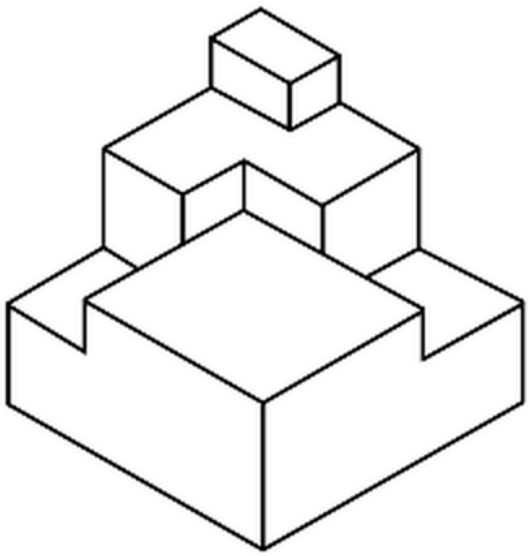
Step 3: Compare the remaining plans Option (A) joins the rear divisions into a continuous transverse line that does not represent the stepped boundary visible in the solid. Option (B) adds an extra horizontal division in the lower right part of the plan. Option (D) introduces a narrow vertical subdivision near the front-right edge, although no such separate strip is present there. Option (C) preserves both the near recess and the actual visible changes of height without these extra edges.

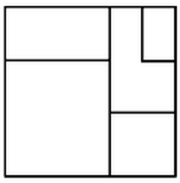
Step 4: Conclusion The top view of the given stepped object is (C). Hence, the correct option is (C).

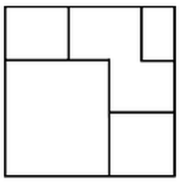
Quick Tip to Solve: First project the base recess, then add only visible boundaries between heights; never copy an oblique vertical wall as an extra strip in the plan.

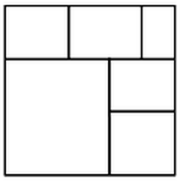
48. **Directions : (For Q. No. 47 to 50). The 3-D figure shows the view of an object. Identify the correct top view from amongst the answer figures.**

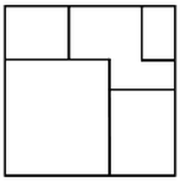
JEE-Main_2017-04-02_Single-Sitting_Paper-2_Q048_Stem-Fig.png [4 marks]

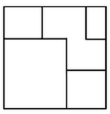


(A) JEE-Main_2017-04-02_Single-Sitting_Paper-2_Q048_Opt1.png 

(B) JEE-Main_2017-04-02_Single-Sitting_Paper-2_Q048_Opt2.png 

(C) JEE-Main_2017-04-02_Single-Sitting_Paper-2_Q048_Opt3.png 

(D) JEE-Main_2017-04-02_Single-Sitting_Paper-2_Q048_Opt4.png 

Correct Answer: (B) JEE-Main_2017-04-02_Single-Sitting_Paper-2_Q048_Opt2.png 

Solution:

Concept:

- In a top view the plan positions of horizontal surfaces remain unchanged, but vertical heights disappear.
- Only a visible edge or a change in surface level gives an internal line in the plan. A continuous horizontal platform must remain an undivided region.

Step 1: Project the base and uppermost block The bottom tier has a complete square footprint: the front corner is solid, with no notch cut into it. The small highest block is situated on the rear portion of the upper tier. Project its two horizontal edge directions down to the base plane. Its footprint divides the rear part of the plan, while the larger exposed front platform remains continuous.

Step 2: Trace the intermediate tier Follow the exposed edges where the intermediate tier ends above the broad lower platform. They form a stepped internal boundary rather than one horizontal line across the entire square. In (B), this boundary runs across the left portion, turns down through the centre-right region, and joins the right-hand horizontal division. The small rear-right region remains separated by the vertical edge of the upper tier. These lines correspond to the visible risers in the given object.

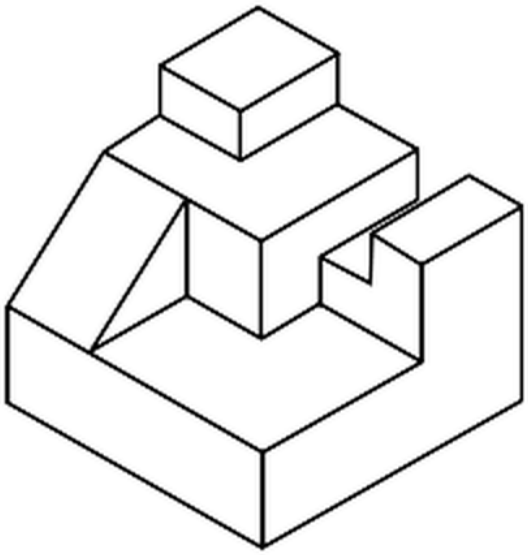
Step 3: Rule out false internal edges Option (A) omits the subdivision in the rear strip required by the topmost block and carries its central boundary too far. Option (C) draws a continuous transverse boundary across the full width, contrary to the stepped arrangement of the upper surfaces. Option (D) has the right-hand horizontal division at the wrong level relative to the central turn. Those line positions would describe different tier footprints. Only (B) matches all the projected corners together.

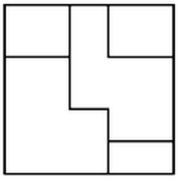
Step 4: Conclusion The correct top view is the plan shown in (B). Hence, the correct option is (B).

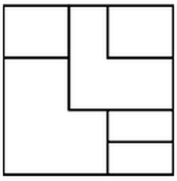
Quick Tip to Solve: For stacked platforms, project the corners of the highest block first, then trace each lower exposed boundary; do not infer plan lines from shading or apparent height.

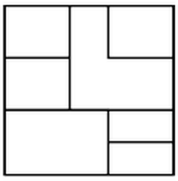
49. Directions : (For Q. No. 47 to 50). The 3-D figure shows the view of an object. Identify the correct top view from amongst the answer figures.

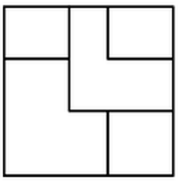
JEE-Main_2017-04-02_Single-Sitting_Paper-2_Q049_Stem-Fig.png [4 marks]

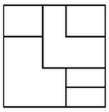


(A) JEE-Main_2017-04-02_Single-Sitting_Paper-2_Q049_Opt1.png 

(B) JEE-Main_2017-04-02_Single-Sitting_Paper-2_Q049_Opt2.png 

(C) JEE-Main_2017-04-02_Single-Sitting_Paper-2_Q049_Opt3.png 

(D) JEE-Main_2017-04-02_Single-Sitting_Paper-2_Q049_Opt4.png 

Correct Answer: (B) JEE-Main_2017-04-02_Single-Sitting_Paper-2_Q049_Opt2.png 

Solution:

Concept:

- An orthographic view projects the solid along parallel lines onto a plane perpendicular to the viewing direction; the coordinate along the line of sight is suppressed.
- Retain the outline and visible changes of face or level. Do not introduce hidden edges as solid lines or preserve the pictorial slant of depth edges.

Step 1: Project the solid vertically Imagine looking straight down at the solid, with the vertical edges pointing towards the eye. The outer base therefore becomes a square. Its thickness contributes no separate strip outside that square. The small upper block appears as a rectangle at the upper left, the

inclined face occupies a strip down the left side, and the raised central platform has a boundary that turns across the middle towards the right.

Step 2: Retain the visible changes of surface Follow the exposed horizontal surfaces rather than copying the slant of an isometric edge. The left strip is separated from the upper block by a horizontal line. The central platform has a vertical boundary down from the top edge and then a horizontal boundary towards the right edge. On the lower right, the stepped portion contributes a short horizontal division above the bottom edge. Its inner vertical boundary reaches the bottom of the square.

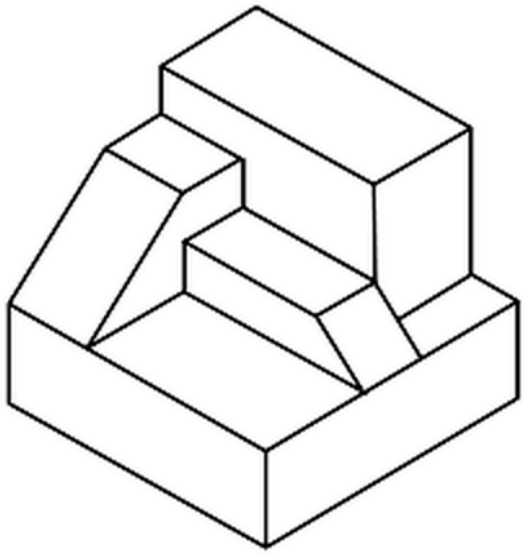
Step 3: Eliminate the competing plans Option (B) has all these boundaries in their correct positions. Option (A) introduces an extra turn in the central platform boundary instead of the straight horizontal edge. Option (C) continues the left-hand division across the middle in a way that does not match the ramp and platform. Option (D) omits the short lower-right step division. Those differences are visible-edge differences, not changes that a top view can suppress.

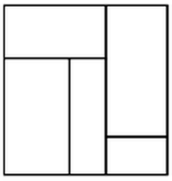
Step 4: Conclusion The plan retains the upper-left block, the left strip, the central platform boundary and the short lower-right step division. These features together match option (B). Hence, the correct option is (B).

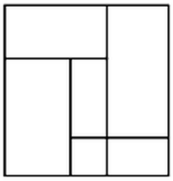
Quick Tip to Solve: In a top view, discard the vertical thickness first, then trace the boundaries of the upper block, ramp footprint and exposed steps separately.

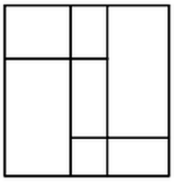
50. Directions : (For Q. No. 47 to 50). The 3-D figure shows the view of an object. Identify the correct top view from amongst the answer figures.

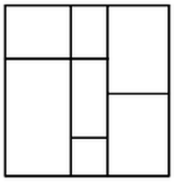
JEE-Main_2017-04-02_Single-Sitting_Paper-2_Q050_Stem-Fig.png [4 marks]

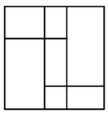


(A) JEE-Main_2017-04-02_Single-Sitting_Paper-2_Q050_Opt1.png 

(B) JEE-Main_2017-04-02_Single-Sitting_Paper-2_Q050_Opt2.png 

(C) JEE-Main_2017-04-02_Single-Sitting_Paper-2_Q050_Opt3.png 

(D) JEE-Main_2017-04-02_Single-Sitting_Paper-2_Q050_Opt4.png 

Correct Answer: (C) JEE-Main_2017-04-02_Single-Sitting_Paper-2_Q050_Opt3.png 

Solution:

Concept:

- An orthographic view projects the solid along parallel lines onto a plane perpendicular to the viewing direction; the coordinate along the line of sight is suppressed.
- Retain the outline and visible changes of face or level. Do not introduce hidden edges as solid lines or preserve the pictorial slant of depth edges.

Step 1: Fix the footprint and viewing direction The required view is from directly above, so every vertical edge collapses to a point or lies on an already projected boundary. The base gives the enclosing square. The long raised block at the rear, the inclined surface on the left and the narrow intermediate feature must all be located inside this square. Their apparent heights in the pictorial view must not be mistaken for widths in the plan.

Step 2: Trace the boundaries of the upper surfaces The narrow middle strip has a boundary running from the rear part of the square towards the front. Its rear end is divided from the adjacent left portion, so the upper-left region is not one uninterrupted rectangle. At its front end another short horizontal edge separates the strip from the front surface. The exposed strip below the long raised block supplies the horizontal division in the lower-right portion. These projected edges meet at the same level across the narrow middle and right-hand portions.

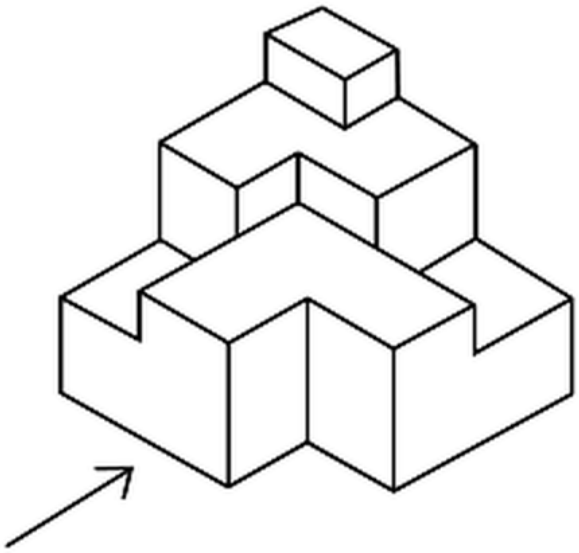
Step 3: Compare the four arrangements Option (C) preserves both the subdivision near the rear of the narrow strip and the aligned horizontal divisions near its front. Option (A) merges the rear left and middle portions and loses the short front division in the middle strip. Option (B) also merges the rear portions, although it includes a lower division. Option (D) moves the right-hand horizontal division upwards relative to the adjoining middle strip. The relative positions of the projected boundaries therefore select (C).

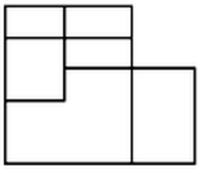
Step 4: Conclusion The top view is the square plan with the narrow central strip subdivided at both ends and its lower division aligned with the right-hand strip, as in option (C). Hence, the correct option is (C).

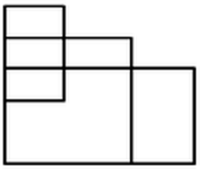
Quick Tip to Solve: Compare where each narrow strip starts and ends; a correct outer square alone cannot distinguish these four plans.

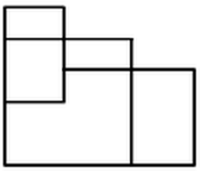
51. Directions : (For Q. No. 51 to 53). The 3–D problem figure shows a view of an object. Identify the correct front view, from amongst the answer figures, looking in the direction of arrow.

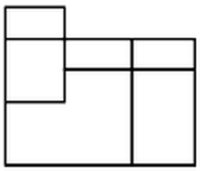
JEE-Main_2017-04-02_Single-Sitting_Paper-2_Q051_Stem-Fig.png [4 marks]

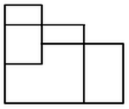


(A) JEE-Main_2017-04-02_Single-Sitting_Paper-2_Q051_Opt1.png 

(B) JEE-Main_2017-04-02_Single-Sitting_Paper-2_Q051_Opt2.png 

(C) JEE-Main_2017-04-02_Single-Sitting_Paper-2_Q051_Opt3.png 

(D) JEE-Main_2017-04-02_Single-Sitting_Paper-2_Q051_Opt4.png 

Correct Answer: (C) JEE-Main_2017-04-02_Single-Sitting_Paper-2_Q051_Opt3.png 

Solution:

Concept:

- An orthographic view projects the solid along parallel lines onto a plane perpendicular to the viewing direction; the coordinate along the line of sight is suppressed.
- Retain the outline and visible changes of face or level. Do not introduce hidden edges as solid lines or preserve the pictorial slant of depth edges.

Step 1: Look along the indicated arrow Use the arrow as the line of sight and project the object onto a vertical plane perpendicular to it. Depth is suppressed, while vertical heights remain unchanged. The small block at the top lies on the left of the elevation. The successive exposed portions extend towards the right at lower levels, giving a descending stepped outline rather than a flat upper edge.

Step 2: Determine the visible internal edges The small top block produces a horizontal line at its base. The taller left part continues below that line to the level where its visible face terminates. The middle raised portion gives a short horizontal division at the next lower level, and the foreground recess gives the vertical division in the lower-right part. A surface hidden by a nearer face must not be drawn as an additional solid line through that face.

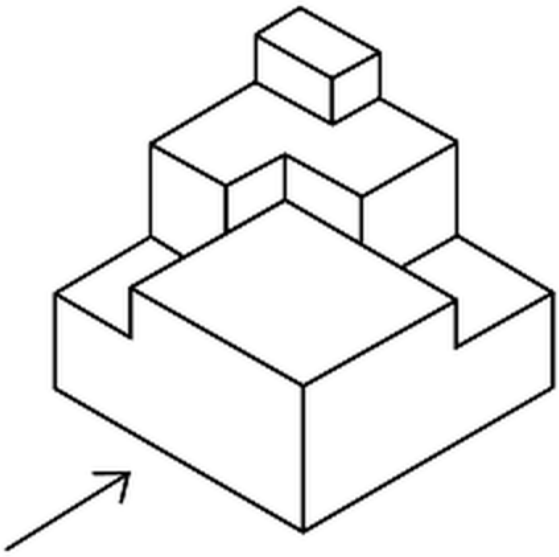
Step 3: Check the alternatives against the projection Option (C) has the correct descending outline and the required uninterrupted tall face at the left. Option (A) makes the upper middle portion as tall as the topmost block, which changes the silhouette. Option (B) inserts an extra horizontal division across the left upright. Option (D) extends the intermediate upper level too far to the right and changes the right-hand face pattern. Matching the silhouette first and then the visible inner edges leaves only (C).

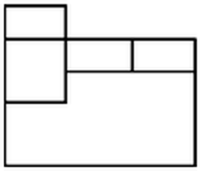
Step 4: Conclusion The front elevation has its highest step on the left, successive lower steps towards the right, and the internal edge pattern shown in option (C). Hence, the correct option is (C).

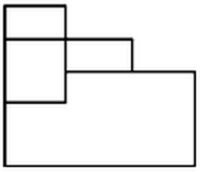
Quick Tip to Solve: First reject an incorrect stepped silhouette; then use the presence or absence of one internal horizontal edge to separate similar elevations.

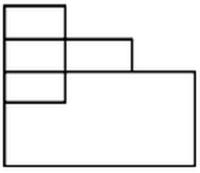
52. Directions : (For Q. No. 51 to 53). The 3–D problem figure shows a view of an object. Identify the correct front view, from amongst the answer figures, looking in the direction of arrow.

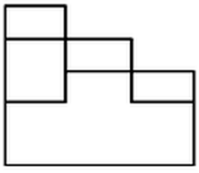
JEE-Main_2017-04-02_Single-Sitting_Paper-2_Q052_Stem-Fig.png [4 marks]

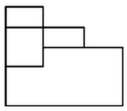


(A) JEE-Main_2017-04-02_Single-Sitting_Paper-2_Q052_Opt1.png 

(B) JEE-Main_2017-04-02_Single-Sitting_Paper-2_Q052_Opt2.png 

(C) JEE-Main_2017-04-02_Single-Sitting_Paper-2_Q052_Opt3.png 

(D) JEE-Main_2017-04-02_Single-Sitting_Paper-2_Q052_Opt4.png 

Correct Answer: (B) JEE-Main_2017-04-02_Single-Sitting_Paper-2_Q052_Opt2.png 

Solution:

Concept:

- An orthographic view projects the solid along parallel lines onto a plane perpendicular to the viewing direction; the coordinate along the line of sight is suppressed.
- Retain the outline and visible changes of face or level. Do not introduce hidden edges as solid lines or preserve the pictorial slant of depth edges.

Step 1: Establish the elevation from the arrow Observe the solid from the lower-left direction indicated by the arrow. The depth along that direction disappears, but the different heights remain. The small upper block becomes the highest step at the left. The raised portion immediately to its right reaches a lower level, and the broad foreground portion forms the lowest and widest part of the visible elevation.

Step 2: Keep only edges visible from the front The small upper block has a horizontal base line. The left upright then appears as a single face down to its lower visible boundary; it is not divided by every edge behind it. The upper middle portion ends before the rightmost part, leaving a descending outline with three height levels. The broad front face masks the rear edges below its top, so no extra vertical division should be added at the right end of that face.

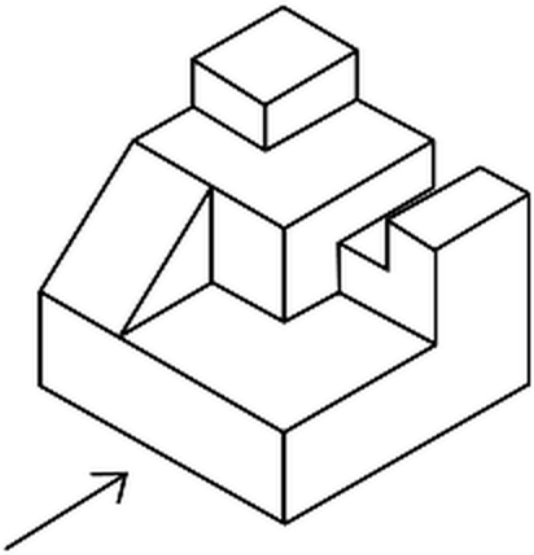
Step 3: Rule out the incorrect line patterns Option (B) shows the three descending heights, the horizontal base of the small top block, and the uninterrupted broad lower face. Option (A) extends the middle-height outline too far right and adds a subdivision across that upper region. Option (C) introduces an extra horizontal edge through the left upright. Option (D) divides the rightmost part of the broad front face by an additional upright and short horizontal line. Those extra or misplaced edges are not visible in the required projection.

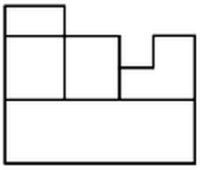
Step 4: Conclusion The visible front outline and the absence of extra divisions in the broad lower face agree with option (B). Hence, the correct option is (B).

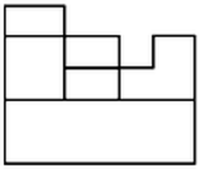
Quick Tip to Solve: Do not transfer every isometric edge into an elevation: a nearer solid face hides edges of the structure behind it.

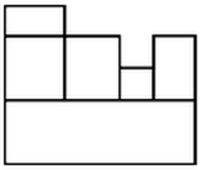
53. Directions : (For Q. No. 51 to 53). The 3–D problem figure shows a view of an object. Identify the correct front view, from amongst the answer figures, looking in the direction of arrow.

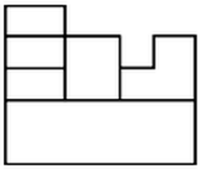
JEE-Main_2017-04-02_Single-Sitting_Paper-2_Q053_Stem-Fig.png [4 marks]

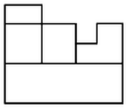


(A) JEE-Main_2017-04-02_Single-Sitting_Paper-2_Q053_Opt1.png 

(B) JEE-Main_2017-04-02_Single-Sitting_Paper-2_Q053_Opt2.png 

(C) JEE-Main_2017-04-02_Single-Sitting_Paper-2_Q053_Opt3.png 

(D) JEE-Main_2017-04-02_Single-Sitting_Paper-2_Q053_Opt4.png 

Correct Answer: (A) JEE-Main_2017-04-02_Single-Sitting_Paper-2_Q053_Opt1.png 

Solution:

Concept:

- An orthographic view projects the solid along parallel lines onto a plane perpendicular to the viewing direction; the coordinate along the line of sight is suppressed.
- Retain the outline and visible changes of face or level. Do not introduce hidden edges as solid lines or preserve the pictorial slant of depth edges.

Step 1: Identify the viewing direction and outer boundary Look along the arrow from the lower left towards the object. The base projects as a broad horizontal rectangle. Above it, the left-hand part carries the highest block, the middle platform is lower, and the right-hand feature has a notch before its outer raised end. The silhouette must retain that notch because it is open to the viewing direction.

Step 2: Project the inclined face and platform The inclined face lies in the viewing direction, so its length into the object is suppressed in this elevation. It does not require a diagonal line across the front view. The upper-left block supplies one horizontal division just below the highest edge. The central vertical support remains a single visible rectangular face between the top of the base and the platform level, with a vertical boundary separating it from the left portion.

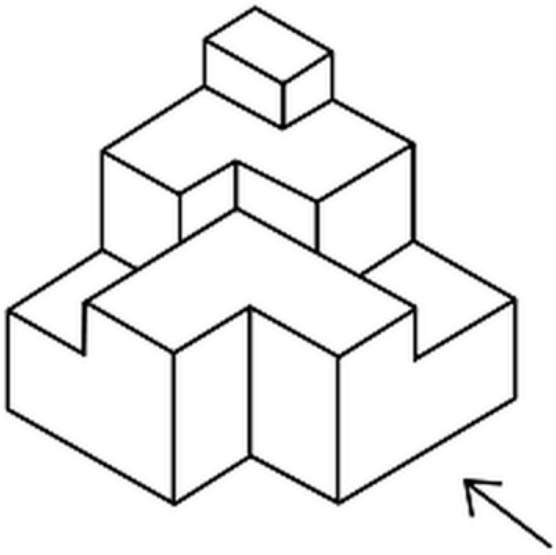
Step 3: Use the central face to choose the answer All four options resemble the same broad stepped outline, so inspect the interior rather than the outer contour alone. Option (A) leaves the central rectangular face undivided and retains the correct upper-left division. Option (B) introduces a horizontal split across the central face. Option (C) adds a small rectangular division in the lower part of the notch region. Option (D) divides the left upright with an additional horizontal line. None of those added visible edges is required by the solid when viewed along the arrow.

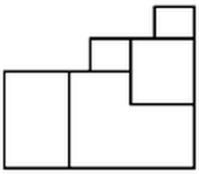
Step 4: Conclusion The elevation has an undivided central face, one division below the highest left block, and the notch on the right, as shown in option (A). Hence, the correct option is (A).

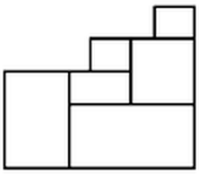
Quick Tip to Solve: For a ramp seen along its run, check whether its slope disappears in projection before adding a diagonal or an extra horizontal line.

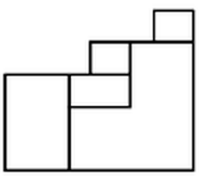
54. Directions : (For Q. No. 54 to 56). The 3-D problem figure shows a view of an object. Identify the correct front view, from amongst the answer figures, looking in the direction of arrow.

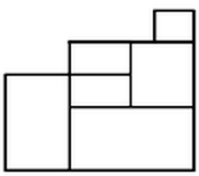
JEE-Main_2017-04-02_Single-Sitting_Paper-2_Q054_Stem-Fig.png [4 marks]

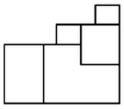


(A) JEE-Main_2017-04-02_Single-Sitting_Paper-2_Q054_Opt1.png 

(B) JEE-Main_2017-04-02_Single-Sitting_Paper-2_Q054_Opt2.png 

(C) JEE-Main_2017-04-02_Single-Sitting_Paper-2_Q054_Opt3.png 

(D) JEE-Main_2017-04-02_Single-Sitting_Paper-2_Q054_Opt4.png 

Correct Answer: (A) JEE-Main_2017-04-02_Single-Sitting_Paper-2_Q054_Opt1.png 

Solution:

Concept:

- An orthographic view projects the solid along parallel lines onto a plane perpendicular to the viewing direction; the coordinate along the line of sight is suppressed.
- Retain the outline and visible changes of face or level. Do not introduce hidden edges as solid lines or preserve the pictorial slant of depth edges.

Step 1: Orient the view using the arrow The arrow is at the lower right, so view the solid from that side rather than reusing the lower-left elevation. In this orientation the small topmost block appears at the right. The silhouette rises in steps from the lowest region at the left, through an intermediate level, to the highest block on the right. Depth edges parallel to the arrow disappear in the projection.

Step 2: Follow the visible faces and recesses The foreground recess contributes a vertical division in the lower-left portion of the elevation. The middle step contributes its short upper rectangular region. At the right, the small top block sits above a taller visible face, whose lower edge is a horizontal line within the outline. The region between the lower-left division and the right face remains continuous; a rear edge hidden by it must not be continued through it.

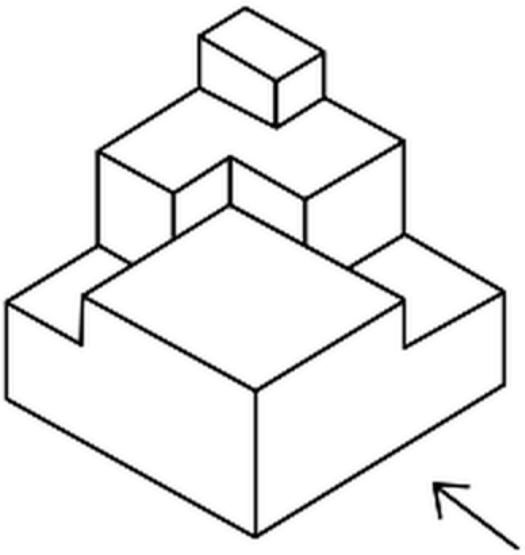
Step 3: Compare the internal divisions in each option Option (A) combines the rising stepped silhouette with the lower-left upright, the narrow upper-middle region and the large right-hand face. Option (B) adds a horizontal division through the middle lower region. Option (C) shifts the upper-middle short division downwards, changing the visible face arrangement. Option (D) introduces an additional horizontal split across the left portion and a different central face pattern. Checking the arrow direction together with these internal boundaries identifies (A), not a mirrored elevation.

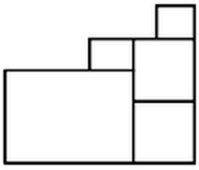
Step 4: Conclusion The required front elevation rises towards the right and has the visible internal divisions of option (A). Hence, the correct option is (A).

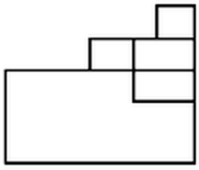
Quick Tip to Solve: When the arrow changes sides, locate the highest block again; then check the foreground recess before comparing the small interior lines.

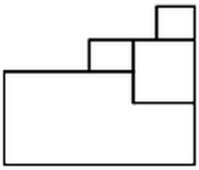
55. Directions : (For Q. No. 54 to 56). The 3-D problem figure shows a view of an object. Identify the correct front view, from amongst the answer figures, looking in the direction of arrow.

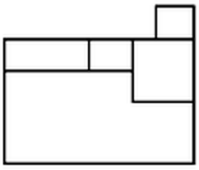
JEE-Main_2017-04-02_Single-Sitting_Paper-2_Q055_Stem-Fig.png [4 marks]

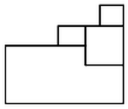


(A) JEE-Main_2017-04-02_Single-Sitting_Paper-2_Q055_Opt1.png 

(B) JEE-Main_2017-04-02_Single-Sitting_Paper-2_Q055_Opt2.png 

(C) JEE-Main_2017-04-02_Single-Sitting_Paper-2_Q055_Opt3.png 

(D) JEE-Main_2017-04-02_Single-Sitting_Paper-2_Q055_Opt4.png 

Correct Answer: (C) JEE-Main_2017-04-02_Single-Sitting_Paper-2_Q055_Opt3.png 

Solution:

Concept:

- An orthographic front view is obtained by projecting parallel to the viewing arrow. Depth disappears, while horizontal positions and vertical heights are retained.
- Only exposed boundaries and changes of visible surface appear as solid lines. An edge behind the nearer solid must not be continued through that solid.

Step 1: Establish the viewing direction Look from the lower right towards the object, in the direction of the arrow. The broad nearest platform occupies the lower part of the elevation. The raised structure behind it gives the middle step, while the small top block projects at the extreme right of the elevation. Do not copy the sloping isometric edges into the front view: their apparent slopes represent depth,

not inclined surfaces.

Step 2: Trace the visible outline and internal edges The resulting outline rises in three levels from left to right. At the right, the taller rear upright is visible above the broad foreground platform, but the foreground platform hides the lower part of its boundary. Consequently the vertical line separating the upper right upright from the rest stops at the horizontal shoulder above the large bottom face. It must not run all the way down to the base. The small intermediate raised part gives a short rectangular step immediately to the left of that upright.

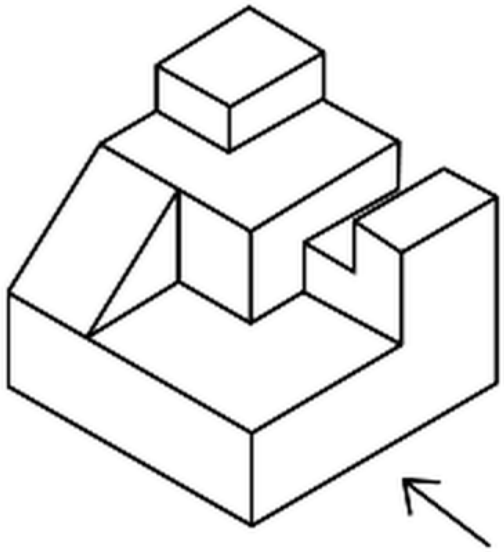
Step 3: Compare all four answer figures Option (C) retains this stepped outline and the appropriate short internal boundary. Option (A) extends the right-hand division down to the base and adds a lower horizontal subdivision, exposing edges that are hidden. Option (B) also adds an intermediate horizontal edge across the right upright. Option (D) introduces an extra horizontal strip across the upper left portion; this is not the visible front boundary of the object from the arrow direction.

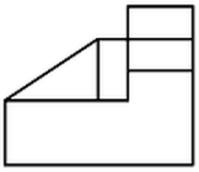
Step 4: Conclusion The three-level profile and the termination of the internal edge at the foreground shoulder agree with figure (C). Hence, the correct option is (C).

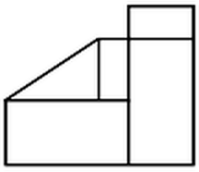
Quick Tip to Solve: For a stepped solid, check where a vertical edge stops: the nearer platform hides its continuation below the visible shoulder.

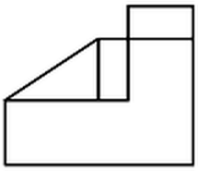
56. Directions : (For Q. No. 54 to 56). The 3-D problem figure shows a view of an object. Identify the correct front view, from amongst the answer figures, looking in the direction of arrow.

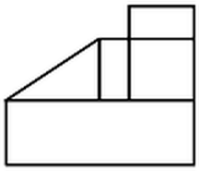
JEE-Main_2017-04-02_Single-Sitting_Paper-2_Q056_Stem-Fig.png [4 marks]

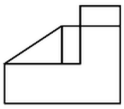


(A) JEE-Main_2017-04-02_Single-Sitting_Paper-2_Q056_Opt1.png 

(B) JEE-Main_2017-04-02_Single-Sitting_Paper-2_Q056_Opt2.png 

(C) JEE-Main_2017-04-02_Single-Sitting_Paper-2_Q056_Opt3.png 

(D) JEE-Main_2017-04-02_Single-Sitting_Paper-2_Q056_Opt4.png 

Correct Answer: (C) JEE-Main_2017-04-02_Single-Sitting_Paper-2_Q056_Opt3.png 

Solution:

Concept:

- Orthographic projection preserves height and sideways position but collapses distance along the viewing arrow.
- A sloping exposed surface contributes an inclined boundary, whereas nearer solid portions hide the edges of surfaces behind them.

Step 1: Project the main features from the arrow View the object from the lower right along the indicated arrow. The inclined face on the left produces the rising oblique edge in the elevation. The small block on top appears above the rear central mass, on the right of the projected profile. Beneath it lies a taller vertical region. These features establish a low left side, a rising slope and a high right side, rather than a uniformly rectangular silhouette.

Step 2: Determine which lines remain visible The low foreground portion forms a continuous large bottom area. The right-hand raised foreground feature has a shoulder below the top block; it hides the lower continuation of the rear mass. Thus the main vertical boundary on the right descends from the top block only to that shoulder, not to the base. The end of the sloping surface gives the shorter vertical line at the left of the small rectangular recess. The top block itself is separated from the mass beneath by one horizontal edge.

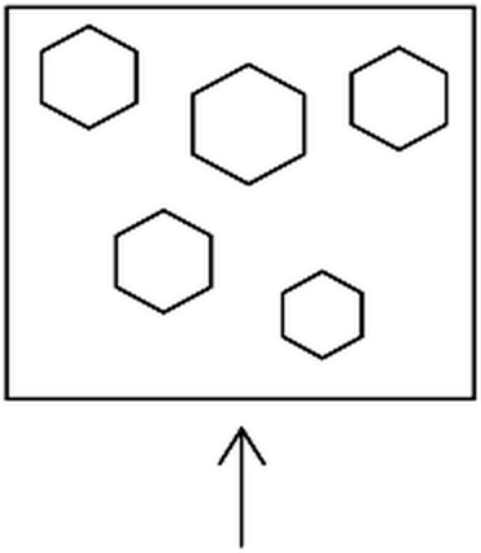
Step 3: Eliminate the incorrect line patterns Figure (C) has the sloping boundary, short vertical recess edge and the correctly terminating right vertical edge. In (A), an extra horizontal line divides the right area below the top block. Figure (B) extends the main right vertical line all the way to the base and places an unnecessary line across the lower left face. Figure (D) similarly introduces a full-width horizontal subdivision through the lower body. These additional lines do not represent exposed edges in the required view.

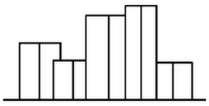
Step 4: Conclusion Figure (C) alone preserves the sloping face and the visible stepped boundaries without showing hidden continuations. Hence, the correct option is (C).

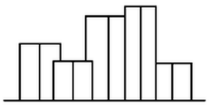
Quick Tip to Solve: First match the inclined silhouette, then reject any option that draws rear vertical edges through a nearer solid face.

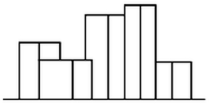
57. Directions : (For Q. No. 57 to 60). The problem figure shows the top view of objects. Looking in the direction of the arrow, identify the correct elevation, from amongst the answer figures.

JEE-Main_2017-04-02_Single-Sitting_Paper-2_Q057_Stem-Fig.png [4 marks]

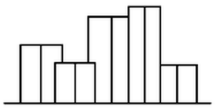


(A) JEE-Main_2017-04-02_Single-Sitting_Paper-2_Q057_Opt1.png 

(B) JEE-Main_2017-04-02_Single-Sitting_Paper-2_Q057_Opt2.png 

(C) JEE-Main_2017-04-02_Single-Sitting_Paper-2_Q057_Opt3.png 

(D) JEE-Main_2017-04-02_Single-Sitting_Paper-2_Q057_Opt4.png 

Correct Answer: (B) JEE-Main_2017-04-02_Single-Sitting_Paper-2_Q057_Opt2.png 

Solution:

Concept:

- For an elevation viewed along the upward arrow, horizontal positions in the plan remain left to right, while the vertical coordinate of the plan represents depth.
- When projections overlap, the object nearer the arrow hides the lower overlapping portion of the object behind. Vertical ribs are shown only over their visible lengths.

Step 1: Order the hexagonal objects by depth The arrow is below the plan, so the two hexagons in the lower half are in front of those in the upper half. From left to right the five projected objects are the far-left hexagon, the lower-left foreground hexagon, the large central rear hexagon, the upper-right rear hexagon and the lower-right foreground hexagon. The front hexagons overlap the horizontal spans of the adjacent rear objects.

Step 2: Follow the overlaps in the elevation At the left, the foreground short prism hides the lower part of the right side of the far-left prism, but does not hide its central vertical rib, which is farther

left. Near the middle, the left part of the large rear prism lies behind the left foreground prism. Its lower outline is therefore interrupted by that foreground prism. On the right, the lower-right prism overlaps the right edge of the tall rear prism; the latter cannot be drawn through the near object.

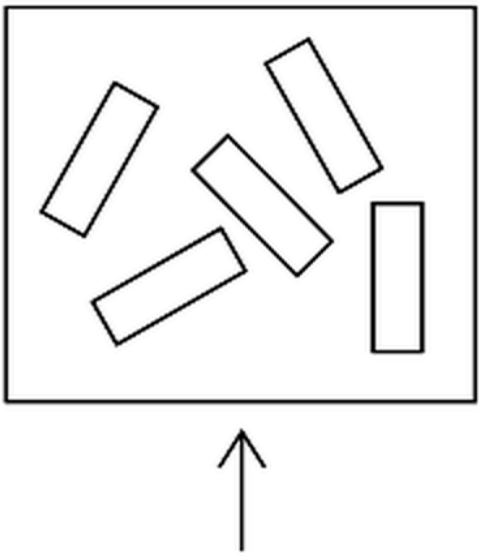
Step 3: Compare the visible ribs in the options Option (B) respects all these interruptions. Option (A) wrongly continues the left boundary of the central rear prism downward through the nearer short prism. Option (C) introduces an interruption across the central rib of the far-left prism, although the front prism overlaps only its right side. Option (D) gives the wrong line continuation in the right-hand overlap. Matching the outside heights alone is insufficient, because the alternatives differ chiefly in these visible internal lines.

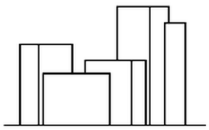
Step 4: Conclusion The correct sequence of foreground masking and uninterrupted visible ribs is shown in (B). Hence, the correct option is (B).

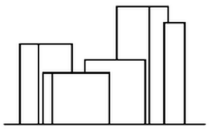
Quick Tip to Solve: Mark the objects nearest the arrow first; use them as masks before tracing any vertical ribs of objects behind them.

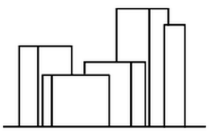
58. Directions : (For Q. No. 57 to 60). The problem figure shows the top view of objects. Looking in the direction of the arrow, identify the correct elevation, from amongst the answer figures.

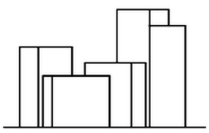
JEE-Main_2017-04-02_Single-Sitting_Paper-2_Q058_Stem-Fig.png [4 marks]

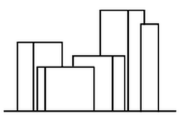


(A) JEE-Main_2017-04-02_Single-Sitting_Paper-2_Q058_Opt1.png 

(B) JEE-Main_2017-04-02_Single-Sitting_Paper-2_Q058_Opt2.png 

(C) JEE-Main_2017-04-02_Single-Sitting_Paper-2_Q058_Opt3.png 

(D) JEE-Main_2017-04-02_Single-Sitting_Paper-2_Q058_Opt4.png 

Correct Answer: (C) JEE-Main_2017-04-02_Single-Sitting_Paper-2_Q058_Opt3.png 

Solution:

Concept:

- An elevation is a projection along the arrow: each plan footprint supplies its horizontal span, and nearer objects mask the parts of rear objects within that span.
- The corners of rotated rectangular prisms give vertical divisions in elevation. These lines must remain visible except where a nearer prism actually covers them.

Step 1: Separate the foreground and background objects Looking upwards from the arrow, the wide oblique rectangle at the lower left and the narrow upright rectangle at the lower right are foreground objects. The left tilted rectangle, the diagonal central rectangle and the upper-right tilted rectangle lie behind them. Their horizontal spans overlap, so the elevation must show interrupted rear outlines rather than five unrelated rectangles.

Step 2: Trace the foreground and the visible rear corners The wide low foreground prism has a visible short side at its left, giving a vertical line close to its left edge. The central rear diagonal prism extends to the right of this foreground block, so its exposed right portion retains its own vertical corner line. The tall upper-right rear prism also retains its vertical corner above and beside the right foreground object. Only the outer edge lying directly behind the narrow foreground prism is hidden at the overlap.

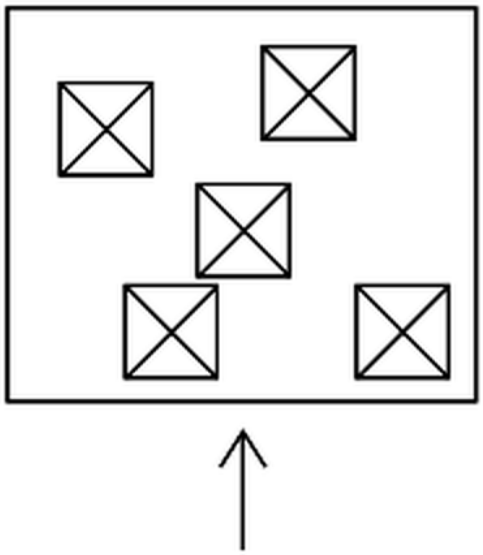
Step 3: Distinguish the four alternatives Figure (C) shows the short left side of the wide foreground block and the visible corner of the middle rear block, together with the proper tall rear corner. Option (A) omits the foreground block's left internal corner. Option (B) loses the visible vertical corner in the exposed part of the middle rear object. Option (D) replaces the tall rear corner pattern by an extra short horizontal division at the right. Those changes conflict with the projected corners and foreground masking in the plan.

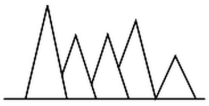
Step 4: Conclusion The corner positions and their visible continuations agree with figure (C). Hence, the correct option is (C).

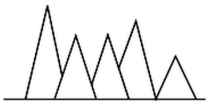
Quick Tip to Solve: With rotated rectangles, check each projected corner line after resolving overlaps; several options can share the same overall silhouette.

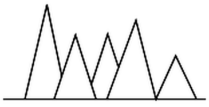
59. Directions : (For Q. No. 57 to 60). The problem figure shows the top view of objects. Looking in the direction of the arrow, identify the correct elevation, from amongst the answer figures.

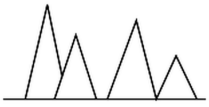
JEE-Main_2017-04-02_Single-Sitting_Paper-2_Q059_Stem-Fig.png [4 marks]

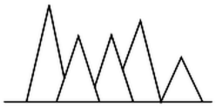


(A) JEE-Main_2017-04-02_Single-Sitting_Paper-2_Q059_Opt1.png 

(B) JEE-Main_2017-04-02_Single-Sitting_Paper-2_Q059_Opt2.png 

(C) JEE-Main_2017-04-02_Single-Sitting_Paper-2_Q059_Opt3.png 

(D) JEE-Main_2017-04-02_Single-Sitting_Paper-2_Q059_Opt4.png 

Correct Answer: (B) JEE-Main_2017-04-02_Single-Sitting_Paper-2_Q059_Opt2.png 

Solution:

Concept:

- A square footprint with diagonals meeting at its centre represents the top view of a square pyramid: its elevation has an apex above the projected centre.
- Nearer pyramids hide the lower portions of rear sloping edges wherever their horizontal projections overlap. A hidden edge must not be drawn through the foreground face.

Step 1: Read the depth order from the plan The arrow points upwards from below the square frame. The lower-left and lower-right pyramids are therefore nearest the observer. The central pyramid stands behind the lower-left one, while the upper-left and upper-right pyramids are farther back. Preserve their left-to-right apex positions when comparing elevations; do not reverse the plan or interpret depth as a height change.

Step 2: Trace the overlapping triangular profiles At the left, the rising edge of the near lower-left pyramid cuts off the descending edge of the taller rear-left pyramid. The rear edge is visible only

above that intersection, rather than continuing to the ground through the near pyramid. Around the middle, the near lower-left pyramid masks the lower part of the central pyramid's left slope. The visible portion of that central slope starts above the foreground face; its other side continues where it is not masked. The rightmost foreground pyramid has its own small triangular outline.

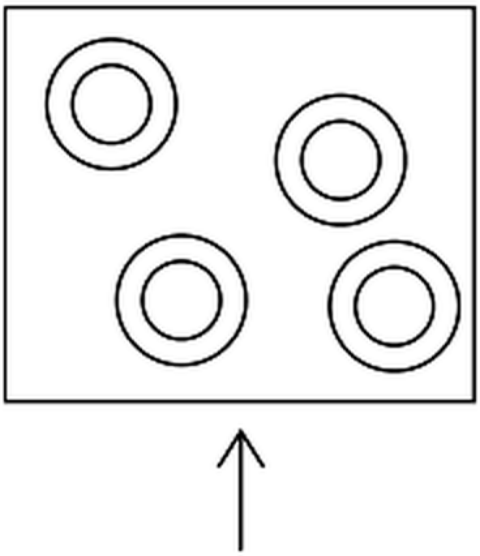
Step 3: Reject the incorrect edge continuations Option (B) gives the proper five triangular profiles and these interrupted sloping edges. Option (A) carries a rear-left descending edge through the lower foreground region. Option (C) removes a portion of the central profile that remains exposed above the nearer pyramid. Option (D) omits the central pyramid's visible peak/profile altogether. The apex count and, more decisively, the visible intersections distinguish (B) from the other figures.

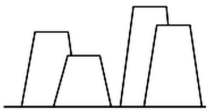
Step 4: Conclusion Figure (B) correctly shows the five pyramid elevations with rear slopes hidden by the nearer pyramids. Hence, the correct option is (B).

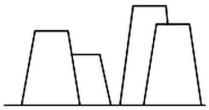
Quick Tip to Solve: For overlapping pyramids, locate every apex first, then erase rear slope segments that fall inside a nearer triangular face.

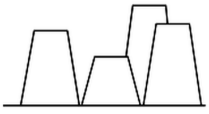
60. Directions : (For Q. No. 57 to 60). The problem figure shows the top view of objects. Looking in the direction of the arrow, identify the correct elevation, from amongst the answer figures.

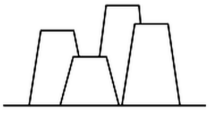
JEE-Main_2017-04-02_Single-Sitting_Paper-2_Q060_Stem-Fig.png [4 marks]

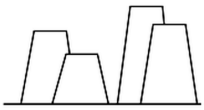


(A) JEE-Main_2017-04-02_Single-Sitting_Paper-2_Q060_Opt1.png 

(B) JEE-Main_2017-04-02_Single-Sitting_Paper-2_Q060_Opt2.png 

(C) JEE-Main_2017-04-02_Single-Sitting_Paper-2_Q060_Opt3.png 

(D) JEE-Main_2017-04-02_Single-Sitting_Paper-2_Q060_Opt4.png 

Correct Answer: (A) JEE-Main_2017-04-02_Single-Sitting_Paper-2_Q060_Opt1.png 

Solution:

Concept:

- Concentric circular outlines in plan are consistent with truncated circular cones, whose side elevations are trapezia with sloping sides.
- In the elevation, overlap is determined by horizontal span and depth order: the object nearer the arrow hides the part of the rear outline behind it.

Step 1: Identify the front pair and the rear pair The viewing arrow lies below the plan. The lower-left and lower-right circular objects are in front; the upper-left and upper-right objects are behind. Horizontally, the lower-left object lies to the right of the upper-left one and overlaps its span. Similarly, the lower-right object lies to the right of the upper-right one and overlaps that rear object. The elevation must retain this pairwise left-to-right relationship.

Step 2: Apply occlusion separately to both pairs For the left pair, the low front frustum covers the lower right side of the rear frustum. Therefore the front frustum's left sloping edge is visible from its top down to the base, while the rear frustum's right sloping edge stops where it meets the front object. For the right pair the same depth rule applies: the right foreground frustum hides the lower right portion of the tall rear frustum, whose upper part remains visible above it.

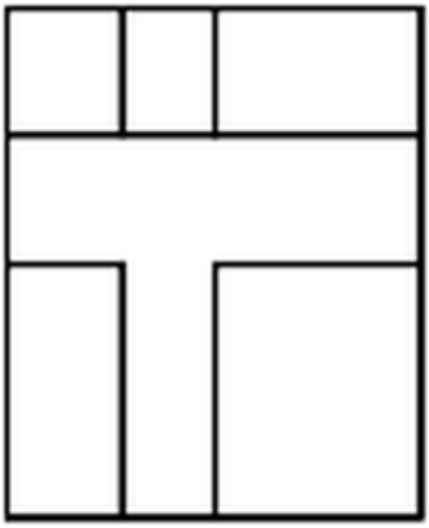
Step 3: Compare the answer figures Option (A) shows both correct pairwise overlaps: a shorter foreground trapezium overlaps the rear one on its right in each pair. Option (B) reverses the masking in the left pair, allowing the taller rear object to cover the nearer short object. Option (C) separates objects that should overlap horizontally. Option (D) shifts the central arrangement and creates a different overlap between the left foreground and right rear objects. Neither separation nor a changed horizontal order is produced by looking along the specified arrow.

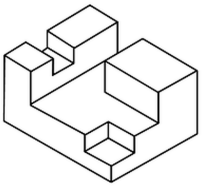
Step 4: Conclusion The two correct foreground overlaps are shown in figure (A). Hence, the correct option is (A).

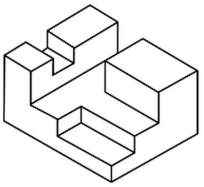
Quick Tip to Solve: Treat each overlapping pair independently: the lower circle in the plan is nearer the arrow and must mask the farther frustum in elevation.

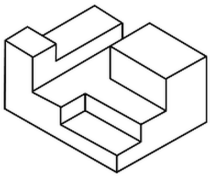
61. Directions : (For Q. No. 61). From the top view given in the problem figure identify the correct 3-D figure from amongst the answer figures.

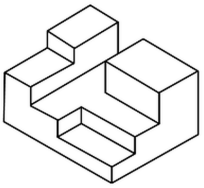
JEE-Main_2017-04-02_Single-Sitting_Paper-2_Q061_Stem-Fig.png [4 marks]

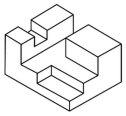


(A) JEE-Main_2017-04-02_Single-Sitting_Paper-2_Q061_Opt1.png 

(B) JEE-Main_2017-04-02_Single-Sitting_Paper-2_Q061_Opt2.png 

(C) JEE-Main_2017-04-02_Single-Sitting_Paper-2_Q061_Opt3.png 

(D) JEE-Main_2017-04-02_Single-Sitting_Paper-2_Q061_Opt4.png 

Correct Answer: (B) JEE-Main_2017-04-02_Single-Sitting_Paper-2_Q061_Opt2.png 

Solution:

Concept:

- A top view is a vertical projection onto the horizontal plane. Heights disappear, but the positions and widths of horizontal surfaces and changes of level remain visible as edges.
- Corresponding edges must occupy the same positions in the plan. An isometric drawing may be mentally rotated about a vertical axis, but it must not be reflected or have a recess changed in size.

Step 1: Read the divisions in the plan The outside boundary is a rectangle. Along its upper edge there is a shallow strip divided into three adjoining portions. Below that strip, the unbroken middle space extends across the width. At the bottom, two vertical boundaries enclose a narrow central strip,

leaving a smaller region on its left and a wider region on its right. These divisions describe positions in plan rather than the heights of the blocks.

Step 2: Project the solid in option (B) Look vertically down on option (B), ignoring its vertical faces. The two high portions at the far side, with the lower portion between them, give the three divisions in the upper strip. The large raised block at the right and the elongated front recess give the two vertical boundaries in the lower part. The resulting arrangement agrees with both the upper strip and the lower divisions of the problem figure.

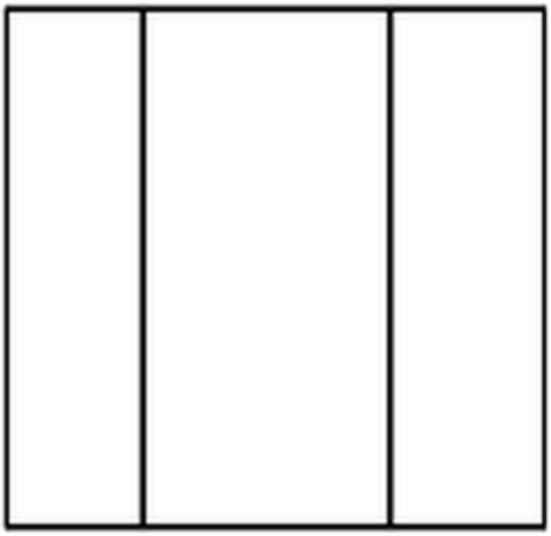
Step 3: Reject the other arrangements Option (A) has a short, approximately square front recess; its projected boundaries stop too early compared with the long central strip in the plan. Option (C) lacks the separate change of level needed to produce the three far-side divisions. In option (D), the lowered left-side surface joins differently at the far side, so one of the required divisions is missing. Matching just the outer rectangle would therefore be insufficient.

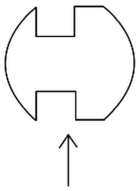
Step 4: Conclusion The complete arrangement of projected edges agrees with the solid in (B). Hence, the correct option is (B).

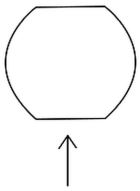
Quick Tip to Solve: For a plan-to-solid question, compare the longest recess and one asymmetrical edge first; then confirm every remaining change of level.

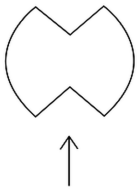
62. Directions : (For Q. No. 62 and 63). The problem figure shows the elevation of an object. Identify the correct top view from amongst the answer figures.

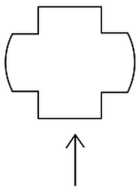
JEE-Main_2017-04-02_Single-Sitting_Paper-2_Q062_Stem-Fig.png [4 marks]

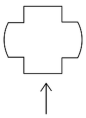


(A) JEE-Main_2017-04-02_Single-Sitting_Paper-2_Q062_Opt1.png 

(B) JEE-Main_2017-04-02_Single-Sitting_Paper-2_Q062_Opt2.png 

(C) JEE-Main_2017-04-02_Single-Sitting_Paper-2_Q062_Opt3.png 

(D) JEE-Main_2017-04-02_Single-Sitting_Paper-2_Q062_Opt4.png 

Correct Answer: (D) JEE-Main_2017-04-02_Single-Sitting_Paper-2_Q062_Opt4.png 

Solution:

Concept:

- An elevation shows width and height, whereas a plan shows width and depth. The arrow on a plan specifies the direction from which its front elevation is to be read.
- Vertical face boundaries in an elevation correspond to changes of the visible surface along the width. A smooth curved surface does not by itself create a sharp vertical seam.

Step 1: Locate the important features of the elevation The given elevation has a rectangular outer boundary, a level top and a level bottom. Two full-height vertical edges divide it into a broad middle panel and narrower side panels. Thus the central surface must be distinguished from the two lateral surfaces, without a change of overall height. Read each proposed plan looking in the direction of its upward arrow.

Step 2: Match the front central projection In option (D), the central rectangular portion projects towards the observer and is flanked by rounded portions on either side. Its left and right corners supply the two full-height vertical boundaries of the middle panel. The curved side portions extend laterally beyond those corners. Projected in elevation, their upper and lower limits remain level with those of the central portion, producing the three-panel rectangle shown.

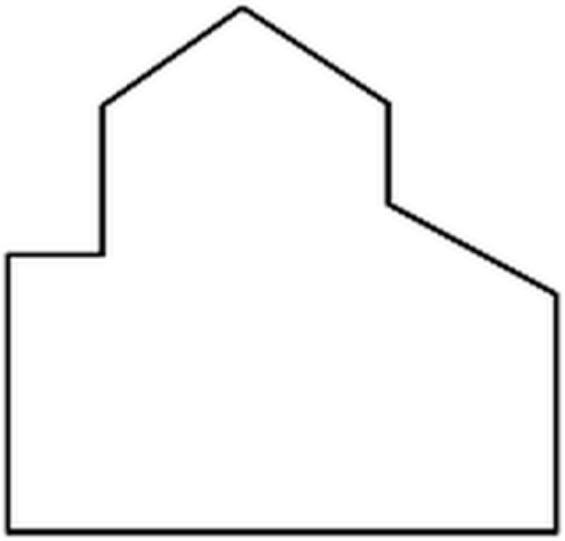
Step 3: Compare the remaining profiles Option (B) has a smooth front outline between its two extremities and lacks the pair of central corners required for the middle panel. Option (C) substitutes a V-shaped indentation for a flat central front face; its two sloping boundaries meet at the centre and would introduce an additional central edge. Option (A) has a much narrower central rectangular cut-in, whose side boundaries do not line up with the relatively broad middle panel in the elevation. In option (D), the central projection occupies approximately the middle half of the width, leaving two narrower side panels, matching the given lateral proportions as well as the two vertical boundaries. Compare their projected positions, not merely the fact that both plans contain curved sides.

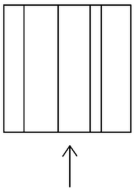
Step 4: Conclusion The plan with the forward central rectangular portion and curved lateral portions is (D). Hence, the correct option is (D).

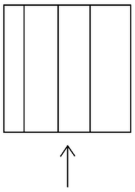
Quick Tip to Solve: Always follow the arrow before comparing views; identify which face is nearest the observer and which two corners produce the central panel.

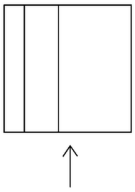
63. Directions : (For Q. No. 62 and 63). The problem figure shows the elevation of an object. Identify the correct top view from amongst the answer figures.

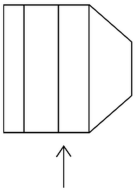
JEE-Main_2017-04-02_Single-Sitting_Paper-2_Q063_Stem-Fig.png [4 marks]

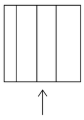


(A) JEE-Main_2017-04-02_Single-Sitting_Paper-2_Q063_Opt1.png 

(B) JEE-Main_2017-04-02_Single-Sitting_Paper-2_Q063_Opt2.png 

(C) JEE-Main_2017-04-02_Single-Sitting_Paper-2_Q063_Opt3.png 

(D) JEE-Main_2017-04-02_Single-Sitting_Paper-2_Q063_Opt4.png 

Correct Answer: (B) JEE-Main_2017-04-02_Single-Sitting_Paper-2_Q063_Opt2.png 

Solution:

Concept:

- A top view retains the left-to-right positions of the edges that appear in an elevation. Height changes can occur above a rectangular plan without changing its outside boundary.
- Compare the number and relative positions of the longitudinal divisions, rather than treating a sloping roof line as a sloping boundary of the plan.

Step 1: Read the elevation from left to right The silhouette begins with a low flat portion at the left. It then rises vertically to the left end of a pitched central portion, rises obliquely to the highest point, and descends obliquely to its right end. After a vertical drop, the surface descends towards the right

extremity. These changes give three principal internal positions across the width: the start of the raised middle portion, its ridge, and the end of that portion.

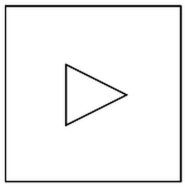
Step 2: Preserve the positions in the plan The top view must show the boundaries corresponding to those changes at the same lateral positions. Option (B) has a rectangular outline and three longitudinal internal lines. From left to right, they correspond to the left rise, the central ridge and the right change of height. The differing heights of the upper surfaces explain the elevation while their rectangular horizontal footprint explains the plan.

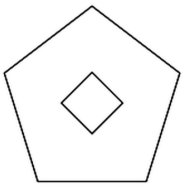
Step 3: Eliminate the mismatching views Option (A) introduces an additional longitudinal division near the right side for which the elevation has no corresponding break. Option (C) omits the right-hand division needed to mark the end of the raised middle part. Option (D) changes the outside boundary into a tapered end in plan; it confuses the descending height profile at the right with a narrowing horizontal footprint. Option (B) retains the required rectangular footprint and exactly the three internal divisions.

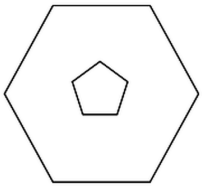
Step 4: Conclusion The positions and number of the plan divisions match option (B). Hence, the correct option is (B).

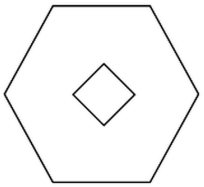
Quick Tip to Solve: Carry each corner or ridge of the elevation straight down mentally into the plan; reject an extra line or a missing line before comparing outlines.

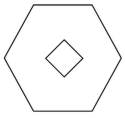
64. Directions : (For Q. No. 64 and 65). Find the odd figure out of the problem figures given below. [4 marks]

(A) JEE-Main_2017-04-02_Single-Sitting_Paper-2_Q064_Opt1.png 

(B) JEE-Main_2017-04-02_Single-Sitting_Paper-2_Q064_Opt2.png 

(C) JEE-Main_2017-04-02_Single-Sitting_Paper-2_Q064_Opt3.png 

(D) JEE-Main_2017-04-02_Single-Sitting_Paper-2_Q064_Opt4.png 

Correct Answer: (D) JEE-Main_2017-04-02_Single-Sitting_Paper-2_Q064_Opt4.png 

Solution:

Concept:

- For nested polygons, a useful invariant is the difference between the number of sides of the outer polygon and that of the inner polygon.
- Rotation changes the apparent orientation of a polygon but does not change its number of sides. A

square drawn as a diamond is still a four-sided polygon.

Step 1: Count the sides in the first three figures Option (A) has a square outside and a triangle inside, giving $4 - 3 = 1$. Option (B) has a pentagon outside and a rotated square inside, giving $5 - 4 = 1$. Option (C) has a hexagon outside and a pentagon inside, giving $6 - 5 = 1$. Thus the outer polygon in each of these figures has exactly one more side than its inner polygon. The common feature concerns the relationship between the pair, not their individual orientation.

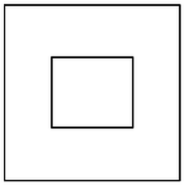
Step 2: Test the fourth figure with the same rule Option (D) has a hexagon outside and a rotated square inside. Their side counts are six and four, so the difference is $6 - 4 = 2$. The inner diamond does not acquire extra sides because it is tilted: its four straight segments meet at four vertices. Therefore this option does not continue the one-side difference shared by the other three.

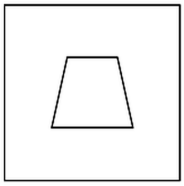
Step 3: Check that the classification singles out one option The triangle inside (A), the square inside (B), and the pentagon inside (C) accompany outer polygons with four, five and six sides respectively. Those three pairs form a consistent progression. Option (D) repeats the six-sided outside boundary but replaces the expected five-sided inside boundary with a four-sided one. Neither the size of the inner figure nor the direction of a vertex alters this count, so neither provides a reason to exclude any of (A), (B) or (C).

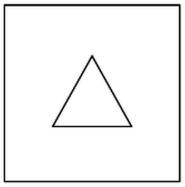
Step 4: Conclusion Only (D) has an outer polygon with two more sides than the inner polygon. Hence, the correct option is (D).

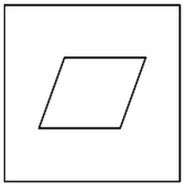
Quick Tip to Solve: In nested-polygon odd-one-out questions, count both boundaries and compare their difference; ignore rotation until after counting the sides.

65. Directions : (For Q. No. 64 and 65). Find the odd figure out of the problem figures given below. [4 marks]

(A) JEE-Main_2017-04-02_Single-Sitting_Paper-2_Q065_Opt1.png 

(B) JEE-Main_2017-04-02_Single-Sitting_Paper-2_Q065_Opt2.png 

(C) JEE-Main_2017-04-02_Single-Sitting_Paper-2_Q065_Opt3.png 

(D) JEE-Main_2017-04-02_Single-Sitting_Paper-2_Q065_Opt4.png 

Correct Answer: (C) JEE-Main_2017-04-02_Single-Sitting_Paper-2_Q065_Opt3.png 

Solution:

Concept:

- An odd-one-out set is classified by a common property shared by three figures. Compare the inner shapes while holding the identical outer boundary fixed.
- A triangle has three straight sides; a quadrilateral has four. Squares, trapeziums and parallelograms all belong to the quadrilateral family despite their different angles or parallel sides.

Step 1: Separate the common frame from the changing shape Each option has the same square outer frame. Its size and orientation therefore cannot distinguish one option from the others. The inner figures are different: (A) contains a square, (B) contains a trapezium, (C) contains a triangle, and (D) contains a parallelogram. Compare a property of these inner figures that can be applied consistently to all four options.

Step 2: Count the sides of the inner figures The inner square in (A) has four sides. The trapezium in (B) also has four sides, even though its top and bottom lengths differ and its lateral sides are inclined. The parallelogram in (D) has four sides as well; its slant does not alter its classification as a quadrilateral. In contrast, the inner triangle in (C) has only three sides and three vertices.

Step 3: Check the proposed exception against every option Options (A), (B) and (D) can all be described by the same statement: a quadrilateral lies inside a square. Option (C) cannot, since its inner shape is not a quadrilateral. Classifying by right angles alone would fail to group the trapezium with the parallelogram and square as simply, while classifying by the presence of a closed straight-sided figure would group all four. The side-count test therefore gives a clear common group and one exception.

Step 4: Conclusion The inner figure in (C) is the only triangle; the other three inner figures are quadrilaterals. Hence, the correct option is (C).

Quick Tip to Solve: When all outer frames are identical, ignore them initially and count the sides of each inner figure before testing subtler angle or symmetry rules.

66. Which color is obtained by mixing red and yellow colors ? [4 marks]

(A) Purple

(B) Pink

(C) Orange

(D) Brown

Correct Answer: (C) Orange

Solution:

Concept:

- In the traditional colour wheel used for painting and design, red and yellow are primary pigment colours. Mixing neighbouring primary pigments produces a secondary colour.
- The three familiar secondary mixtures are red with yellow to give orange, yellow with blue to give green, and blue with red to give purple. The question concerns coloured paints or pigments in this

elementary design context.

Step 1: Identify the mixing pair The colours named are red and yellow. On the traditional painting colour wheel, orange lies between these two primaries. Combining them gives an orange mixture. The precise shade depends on their relative amounts: more red produces a red-orange shade, while more yellow produces a yellow-orange shade. These variations remain within the orange family rather than becoming one of the other colours listed.

Step 2: Compare the four choices Purple, option (A), is associated with mixing red and blue, so it does not match the stated pair. Pink, option (B), is a tint normally obtained by adding white to red; adding yellow is not the operation that produces pink. Orange, option (C), is the secondary colour directly formed from red and yellow. Brown, option (D), is a muted colour generally involving complementary mixtures or additional darkening; it is not the standard secondary result of the two primaries given.

Step 3: Apply the colour-wheel relation The problem asks for the resulting colour, not for a particular ratio, hue code or brightness. It is therefore enough to use the standard pigment-colour relation red plus yellow gives orange. No third pigment or change of lighting is specified. Selecting orange answers the stated mixing operation directly and avoids confusing a secondary colour with a tint or a subdued mixture.

Step 4: Conclusion Mixing red and yellow colours gives orange. Hence, the correct option is (C).

Quick Tip to Solve: Remember the traditional pigment pairs: red-yellow gives orange, yellow-blue gives green, and blue-red gives purple; adding white instead makes a tint.

67. Salim Chisti mosque is located in : [4 marks]

(A) Gwalior

(B) Fatehpur Sikri

(C) Hyderabad

(D) Delhi

Correct Answer: (B) Fatehpur Sikri

Solution:

Concept:

- Salim Chisti is associated with the Mughal complex at Fatehpur Sikri, near Agra in Uttar Pradesh.
- Architectural location questions are answered by matching the named monument or historical person with the correct site, rather than by matching a general architectural style.

Step 1: Identify the historical association The name Salim Chisti refers to the Sufi saint Shaikh Salim Chishti. His celebrated white-marble tomb stands in the courtyard of the Jama Masjid at Fatehpur Sikri. Thus, although the wording calls it a mosque, the relevant architectural complex is unambiguously Fatehpur Sikri. The association with Akbar's capital distinguishes this site from other Mughal centres.

Step 2: Compare the four locations Fatehpur Sikri is therefore the matching location, option (B). Gwalior is associated with its hill fort and palaces, but it is not the location of this shrine and mosque

complex. Hyderabad is associated with monuments such as the Charminar and Mecca Masjid. Delhi has several major mosques and Sufi shrines, but the Salim Chishti monument named here is not one of them. The presence of Islamic monuments in all these regions does not make their locations interchangeable.

Step 3: Conclusion The Salim Chishti monument and its mosque complex are at Fatehpur Sikri. Hence, the correct option is (B).

Quick Tip to Solve: Associate Salim Chishti with Akbar and Fatehpur Sikri; do not confuse this shrine with the different Sufi shrines of Delhi.

68. Temperature of the Earth due to the 'Greenhouse Effect' : [4 marks]

(A) Increases

(B) Decreases

(C) Remains constant

(D) Keeps increasing/decreasing

Correct Answer: (A) Increases

Solution:

Concept:

- The greenhouse effect warms the surface and lower atmosphere by reducing the direct escape of outgoing terrestrial infrared radiation to space.
- The Earth absorbs incoming solar energy and emits energy at longer wavelengths; greenhouse gases absorb and re-emit part of this outgoing radiation.

Step 1: Trace the energy flow Much incoming short-wave solar radiation passes through the atmosphere and is absorbed by the Earth's surface. The warmed surface emits long-wave infrared radiation. Greenhouse gases, including water vapour and carbon dioxide, absorb some of that radiation and emit infrared radiation in different directions, including back towards the surface. This exchange reduces the net rate at which the surface loses energy at a given temperature.

Step 2: Determine the temperature response With less energy escaping initially, the surface and lower atmosphere warm until the outgoing energy again balances the absorbed solar energy. The greenhouse effect consequently raises the Earth's temperature compared with an otherwise comparable atmosphere without that effect. It does not cool the Earth, so (B) is wrong. Option (C) omits this warming influence. Option (D) describes alternating changes rather than the direction of the greenhouse effect itself; unrelated weather fluctuations do not change that direction.

Step 3: Conclusion The greenhouse effect increases the Earth's surface temperature. Hence, the correct option is (A).

Quick Tip to Solve: Track the outgoing infrared radiation: reduced heat loss at the original temperature implies warming until energy balance is restored.

69. Vertical sun protectors over wall openings help in cutting off summer sun rays on : [4 marks]

(A) South side

(B) West side

(C) North side

(D) On all sides

Correct Answer: (C) North side

Solution:

Concept:

- Vertical sun protectors beside an opening cast lateral shadows and are effective when sunlight strikes the wall obliquely in plan.
- In the northern-hemisphere summer sun path, a north-facing wall can receive low morning and evening rays from the north-east and north-west; vertical fins can screen these oblique rays.

Step 1: Examine the summer exposure of a north wall During summer, sunrise is north of east and sunset is north of west in the northern hemisphere. Consequently, north-facing openings can receive direct sunlight in the early morning and late evening even though the midday sun is towards the south. These rays approach a north wall from its sides. Vertical projecting protectors beside the openings can intercept the oblique rays and cast a shadow across the opening. Their useful action is therefore lateral shading, rather than screening the high midday sun from above.

Step 2: Compare the other wall orientations For a south-facing opening, a horizontal overhang is the characteristic means of excluding high summer sun, so (A) is not the best match to the specified vertical protectors. On a west wall, the low afternoon sun can approach nearly normal to the wall; simple vertical side fins then cast little shadow across the opening and cannot be relied on to exclude it. West openings may need an angled screen, shutters or a combination of shading devices instead. Thus (B) is less appropriate than the north-side application described. Option (D) is also wrong because the effectiveness of a fixed protector changes with the direction and altitude of the sun; it cannot provide the same cutoff on every side.

Step 3: Conclusion Vertical sun protectors can cut off the oblique summer morning and evening rays reaching openings on the north side. Hence, the correct option is (C).

Quick Tip to Solve: For vertical side fins, inspect the sun direction in plan: summer north-east and north-west rays reach a north opening obliquely and can be blocked laterally.

70. Which one of the following is not a load bearing component in a building ? [4 marks]

(A) Column

(B) Beam

(C) Partition wall

(D) Concrete floor slab

Correct Answer: (C) Partition wall

Solution:

Concept:

- A load-bearing structural component is designed to carry building loads and transfer them safely through the structure towards the foundations.
- A partition wall primarily subdivides interior space; it is normally a non-load-bearing element even though its own weight must be supported.

Step 1: Follow the structural load path A concrete floor slab supports occupants, furniture and other imposed loads, as well as its own dead weight. It transfers these actions to supporting beams or walls. A beam carries loads mainly through bending and shear and transfers them to columns or other supports. Columns transmit the supported loads down through the building to its foundations. These functions make the slab, beam and column structural load-bearing components.

Step 2: Distinguish the space divider A partition wall separates rooms or other usable spaces and is not intended to carry the floor or roof system above it. Its weight is a load applied to the supporting slab, rather than evidence that it is a principal supporting member. Therefore column (A), beam (B) and concrete floor slab (D) are excluded: each has a direct structural load-carrying function. Partition wall (C) is the required non-load-bearing component. A masonry load-bearing wall is a different category and should not be confused with a partition merely because both are called walls.

Step 3: Conclusion A partition wall is the non-load-bearing component among the choices. Hence, the correct option is (C).

Quick Tip to Solve: Ask whether an element supports the floor or roof above, or merely divides the space; a partition belongs to the second category.

71. Which type of roof will provide maximum protection from heat radiation in a building ? [4 marks]

(A) Painted aluminium sheeting

(B) Concrete slab with plaster

(C) Concrete slab with mud and brick tiles

(D) Concrete slab, water proofed and covered with a roof garden

Correct Answer: (D) Concrete slab, water proofed and covered with a roof garden

Solution:

Concept:

- Protection from roof heat gain depends on shading, reflection, insulation and the heat-transfer path through the roof layers.
- A roof garden shades the roof surface and adds a soil and vegetation layer; evaporation and plant transpiration also help reduce surface heating.

Step 1: Assess the roof-garden arrangement In the roof-garden option, vegetation intercepts a substantial part of the incident solar radiation before it reaches the waterproofed concrete slab. The soil layer increases resistance to heat flow and moderates temperature changes. Moisture loss by evaporation and transpiration provides an additional cooling mechanism. Waterproofing protects the slab from moisture; the garden above it supplies the principal additional thermal protection described in this choice.

Step 2: Compare the alternatives Painted aluminium sheeting may reflect radiation, depending on its finish, but a thin metal roof provides little thermal resistance and can transmit surface heat readily. A plastered concrete slab lacks the extra shading and insulating layer. Mud and brick tiles improve a concrete roof's thermal performance, but do not provide the combined vegetation shade, soil cover and evaporative cooling of a roof garden. Thus (A), (B) and (C) offer fewer of these protective mechanisms than (D). The comparison concerns the conventional roof systems listed, rather than a claim that every garden roof performs identically regardless of design or maintenance.

Step 3: Conclusion A waterproofed concrete slab covered with a roof garden provides the greatest protection among the stated roof types. Hence, the correct option is (D).

Quick Tip to Solve: For a hot exposed roof, look for several protections acting together: vegetation shade, an insulating cover and evaporative cooling.

72. Ellora temples are : [4 marks]

(A) Made in marble

(B) Built in sandstone

(C) Cut out of rock

(D) Built in wood

Correct Answer: (C) Cut out of rock

Solution:

Concept:

- Ellora is a major example of rock-cut architecture: its monuments were excavated or carved from the existing rock mass.
- Rock-cut construction removes surrounding material to form spaces and details, unlike masonry construction that assembles separate blocks.

Step 1: Identify the construction technique The Ellora cave and temple complex was formed by cutting into the local rock. Its halls, shrines, columns and sculptural details were created through excavation and carving. The Kailasa temple is a particularly striking example of a temple carved from the rock mass, rather than erected by stacking separately quarried blocks. This makes the construction process the decisive feature in the question.

Step 2: Eliminate the material-based alternatives Option (C), cut out of rock, states the defining technique and is correct. Marble in (A) is not the material and construction description for the Ellora complex. Sandstone masonry in (B) would involve building with separate sandstone blocks, which does not describe these rock-cut monuments. Timber construction in (D) likewise differs fundamentally from excavation into rock. Some carved forms can resemble beams or other familiar architectural members, but the appearance of such details does not change the material or the method used to create them.

Step 3: Conclusion The Ellora temples are cut out of rock. Hence, the correct option is (C).

Quick Tip to Solve: Distinguish excavation from assembly: Ellora is identified by carving the existing rock, not by joining marble, sandstone or timber members.

73. Gol Gumbaj of Bijapur is : [4 marks]

(A) A Fort

(B) A Mausoleum

(C) A Palace

(D) A Mosque

Correct Answer: (B) A Mausoleum

Solution:

Concept:

- A monument is classified by its principal purpose. A mausoleum is a monumental tomb; a fort serves defence, a palace is a royal residence, and a mosque is primarily a place of congregational worship.
- Gol Gumbaj, more commonly written Gol Gumbaz, is the domed tomb of Muhammad Adil Shah at Bijapur, now called Vijayapura. Its primary identity is therefore funerary.

Step 1: Identify the monument Associate Gol Gumbaz with the Adil Shahi monuments of Bijapur. The large domed structure commemorates Muhammad Adil Shah and houses his tomb. Its scale and dome are architectural features, but these features alone do not decide the type of building: the decisive fact is its function as a tomb.

Step 2: Match its function to the choices A monumental tomb is a mausoleum, which matches option (B). The description is not that of a fortified defensive enclosure, so option (A) is unsuitable. It is not a residence designed for the daily occupation of a ruler, which rules out option (C).

Step 3: Distinguish the monument from its surroundings A monument complex can contain several kinds of buildings. The presence of a mosque within the broader Gol Gumbaz complex does not turn the tomb itself into a mosque. The question names Gol Gumbaz specifically, so option (D) does not describe its principal function.

Step 4: Conclusion Gol Gumbaj of Bijapur is a mausoleum. Hence, the correct option is (B).

Quick Tip to Solve: Classify a monument by its main use: tomb means mausoleum, residence means palace, and defensive enclosure means fort.

74. Buland Darwaza is located in : [4 marks]

(A) Fatehpur Sikri

(B) Red Fort

(C) Agra Fort

(D) Golconda

Correct Answer: (A) Fatehpur Sikri

Solution:

Concept:

- Architectural location questions test the association of a named monument with its own historical site, rather than simply with the dynasty that built it.
- Buland Darwaza is the monumental gateway at Fatehpur Sikri, associated with the mosque complex of Akbar's Mughal city.

Step 1: Recall the monument and its setting The name Buland Darwaza refers to the imposing gateway at Fatehpur Sikri. Recall the complete pair, Buland Darwaza–Fatehpur Sikri, before comparing the alternatives. This avoids confusing a gateway belonging to one Mughal complex with a gate in another fort.

Step 2: Select the matching location Fatehpur Sikri is explicitly listed in option (A), so it matches the site of the gateway. Red Fort and Agra Fort are separate fortified complexes; the fact that they are also important Mughal monuments does not make either one the location of Buland Darwaza.

Step 3: Eliminate the remaining distractor Golconda is another historic fortified site, associated with the Deccan rather than with Akbar's city at Fatehpur Sikri. It therefore cannot be selected here. The relevant architectural association is a particular gateway and a particular complex, not the general category of a large historical building.

Step 4: Conclusion Buland Darwaza is located at Fatehpur Sikri. Hence, the correct option is (A).

Quick Tip to Solve: Learn monument–site pairs together; attach Buland Darwaza to Fatehpur Sikri rather than to the general label Mughal architecture.

75. Big Ben is a : [4 marks]

(A) Clock Tower

(B) Palace

(C) Mosque

(D) Temple

Correct Answer: (A) Clock Tower

Solution:

Concept:

- A landmark may have an everyday name different from its precise architectural or component name. An aptitude question must be interpreted in the context of its listed building types.

- Big Ben is commonly used for the clock-tower landmark at the Palace of Westminster in London. Strictly, Big Ben names the Great Bell inside the tower; the tower itself is Elizabeth Tower.

Step 1: Identify the landmark meant by the options The alternatives ask whether the familiar landmark is a clock tower, palace, mosque or temple. In common architectural usage, the name Big Ben identifies the famous tower with its clock faces at Westminster. This is the sense in which the question uses the name.

Step 2: Separate the tower from the larger complex The tower forms part of the Palace of Westminster, but it is not itself a palace. A component of a palace complex should not be assigned the function of the whole complex. Thus option (B) confuses the landmark with its setting, while option (A) correctly identifies the visible building type.

Step 3: Apply the naming qualification and reject the others Neither mosque nor temple describes this clock-tower landmark, so options (C) and (D) are excluded. The technically precise distinction between the Great Bell and Elizabeth Tower is useful to remember, but among the printed choices the intended and appropriate answer remains clock tower.

Step 4: Conclusion In the common landmark sense used here, Big Ben is a clock tower. Strictly, the name belongs to its Great Bell. Hence, the correct option is (A).

Quick Tip to Solve: For this landmark, remember three linked names: Westminster is the complex, Elizabeth Tower is the tower, and Big Ben is its Great Bell.

76. IGBC stands for : [4 marks]

(A) International Great Beautiful City

(B) Indian Green Building Council

(C) Indian Great Building Center

(D) Indian Government Biological Center

Correct Answer: (B) Indian Green Building Council

Solution:

Concept:

- Acronyms should be expanded using the established name of the relevant institution. Merely finding plausible words for the same letters does not establish a correct expansion.
- In green architecture and sustainable construction, IGBC stands for Indian Green Building Council. The words Green Building identify its connection with environmentally responsible buildings.

Step 1: Use the architectural context The question occurs in awareness of buildings and materials. The relevant institution is the Indian Green Building Council, associated with sustainable buildings. Read its initials in order: Indian gives I, Green gives G, Building gives B, and Council gives C.

Step 2: Compare the two building-related choices Option (B) reproduces that established name exactly. Option (C), Indian Great Building Center, may resemble an architectural organisation in its wording, but it substitutes both Great for Green and Center for Council. It is therefore not the expansion of IGBC in this context.

Step 3: Reject unrelated combinations Option (A), International Great Beautiful City, is a sequence of words that can supply the initials but is not the council's name. Option (D), Indian Government Biological Center, refers in wording to a different field and also fails to name the green-building council. The answer follows from identifying the institution, not from acronym matching alone.

Step 4: Conclusion IGBC stands for Indian Green Building Council. Hence, the correct option is (B).

Quick Tip to Solve: Anchor the acronym to its field: Green Building is the middle pair, and Council completes the institutional name.

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77. Solar energy is converted to electrical energy by : [4 marks]

(A) Photovoltaic cells

(B) Electro magnets

(C) Bio technology

(D) Rain water

Correct Answer: (A) Photovoltaic cells

Solution:

Concept:

- A photovoltaic cell converts incident light energy directly into electrical energy. Photons transfer energy to charge carriers in a semiconductor, and the cell separates those carriers.
- An electrical output requires both mobile charges and a driving action that separates them. In a solar cell, the internal electric field at the junction supports this separation and produces a voltage.

Step 1: Identify the required energy conversion The input specified is solar energy and the output is electrical energy. A photovoltaic cell is designed for this direct conversion: illumination creates electron–hole pairs, which are separated so that an external circuit can carry current. Thus its operation matches both sides of the required conversion.

Step 2: Check the electromagnetic alternative An electromagnet normally uses electric current in a coil to produce a magnetic field. It does not by itself convert sunlight into electricity. Electromagnetic induction is important in generators, but an electromagnet alone is not a photovoltaic energy-conversion device, so option (B) is unsuitable.

Step 3: Eliminate the other listed terms Biotechnology describes applications of biological systems; it is not the name of the direct solar-to-electric device asked for here. Rain water is a resource, not a light-sensitive electrical generator. Neither option (C) nor option (D) matches the stated physical process. Only option (A) explicitly identifies the appropriate converter.

Step 4: Conclusion Solar energy is converted directly to electrical energy by photovoltaic cells. Hence, the correct option is (A).

Quick Tip to Solve: Use the word parts as a reminder: photo refers to light and voltaic to electrical voltage; solar heating is a different conversion.

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78. The ruins of Hampi are located in which State ? [4 marks]

(A) Karnataka

(B) Andhra Pradesh

(C) Kerala

(D) Tamil Nadu

Correct Answer: (A) Karnataka

Solution:

Concept:

- For a heritage-location question, distinguish the historical kingdom associated with a site from the present Indian State in which the site lies.
- Hampi is the celebrated ruined city associated with the Vijayanagara Empire. Its location is in Karnataka, beside the Tungabhadra river landscape.

Step 1: Identify the historical site The ruins referred to are the monuments and remains of the former Vijayanagara capital at Hampi. Recognising the historic capital is useful, but the question asks for the State, so the answer must be a modern geographical location rather than the empire's name.

Step 2: Match the site with its present State Hampi lies in Karnataka. This directly matches option (A). The Vijayanagara Empire extended across a much larger part of southern India, so the historical extent of that empire should not be used to assign the capital site to another present-day State.

Step 3: Check the other State names Andhra Pradesh, Kerala and Tamil Nadu each have important monuments of their own, but none is the location of the ruins named in this question. A general association with southern Indian temple architecture is insufficient to choose among them; the specific pair Hampi–Karnataka settles the choice. Options (B), (C) and (D) are consequently excluded.

Step 4: Conclusion The ruins of Hampi are located in Karnataka. Hence, the correct option is (A).

Quick Tip to Solve: Remember Hampi–Vijayanagara–Karnataka as a chain, while keeping the historical empire distinct from the present State.

79. What is Venice famous for ? [4 marks]

(A) Canals

(B) Mountains

(C) Valleys

(D) Springs

Correct Answer: (A) Canals

Solution:

Concept:

- A city can be identified by the landscape and urban feature most strongly associated with it. Venice is internationally associated with its waterways and canal-based urban form.
- A canal is a water channel used for movement or drainage. In Venice, canals form routes between

built-up islands, with bridges providing pedestrian connections.

Step 1: Identify the characteristic urban feature Venice is situated in a lagoon in north-eastern Italy. Its historic urban fabric is spread over islands and is closely integrated with water. The canals pass between buildings and act as important movement routes, rather than merely being an occasional feature beside a conventional road layout. The Grand Canal is the best-known example. Gondolas, water buses and boats are familiar parts of the cityscape, so canals provide the direct architectural and geographical association asked for here.

Step 2: Compare all four alternatives Option (A), canals, describes this defining water-based cityscape. Option (B), mountains, describes elevated landforms and is not the feature for which Venice is famous. Option (C), valleys, describes low areas between hills or mountains and likewise does not identify the city's characteristic urban form. Option (D), springs, means natural points where groundwater emerges; these are not the celebrated feature of Venice. The choice is based on the city's distinctive identity, rather than on whether some other landform might occur elsewhere in its wider region.

Step 3: Conclusion Venice is famous for its canals and the urban life organised around them. Hence, the correct option is (A).

Quick Tip to Solve: Associate Venice with gondolas, bridges and the Grand Canal; all three cues point directly to canals.

80. Pyramids are located in : [4 marks]

(A) Rome

(B) Egypt

(C) Greece

(D) Ethiopia

Correct Answer: (B) Egypt

Solution:

Concept:

- Famous monuments are commonly identified with the country and civilisation to which their best-known examples belong. The monumental pyramids of ancient Egypt are a standard architectural landmark.
- A pyramid has a broad base and sloping faces that converge towards an apex. The major Egyptian pyramids served as royal funerary monuments.

Step 1: Recognise the landmark intended In a general architectural-awareness question, the unqualified reference to the pyramids conventionally points to the ancient Egyptian monuments, particularly the pyramids at Giza. Their massive geometric form and association with the pharaohs make them one of Egypt's most recognisable architectural symbols. The question asks for their location, so the required response is the country Egypt; it does not ask for the construction period, material or the names of individual rulers.

Step 2: Eliminate the alternative locations Option (B), Egypt, gives the country of the celebrated Giza

pyramid complex and is therefore the intended answer. Option (A), Rome, is a city in Italy associated with Roman monuments such as the Colosseum, rather than the Egyptian pyramid complex. Option (C), Greece, is associated with ancient Greek architecture, including classical temples, and is not the location intended here. Option (D), Ethiopia, is also not the location of the Egyptian pyramids. Pyramid-shaped monuments exist in more than one part of the world, so the reasoning does not require the false claim that every pyramid is in Egypt: it identifies the famous architectural group referred to by this question.

Step 3: Conclusion The famous pyramids referred to are located in Egypt. Hence, the correct option is (B).

Quick Tip to Solve: Link the Giza pyramids and the pharaohs with Egypt; distinguish this landmark association from a claim about every pyramid worldwide.

Drawing Test (70 marks)

81(a). Make an interesting. Design using outer profile of keys. [40 marks total]

Solution:

Concept:

- A successful design transforms a recognisable source shape through repetition, rotation and changes of scale while retaining its identity. A key profile can be recognised by its bow, narrow shaft and toothed end.
- Positive shapes and the spaces between them must both be considered. Contrast, rhythm and a clear focal point make a repeated motif into a coherent composition rather than a scattered collection.

Step 1: Choose a motif and establish the composition Use one clear key silhouette with a round bow, a straight shaft and a visibly toothed end. Lightly mark a square working area and its centre. Plan a radial arrangement of eight key profiles, with their bows around a small central negative space and their shafts pointing outwards. This provides a clear organising principle while keeping the outer profile of each key recognisable. Leave a clean border so the design does not appear accidentally cropped.

Step 2: Build rhythm through controlled variation Draw four larger profiles on the horizontal and vertical axes, then four slightly smaller profiles between them. Rotate each profile about the centre instead of merely placing identical upright keys side by side. Maintain enough space between neighbouring teeth and shafts to avoid unreadable tangles. Balance the four quadrants, but vary the intervals subtly to create interest. Repeat a smaller key outline near selected outer ends only if it strengthens the rhythm without overcrowding the main arrangement.

Step 3: Resolve the outlines and tonal pattern Check every silhouette before darkening it: the bow, shaft and teeth must connect into a continuous outer contour. Treat the interior of each silhouette as one design area; do not replace the requested outer profile with detailed mechanical drawings. Alternate solid dark and light profiles to distinguish adjacent motifs, keeping the centre as the strongest focus. If colour is used, restrict it to a coordinated two- or three-colour scheme. The arrangement

should remain clear in monochrome, so colour supports the design rather than rescuing weak outlines.

Step 4: Finish the positive and negative spaces Remove construction lines, even out the contour weight and inspect the white spaces between profiles. These gaps should form deliberate wedges or arcs rather than tiny accidental slivers. Compare opposite sides of the composition for visual weight and adjust one large dark shape if it dominates. The finished design should read first as an organised ornamental pattern and then reveal that all the main shapes come from key profiles.

Step 5: Conclusion A suitable composition is a balanced radial pattern made from rotated large and small key silhouettes, with a clear central focus, legible teeth and bows, and controlled dark-light contrast.

Quick Tip to Solve: Test the design as black silhouettes first: if each key remains recognisable and the gaps look intentional, the composition is ready to finish.

81(b). Draw a picture of your favourite film star's face as realistic as possible.

Solution:

Concept:

- A realistic portrait depends on the relationships between features and the underlying three-dimensional head, rather than on separately drawing symbolic eyes, a nose and a mouth.
- Likeness is strengthened by the subject's distinctive proportions, hairstyle and expression. Consistent lighting and graded tones describe the planes of the face without outlining every change of surface.

Step 1: Select a familiar face and frame the portrait Choose a film star whose face and characteristic features you know well; for example, a front-facing portrait of Amitabh Bachchan can be developed around his elongated face, prominent nose, familiar hair and facial hair. This is one possible choice, not a compulsory subject. Use a head-and-shoulders composition, leaving breathing space above the hair and more room in the direction of the gaze if the head is turned. Begin with a light head mass and indicate the neck and shoulder slope before adding facial detail.

Step 2: Establish the head and place the features Mark a centre line down the face and a curved eye line that follows the head's orientation. Locate the brow, base of the nose and mouth in relation to the chin, checking the chosen person's proportions rather than treating a generic division as exact. Place the eyes symmetrically about the centre line for a frontal view and compare their spacing. Indicate the width of the nose, the shape of the cheekbones and the jaw. Recheck the overall head shape: accurate eyes cannot compensate for a wrong jaw or an incorrectly placed mouth.

Step 3: Develop likeness through forms and expression Refine the eyebrows, eyelids, nose bridge, nostrils and lips using observed or well-remembered shapes. Preserve the star's characteristic expression and hairline. Construct the ears in relation to the brow and nose and let the neck support the head naturally. Show the eyeballs within the sockets rather than as flat almond symbols, and make the lips wrap around the muzzle of the face. Use the example subject's distinctive moustache or beard only when they belong to the version of the face being portrayed.

Step 4: Model the face with one lighting direction Choose light from the upper left. Keep the forehead

and left cheek relatively light, place softer middle tones on turning planes and deeper tones beneath the brows, nose, lower lip and chin. Give the hair larger tonal masses before adding a few strands; excessive individual hairs distract from the face. Blend transitions selectively, retaining sharper edges at the eyelids and nostrils. Finish by comparing feature positions, removing construction marks and keeping the background quiet so the face remains the focus.

Step 5: Conclusion The final portrait plan is a carefully proportioned head-and-shoulders likeness of a chosen film star, supported by characteristic features, a natural expression and consistent tonal modelling.

Quick Tip to Solve: Check the silhouette, feature spacing and nose-to-chin relationship before adding hair texture; likeness is mainly a matter of proportions.

82(a). Design a t-shirt in the topic of Save plants. [30 marks]

Solution:

Concept:

- A T-shirt graphic should communicate its message quickly from a distance. A single strong image, concise lettering and clear contrast are more effective than many small competing details.
- The design must fit the garment, with a legible central print and balanced empty space. The environmental message should be visible in both the picture and the wording.

Step 1: Plan the garment and the main graphic Lightly outline a front view of a simple round-neck T-shirt, showing the neck opening, sleeves and side seams. Keep the garment outline lighter than the print. In the central chest area, place a pair of cupped hands protecting a young sapling, with two or three clearly shaped leaves. This directly expresses care for plants and gives the design a recognisable focal image. Leave clear margins from the neck, armholes and hem so the graphic fits the clothing rather than covering it indiscriminately.

Step 2: Organise the lettering and visual hierarchy Set SAVE PLANTS in bold, simple uppercase letters above the sapling. Use a short secondary line, such as GROW A GREENER TOMORROW, below it in smaller letters. Centre the principal wording and image on the shirt's vertical axis. Keep the main message larger than the secondary line and avoid decorative letter shapes that are difficult to read. Let the hands form a broad base while the sapling grows into the open space beneath the headline, linking image and text into one unit.

Step 3: Choose a limited and purposeful colour scheme Use a light cream or white shirt ground, two green values for the leaves and a restrained earth brown for the hands or soil. Dark green lettering gives sufficient contrast against the light ground. If the work is completed in pencil, preserve the same hierarchy with a dark headline, medium-toned hands and clearly separated leaves. Avoid filling the whole shirt with shading, because the blank garment area makes the message more visible. Keep small details out of the leaves so the print remains clear at a reduced size.

Step 4: Refine the print and present the finished concept Check the spacing between letters, the symmetry of the main placement and the connection between the stem and leaves. Use a clean contour for the hands and a small mound of soil only if it helps make the sapling's support clear. Add

a few light folds at the sleeves and lower hem to identify the garment, without bending the graphic beyond recognition. Erase construction guides and inspect the design from a distance: the words SAVE PLANTS and the protected plant should be understood immediately.

Step 5: Conclusion A suitable T-shirt design uses a central sapling protected by cupped hands, the bold message SAVE PLANTS, a small supporting slogan and a restrained green-and-earth colour scheme.

Quick Tip to Solve: Reduce the graphic mentally to a small chest print: if the plant and main slogan still read clearly, the design has the right level of simplicity.

OR

82(b). Imagine that you've an examiner in a class room & test is going on, from your memory, draw the view. [30 marks]

Solution:

Concept:

- The scene is viewed from the examiner's position inside the classroom. Perspective, overlap and decreasing scale establish the room and the orderly rows of students taking a test.
- A convincing memory drawing uses a clear viewpoint and consistent lighting. Small gestures such as bent heads, writing hands and answer sheets communicate the activity without requiring excessive detail.

Step 1: Choose the examiner's viewpoint and establish the room Place the viewpoint near the front of the classroom, looking towards the back through the rows of desks. Lightly mark an eye-level horizon and a central vanishing point on the far wall. Draw the far wall, floor and side walls as a simple room envelope. Show a small corner of the examiner's desk or a stack of papers in the lower foreground to suggest the observer's position, without blocking the main view. Keep enough floor space visible to make the aisles understandable.

Step 2: Construct the desk rows in perspective Set out three rows of desks with an aisle between them. Lines that run away into the room should converge towards the same vanishing point, while vertical legs and wall edges remain vertical. Draw the nearest desk larger, and reduce desk width and spacing progressively towards the back. Let nearer furniture overlap farther furniture. Do not use identical desk sizes at every depth: that would flatten the room. Add seats and chair backs in proportion to the desks and leave plausible walking space for the examiner.

Step 3: Place students and convey the ongoing test Seat students behind the desks with heads bent towards their answer sheets. Vary the poses slightly: one student writes, another reads the question paper, and another pauses to think. Keep their bodies and heads consistent with the shrinking scale of the desks. Indicate writing hands, pencils and sheets clearly in the foreground, using simpler silhouettes in the distance. The room should feel concentrated and orderly, with no distracting conversation or unrelated action that weakens the examination setting.

Step 4: Add room details and finish the tonal structure Place windows on one side wall and use them as the main light source. Add a door, a simple clock or a notice board on the far wall as secondary

details, following the wall perspective. Lay soft shadows beneath desks and chairs, with darker overlaps in the foreground and lighter treatment towards the back. Keep window panes and lettering subordinate to the students. Strengthen selected foreground contours, erase guides and check that desk rows, floor edges and ceiling lines all belong to the same view.

Step 5: Conclusion The proposed scene shows an examination classroom from the front examiner's viewpoint, with receding desk rows, students quietly writing, visible answer sheets and consistent perspective and window light.

Quick Tip to Solve: Draw the room and desk grid first, then fit the students into it; this keeps the classroom perspective coherent and the test activity readable.

OR

82(c). Imagine you are sitting on a merry go round, draw the view. [30 marks]

Solution:

Concept:

- The viewer sits on the merry-go-round, so the nearest ride elements frame the scene while the surrounding fairground is seen beyond. Foreground overlap, relative scale and perspective establish this personal viewpoint.
- Curved forms suggest the circular platform and canopy. A slight sweep in surrounding gestures and the arrangement of figures can suggest movement while keeping the scene legible.

Step 1: Set the seated viewpoint and foreground frame Choose a view looking outward from a carousel seat. Place part of the viewer's mount, such as the horse's neck and ears, in the lower foreground, together with a vertical support pole close to one side. Show a second pole or a small part of the canopy above to establish the ride without enclosing the whole picture. Keep the eye level low enough to feel like a seated position. These nearby elements should be larger and more strongly drawn than the fairground beyond.

Step 2: Construct the carousel and its circular arrangement Indicate the curved edge of the platform using an elliptical arc. Place one or two neighbouring horses along the circular course, with their riders partly overlapping the distant view. Poles must connect plausibly with the platform and canopy, and the horses should follow the ride's circular organisation rather than stand on unrelated ground planes. Preserve vertical supports while showing the foreshortening of mounts farther around the ring. Do not attempt to draw every horse: a few well-placed forms give a clearer view.

Step 3: Build the surrounding fairground in layers Beyond the platform, place waiting families and a simple safety railing, then a ticket booth, trees and one distant stall. The nearest standing figures should be larger than those near the booth, and overlapping silhouettes should make their depth clear. Orient gazes or raised hands towards the ride to connect the outside crowd with the viewer. Keep the far background simple so the distinctive seated carousel viewpoint remains the subject. Leave a visible route or open patch between the railing and booth to prevent the scene becoming a flat band of objects.

Step 4: Suggest movement and apply consistent light Use the sweep of the canopy decoration, the curved platform edge and the changing angles of adjacent mounts to suggest rotation. A few light directional accents can reinforce motion, but do not blur all contours or make the stationary background structurally incorrect. Choose one daylight direction, giving the nearest horse rounded shading and placing cast shadows consistently. Use stronger contrast for the foreground mount and pole, middle tones for nearby riders, and lighter detail for the stalls and trees. Finish by checking the seated eye level and all overlaps.

Step 5: Conclusion A convincing composition places the viewer on a carousel horse, frames the foreground with the mount and a support pole, and shows neighbouring riders and the surrounding fairground through layered depth, curved forms and controlled movement cues.

Quick Tip to Solve: Include a large foreground mount or pole: that single framing cue makes the drawing read as a view from the ride rather than a view of it.