JEE Main 2018 Paper 2 (B.Arch/B.Plan) Apr 8 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) 2018, Annual (offline), conducted by the Central Board of Secondary Education (CBSE) in pen and paper mode on 8 April 2018, 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 $f(x)+2f(1-x)=x^2+1, \forall x \in \mathbf{R}$, then the range of f is : [4 marks]

(A) $\left(-\infty, \frac{1}{3}\right]$
(B) $\left[-\frac{1}{3}, \infty\right)$
(C) $\left[-\frac{1}{3}, \frac{1}{3}\right]$
(D) $\left[\frac{1}{3}, \infty\right)$

Correct Answer: (B) $\left[-\frac{1}{3}, \infty\right)$

Solution:

Concept:

- The two equations obtained at x and $1-x$ form simultaneous linear equations for $f(x)$ and $f(1-x)$. This works because the stated identity holds for every real input.
- A quadratic with positive leading coefficient has a minimum at its vertex. Completing the square gives both the least value and the entire range when the domain is $\mathbf{R}$.

Step 1: Replace the input and eliminate the second function Replacing x by $1-x$, we have

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

Multiply this equation by 2 and subtract the original identity. The coefficients of $f(1-x)$ cancel:

$$3f(x)=2(x^2-2x+2)-(x^2+1)=x^2-4x+3.$$

Thus the functional identity determines f uniquely; there is no additional freedom to choose a different function.

Step 2: Complete the square and find all output values Dividing by 3 and completing the square gives

$$f(x)=\frac{x^2-4x+3}{3}=\frac{(x-2)^2}{3}-\frac{1}{3}.$$

For every real x, the square is nonnegative, and it equals zero at $x=2$. Therefore the minimum is $-1/3$, attained at that input. Conversely, if $y \geq -1/3$, then $x=2+\sqrt{3y+1}$ is real and satisfies $f(x)=y$. Hence every number above the minimum occurs; the range has no finite upper endpoint. Option (A) incorrectly makes the range bounded above, (C) imposes an upper bound that does not exist, and (D) gives the wrong minimum.

Step 3: Conclusion The range is $\boxed{[-1/3, \infty)}$. Hence, the correct option is (B).

Quick Tip to Solve: For an identity involving both $f(x)$ and $f(1-x)$, replace x by $1-x$ first; solve the resulting pair before investigating the range.

2. Let $A = \{z \in \mathbf{C} : |z| = 25\}$ and $B = \{z \in \mathbf{C} : |z + 5 + 12i| = 4\}$. Then the minimum value of $|z - \omega|$, for $z \in A$ and $\omega \in B$, is : [4 marks]

(A) 6

(B) 7

(C) 8

(D) 9

Correct Answer: (C) 8

Solution:

Concept:

- The locus $|z - a| = r$ is a circle of centre a and radius r in the Argand plane. The modulus $|z - \omega|$ is the Euclidean distance between the corresponding points.
- The triangle inequality bounds the modulus of a point on a translated circle. Equality is possible when the relevant complex numbers have the same direction.

Step 1: Locate the two circles The set A is the circumference of a circle with centre 0 and radius 25. The set B has centre $c = -5 - 12i$ and radius 4, since its defining equation is $|\omega - c| = 4$. The distance of its centre from the origin is

$$|c| = \sqrt{(-5)^2 + (-12)^2} = 13.$$

Consequently every point of the smaller circle is strictly inside the circle of radius 25: its greatest possible distance from the origin is $13 + 4 = 17 < 25$. The required distance is the gap between these circumferences, not the distance between their centres.

Step 2: Bound the distance and attain the bound For any permitted pair, the reverse triangle inequality and then the triangle inequality give

$$|z - \omega| \geq |z| - |\omega| \geq 25 - (13 + 4) = 8.$$

To show that this lower bound is the actual minimum, take the unit complex number $u = c/13$. Choose

$$\omega = 17u = c + 4u, \qquad z = 25u.$$

Then $|\omega - c| = 4$, $|z| = 25$, and $|z - \omega| = |8u| = 8$. Both points lie on the same ray from the origin, with the point of B farthest from the origin used. Values 6 and 7 violate the lower bound, while 9 is larger than the attained distance and therefore cannot be the minimum.

Step 3: Conclusion The minimum distance is $\boxed{8}$. Hence, the correct option is (C).

Quick Tip to Solve: When one circle lies inside another, subtract the centre distance and the inner radius from the outer radius; verify attainment along the line of centres.

3. If the product of the roots of the equation, $x^2 - 5kx + 2e^{2\log_e|k|} - 1 = 0$ is 49, then the sum of the squares of the roots of the equation is : [4 marks]

(A) 525

(B) 527

(C) 576

(D) 627

Correct Answer: (B) 527

Solution:

Concept:

- For a monic quadratic $x^2 - sx + p = 0$, its roots α, β satisfy $\alpha + \beta = s$ and $\alpha\beta = p$. These identities avoid solving the quadratic explicitly.
- The identity $e^{2\log_e|k|} = |k|^2 = k^2$ holds for real $k \neq 0$. Also, $\alpha^2 + \beta^2 = (\alpha + \beta)^2 - 2\alpha\beta$.

Step 1: Use the given product to determine the parameter square The logarithm requires $|k| > 0$, so $k \neq 0$. Simplify the constant term first:

$$2e^{2\log_e|k|} - 1 = 2k^2 - 1.$$

By the product-of-roots formula and the given product 49,

$$2k^2 - 1 = 49 \quad \Longrightarrow \quad k^2 = 25.$$

Both $k = 5$ and $k = -5$ satisfy the logarithmic domain. We need not select one sign, because the requested sum of squares will depend only on k^2. In particular, the absolute value inside the logarithm does not force k itself to be positive.

Step 2: Find the square sum without calculating individual roots The coefficient of x is $-5k$, and hence $\alpha + \beta = 5k$. Therefore

$$\begin{aligned} \alpha^2 + \beta^2 &= (5k)^2 - 2(49) \\ &= 25(25) - 98 \\ &= 625 - 98 = 527. \end{aligned}$$

This result is unchanged for the two possible signs of k. As a consistency check, the discriminant is $25k^2 - 4(49) = 625 - 196 = 429 > 0$, so the parameters yield real roots as well. The other proposed numbers 525, 576 and 627 do not equal the value obtained from the exact root identities; directly squaring the sum alone would also wrongly omit the cross term.

Step 3: Conclusion The sum of the squares of the roots is $\boxed{527}$. Hence, the correct option is (B).

Quick Tip to Solve: When a quadratic question gives a product and asks for a square sum, use $s^2 - 2p$; solving for the individual roots introduces unnecessary radicals.

4. If $A = \begin{bmatrix} 2 & 52 & 152 \\ 4 & 106 & 358 \\ 6 & 162 & 620 \end{bmatrix}$, then the determinant of the matrix $\mathrm{adj}(2A)$ is equal to : [4 marks]

(A) 64

(B) 256

(C) 2048

(D) 4096

Correct Answer: (D) 4096

Solution:

Concept:

- For an $n \times n$ matrix M, $\det(\mathrm{adj}\, M) = (\det M)^{n-1}$. Here $n = 3$, so the determinant of the adjugate is the square of the determinant.
- Scaling an entire 3×3 matrix by 2 multiplies its determinant by 2^3, since each of its three rows is scaled. Adding a multiple of one row to another leaves a determinant unchanged.

Step 1: Simplify the determinant of the given matrix Apply $R_2 \mapsto R_2 - 2R_1$ and $R_3 \mapsto R_3 - 3R_1$. These operations introduce two zeros in the first column without changing the determinant:

$$\det A = \begin{vmatrix} 2 & 52 & 152 \\ 0 & 2 & 54 \\ 0 & 6 & 164 \end{vmatrix}.$$

Expanding along the first column now gives

$$\det A = 2 \begin{vmatrix} 2 & 54 \\ 6 & 164 \end{vmatrix} = 2(328 - 324) = 8.$$

The subtraction in the minor is essential: its entries are close enough that using their product sum instead would give a very different determinant.

Step 2: Apply the scaling and adjugate identities in order First compute the determinant of $2A$, keeping account of the matrix order:

$$\det(2A) = 2^3 \det A = 8 \times 8 = 64.$$

Now put $M = 2A$ in the adjugate identity:

$$\det(\mathrm{adj}(2A)) = (\det(2A))^2 = 64^2 = 4096.$$

To check the exponent, take determinants in the matrix identity $M\,\mathrm{adj}\, M = (\det M) I_3$. The resulting scalar identity has one factor $\det M$ on the left and its cube on the right. Dividing is valid here because $\det M = 64 \neq 0$; the remaining power is two. Option (A) is only $\det(2A)$, before taking its square. Options (B) and (C) also fail to apply both dimension-dependent powers correctly.

Step 3: Conclusion The required determinant is $\boxed{4096}$. Hence, the correct option is (D).

Quick Tip to Solve: Keep the two operations separate: scalar multiplication contributes a power equal to the matrix order, and the adjugate contributes a power one less than that order.

5. Let S be the set of all real values of λ for which the system of linear equations

$$\lambda x + y + z = 5\lambda$$

$$2\lambda x + 2y - z = 1$$

$$3y + z = 9$$

has infinitely many solutions. Then, S : [4 marks]

(A) equals **R**.

(B) is a singleton.

(C) contains exactly two elements.

(D) is an empty set.

Correct Answer: (D) is an empty set.

Solution:

Concept:

- A square linear system has a unique solution when its coefficient determinant is nonzero. Infinitely many solutions require a singular coefficient matrix and a consistent augmented system.
- Eliminating x between the first two equations is valid for every real λ, because it does not involve division by λ. The case $\lambda = 0$ must be tested separately before division.

Step 1: Treat every nonzero parameter Subtract twice the first equation from the second. This eliminates both the x and y terms:

$$-3z = 1 - 10\lambda \quad \Longrightarrow \quad z = \frac{10\lambda - 1}{3}.$$

The third equation then gives $y = (9 - z)/3$. If $\lambda \neq 0$, the first equation gives $x = (5\lambda - y - z)/\lambda$. Thus each variable is determined uniquely for every nonzero parameter, and no such value belongs to S. Equivalently, the coefficient determinant is 9λ, which is nonzero in precisely this case.

Step 2: Check the singular parameter for consistency At $\lambda = 0$, the first two equations reduce to

$$y + z = 0, \qquad 2y - z = 1.$$

Adding them yields $3y = 1$, so $y = 1/3$ and $z = -1/3$. But these values give

$$3y + z = 1 - \frac{1}{3} = \frac{2}{3} \neq 9,$$

contradicting the third equation. Although x disappears when the parameter is zero, the remaining equations have no solution; a free-looking variable does not ensure infinitely many solutions. Hence zero also does not belong to S. We have exhausted all real values of the parameter, so the set cannot be all of **R**, a singleton, or a two-element set as in the other three alternatives.

Step 3: Conclusion There is no real parameter producing infinitely many solutions: $\boxed{S = \varnothing}$. Hence, the correct option is (D).

Quick Tip to Solve: A zero determinant is only a necessary condition for infinitely many solutions. Substitute every singular parameter into the original equations and check consistency.

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6. In order to get through in an examination of nine papers, a candidate has to pass in more papers than the number of papers in which he fails. The number of ways in which he can fail, in this examination, is : [4 marks]

(A) 128

(B) 255

(C) 256

(D) $9 \times (8)!$

Correct Answer: (C) 256

Solution:

Concept:

- For nine distinct papers, an examination outcome is specified by the subset of papers failed. If exactly r papers are failed, the number of outcomes is $\binom{9}{r}$.
- The candidate gets through only when the number passed exceeds the number failed. Complementation pairs each subset of nine papers with one of opposite majority size.

Step 1: Translate failure into the size of the failed subset If the candidate fails in r papers, the number passed is $9 - r$. Getting through requires

$$9 - r > r \quad \Longleftrightarrow \quad r < \frac{9}{2}.$$

Since r is an integer, this means $r \leq 4$. Consequently the candidate fails the examination as a whole exactly when $r \geq 5$. The problem asks for ways to fail the examination, not ways merely to fail at least one individual paper. There is no tied outcome because the total number of papers is odd.

Step 2: Count the outcomes with a failure majority Choose the failed papers for each allowable size and add:

$$N = \binom{9}{5} + \binom{9}{6} + \binom{9}{7} + \binom{9}{8} + \binom{9}{9}$$
$$= 126 + 84 + 36 + 9 + 1 = 256.$$

For an independent check, there are $2^9 = 512$ pass/fail assignments altogether. Swapping pass and fail in every paper gives a bijection between passing outcomes and failing outcomes, so each class has $512/2 = 256$ outcomes. Option (B), 255, would omit the all-nine-failed outcome from the sum. Option (A), 128, halves the relevant total once too often. The factorial expression in (D) counts ordered arrangements, whereas the order of papers does not distinguish a pass/fail outcome.

Step 3: Conclusion The candidate can fail the examination in $\boxed{256}$ ways. Hence, the correct option is (C).

Quick Tip to Solve: For an odd number of papers and a strict majority pass rule, complement each pass/fail pattern: exactly half of all binary outcomes fail the examination.

7. Let T_r denote the r^{th} term in the binomial expansion of $(\mathrm{a}+1)^{50}$. If

$$\mathrm{T}_{25}+\mathrm{T}_{27}=\frac{125}{52}\,\mathrm{T}_{26}$$

then the sum of all the values of a is : [4 marks]

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

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

(C) 2

(D) $\frac{5}{2}$

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

Solution:

Concept:

- The rth term of $(a+1)^{50}$, counted from the first term, is $T_r=\binom{50}{r-1}a^{51-r}$. The term number differs from the lower binomial index by one.
- Ratios of neighbouring binomial coefficients cancel factorials. For a quadratic equation, the sum of its roots is minus the coefficient of the linear term divided by its leading coefficient.

Step 1: Write the three central terms The three terms in the equation are

$$T_{25}=\binom{50}{24}a^{26},\qquad T_{26}=\binom{50}{25}a^{25},\qquad T_{27}=\binom{50}{26}a^{24}.$$

Symmetry gives equal coefficients for the first and third expressions. Also,

$$\frac{\binom{50}{24}}{\binom{50}{25}}=\frac{25}{26},\qquad \binom{50}{26}=\binom{50}{24}.$$

These relations keep the algebra small without expanding the full power.

Step 2: Factor the given equality Substituting the terms and dividing only by the nonzero constant $\binom{50}{25}$, we obtain

$$\frac{25}{26}a^{24}(a^2+1)=\frac{125}{52}a^{25}.$$

Thus

$$a^{24}(2a^2-5a+2)=0.$$

This factorisation retains the possible value $a=0$, which would be lost by directly dividing by the central term.

Step 3: Find the values and compare the options The quadratic factors as

$$(2a-1)(a-2)=0,$$

giving $a=\frac{1}{2}$ and $a=2$. At $a=0$, all three specified terms vanish, so the original equality also holds.

Its contribution to the requested sum is zero. Consequently the sum is

$$0 + \frac{1}{2} + 2 = \frac{5}{2}.$$

Option (A) counts only one nonzero root, option (C) counts the other, and option (B) is not their sum.

Step 4: Conclusion The sum of all allowed values of a is $\boxed{\frac{5}{2}}$. Hence, the correct option is (D).

Quick Tip to Solve: Factor out the common power of the parameter before dividing by a term; a zero value may satisfy the original identity.

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8. In an ordered set of four numbers, the first 3 are in A.P. and the last 3 are in G.P., whose common ratio is $\frac{7}{4}$. If the product of the first and fourth of these numbers is 49, then the product of the second and third of these is : [4 marks]

(A) 60

(B) 112

(C) 128

(D) 144

Correct Answer: (B) 112

Solution:

Concept:

- For three consecutive terms of an arithmetic progression, the first plus the third equals twice the middle. This identity applies only to the first three numbers here.
- For a geometric progression with common ratio r, consecutive terms can be written as t, rt, r^2t. Here the final three numbers have ratio $r = 7/4$.

Step 1: Parameterise the final three numbers Let the four ordered numbers be a, b, c, d, with $b = t$. Since b, c, d are in geometric progression,

$$b = t, \qquad c = \frac{7}{4}t, \qquad d = \frac{49}{16}t.$$

The first three numbers are in arithmetic progression, hence

$$a + c = 2b \quad \Rightarrow \quad a = 2t - \frac{7}{4}t = \frac{1}{4}t.$$

The two progression conditions apply to overlapping triples.

Step 2: Use the product of the endpoint numbers The given information is $ad = 49$, so substitution gives

$$\left(\frac{1}{4}t\right)\left(\frac{49}{16}t\right) = 49.$$

Therefore

$$\frac{49}{64}t^2 = 49 \quad \Rightarrow \quad t^2 = 64.$$

Either sign of t satisfies this equation; choosing a sign prematurely is unnecessary because the requested product depends on its square.

Step 3: Calculate the middle product The second and third numbers have product

$$bc = t\left(\frac{7}{4}t\right) = \frac{7}{4}t^2 = \frac{7}{4}(64) = 112.$$

Taking $t = 8$ checks the sequence as $2, 8, 14, 49/2$; the endpoint product is 49. Both signs give the same products. Thus 60, 128 and 144 cannot satisfy the derived product relation.

Step 4: Conclusion The product of the second and third numbers is $\boxed{112}$. Hence, the correct option is (B).

Quick Tip to Solve: Use one common parameter for the overlapping term; derive the first number from A.P. and the fourth from G.P.

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9. If $e^{(\sin^2 x+\sin^4 x+\sin^6 x+\ldots+\text{ ad inf. })\log_e 2}$ $\left(0 < x < \frac{\pi}{2}\right)$ satisfies the equation, $y^2 - 5y + 4 = 0$, then $\frac{\sin x}{\cos x - \sin x}$ is equal to : [4 marks]

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

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

(C) $\sqrt{2}-1$

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

Correct Answer: (A) $-(2+\sqrt{2})$

Solution:

Concept:

- An infinite geometric series with first term u and ratio u has sum $u/(1-u)$ when $|u| < 1$. For $0 < x < \pi/2$, $u = \sin^2 x$ lies strictly between zero and one.
- The identity $e^{v \log_e 2} = 2^v$ converts the given exponential into a power of 2. In the first quadrant, both sine and cosine are positive.

Step 1: Sum the exponent series The series is geometric:

$$S = \sin^2 x + \sin^4 x + \sin^6 x + \cdots = \frac{\sin^2 x}{1 - \sin^2 x} = \tan^2 x.$$

The open interval ensures convergence and excludes both zero sine and zero cosine. Thus the number satisfying the quadratic is

$$y = e^{S \log_e 2} = 2^{\tan^2 x}.$$

Since $\tan^2 x > 0$, this implies $y > 1$.

Step 2: Select the permissible quadratic root Factor the stated equation:

$$y^2 - 5y + 4 = (y-1)(y-4) = 0.$$

Its roots are 1 and 4, but $y = 1$ is impossible in the specified open interval. Therefore

$$2^{\tan^2 x} = 4 = 2^2 \quad \Rightarrow \quad \tan^2 x = 2.$$

As x is in the first quadrant, $\tan x = \sqrt{2}$, not the negative square root.

Step 3: Evaluate the requested ratio Divide numerator and denominator by the positive quantity $\cos x$:

$$\frac{\sin x}{\cos x - \sin x} = \frac{\tan x}{1 - \tan x} = \frac{\sqrt{2}}{1 - \sqrt{2}}.$$

Rationalising gives

$$\frac{\sqrt{2}(1 + \sqrt{2})}{1 - 2} = -(2 + \sqrt{2}).$$

The denominator is negative because $\tan x > 1$, immediately rejecting the positive options (C) and (D). Option (B) has the wrong numerator factor after rationalisation.

Step 4: Conclusion The required value is $\boxed{-(2 + \sqrt{2})}$. Hence, the correct option is (A).

Quick Tip to Solve: Use the interval before selecting roots: the exponential is strictly greater than 1 and the tangent is positive.

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10. Let $f(x) = x\left[\frac{1}{x}\right]$ for all $x(\neq 0) \in$ R, where for each $t \in$ R, $[t]$ denotes the greatest integer less than or equal to t. Then : [4 marks]

(A) $\lim_{x \to 0+} f(x) = 0$

(B) $\lim_{x \to \frac{1}{3}+} f(x) = 1$

(C) $\lim_{x \to \frac{1}{2}-} f(x) = 1$

(D) $\lim_{x \to 2-} f(x) = 1$

Correct Answer: (C) $\lim_{x \to \frac{1}{2}-} f(x) = 1$

Solution:

Concept:

- The floor function satisfies $t - 1 < [t] \leq t$. At a nonintegral argument it is constant locally, but at an integer its two one-sided values differ.
- When x is positive, the reciprocal $1/x$ decreases as x increases. A left-sided approach to a positive x therefore becomes a right-sided approach for its reciprocal.

Step 1: Check the limit at zero For $x > 0$, apply the floor bounds to $1/x$, then multiply by x without reversing inequalities:

$$1 - x < x\left[\frac{1}{x}\right] \leq 1.$$

Both outer expressions tend to 1 as $x \to 0^+$, so the squeeze theorem gives a limit of 1. Option (A), which claims zero, is false. Although the floor itself grows without bound, its product with x remains close to 1.

Step 2: Check the limits at one third and one half If x approaches $1/3$ from above, its reciprocal approaches 3 from below. For nearby such x, $2 < 1/x < 3$, so the floor equals 2. The resulting limit is $2/3$, rejecting (B). If x approaches $1/2$ from below, its reciprocal approaches 2 from above. Nearby, $2 < 1/x < 3$, again giving floor 2. Therefore

$$\lim_{x\to(1/2)^-} x\left[\frac{1}{x}\right] = \lim_{x\to(1/2)^-} 2x = 1.$$

This is precisely statement (C).

Step 3: Check the remaining alternative For x just below 2, x is still greater than 1, hence $1/2 < 1/x < 1$. Its greatest integer is zero, so f(x) is identically zero in this left neighbourhood. Thus the limit in (D) is zero rather than 1. All four alternatives have now been checked using the local constant floor values; the only true statement is the left-sided limit at $x = 1/2$.

Step 4: Conclusion $\lim_{x\to(1/2)^-} f(x) = 1$. The supplied key's right-hand-limit choice is incorrect: that limit is $2/3$, so the literal one-sided limits prove (C). Hence, the correct option is (C).

Quick Tip to Solve: First locate the reciprocal in an interval between consecutive integers; then replace the floor by that integer.

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11. If $f(x) = \begin{cases} \frac{72^x - 9^x - 8^x + 1}{\sqrt{2} - \sqrt{1+\cos x}}, & x \neq 0 \\ \mathrm{k}\sqrt{2}\log_e 2 \log_e 3, & x = 0 \end{cases}$

is a continuous function in the interval $[0, 2\pi)$**, then k is equal to :** [4 marks]

(A) 4

(B) 18

(C) 24

(D) 36

Correct Answer: (C) 24

Solution:

Concept:

- Continuity at zero requires the right-hand limit of the expression for nonzero x to equal the assigned value f(0), since zero is the endpoint of the interval.
- The standard limits are $(a^x - 1)/x \to \log_e a$ and $(1 - \cos x)/x^2 \to 1/2$. Rationalising a difference of square roots reveals the second limit.

Step 1: Factor the exponential numerator Because $72 = 9 \cdot 8$, the numerator has the exact factorisation

$$72^x - 9^x - 8^x + 1 = (9^x - 1)(8^x - 1).$$

Each factor tends to zero linearly with x. Dividing the numerator by x^2 gives the product of two standard limits, rather than requiring repeated differentiation.

Step 2: Rationalise the square-root denominator Multiply numerator and denominator by $\sqrt{2} +$

$\sqrt{1+\cos x}$. For nonzero x near zero,

$$f(x) = \frac{(9^x - 1)(8^x - 1)\left(\sqrt{2} + \sqrt{1+\cos x}\right)}{1 - \cos x}.$$

Hence its endpoint limit is

$$\begin{aligned}\lim_{x \to 0^+} f(x) &= (\log_e 9)(\log_e 8)(2\sqrt{2})(2) \\ &= 4\sqrt{2}(2\log_e 3)(3\log_e 2) \\ &= 24\sqrt{2}\log_e 2 \log_e 3.\end{aligned}$$

The factor 2 from $x^2/(1-\cos x)$ is essential.

Step 3: Impose the continuity condition The value defined at zero is $k\sqrt{2}\log_e 2 \log_e 3$. The multiplier $\sqrt{2}\log_e 2 \log_e 3$ is nonzero, so equality with the limit yields k=24. Away from zero in the given interval, $1+\cos x \geq 0$, and the denominator vanishes only when $\cos x = 1$. There is no other such point before the excluded endpoint 2π; thus no further continuity condition is needed. Options 4, 18 and 36 do not match the exact limiting coefficient.

Step 4: Conclusion Continuity requires $\boxed{k = 24}$. Hence, the correct option is (C).

Quick Tip to Solve: Factor the exponential numerator and rationalise the radical denominator before applying standard limits.

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12. If $y = y(x)$ is an implicit function of x given by $y\cos x + x\cos y = \pi$; then $y''(0)$ is equal to : [4 marks]

(A) π

(B) $-\pi$

(C) 0

(D) 2π

Correct Answer: (A) π

Solution:

Concept:

- An implicit equation can be differentiated with respect to x by treating y as a function of x and applying the product rule and chain rule.
- To evaluate derivatives at a point, first determine y there from the original equation. The second differentiation must retain every term involving both y and its derivatives.

Step 1: Find the point and first derivative At x=0, the original equation becomes

$$y\cos 0 + 0\cos y = \pi,$$

so $y(0) = \pi$. Differentiating once gives

$$y'\cos x - y\sin x + \cos y - x\sin y\, y' = 0.$$

At $(x, y) = (0, \pi)$, this reduces to $y'(0) - 1 = 0$. Thus $y'(0) = 1$. The factor multiplying y prime in the implicit derivative is nonzero at this point, so a differentiable local branch is well defined.

Step 2: Differentiate the first-derivative identity Apply the product rule separately to all four terms. The derivative of $-x \sin y\, y'$ contributes three terms. Combining like terms gives

$$0 = y'' \cos x - 2y' \sin x - y \cos x \\ - 2 \sin y\, y' - x \cos y\, (y')^2 - x \sin y\, y''.$$

In particular, one $-\sin y\, y'$ term comes from differentiating $\cos y$, and another comes from differentiating the explicit factor x in the last term.

Step 3: Evaluate the second derivative at zero Now use $\sin 0 = 0$, $\cos 0 = 1$, $\sin \pi = 0$ and $y(0) = \pi$. Every term with an explicit factor x or a sine vanishes. The remaining identity is

$$y''(0) - \pi = 0.$$

Therefore $y''(0) = \pi$. The negative sign in option (B) would come from moving the surviving term incorrectly; option (C) would omit the derivative of $-y \sin x$. The factor two in (D) is not present in the surviving equation.

Step 4: Conclusion The value is $\boxed{y''(0) = \pi}$. Hence, the correct option is (A).

Quick Tip to Solve: Find y(0) first, then differentiate the full identity twice before substituting the point; vanishing terms become obvious.

13. For each $x \in \mathbf{R}$, let $f(x) = |x - 1|$, $g(x) = \cos x$ and $\varphi(x) = f(g(2 \sin x)) - g(f(x))$. Then, φ is :

[4 marks]

(A) differentiable at each point of **R**.

(B) not differentiable at 0.

(C) not differentiable at 1.

(D) differentiable only in $\left(-\frac{\pi}{2}, \frac{\pi}{2}\right)$.

Correct Answer: (A) differentiable at each point of **R**.

Solution:

Concept:

- The absolute-value function can have corners, but an absolute value disappears when the sign of its argument is known. For every real argument u, $\cos u \leq 1$.
- The cosine function is even: $\cos |v| = \cos v$. Compositions and differences of differentiable functions are differentiable on their common domain.

Step 1: Simplify the first composite function Here $f(g(2 \sin x)) = |\cos(2 \sin x) - 1|$. Its inner expression is always nonpositive, so the correct sign is the negative one, including at its zeros. Therefore

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

Although the outer absolute value can produce a corner in other problems, it produces none here: this identity is valid for every real x.

Step 2: Simplify the second composite and differentiate Evenness gives $g(f(x)) = \cos|x-1| = \cos(x-1)$, also across $x = 1$. Consequently

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

The chain rule now gives

$$\varphi\prime(x) = 2\cos x \sin(2\sin x) + \sin(x-1).$$

This derivative exists for every real number. In particular, there is no exceptional behavior at 0 or 1, which excludes (B) and (C); there is no interval restriction, which excludes (D).

Step 3: Conclusion φ is differentiable at each point of $\mathbf{R}$. Hence, the correct option is (A).

Quick Tip to Solve: Before testing one-sided derivatives of a composite absolute value, use the range of its inner function and the evenness of cosine.

14. If $f(x) = \left|x^2 - 16\right|$ for all $x \in \mathbf{R}$, then the total number of points of $\mathbf{R}$ at which $f : \mathbf{R} \to \mathbf{R}$ attains local extreme values, is : [4 marks]

(A) 1

(B) 2

(C) 3

(D) 4

Correct Answer: (C) 3

Solution:

Concept:

- A local maximum or minimum is determined by comparison with nearby function values. A nondifferentiable point can be an extremum, so solving $f\prime(x) = 0$ alone is insufficient.
- The sign of $x^2 - 16$ changes at $x = \pm 4$. On each resulting open interval the absolute value can be removed and the usual derivative test applies.

Step 1: Remove the absolute value on each interval For $|x| \geq 4$, $f(x) = x^2 - 16$; for $|x| < 4$, $f(x) = 16 - x^2$. Thus

$$f\prime(x) = \begin{cases} 2x, & x < -4 \text{ or } x > 4, \\ -2x, & -4 < x < 4. \end{cases}$$

The only zero of the derivative within these intervals is $x = 0$. The sign changes from positive to negative there, so $f(0) = 16$ is a strict local maximum.

Step 2: Check the two corners and rule out other points At both $x = -4$ and $x = 4$, the function equals zero, whereas all sufficiently close distinct points have positive values. Each corner is therefore a strict local minimum. Equivalently the slope changes from negative to positive at each corner. On the remaining portions of the four intervals separated by $-4, 0, 4$, the derivative has a fixed nonzero

sign, so the function is strictly monotone and cannot attain another local extremum. Counting only differentiable stationary points would incorrectly give one; counting only corners would incorrectly give two. There is no fourth candidate.

Step 3: Conclusion The three points are $x = -4, 0, 4$, comprising two local minima and one local maximum. Hence, the correct option is (C).

Quick Tip to Solve: For the absolute value of a polynomial, test both zeros of the polynomial and stationary points of each smooth piece.

15. Let

$$I = \int \frac{e^x}{e^{4x} + e^{2x} + 1}\, dx, \quad J = \int \frac{e^{-x}}{e^{-4x} + e^{-2x} + 1}\, dx$$

then, $J - I$ equals :

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

(A) $\frac{1}{2}\log_e\left|\frac{e^{4x}-e^{2x}+1}{e^{4x}+e^{2x}+1}\right| + C$

(B) $\frac{1}{2}\log_e\left|\frac{e^{2x}+e^{x}+1}{e^{2x}-e^{x}+1}\right| + C$

(C) $\frac{1}{2}\log_e\left|\frac{e^{2x}-e^{x}+1}{e^{2x}+e^{x}+1}\right| + C$

(D) $\frac{1}{2}\log_e\left|\frac{e^{4x}+e^{2x}+1}{e^{4x}-e^{2x}+1}\right| + C$

Correct Answer: (C) $\frac{1}{2}\log_e\left|\frac{e^{2x}-e^{x}+1}{e^{2x}+e^{x}+1}\right| + C$

Solution:

Concept:

- Linearity allows the difference of antiderivatives to be obtained by integrating the difference of their integrands. Their arbitrary constants combine into one constant C.
- The substitution $t = e^x > 0$, with $dx = dt/t$, turns both expressions into rational functions. Also $t^4 + t^2 + 1 = (t^2 - t + 1)(t^2 + t + 1)$.

Step 1: Put both integrals in the same variable With $t = e^x$, the first integral is

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

For the second integrand multiply numerator and denominator by e^{4x}, obtaining $e^{3x}/(1 + e^{2x} + e^{4x})$. Hence

$$J = \int \frac{t^2\, dt}{t^4 + t^2 + 1}, \qquad J - I = \int \frac{t^2 - 1}{t^4 + t^2 + 1}\, dt.$$

Step 2: Recognise a difference of logarithmic derivatives Factorising the denominator gives the exact identity

$$\frac{t^2 - 1}{t^4 + t^2 + 1} = \frac{1}{2}\left(\frac{2t - 1}{t^2 - t + 1} - \frac{2t + 1}{t^2 + t + 1}\right).$$

Integrating and replacing t yields

$$J - I = \frac{1}{2}\log_e\left|\frac{e^{2x} - e^x + 1}{e^{2x} + e^x + 1}\right| + C.$$

The reciprocal ratio in (B) changes the derivative sign. Options (A) and (D) use quadratics in t^2 instead of the required factors in t, so their derivatives do not equal this integrand.

Step 3: Conclusion $J - I = \frac{1}{2}\log_e\left|\frac{e^{2x}-e^x+1}{e^{2x}+e^x+1}\right| + C$. Hence, the correct option is (C).

Quick Tip to Solve: Combine related integrals before integrating; the difference often exposes a logarithmic derivative that neither integral shows separately.

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16. If $\int_0^1 x^5\sqrt{\frac{1+x^2}{1-x^2}}\,dx = m\pi + n$, then the ordered pair (m, n) is equal to : [4 marks]

(A) $\left(\frac{1}{3}, \frac{1}{8}\right)$
(B) $\left(\frac{1}{8}, \frac{2}{3}\right)$
(C) $\left(\frac{1}{4}, \frac{1}{3}\right)$
(D) $\left(\frac{1}{8}, \frac{1}{3}\right)$

Correct Answer: (D) $\left(\frac{1}{8}, \frac{1}{3}\right)$

Solution:

Concept:

- The substitution $t = x^2$ is useful when an odd power of x accompanies a radical in x^2. Here $x^5 dx = t^2 dt/2$.
- For $0 \le t < 1$, $\sqrt{(1+t)/(1-t)} = (1+t)/\sqrt{1-t^2}$. The substitution $t = \sin\theta$ removes the remaining square root.

Step 1: Reduce the integral to two standard trigonometric integrals Call the given integral K. The endpoint $x = 1$ is improper, so the substitutions can first be applied below that endpoint and then the limit taken. Set $t = x^2$ to obtain

$$K = \frac{1}{2}\int_0^1 \frac{t^2 + t^3}{\sqrt{1-t^2}}\,dt.$$

Now put $t = \sin\theta$, with $0 \le \theta \le \pi/2$. Since the cosine is nonnegative on this interval,

$$K = \frac{1}{2}\int_0^{\pi/2} (\sin^2\theta + \sin^3\theta)\,d\theta.$$

Both transformed integrals are finite, also establishing convergence.

Step 2: Evaluate and identify the two coefficients Using $\sin^2\theta = (1 - \cos 2\theta)/2$ gives $\int_0^{\pi/2}\sin^2\theta\,d\theta = \pi/4$. For the cubic term put $u = \cos\theta$, giving

$$\int_0^{\pi/2}\sin^3\theta\,d\theta = \int_0^1 (1-u^2)\,du = \frac{2}{3}.$$

Thus

$$K = \frac{1}{2}\left(\frac{\pi}{4} + \frac{2}{3}\right) = \frac{\pi}{8} + \frac{1}{3}.$$

The factor one-half multiplies both terms. Option (B) misses it on the rational term; (A) interchanges or changes the coefficients, and (C) doubles the coefficient of π.

Step 3: Conclusion $(m, n) = (1/8, 1/3)$. Hence, the correct option is (D).

Quick Tip to Solve: Rewrite the radical as $(1+t)/\sqrt{1-t^2}$ after setting $t = x^2$; this makes the sine substitution immediate.

17. The area (in sq. units) of the region bounded by the curve, $12y = 36 - x^2$ and the tangents drawn to it at the points, where the curve intersects the x-axis, is : [4 marks]

(A) 12

(B) 18

(C) 27

(D) 6

Correct Answer: (A) 12

Solution:

Concept:

- The area between two graphs is the integral of the upper ordinate minus the lower ordinate. Symmetry about the y-axis lets us evaluate twice the area on the right half.
- A tangent at $(a, y(a))$ has equation $y - y(a) = y\prime(a)(x - a)$. The bounded region here lies above the parabola and below the two intersecting tangent segments.

Step 1: Find the intercepts and tangent equations The parabola is $y = 3 - x^2/12$, so it meets the x-axis at $x = \pm 6$. Its derivative is $y\prime = -x/6$. At $(-6, 0)$ the slope is 1, giving $y = x + 6$; at $(6, 0)$ the slope is -1, giving $y = 6 - x$. These two lines meet at $(0, 6)$. Therefore, on $0 \le x \le 6$, the upper boundary of the required region is the right tangent $6 - x$, and the lower boundary is the parabola.

Step 2: Integrate the vertical separation The right-half separation is

$$(6 - x) - (3 - x^2/12) = 3 - x + x^2/12 = \frac{(x-6)^2}{12} \ge 0.$$

It vanishes at the point of tangency, confirming the correct choice of upper and lower boundaries. The full area is

$$\begin{aligned} A &= 2\int_0^6 \left(3 - x + \frac{x^2}{12}\right) \mathrm{d}x \\ &= 2\left[3x - \frac{x^2}{2} + \frac{x^3}{36}\right]_0^6 \\ &= 2(18 - 18 + 6) = 12. \end{aligned}$$

The value 6 in (D) is only half the required area. Values 18 and 27 do not equal the integral of the separation; the tangent triangle has area 36 and the area under the parabola is 24, giving the same

difference 12.

Step 3: Conclusion The required area is 12 square units. Hence, the correct option is (A).

Quick Tip to Solve: Use symmetry and subtract the parabola from the relevant tangent; integrating only the parabola computes a different region.

18. Let $y = y(x)$ be the solution of the differential equation :

$x \log_e x \frac{dy}{dx} + y = 3x \log_e x, (x > 1)$.

If $y(e) = 0$, then $y\left(e^2\right)$ is equal to : [4 marks]

(A) e^2

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

(C) $\frac{3}{2}e^2$

(D) $3e^2$

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

Solution:

Concept:

- A first-order linear equation $y\prime + P(x)y = Q(x)$ has integrating factor $\exp(\int P(x)\,dx)$. Multiplication by this factor converts the left side into a product derivative.
- The condition $x > 1$ makes $\log_e x > 0$, allowing division by both x and $\log_e x$ throughout the domain.

Step 1: Obtain the integrating factor and integrate Dividing the equation by $x \log_e x$ gives

$$y\prime + \frac{y}{x \log_e x} = 3.$$

Its integrating factor is

$$\exp\left(\int \frac{dx}{x \log_e x}\right) = \log_e x.$$

Thus

$$\frac{d}{dx}(y \log_e x) = 3 \log_e x.$$

Integration by parts, with derivative of $\log_e x$ equal to $1/x$, gives

$$y \log_e x = 3(x \log_e x - x) + C.$$

Step 2: Apply the initial condition before evaluating At $x = e$, the given value $y(e) = 0$ gives $0 = 3(e - e) + C$, hence $C = 0$. Therefore the solution is

$$y = \frac{3x(\log_e x - 1)}{\log_e x}.$$

It satisfies the initial value, and its product with $\log_e x$ differentiates to $3 \log_e x$, verifying the original

equation. At $x = e^2$, the logarithm equals 2, giving

$$y(e^2) = \frac{3e^2(2-1)}{2} = \frac{3}{2}e^2.$$

Options (A) and (B) have the wrong coefficient, while (D) omits the final division by 2.

Step 3: Conclusion $y(e^2) = \frac{3}{2}e^2$. Hence, the correct option is (C).

Quick Tip to Solve: Notice that dividing the original equation by x already produces $(y \log x)'$; use the initial condition on that product.

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19. Let the straight lines, $5x - 3y + 15 = 0$ and $5x + 3y - 15 = 0$ form a triangle with the x-axis. Then the radius of the circle circumscribing this triangle is : [4 marks]

(A) $\frac{8}{5}$
(B) $\frac{17}{5}$
(C) $\frac{12}{5}$
(D) $\frac{16}{5}$

Correct Answer: (B) $\frac{17}{5}$

Solution:

Concept:

- The circumradius of a triangle with side lengths a, b, c and area Δ is $R = abc/(4\Delta)$. The vertices must first be obtained from the three given lines.
- The two oblique lines are reflections in the y-axis, so the triangle is isosceles. Its altitude from their intersection meets the midpoint of its horizontal base.

Step 1: Locate the three vertices Set $y = 0$ in each oblique line to find its intersection with the x-axis. The first gives $5x + 15 = 0$, so $A = (-3, 0)$; the second gives $5x - 15 = 0$, so $B = (3, 0)$. Add the two oblique-line equations to locate their common point: $10x = 0$, hence $x = 0$. Substitution then gives $y = 5$, so $C = (0, 5)$. Thus the base is $AB = 6$, and the perpendicular altitude from C to the base is 5.

Step 2: Calculate the sides and area The distance formula gives equal sloping sides:

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

The area uses the full base, not its half:

$$\Delta = \frac{1}{2} \times 6 \times 5 = 15.$$

All these quantities are positive, as required for a nondegenerate triangle.

Step 3: Apply the circumradius formula Substitute the three side lengths and the area:

$$R = \frac{6 \times \sqrt{34} \times \sqrt{34}}{4 \times 15} = \frac{204}{60} = \frac{17}{5}.$$

For a direct check, the circumcentre lies on the y-axis. If it is $(0, k)$, equality of its squared distances from A and C gives $9 + k^2 = (5 - k)^2$, hence $k = 8/5$. The radius is therefore $5 - 8/5 = 17/5$; $8/5$ is the centre coordinate, not the radius. The values $12/5$ and $16/5$ fail this equal-distance check.

Step 4: Conclusion The radius is $\boxed{17/5}$, since $abc/(4\Delta) = 204/60 = 17/5$. This calculation rules out the supplied key value $16/5$. Hence, the correct option is (B).

Quick Tip to Solve: For a symmetric triangle, check the circumradius by placing its circumcentre on the symmetry axis and equating two squared distances.

20. The mirror image of the circle $x^2 + y^2 - 10x - 10y = 0$ in the line $x + y + 5 = 0$ is a circle passing through the point : [4 marks]

(A) $(-3, -7)$

(B) $(-9, -7)$

(C) $(-3, -11)$

(D) $(-9, -11)$

Correct Answer: (C) $(-3, -11)$

Solution:

Concept:

- A reflection maps the centre of a circle to the centre of its image and preserves its radius. Complete squares before reflecting the centre.
- 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 original centre and radius Complete squares in the given equation:

$$x^2 - 10x + y^2 - 10y = 0 \quad \Longrightarrow \quad (x - 5)^2 + (y - 5)^2 = 50.$$

Thus the centre is $C = (5, 5)$ and the radius is $\sqrt{50}$. Reflection is a distance-preserving transformation, so the reflected circle has this same radius. Reflecting a single arbitrary point would not by itself determine the whole image; reflecting the centre is more direct.

Step 2: Reflect the centre in the specified line For $x + y + 5 = 0$, take $a = b = 1$, $c = 5$. At $(5, 5)$,

$$d = \frac{5 + 5 + 5}{1^2 + 1^2} = \frac{15}{2}.$$

Therefore

$$C' = (5 - 15, 5 - 15) = (-10, -10).$$

The midpoint of the two centres is $(-5/2, -5/2)$, which satisfies the mirror line, and the joining segment has direction $(1, 1)$, normal to that line. These checks fix both the sign and the displacement.

Step 3: Test the four proposed points The image circle is

$$(x + 10)^2 + (y + 10)^2 = 50.$$

For (A), $(-3,-7)$, the left side is $7^2+3^2=58$. For (B), $(-9,-7)$, it is $1^2+3^2=10$. For (C), $(-3,-11)$, it is $7^2+(-1)^2=50$, exactly the required value. For (D), $(-9,-11)$, it is $1^2+(-1)^2=2$. Only the third point lies at the required distance from the reflected centre.

Step 4: Conclusion The reflected circle passes through $\boxed{(-3,-11)}$. Hence, the correct option is (C).

Quick Tip to Solve: Reflect the centre, retain the radius, and test squared distances; this avoids reflecting the entire expanded circle equation.

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21. Let S be the focus of the parabola, $x^2+8y=0$ and Q be any point on it. If P divides the line segment SQ in the ratio $1:2$, then the locus of P is : [4 marks]

(A) $9x^2+24y+32=0$

(B) $9y^2+24x+32=0$

(C) $32x^2+27y+36=0$

(D) $32y^2+27x+36=0$

Correct Answer: (A) $9x^2+24y+32=0$

Solution:

Concept:

- For the standard parabola $x^2=4ay$, the focus is $(0,a)$. Here the sign of a determines the downward opening.
- If $SP:PQ=m:n$, internal division gives $P=(nS+mQ)/(m+n)$. Express the moving point Q in terms of P, then impose the original parabola equation.

Step 1: Find the focus and assign coordinates Rewrite the parabola as $x^2=-8y$. Comparing with $x^2=4ay$ gives $a=-2$, so its focus is $S=(0,-2)$. Let the arbitrary point on the parabola be $Q=(u,v)$, where

$$u^2+8v=0.$$

Write the moving division point as $P=(x,y)$. The statement that it divides SQ in the ratio $1:2$ means $SP:PQ=1:2$, so P is one-third of the way from the focus towards Q.

Step 2: Use the internal section formula The coordinate weights must be opposite to the stated distances:

$$x=\frac{2(0)+u}{3}=\frac{u}{3}, \qquad y=\frac{2(-2)+v}{3}=\frac{v-4}{3}.$$

Consequently,

$$u=3x, \qquad v=3y+4.$$

The negative focus coordinate is essential: replacing -2 by 2 would change the constant term in the final locus. The division is internal because P lies on the segment, rather than its extension.

Step 3: Eliminate the original moving coordinates Substitute these expressions into the equation obeyed by Q:

$$(3x)^2+8(3y+4)=0.$$

After simplification this becomes

$$9x^2 + 24y + 32 = 0.$$

Conversely, any point on this equation produces $Q = (3x, 3y + 4)$ on the original parabola, so the equation gives the whole locus. Options (B) and (D) square the wrong coordinate and have horizontal axes. Option (C) has incompatible coefficients and does not result from the prescribed one-third scaling.

Step 4: Conclusion The locus of P is $\boxed{9x^2 + 24y + 32 = 0}$. Hence, the correct option is (A).

Quick Tip to Solve: For a division-point locus, first invert the section formula to express the original moving coordinates in the new coordinates; then substitute only once.

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22. Let $\theta \in \left(0, \frac{\pi}{2}\right)$. If the eccentricity of the hyperbola $x^2\cos^2\theta - y^2 = 6\cos^2\theta$ is $\sqrt{3}$ times the eccentricity of the ellipse $x^2 + y^2\cos^2\theta = 30\cos^2\theta$ then θ is equal to : [4 marks]

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

(B) $\frac{\pi}{4}$

(C) $\cos^{-1}\left(\frac{1}{\sqrt{3}}\right)$

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

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

Solution:

Concept:

- For a hyperbola $x^2/a^2 - y^2/b^2 = 1$, the eccentricity satisfies $e_h^2 = 1 + b^2/a^2$.
- For an ellipse with semi-major axis a and semi-minor axis b, $e_e^2 = 1 - b^2/a^2$. The larger denominator identifies the major axis, irrespective of whether it is the x- or y-axis.

Step 1: Put the hyperbola in standard form Let $c = \cos\theta$. Since $0 < \theta < \pi/2$, we have $0 < c < 1$, so division by c^2 is legitimate. Dividing the hyperbola equation by $6c^2$ gives

$$\frac{x^2}{6} - \frac{y^2}{6c^2} = 1.$$

Thus its squared semi-axes are $a_h^2 = 6$, $b_h^2 = 6c^2$, and

$$e_h^2 = 1 + c^2.$$

The eccentricity exceeds one, consistently with a hyperbola.

Step 2: Identify the major axis of the ellipse Divide the ellipse equation by $30c^2$:

$$\frac{x^2}{30c^2} + \frac{y^2}{30} = 1.$$

Because $c^2 < 1$, its larger denominator is 30, under y^2. Therefore $a_e^2 = 30$, $b_e^2 = 30c^2$, and

$$e_e^2 = 1 - c^2.$$

Using the first denominator as the major semi-axis without comparing the two would give an invalid negative eccentricity square.

Step 3: Impose the eccentricity relation Both eccentricities are positive. Squaring $e_h = \sqrt{3}\, e_e$ therefore introduces no sign ambiguity:

$$1 + c^2 = 3(1 - c^2).$$

Hence $4c^2 = 2$, so $c^2 = 1/2$. In the given first-quadrant interval, $c = 1/\sqrt{2}$, and $\theta = \pi/4$. Options (A), (C) and (D) give respectively $c^2 = 3/4, 1/3, 1/4$, none of which satisfies $4c^2 = 2$. The interval excludes any additional trigonometric branches.

Step 4: Conclusion The required angle is $\boxed{\theta = \pi/4}$. Hence, the correct option is (B).

Quick Tip to Solve: Compare the ellipse denominators before computing eccentricity; its major axis can be vertical even when the equation starts with an x-term.

23. If the line $\frac{x-1}{4} = \frac{y+3}{-2} = \frac{z+5}{1}$ lies in the plane $2x + ly + \mathrm{m}z = 16$, then $l^2 + \mathrm{m}^2$ is equal to : [4 marks]

(A) 16

(B) 20

(C) 98

(D) 85

Correct Answer: (B) 20

Solution:

Concept:

- A line lies in a plane precisely when one point of the line lies in it and its direction vector is perpendicular to the plane normal.
- Equivalently, substituting the parametric line into the plane equation must give an identity for every real parameter: the constant and parameter coefficients must both agree.

Step 1: Parameterise the given line Let the common value of the symmetric ratios be t. Then

$$x = 1 + 4t, \qquad y = -3 - 2t, \qquad z = -5 + t.$$

This identifies a point $A = (1, -3, -5)$ and direction vector $\boldsymbol{d} = (4, -2, 1)$. The candidate plane has normal $\boldsymbol{n} = (2, l, m)$. Containment requires more than merely intersecting the plane at a point; the direction must also remain within it.

Step 2: Match the constant and parameter terms Substitute the parametric coordinates into $2x + ly + mz = 16$:

$$2(1 + 4t) + l(-3 - 2t) + m(-5 + t) = 16.$$

Collecting terms gives

$$(2 - 3l - 5m) + (8 - 2l + m)t = 16.$$

For this to hold for every t,

$$3l + 5m = -14, \qquad 8 - 2l + m = 0.$$

The second equation is exactly $\boldsymbol{n} \cdot \boldsymbol{d} = 0$, while the first places A in the plane. These independent conditions determine both unknown coefficients.

Step 3: Solve and check the coefficients From the direction condition, $m = 2l - 8$. Substitute into the point condition:

$$3l + 5(2l - 8) = -14 \quad \Longrightarrow \quad 13l = 26.$$

Hence $l = 2$ and $m = -4$. Check directly: $2(1) + 2(-3) - 4(-5) = 16$, and $8 - 4 - 4 = 0$, as required. The requested expression is

$$l^2 + m^2 = 2^2 + (-4)^2 = 4 + 16 = 20.$$

Option (A), 16, retains only m^2. Options (C) and (D) do not equal the sum obtained from the unique pair satisfying both containment equations.

Step 4: Conclusion The required value is $\boxed{l^2 + m^2 = 20}$. Hence, the correct option is (B).

Quick Tip to Solve: For a line wholly inside a plane, impose two conditions: one point satisfies the plane and the direction has zero dot product with its normal.

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24. The equation of the plane passing through the line of intersection of the planes $\vec{r} \cdot (2\hat{i} - 3\hat{j} + 4\hat{k}) = 1$ and $\vec{r} \cdot (\hat{i} - \hat{j}) + 4 = 0$ and perpendicular to the plane $\vec{r} \cdot (2\hat{i} - \hat{j} - \hat{k}) + 4 = 0$, is : [4 marks]

(A) $\vec{r} \cdot (\hat{i} - 2\hat{j} + 4\hat{k}) = 3$

(B) $\vec{r} \cdot (\hat{i} - 2\hat{j} + 4\hat{k}) = 5$

(C) $\vec{r} \cdot (2\hat{i} - \hat{j} + 5\hat{k}) = 3$

(D) $\vec{r} \cdot (2\hat{i} - \hat{j} + 5\hat{k}) = 5$

Correct Answer: (B) $\vec{r} \cdot (\hat{i} - 2\hat{j} + 4\hat{k}) = 5$

Solution:

Concept:

- Every plane in the pencil through the intersection of $F_1 = 0$ and $F_2 = 0$ can be written $F_1 + \lambda F_2 = 0$, together with the possible separate member $F_2 = 0$.
- Two planes are perpendicular when the dot product of their normal vectors is zero. The constant terms do not enter this orthogonality condition, but must be retained when forming the final equation.

Step 1: Form the pencil of planes Write the original planes as

$$F_1 = 2x - 3y + 4z - 1 = 0, \qquad F_2 = x - y + 4 = 0.$$

Every point on their intersection also lies on

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

This member has normal $(2+\lambda,-3-\lambda,4)$. The separate member $F_2=0$ has normal $(1,-1,0)$, with dot product 3 against $(2,-1,-1)$, so it is not perpendicular to the specified plane.

Step 2: Apply the perpendicularity condition The third plane has normal $(2,-1,-1)$. Its dot product with the pencil normal must vanish:

$$2(2+\lambda)-(-3-\lambda)-4=0.$$

This gives $3+3\lambda=0$, hence $\lambda=-1$. The constant term does not enter this condition; it is restored when the selected pencil member is simplified.

Step 3: Simplify the selected plane and compare options Set $\lambda=-1$, which subtracts the second original plane from the first:

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

Thus

$$x-2y+4z-5=0, \qquad \vec{r}\cdot(\hat{i}-2\hat{j}+4\hat{k})=5.$$

Its normal passes the check $(1,-2,4)\cdot(2,-1,-1)=2+2-4=0$. Option (A) has the right normal but the wrong constant, so it does not contain the given intersection line. The normals in (C) and (D) have dot product $4+1-5=0$, but are not proportional to the unique pencil normal obtained above, so those planes do not contain that intersection line.

Step 4: Conclusion The plane is $\boxed{\vec{r}\cdot(\hat{i}-2\hat{j}+4\hat{k})=5}$. Hence, the correct option is (B).

Quick Tip to Solve: Use the normal dot product to choose a member of the pencil, then carefully simplify its constant term; perpendicularity alone cannot fix the offset.

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25. If $\hat{a},\hat{b},\hat{c}$ be three unit vectors, $\hat{b}$ and $\hat{c}$ are non-parallel, such that $\hat{a}\times(\hat{b}\times\hat{c})=\frac{\hat{b}+\hat{c}}{2}$, then the angle between $\hat{a}$ and $\hat{b}$ is : [4 marks]

(A) $\frac{\pi}{6}$
(B) $\frac{2\pi}{3}$
(C) $\frac{\pi}{4}$
(D) $\frac{3\pi}{4}$

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

Solution:

Concept:

- The vector triple-product identity is $\mathbf{u}\times(\mathbf{v}\times\mathbf{w})=\mathbf{v}(\mathbf{u}\cdot\mathbf{w})-\mathbf{w}(\mathbf{u}\cdot\mathbf{v})$. The order of the two terms determines their signs.

- For unit vectors, $\hat{a} \cdot \hat{b} = \cos\theta$, where $\theta \in [0, \pi]$ is their angle. Two non-parallel nonzero vectors are linearly independent, so coefficients in their linear combination can be compared.

Step 1: Expand the given triple product Apply the identity with the vectors in the printed order:

$$\hat{a} \times (\hat{b} \times \hat{c}) = \hat{b}(\hat{a} \cdot \hat{c}) - \hat{c}(\hat{a} \cdot \hat{b}).$$

Hence the stated equation is

$$\hat{b}(\hat{a} \cdot \hat{c}) - \hat{c}(\hat{a} \cdot \hat{b}) = \tfrac{1}{2}\hat{b} + \tfrac{1}{2}\hat{c}.$$

The minus sign before the second coefficient is essential; changing it would change the requested angle.

Step 2: Compare the independent coefficients Since $\hat{b}$ and $\hat{c}$ are non-parallel, their coefficients agree separately:

$$\hat{a} \cdot \hat{c} = \tfrac{1}{2}, \qquad -\hat{a} \cdot \hat{b} = \tfrac{1}{2}.$$

Therefore $\cos\theta = -1/2$. The angle must be obtuse. Among the proposed angles only $2\pi/3$ has cosine $-1/2$: the cosines of $\pi/6$ and $\pi/4$ are positive, whereas the cosine of $3\pi/4$ is $-1/\sqrt{2}$.

Step 3: Conclusion The angle between $\hat{a}$ and $\hat{b}$ is $\boxed{2\pi/3}$. Hence, the correct option is (B).

Quick Tip to Solve: Expand the triple product before taking dot products; compare coefficients only after checking that the two outer basis vectors are independent.

26. A box contains 6 red balls and 2 black balls. Two balls are drawn, at random, from it without replacement. If X denotes the number of red balls drawn, then $\mathrm{E}(\mathrm{X})$ is equal to : [4 marks]

(A) $\frac{3}{2}$
(B) $\frac{1}{2}$
(C) $\frac{5}{2}$
(D) $\frac{27}{28}$

Correct Answer: (A) $\frac{3}{2}$

Solution:

Concept:

- For a discrete random variable, $E(X) = \sum_x xP(X = x)$. Here X counts red balls, so its possible values are 0, 1 and 2.
- For two draws without replacement from eight distinct balls, all $\binom{8}{2} = 28$ unordered pairs are equally likely. Count the favourable pairs using combinations, keeping the reduced supply on the second draw in mind.

Step 1: Find the probability distribution There are six red balls and two black balls. Zero red balls means choosing both black balls, one red means choosing one of each colour, and two red means

choosing two red balls. Thus

$$P(X=0)=\frac{\binom{2}{2}}{\binom{8}{2}}=\frac{1}{28},$$

$$P(X=1)=\frac{\binom{6}{1}\binom{2}{1}}{\binom{8}{2}}=\frac{12}{28},\qquad P(X=2)=\frac{\binom{6}{2}}{\binom{8}{2}}=\frac{15}{28}.$$

Their sum is $(1+12+15)/28=1$, as required.

Step 2: Compute the weighted mean Multiply each count by its probability rather than averaging the three counts equally:

$$E(X)=0\frac{1}{28}+1\frac{12}{28}+2\frac{15}{28}=\frac{42}{28}=\frac{3}{2}.$$

As a second check, each draw has marginal probability $6/8$ of being red. Linearity of expectation gives $2(6/8)=3/2$, even though the draws are dependent. Option (B) is the expected black-ball count, option (C) exceeds the maximum possible red count 2, and option (D) equals the probability of at least one red ball, not its expectation.

Step 3: Conclusion $\boxed{E(X)=3/2}$. Hence, the correct option is (A).

Quick Tip to Solve: For an expected count in a sample without replacement, multiply the sample size by the original fraction of objects of the desired type; independence is unnecessary.

27. A six faced die is so biased that it is thrice likely to show an even number than an odd number, when thrown. If the die is thrown twice, the probability that sum of the numbers on the die is even, is : [4 marks]

(A) $\frac{3}{4}$
(B) $\frac{5}{8}$
(C) $\frac{7}{9}$
(D) $\frac{3}{8}$

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

Solution:

Concept:

- An even sum is obtained from two even numbers or two odd numbers. An odd sum is obtained from one even and one odd number.
- If p is the probability of an odd result, the given bias makes the even probability $3p$. Their sum is one. The two throws are independent, so probabilities multiply for specified pairs of parity events.

Step 1: Normalize the parity probabilities Let O denote an odd face and E an even face on one throw. The die is three times as likely to produce an even result as an odd result, hence

$$P(E)=3P(O),\qquad P(E)+P(O)=1.$$

Solving gives

$$P(O) = \frac{1}{4}, \qquad P(E) = \frac{3}{4}.$$

We do not need the individual face probabilities: only the total probability of each parity affects whether the sum is even.

Step 2: Add the two disjoint successful cases For two independent throws, both even has probability $(3/4)^2 = 9/16$, while both odd has probability $(1/4)^2 = 1/16$. These cannot occur together, so

$$P(\text{even sum}) = \frac{9}{16} + \frac{1}{16} = \frac{10}{16} = \frac{5}{8}.$$

The complementary mixed-parity cases have probability $2(3/4)(1/4) = 3/8$, confirming that the totals add to one. Thus option (D) is the odd-sum probability, option (A) is the single-throw even probability, and option (C) does not follow from the normalized parity probabilities.

Step 3: Conclusion The required probability is $\boxed{5/8}$. Hence, the correct option is (B).

Quick Tip to Solve: An even sum requires equal parities. Square each single-throw parity probability and add; do not confuse this with the probability that an individual throw is even.

28. The total number of $x \in [0, 2\pi]$ which satisfy the equation $4\left(\cos^{10} x + \sin^2 x\right) = 4 + \sin^6 x \sin^2(2x)$, is : [4 marks]

(A) 2

(B) 3

(C) 5

(D) 6

Correct Answer: (C) 5

Solution:

Concept:

- Set $t = \cos^2 x$, so $0 \le t \le 1$, $\sin^2 x = 1 - t$, and $\sin^2(2x) = 4t(1-t)$. This converts the even powers to a polynomial.
- Factor the equation without dividing by t or $1 - t$: division could remove endpoint roots. After solving for t, count the distinct angles in the closed interval, including both endpoints.

Step 1: Reduce to a factored polynomial The left side is $4[t^5 + (1-t)]$. On the right, $\sin^6 x = (1-t)^3$, so the product is $4t(1-t)^4$. Dividing the equation by the nonzero constant 4 gives

$$t^5 + 1 - t = 1 + t(1-t)^4.$$

Rearrange and factor:

$$t\{t^4 - 1 - (1-t)^4\} = 0.$$

Using $(1-t)^4 = 1 - 4t + 6t^2 - 4t^3 + t^4$, this becomes

$$2t(t-1)(2t^2 - t + 1) = 0.$$

Step 2: Identify roots and count their angles The quadratic factor is always positive because

$$2t^2 - t + 1 = 2\left(t - \tfrac{1}{4}\right)^2 + \tfrac{7}{8} > 0.$$

Thus only $t = 0$ or $t = 1$ can occur. For $\cos^2 x = 0$, the angles are $\pi/2, 3\pi/2$. For $\cos^2 x = 1$, the angles are $0, \pi, 2\pi$. All five are distinct and belong to the stated closed interval. There are no other polynomial roots in $[0, 1]$, so the counts 2, 3 and 6 in the other options are excluded.

Step 3: Conclusion There are $\boxed{5}$ solutions in $[0, 2\pi]$. Hence, the correct option is (C).

Quick Tip to Solve: When replacing even powers by $t = \cos^2 x$, retain the factors t and $t - 1$; these endpoint values often account for all the angles.

29. $\tan\left(\frac{1}{2}\sin^{-1}\frac{4}{5} + \frac{1}{2}\cos^{-1}\frac{15}{17}\right)$ **is equal to :** [4 marks]

(A) $\frac{6}{7}$

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

(C) $\frac{4}{15}$

(D) $\frac{9}{22}$

Correct Answer: (A) $\frac{6}{7}$

Solution:

Concept:

- Take $A = \sin^{-1}(4/5)$ and $B = \cos^{-1}(15/17)$. Both principal angles are in $(0, \pi/2)$, so all sine, cosine and half-angle values used here are positive.
- The identities $\tan(\theta/2) = \sin\theta/(1 + \cos\theta)$ and $\tan(u + v) = (\tan u + \tan v)/(1 - \tan u \tan v)$ determine the requested value without decimal approximations.

Step 1: Find the two half-angle tangents Since $\sin A = 4/5$ and A is acute,

$$\cos A = \sqrt{1 - 16/25} = 3/5.$$

Similarly, $\cos B = 15/17$ and the positive sine is

$$\sin B = \sqrt{1 - 225/289} = 8/17.$$

Therefore

$$\tan\frac{A}{2} = \frac{4/5}{1 + 3/5} = \frac{1}{2}, \qquad \tan\frac{B}{2} = \frac{8/17}{1 + 15/17} = \frac{1}{4}.$$

The principal-value ranges justify the positive roots; changing either sign would be invalid.

Step 2: Apply the tangent addition formula The expression is $\tan(A/2 + B/2)$. Substituting the exact

fractions gives

$$\tan\left(\frac{A}{2}+\frac{B}{2}\right)=\frac{\frac{1}{2}+\frac{1}{4}}{1-\frac{1}{2}\frac{1}{4}}=\frac{3/4}{7/8}=\frac{6}{7}.$$

The denominator $7/8$ is nonzero, so the tangent is defined. Cross-multiplication distinguishes the remaining options: $6/7 \neq 2/3$ since $18 \neq 14$, $6/7 \neq 4/15$ since $90 \neq 28$, and $6/7 \neq 9/22$ since $132 \neq 63$.

Step 3: Conclusion The exact value is $\boxed{6/7}$. Hence, the correct option is (A).

Quick Tip to Solve: For inverse sine and cosine of positive rational numbers, first use a right-triangle ratio to find the missing function, then apply rational half-angle formulae.

30. The Boolean expression

$(p \wedge q) \vee ((\sim q) \vee p)$ **is equivalent to :** [4 marks]

(A) $\sim p \vee q$

(B) $\sim q \vee p$

(C) $p \vee q$

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

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

Solution:

Concept:

- The connective $\wedge$ means AND, $\vee$ means OR, and $\sim q$ is the negation of q. Associativity and commutativity allow OR terms to be regrouped.
- The absorption law $p \vee (p \wedge q) = p$ follows because whenever the conjunction is true, p is already true. Adding the conjunction to p therefore adds no new true cases.

Step 1: Regroup and absorb the conjunction Write the expression in a form where the repeated p is visible:

$$(p \wedge q) \vee ((\sim q) \vee p) = \{p \vee (p \wedge q)\} \vee (\sim q).$$

Apply absorption to the terms in braces:

$$p \vee (p \wedge q) = p.$$

The original expression therefore reduces to

$$p \vee (\sim q) = (\sim q) \vee p.$$

This reduction uses equivalence laws and is valid for every pair of truth values, rather than for a single example.

Step 2: Check the alternatives by truth values The reduced expression is false only when p is false and q is true; it is true for the other three assignments. Option (B) has exactly this form. To reject (A),

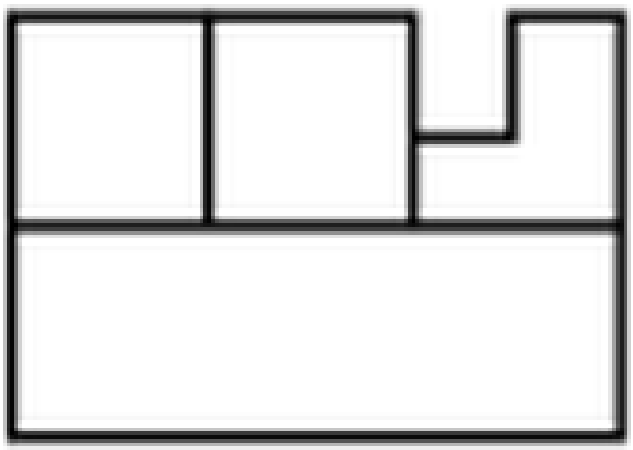
take p false and q true: its value is true, whereas the given expression is false. To reject (C), take both false: $p \vee q$ is false but the given expression is true. To reject (D), take both true: $(\sim p) \vee (\sim q)$ is false, but the given expression is true. These counterexamples confirm that none of the other expressions is equivalent.

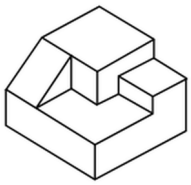
Step 3: Conclusion The equivalent expression is $\boxed{(\sim q) \vee p}$. Hence, the correct option is (B).

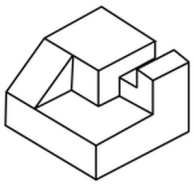
Quick Tip to Solve: Look for an isolated proposition beside a conjunction containing it: $p \vee (p \wedge q)$ immediately absorbs to p.

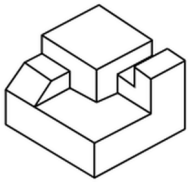
31. ***Directions : (For Q. No. 31 to 34). For the elevation given in the problem figure identify the correct 3-D figure from amongst the answer figures.***

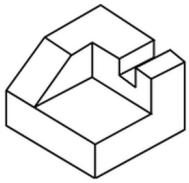
[4 marks]

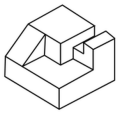


(A) 

(B) 

(C) 

(D) 

Correct Answer: (B) 

Solution:

Concept:

- An orthographic view preserves positions and outlines in the viewing plane while suppressing depth along the line of sight.
- Match both the outer boundary and every visible internal edge; a perspective slope may project as a rectangle, and a vertical face disappears in a top view.

Step 1: Read the outline The elevation has a rectangular base extending across its complete width. Above the base, the left and middle portions reach the same upper level. At the right, the outline drops into a recess before rising again to a narrow upright. Thus a solid with an uninterrupted low

block at the right cannot produce this outline.

Step 2: Track the internal edges The vertical line dividing the two upper rectangles indicates an edge between surfaces at the same apparent top level. A sloping surface seen along its direction of slope can project as a rectangle, so its diagonal appearance in the perspective drawing is not a reason to reject it. The important tests are the heights and the projected positions of the edges.

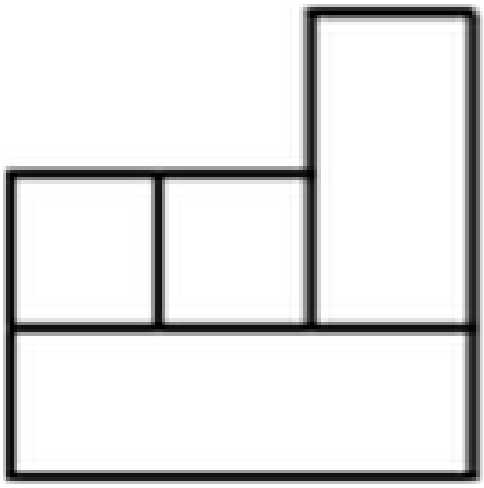
Step 3: Eliminate the other solids Option (B) combines the inclined piece on the left, the upper central block and the narrow raised strip at the right. Looking squarely at the appropriate elevation gives the two adjacent high rectangles and the right-hand notch. Option (A) has a broad lower right platform rather than this raised notched edge. Option (C) introduces an extra step on the left inclined piece. Option (D) changes the central upper arrangement and lacks the required division into the same two rectangular upper regions.

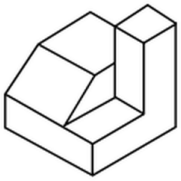
Step 4: Conclusion The required view agrees with the solid in option (B). Hence, the correct option is (B).

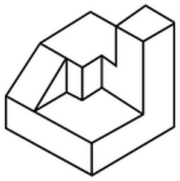
Quick Tip to Solve: Compare the upper silhouette first: the narrow right upright and its adjacent notch eliminate most choices before internal edges are checked.

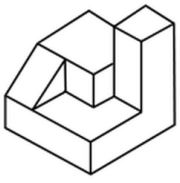
32. ***Directions : (For Q. No. 31 to 34). For the elevation given in the problem figure identify the correct 3-D figure from amongst the answer figures.***

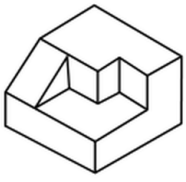
[4 marks]

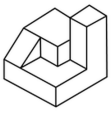


(A) 

(B) 

(C) 

(D) 

Correct Answer: (C) 

Solution:

Concept:

- An orthographic view preserves positions and outlines in the viewing plane while suppressing depth along the line of sight.
- Match both the outer boundary and every visible internal edge; a perspective slope may project as a rectangle, and a vertical face disappears in a top view.

Step 1: Separate the three height bands Read the elevation from bottom to top. A low rectangular base runs across the entire width. Two adjacent portions above its left side have the same intermediate height. The rightmost portion is a tall rectangular tower, whose top is clearly above those two portions. Both the height difference and the division between the two intermediate portions must survive projection.

Step 2: Project the matching solid Option (C) has a narrow inclined piece at the left, a projecting intermediate block beside it and a tall upright at the right. In elevation the inclined piece loses its visible perspective depth, while the adjacent block supplies the second rectangle at the same level. The upright remains a separate full-height rectangle above the base. These are precisely the three components of the problem figure.

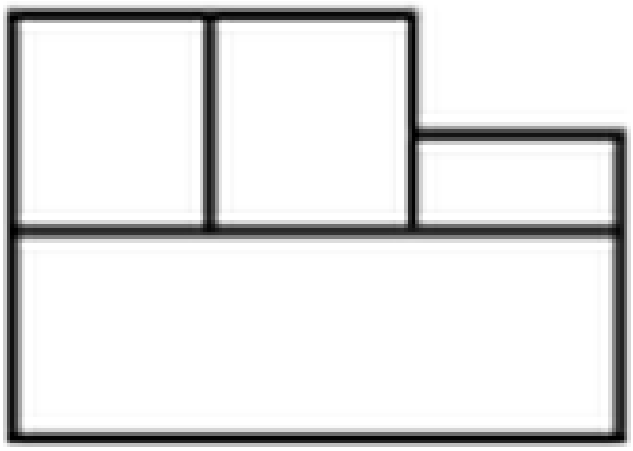
Step 3: Check the alternatives Option (A) gives a broad continuous sloping element instead of the required narrow left portion and separate middle block. Option (B) has an indentation in the intermediate block, altering its projected edge arrangement. Option (D) has no tall right-hand tower rising above the other upper elements. It therefore fails the most conspicuous feature of the elevation. The matching silhouette and internal division occur together only in (C).

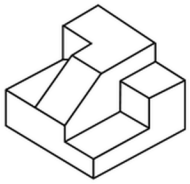
Step 4: Conclusion The required view agrees with the solid in option (C). Hence, the correct option is (C).

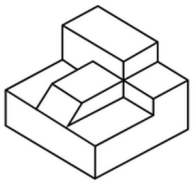
Quick Tip to Solve: In elevation problems compare relative heights before comparing slopes; a slope viewed end-on can have a rectangular projection.

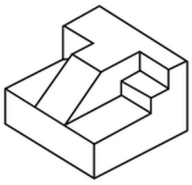
33. ***Directions : (For Q. No. 31 to 34). For the elevation given in the problem figure identify the correct 3-D figure from amongst the answer figures.***

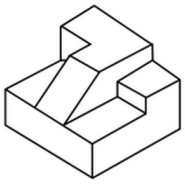
[4 marks]

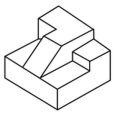


(A) 

(B) 

(C) 

(D) 

Correct Answer: (D) 

Solution:

Concept:

- An orthographic view preserves positions and outlines in the viewing plane while suppressing depth along the line of sight.
- Match both the outer boundary and every visible internal edge; a perspective slope may project as a rectangle, and a vertical face disappears in a top view.

Step 1: Read the three upper regions The base of the elevation is one complete rectangle. Above it, the left and central regions are equally high and are separated by one vertical line. The right-hand region is lower, with a flat horizontal top. There is no extra stair-like rise at the far right and no depression below the common base-top line.

Step 2: Project the selected solid In option (D), the main upper block and the inclined member produce the two adjacent high regions when viewed in the indicated elevation. The inclined member

meets the top surface of the base at its lower end. On the right there is one lower rectangular platform. Its height is below the main upper block, matching the lower right rectangle of the elevation.

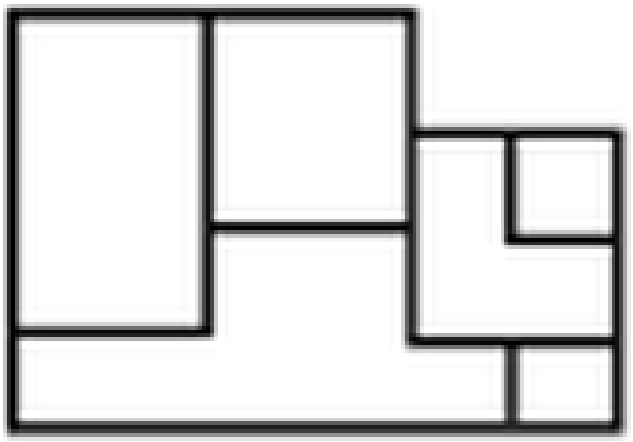
Step 3: Reject changes to the lower edge and steps Option (A) has the lower end of the central sloping piece meeting a different base level; the visible vertical step below that end changes the projection. Option (B) replaces the long inclined element by a smaller stepped arrangement, producing additional intermediate edges. Option (C) has extra rises at the right, rather than the single low platform required. Option (D) alone combines the continuous rectangular base, the two high upper projections and the single lower right projection without these extra changes.

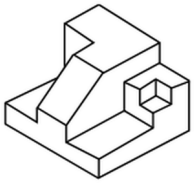
Step 4: Conclusion The required view agrees with the solid in option (D). Hence, the correct option is (D).

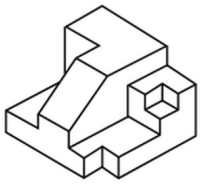
Quick Tip to Solve: Trace where an inclined face ends as well as where it starts: a small vertical drop at its foot can distinguish otherwise similar solids.

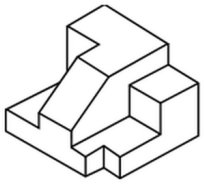
34. ***Directions : (For Q. No. 31 to 34). For the elevation given in the problem figure identify the correct 3-D figure from amongst the answer figures.***

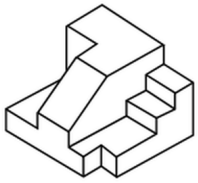
[4 marks]

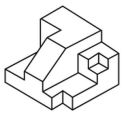


(A) 

(B) 

(C) 

(D) 

Correct Answer: (B) 

Solution:

Concept:

- An orthographic view preserves positions and outlines in the viewing plane while suppressing depth along the line of sight.
- Match both the outer boundary and every visible internal edge; a perspective slope may project as a rectangle, and a vertical face disappears in a top view.

Step 1: Record the distinctive small edges The problem figure contains more information than its outer stepped outline. In the upper right region there is a small inset rectangular corner. Near the bottom right, a short vertical line also divides the narrow base strip. These edges represent two separate features and both must be accounted for; matching just the large central slope is insufficient.

Step 2: Locate both features in the solid Option (B) has the central inclined face, a recessed corner in the raised block at the right and a notch in the front edge of the base. Under projection the recessed corner gives the small upper-right rectangular detail. The front base notch supplies the additional short vertical edge in the bottom strip. The large upper and lower regions also retain the stepped arrangement shown in the elevation.

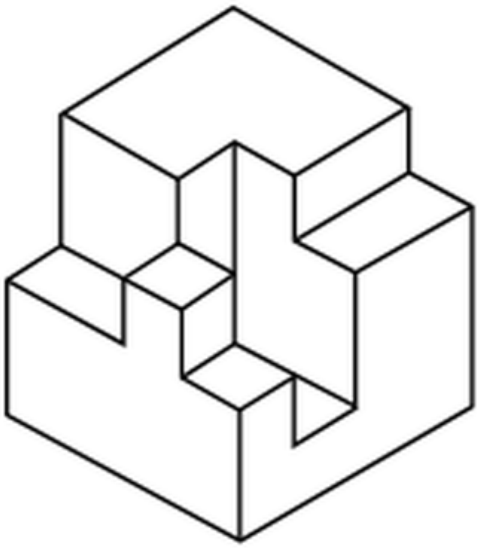
Step 3: Compare the near-matching alternatives Option (A) has the upper-right recess but its base edge is unnotched, so it cannot supply the extra lower division. Option (C) has the base notch but the right block is solid, losing the small recessed upper corner. Option (D) replaces that recess with exposed stairs, creating the wrong right-hand detail. Option (B) is the only figure that contains both independent diagnostic features while retaining the common inclined central member.

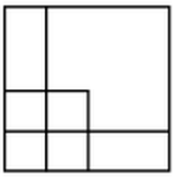
Step 4: Conclusion The required view agrees with the solid in option (B). Hence, the correct option is (B).

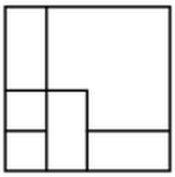
Quick Tip to Solve: For nearly identical solids, mark two small diagnostic details and require the answer to reproduce both; do not decide from the main silhouette alone.

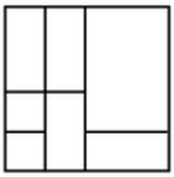
35. ***Directions : (For Q. No. 35 to 37). The 3-D figure shows the view of an object. Identify the correct top view from amongst the answer figures.***

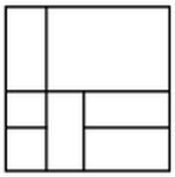
[4 marks]

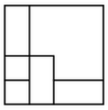


(A) 

(B) 

(C) 

(D) 

Correct Answer: (B) 

Solution:

Concept:

- An orthographic view preserves positions and outlines in the viewing plane while suppressing depth along the line of sight.
- Match both the outer boundary and every visible internal edge; a perspective slope may project as a rectangle, and a vertical face disappears in a top view.

Step 1: Discard the vertical height A top view is obtained by looking vertically downward. Vertical faces reduce to their boundary lines; only the outlines and boundaries of upward-facing surfaces remain. The highest surface of the object has a re-entrant corner. At its lower left there are stepped surfaces, and along the right side there is a lower longitudinal strip.

Step 2: Trace the visible plan boundaries Start with the outer square. The large upper region occupies

the rear portion and extends down the right side of the inner corner. On the left is a narrow strip divided by a short horizontal edge. Immediately beside it, the central projecting strip continues toward the near edge without a horizontal line crossing its lower portion. The right-hand lower strip has its own transverse boundary. This pattern is the arrangement in option (B).

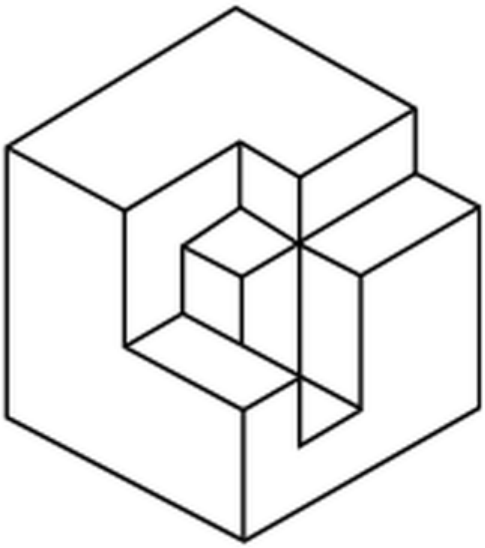
Step 3: Test every extra line Option (A) carries a horizontal line through the bottom of the central strip, creating an edge that the object does not show from above. Option (C) adds a division across the upper part of the central strip, cutting a continuous top surface. Option (D) joins a long horizontal boundary across the rear region, changing the outline of the high surface. In (B), the short left subdivision, the unbroken central strip and the right-side boundary all correspond to actual edges of the solid.

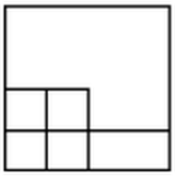
Step 4: Conclusion The required view agrees with the solid in option (B). Hence, the correct option is (B).

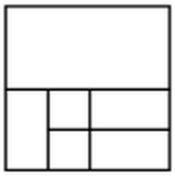
Quick Tip to Solve: When checking a plan, ask what physical edge creates each line; reject an option if a line cuts an upward-facing surface that is continuous.

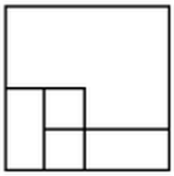
36. ***Directions : (For Q. No. 35 to 37). The 3-D figure shows the view of an object. Identify the correct top view from amongst the answer figures.***

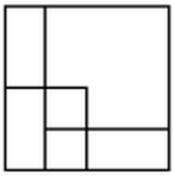
[4 marks]

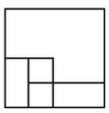


(A) 

(B) 

(C) 

(D) 

Correct Answer: (C) 

Solution:

Concept:

- An orthographic view preserves positions and outlines in the viewing plane while suppressing depth along the line of sight.
- Match both the outer boundary and every visible internal edge; a perspective slope may project as a rectangle, and a vertical face disappears in a top view.

Step 1: Identify the uninterrupted upper surface Look down on the solid rather than following its vertical faces. Its highest surface wraps around a recess: a broad rear portion joins a continuous strip at the left. No step crosses that left strip. Inside the recess is a smaller raised square feature, while the right-hand side has a lower ledge. All these boundaries must appear in the plan.

Step 2: Draw the plan in words Begin with the outer square. Keep the left strip continuous from the rear region toward the front; there should be no short horizontal subdivision through this strip. The inward corner of the high surface outlines the central recess. Inside the recess, the little raised block produces a small square region, and the lower ledge gives the horizontal boundary extending to the right edge. Option (C) has this complete combination.

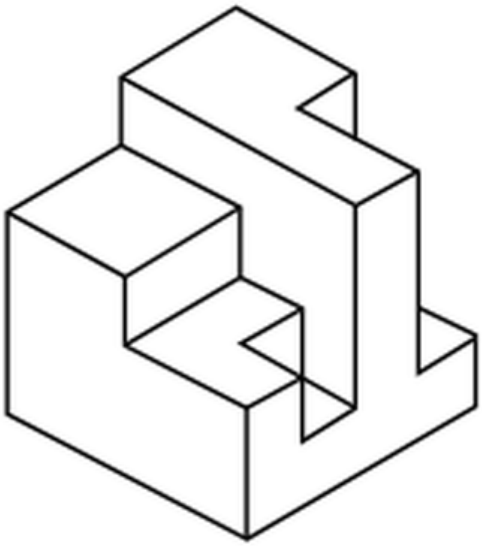
Step 3: Eliminate spurious subdivisions Option (A) inserts a horizontal division across the lower left portion, although the top surface there is uninterrupted. Option (B) makes the upper boundary a straight full-width band and arranges the inner square differently, losing the re-entrant high-surface outline. Option (D) splits the left strip into additional regions with a horizontal edge. Option (C) preserves the continuous left portion and correctly places both the internal square and the right-hand ledge boundary.

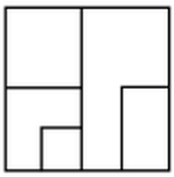
Step 4: Conclusion The required view agrees with the solid in option (C). Hence, the correct option is (C).

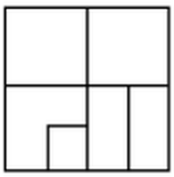
Quick Tip to Solve: Follow one continuous high surface around its inward corner before adding lower ledges; this avoids mistaking vertical wall edges for lines across the plan.

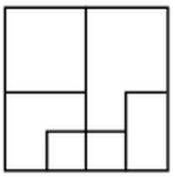
37. ***Directions : (For Q. No. 35 to 37). The 3-D figure shows the view of an object. Identify the correct top view from amongst the answer figures.***

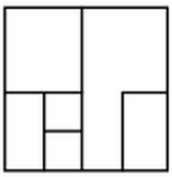
[4 marks]

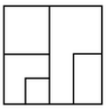


(A) 

(B) 

(C) 

(D) 

Correct Answer: (A) 

Solution:

Concept:

- The top view is the vertical projection of the visible upper surfaces. Heights disappear, but the horizontal footprint and changes between upper terraces remain as plan edges.
- Project each corner straight down and preserve adjacency. A vertical wall does not become a separate strip merely because it is tall; only its horizontal thickness contributes to the plan.

Step 1: Trace the outline and main division The object occupies a rectangular footprint. The tall stepped member has a continuous longitudinal run through the plan. Its long edge therefore appears as an uninterrupted dividing line across the depth of the rectangular top view. The projecting base on the right belongs inside the same overall outline; its vertical face must not be confused with an extra external rectangle.

Step 2: Place the shorter terrace edges The lower block on the left has a broad upper terrace and a lower recessed portion. From above, their common edge stops at the main longitudinal division. The small step within the lower-left portion creates a short L-shaped return near the bottom. The right side has another inset rectangular return, but this does not cross the continuous main division. These relative positions are exactly those shown in (A).

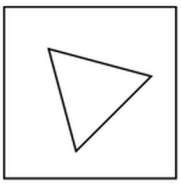
Step 3: Reject the competing plans In (B), the transverse division is carried across the middle and the long dividing edge is interrupted, changing which terraces meet. In (C), an additional lower transverse segment joins across the plan, which is not the projected boundary of the object. In (D), a narrow upright strip is inserted within the lower-left terrace. That subdivision has no corresponding upper-surface edge in the object. Thus matching only the rectangular outline is insufficient; the internal junctions identify the required plan.

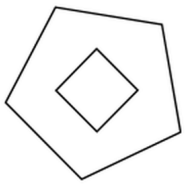
Step 4: Conclusion The projected outline and the internal terrace junctions match (A). Hence, the correct option is (A).

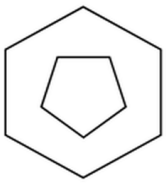
Quick Tip to Solve: For stepped solids, trace the footprint first; then project only upper-surface boundaries and check where each short edge ends.

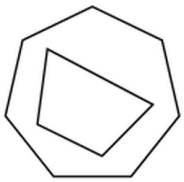
38. ***Directions : (For Q. No. 38 to 41). Find the odd figure out of the problem figures given below.***

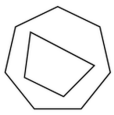
[4 marks]

(A) 

(B) 

(C) 

(D) 

Correct Answer: (D) 

Solution:

Concept:

- For nested polygons, count sides of the outer and inner boundaries separately. Rotating a polygon changes its orientation but never its number of sides.
- An odd figure violates the same numerical relationship that the other three satisfy. Use the pair of side counts rather than apparent size or tilt.

Step 1: Count the first three pairs In (A), the outer boundary is a square with four sides and the inner boundary is a triangle with three sides. In (B), the outer pentagon has five sides and the inner quadrilateral has four. In (C), the outer hexagon has six sides and the inner pentagon has five.

Although the figures are drawn at different inclinations, their vertices can be followed continuously around each closed boundary.

Step 2: Express the common relationship Writing the ordered pair as (outer sides, inner sides), the three pairs are (4,3), (5,4) and (6,5). Each obeys the rule that the outer polygon has exactly one more side than the inner polygon. The progression in outer side count is therefore accompanied by the same progression in inner side count. None of these three breaks the rule, so none can be selected simply for being rotated or having unequal side lengths.

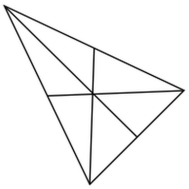
Step 3: Test the remaining figure In (D), following the outer boundary gives seven sides, whereas the enclosed polygon has only four sides. Its pair is (7,4), and the difference is three rather than one. A seven-sided outer polygon would require a six-sided inner polygon to continue the relationship. The supplied inner quadrilateral does not meet that condition. This is a structural count difference, independent of drawing scale and orientation.

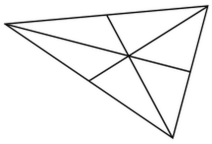
Step 4: Conclusion Only (D) fails the rule that the outer polygon has one more side than the inner polygon. Hence, the correct option is (D).

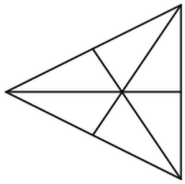
Quick Tip to Solve: Count vertices around each closed boundary once; compare outer minus inner side counts before judging visual appearance.

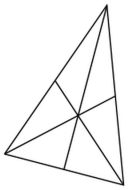
39. ***Directions : (For Q. No. 38 to 41). Find the odd figure out of the problem figures given below.***

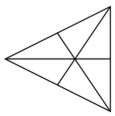
[4 marks]

(A) 

(B) 

(C) 

(D) 

Correct Answer: (C) 

Solution:

Concept:

- A rotation or change in the proportions of a triangle preserves straightness and incidence: a straight segment remains straight and the same lines pass through each intersection.
- For a triangle partitioned by concurrent cevians, trace each line from a vertex through the common interior point to the opposite side. A bend at that point changes the construction.

Step 1: Trace the common construction In (A), (B) and (D), the three vertex-to-opposite-side lines

meet at one interior point. Each of these lines passes through that point without changing direction. The six small triangular regions therefore arise from three straight cevians. The outer triangles are tilted and stretched differently, but their interior line construction has the same connectivity and straight-through continuation.

Step 2: Inspect the exceptional continuation In (C), examine the line joining the lower-right vertex towards the upper-left sloping side through the interior junction. Its two portions do not form the same straight continuation: the segment above the junction and the segment below it meet with a visible change in direction. This makes the interior junction different from the three-straight-cevian junction in the other figures. Counting six small regions alone would miss this difference.

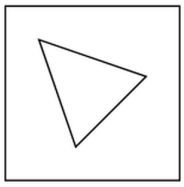
Step 3: Eliminate orientation as a reason The point facing left in (C) is not itself a reason to select it, since the entire figure could be rotated. Similarly, the top-pointing and side-pointing orientations of (A), (B) and (D) do not make any of them exceptional. What matters is the local continuation of the strokes through the common point. Following the suspect stroke end to end singles out (C), while the corresponding strokes in the other three remain straight.

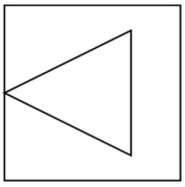
Step 4: Conclusion The interior stroke in (C) bends at the junction instead of continuing as a straight cevian. Hence, the correct option is (C).

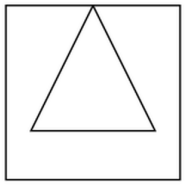
Quick Tip to Solve: At a crowded intersection, follow each stroke straight through it; do not rely only on the number of enclosed regions.

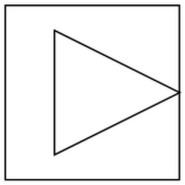
40. ***Directions : (For Q. No. 38 to 41). Find the odd figure out of the problem figures given below.***

[4 marks]

(A) 

(B) 

(C) 

(D) 

Correct Answer: (A) 

Solution:

Concept:

- A topological relationship such as touching a boundary is unchanged by rotation. Compare contact between the inner and outer figures rather than the direction in which the inner triangle points.
- A triangle completely inside a square is separated from all four sides. A triangle with a vertex on a square side has a different boundary-contact relationship.

Step 1: Check for a shared boundary point In (B), the leftmost vertex of the triangle lies on the left side of the outer square. In (C), the upper vertex of the triangle lies on the top side of the square. In (D), the rightmost vertex lies on the right side. Each of these figures therefore has exactly one triangular vertex touching the enclosing square, with the other two vertices lying inside it.

Step 2: Inspect the first figure In (A), all three vertices of the triangle lie strictly inside the square. There is visible white space between every vertex and the surrounding square boundary. The triangular sides also remain within the square, so there is no point of contact anywhere. Thus its contact count is zero, whereas the other three have one. This difference remains even if the tilted triangle is mentally rotated to face a different direction.

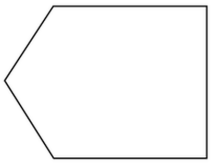
Step 3: Rule out the distracting differences The triangles in (B), (C) and (D) point left, up and right respectively. These orientations differ, but all satisfy the same one-vertex contact condition, so none is the odd figure on that basis. The square itself is unchanged in all four choices. Comparing the relationship between the two boundaries, rather than apparent tilt, leaves only (A) outside the common group.

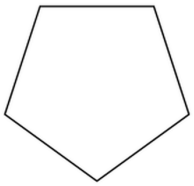
Step 4: Conclusion In (A), the triangle does not touch the square; in all other figures one vertex does. Hence, the correct option is (A).

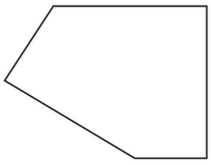
Quick Tip to Solve: For an inner figure inside a frame, check contact points first; orientation is often only a distraction.

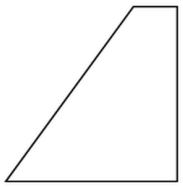
41. ***Directions : (For Q. No. 38 to 41). Find the odd figure out of the problem figures given below.***

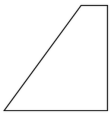
[4 marks]

(A) 

(B) 

(C) 

(D) 

Correct Answer: (D) 

Solution:

Concept:

- A polygon is classified by the number of straight boundary segments. Rotation, unequal lengths and different angle sizes do not alter that count.
- Count only genuine corners, where the boundary changes direction. An irregular pentagon still has five sides, even if it resembles a rectangle with an added or cut corner.

Step 1: Count the sides in the first figure Starting at the upper-left corner of (A), follow the boundary clockwise: the upper horizontal side, the right vertical side, the lower horizontal side, and the two sloping sides leading through the left-pointing vertex. That is five sides in all. Its two right angles do not make it a quadrilateral, because the pointed end contributes two separate segments.

Step 2: Check the next two figures Figure (B) also has five sides: a short top edge, two edges down to the lower point, and two edges returning upward. In (C), the upper horizontal and right vertical sides are followed by a short lower horizontal segment and two sloping segments returning to the upper-left corner. This is again a five-sided closed polygon. The different proportions and arrangements of right angles do not change the shared pentagon classification.

Step 3: Count the final boundary Figure (D) has a top horizontal segment, a right vertical segment, a bottom horizontal segment and one long sloping segment returning to the starting point. It has four sides and four corners, so it is a quadrilateral rather than a pentagon. No extra corner occurs along the long sloping side. Consequently, (A), (B) and (C) belong to the same five-sided group and (D) alone differs.

Step 4: Conclusion The exceptional figure is the quadrilateral; the other three figures are pentagons. Hence, the correct option is (D).

Quick Tip to Solve: Trace the boundary with a fixed starting corner and count each change of direction exactly once.

42. ***Directions : (For Q. No. 42 to 47). Which one of the answer figures will complete the sequence of the three problem figures ?***

[4 marks]



(A) 

(B) 

(C) 

(D) 

Correct Answer: (B) 

Solution:

Concept:

- A figure sequence can move its outline and internal markings together. The correct continuation must preserve the movement of both the broad sectors and their concentric arcs.
- Use a distinctive sector as a reference and compare consecutive panels. Matching the outer silhouette alone is insufficient when the choices differ only in internal arc placement.

Step 1: Track the broad sector positions The fan advances by a 45-degree anticlockwise rotation at each stage. The large projecting sectors alternate between the two diagonal arrangements visible in the sequence. The first and third panels have the same general arrangement of the projecting sectors, while the second panel has the intervening arrangement. The missing fourth panel must return to that second arrangement. All the proposed choices have broadly similar outlines, so this first comparison sets the orientation but does not yet settle the answer.

Step 2: Carry the internal bands forward Next follow the concentric bands inside the fan rather than treating them as decoration. Compare the location of each short inner arc and each doubled outer rim in the first, second and third panels. The 45-degree anticlockwise rotation carries these markings with the sector pattern; it does not independently redraw or remove a band. Advancing it one more position places the doubled curved rim in the lower-left projecting sector and preserves the corresponding short arc divisions around the centre. The complete arrangement is the one drawn in (B).

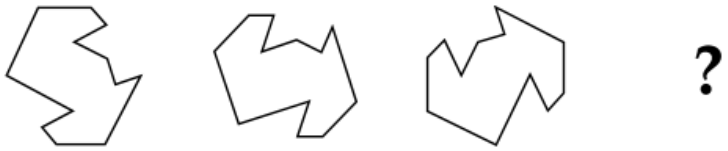
Step 3: Compare the near-matching alternatives Choice (A) has the required general fan outline but loses the doubled curved rim in the lower-left sector. Choice (C) resembles (B) in that region, yet changes the placement of an internal curved band in the lower part of the fan. Choice (D) changes the lower-right projecting sector and its concentric divisions. These are changes in the pattern itself, not merely differences of overall orientation. Only (B) continues both the sector placement and the internal band arrangement together.

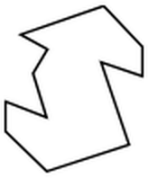
Step 4: Conclusion The next arrangement of fan sectors and concentric arc markings is (B). Hence, the correct option is (B).

Quick Tip to Solve: Track one doubled rim and one short inner arc together; similar outer silhouettes can conceal a different internal pattern.

43. ***Directions : (For Q. No. 42 to 47). Which one of the answer figures will complete the sequence of the three problem figures ?***

[4 marks]

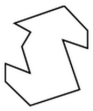


(A) 

(B) 

(C) 

(D) 

Correct Answer: (A) 

Solution:

Concept:

- An outline sequence can be tested by following one distinctive corner through successive rotations. A rotation preserves the order of all convex and concave corners around the boundary.
- The direction and angle must agree in both displayed transitions. A similar overall silhouette is insufficient when a small notch or projecting corner has changed.

Step 1: Identify the repeated movement The first outline turns through 45° anticlockwise to give the second, and the same turn gives the third. Follow the pair of long sides and then the short triangular indentation: their positions change together. The drawing is turning as a rigid shape; no side is added, deleted or reflected.

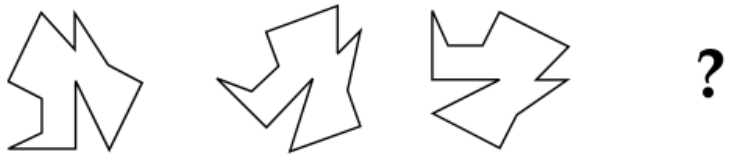
Step 2: Continue the turn and compare the notches Turn the third outline a further 45° anticlockwise. Equivalently, the required figure is the first outline after a total anticlockwise turn of 135°. Its upper edge slopes towards the right, with a small inward corner near the upper left, a deeper indentation below it, and the original recess retained on the right. Option (A) keeps this complete boundary in the required cyclic order. Option (B) replaces the right-hand recess by an outward point; option (C) changes the lower-left projecting corner into a different diagonal; option (D) removes the right-hand recess. These are changes of shape rather than rotations.

Step 3: Conclusion The next figure is the original outline turned a further 45° anticlockwise from the third position. Hence, the correct option is (A).

Quick Tip to Solve: Trace the boundary from a sharp inward corner and check the next two corners; this distinguishes nearly identical rotated outlines.

44. ***Directions : (For Q. No. 42 to 47). Which one of the answer figures will complete the sequence of the three problem figures ?***

[4 marks]



(A) 

(B) 

(C) 

(D) 

Correct Answer: (C) 

Solution:

Concept:

- For a rigidly rotating irregular figure, every edge and notch turns by the same angle. Side lengths and the clockwise order of boundary features remain unchanged.
- Use a narrow projecting spike and a deep indentation as two reference features. Agreement of only one feature can mistakenly accept an altered shape.

Step 1: Determine the sense of rotation The first outline turns 45° clockwise into the second outline. Repeating that clockwise turn produces the third. The narrow spike and the long edge move together, so this is a repeated rotation rather than a mirror reflection or an exchange of separate pieces.

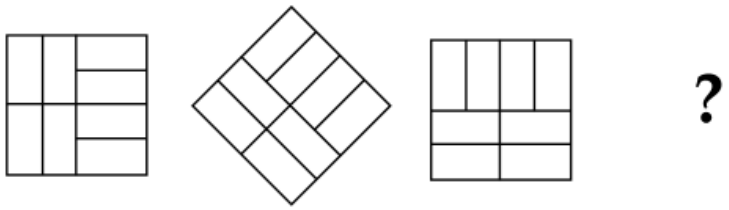
Step 2: Rotate once more and reject changed outlines Apply another 45° clockwise turn to the third figure. The required orientation is therefore a total clockwise turn of 135° from the first. The sharp upper spike must remain, the long concave cut on the left must remain deep, and the right boundary must retain the short horizontal ledge before the lower spike. Option (C) has all these features in the correct order. In option (A), the upper spike has been replaced by a broad corner. Option (B) substitutes a sloping inward cut for the right-hand ledge. Option (D) changes the deep left indentation into a short stepped notch. Each distractor thus violates preservation of the boundary, even though its broad orientation looks plausible.

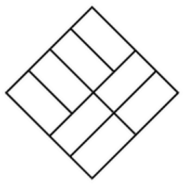
Step 3: Conclusion The unchanged outline in its next clockwise position is option (C). Hence, the correct option is (C).

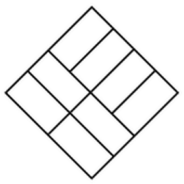
Quick Tip to Solve: Check one outward spike and one inward notch together; a rotation must preserve both, including the edges between them.

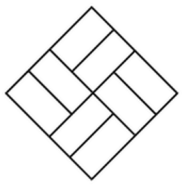
45. ***Directions : (For Q. No. 42 to 47). Which one of the answer figures will complete the sequence of the three problem figures ?***

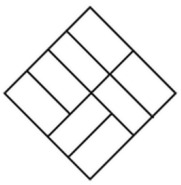
[4 marks]

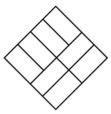


(A) 

(B) 

(C) 

(D) 

Correct Answer: (A) 

Solution:

Concept:

- A subdivided square must be rotated as a single diagram: its outside boundary and every internal dividing line move together.
- When the rotation between successive positions is $45°$, a square alternates between an upright position and a diamond. The arrangement of short and long internal strips determines the answer.

Step 1: Follow the divisions as the square turns The first upright square turns $45°$ anticlockwise to give the second, diamond-shaped figure. A further equal turn gives the third upright figure. In particular, the half containing four narrow strips and the half containing the paired subdivisions move around the centre together. The internal lines are not being redrawn independently at each stage.

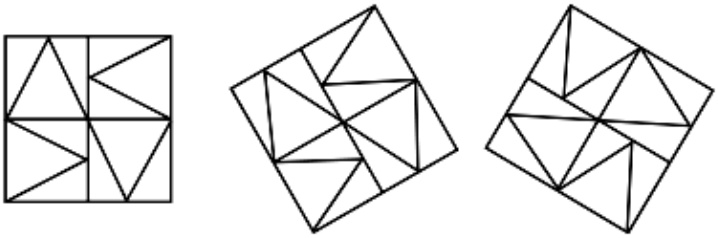
Step 2: Predict the fourth diamond Continue with one more anticlockwise turn of $45°$. The outer square becomes a diamond again. Relative to the first figure, its total turn is $135°$ anticlockwise. The group of four parallel strips must now occupy the upper-left part of the diamond, while the paired rectangular subdivisions occupy the opposite part; their central junction remains connected to the same lines. Option (A) preserves precisely this partition. Option (B) puts the narrow strip group on the wrong side. Option (C) changes the lengths and meetings of the internal dividing lines. Option (D) interchanges the subdivided regions and gives the wrong strip arrangement. Matching only the diamond boundary would therefore not determine the answer.

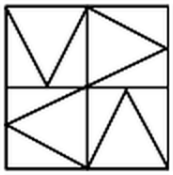
Step 3: Conclusion The fourth figure is the diamond with the internal partition shown in option (A). Hence, the correct option is (A).

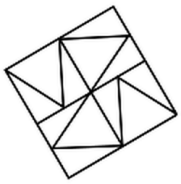
Quick Tip to Solve: Track the half containing the four narrow strips before comparing the smaller internal intersections.

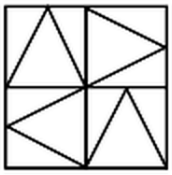
46. Directions : (For Q. No. 42 to 47). Which one of the answer figures will complete the sequence of the three problem figures ?

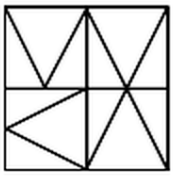
[4 marks]

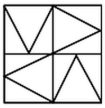


(A) 

(B) 

(C) 

(D) 

Correct Answer: (A) 

Solution:

Concept:

- A square divided into four smaller squares may contain several similar triangular motifs. Under a rigid rotation, both the quadrant of each motif and its pointing direction change together.
- The angles of successive outside boundaries reveal the amount of rotation. The internal line arrangement must then confirm the same rule.

Step 1: Find the common angular step The outside square turns 30° clockwise from the first figure to the second, and another 30° clockwise to the third. Consequently, the missing fourth figure is reached after a total clockwise rotation of 90° from the first. Its outside edges must again be horizontal and vertical.

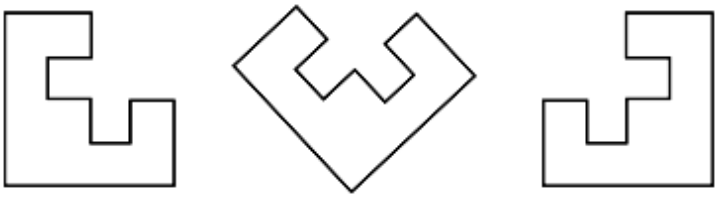
Step 2: Transfer the four triangular motifs In the first figure, the top-left triangular motif points upward, the top-right one points left, the bottom-left one points right, and the bottom-right one points downward. After a clockwise quarter-turn, the new top-left motif comes from the old bottom-left and points downward; the new top-right comes from the old top-left and points right. The new bottom-left comes from the old bottom-right and points left, while the new bottom-right comes from the old top-right and points upward. Option (A) gives this complete arrangement. Option (B) retains a tilted outside square. Option (C) incorrectly makes the upper-left motif point upward. Option (D) changes the upper-right motif as well, so it does not preserve the original four-part pattern.

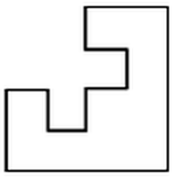
Step 3: Conclusion The next diagram is the quarter-turned pattern displayed in option (A). Hence, the correct option is (A).

Quick Tip to Solve: Use the outside square to find the angle, then check the arrow-like direction of one triangle in each quadrant.

47. Directions : (For Q. No. 42 to 47). Which one of the answer figures will complete the sequence of the three problem figures ?

[4 marks]



(A) 

(B) 

(C) 

(D) 

Correct Answer: (B) 

Solution:

Concept:

- An irregular stepped outline preserves its widths, recess depths and sequence of right-angle turns when rotated. A mirror image can look close while failing this test.
- Compare two consecutive positions to determine the angle and direction, then continue the same movement without changing the outline.

Step 1: Recognise the equal rotations The first outline turns 45° anticlockwise to become the second, diamond-oriented outline. Repeating that turn produces the third upright outline. The broad outer band and both rectangular recesses move together. The transformation is a rigid rotation, so the thickness of every projecting arm and the depth of every indentation must be retained.

Step 2: Select the unchanged outline in its next position Rotate the third figure a further 45° anticlockwise. This makes the fourth figure a diamond-oriented shape, equivalent to rotating the first figure 135° anticlockwise in total. Its long unbroken outside edges lie above and to the right,

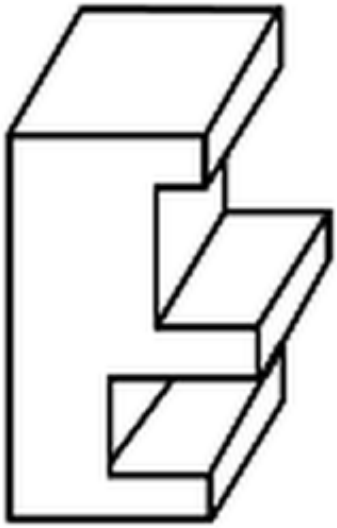
while the stepped opening lies towards the lower left. Option (B) preserves the complete opening, including both re-entrant corners and the lengths of the connecting diagonal segments. Option (A) is still upright, so it fails the angular step. Option (C) shifts the internal step and alters the arm width. Option (D) changes the relative length and position of a notch. Thus those similar silhouettes cannot be obtained by simply turning the given figure.

Step 3: Conclusion The rigidly rotated outline is the figure in option (B). Hence, the correct option is (B).

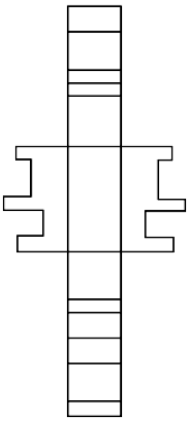
Quick Tip to Solve: After checking orientation, follow the zigzag edge of the opening; its step lengths identify the genuine rotation.

48. Directions : (For Q. No. 48 to 53). Which one of the answer figures shows the correct view of the 3–D problem figure after the problem figure is opened up ?

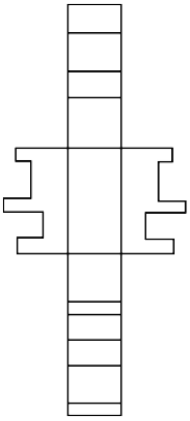
[4 marks]



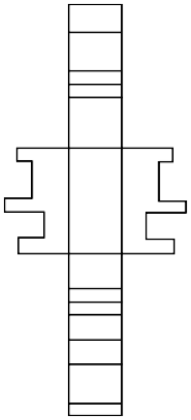
(A)



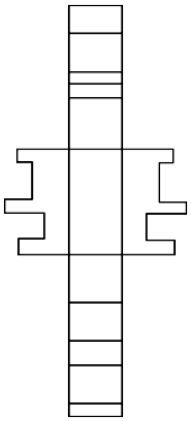
(B)



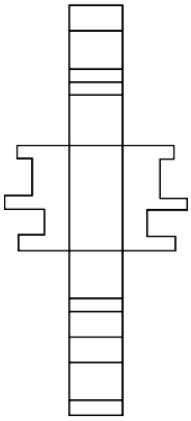
(C)



(D)



Correct Answer: (A)



Solution:

Concept:

- The net of a prism contains two identical end profiles and a band of rectangular lateral faces. Each straight edge of an end profile corresponds to one rectangle in that band.
- For a concave profile, the band must follow the recesses as well as the outside boundary. Missing or additional fold divisions prevent the lateral faces from meeting the profile correctly.

Step 1: Trace the end profile of the solid The solid is an extrusion of the stepped, E-shaped end profile. Its two end faces must therefore be congruent, and the lateral band must pass around the outer top, outer back, bottom and both recesses between the three projecting arms. Walking once around the end profile gives twelve straight boundary segments. There must be twelve corresponding lateral rectangles, with their successive lengths matching those segments.

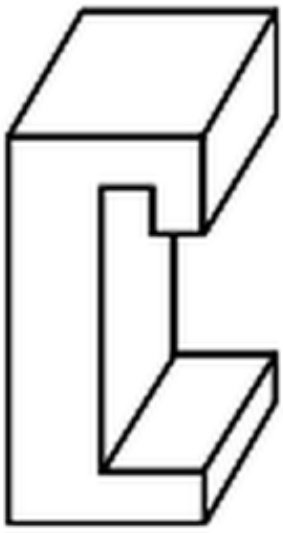
Step 2: Check the fold divisions of the four nets All four options have the broad idea of two stepped end profiles attached to a central band, so the end silhouette alone does not decide the answer. In option (A), the central long rectangle and the five rectangles above it plus six below it give the twelve lateral faces required. The short fold intervals occur where the band turns around the thin projecting edges, and the longer intervals cover the arm surfaces and recess walls. The end profiles can consequently close without changing any edge. Option (B) omits a needed division in the upper part of the strip. Option (C) adds an extra division in its lower part. Option (D) omits a needed division lower down. Those bands do not reproduce the same successive faces of the given prism.

Step 3: Conclusion The development that preserves the stepped end profiles and all lateral faces is option (A). Hence, the correct option is (A).

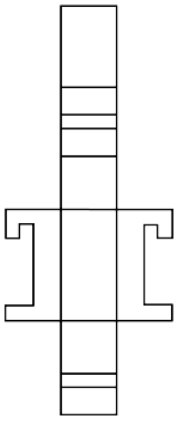
Quick Tip to Solve: For a concave prism, count every edge around an end profile, including the recesses, and match that count to the lateral rectangles.

49. Directions : (For Q. No. 48 to 53). Which one of the answer figures shows the correct view of the 3–D problem figure after the problem figure is opened up ?

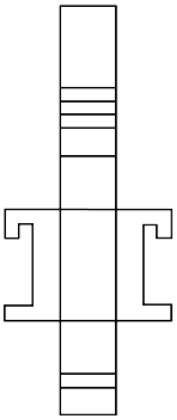
[4 marks]



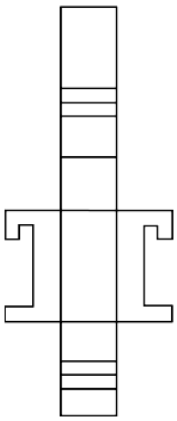
(A)



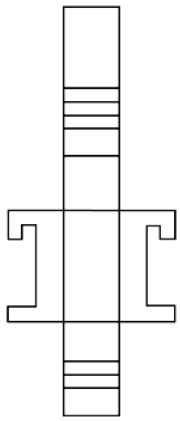
(B)



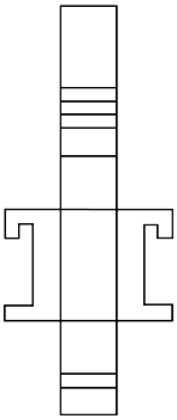
(C)



(D)



Correct Answer: (B)



Solution:

Concept:

- The solid has two matching C-shaped end faces, joined by a constant-depth band. The development must preserve the deep inner recess, the small lip near its upper mouth and the lower return. These features make it more informative than the outer rectangular outline alone.
- A valid choice must satisfy every visible edge and every fold or projection together. An attractive outer silhouette cannot compensate for a missing corner or an additional face.

Step 1: Trace the defining edges Start at the long outside edge of a C-shaped end and walk around its boundary. Across the upper return the surface turns around the short lip, travels along the long inside wall, and then turns around the lower return. Each change of direction requires a transverse fold line in the connecting strip. The two end faces must be attached as reflected outlines so their corresponding edges meet the same lateral panels.

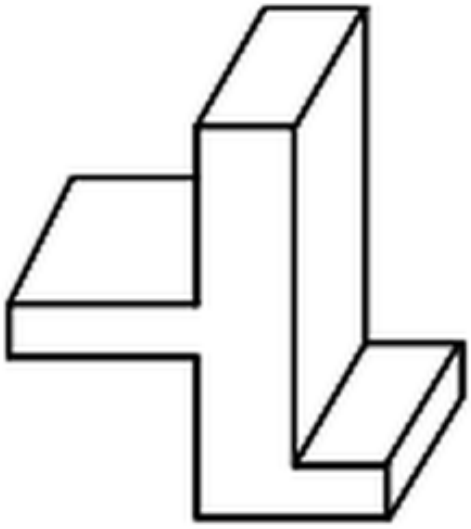
Step 2: Compare the complete alternatives In (B), the consecutive small panels above the end faces account separately for the short edges around the upper lip. Its long panel then supplies the inside wall, and the lower panels close around the lower return. Option (A) combines two successive short faces and therefore loses a required fold. Option (C) redistributes the divisions into the wrong longer panels. Option (D) introduces an extra division below the end faces, so that its lower edge sequence does not match the C-shaped boundary.

Step 3: Conclusion The correct development is the one in option (B). Hence, the correct option is (B).

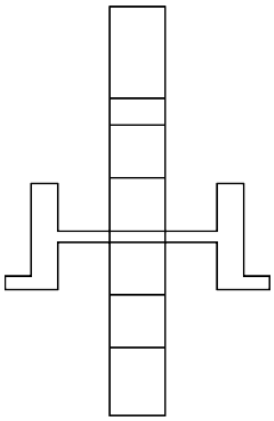
Quick Tip to Solve: Trace the perimeter in one direction and mark each corner as a fold; do not compare only the two matching end outlines.

50. Directions : (For Q. No. 48 to 53). Which one of the answer figures shows the correct view of the 3–D problem figure after the problem figure is opened up ?

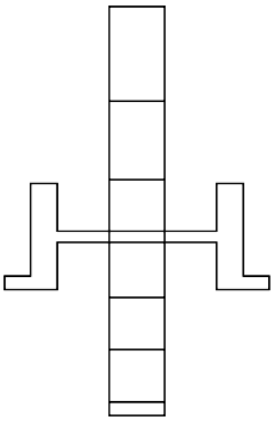
[4 marks]



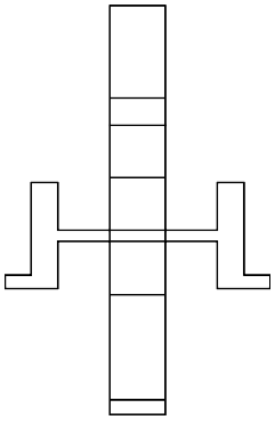
(A)



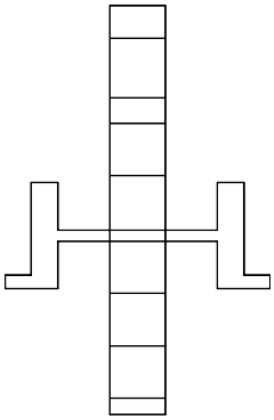
(B)



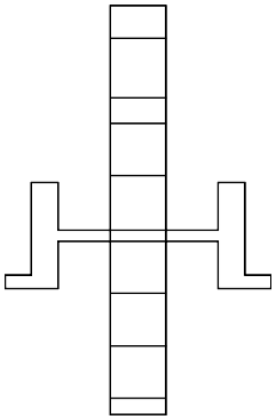
(C)



(D)



Correct Answer: (D)



Solution:

Concept:

- The solid is an extrusion of a stepped end profile. Its upright, side arm and projecting lower foot must all survive when the development is folded. The outline of either end face by itself is insufficient because all four choices use a similar stepped outline.
- A valid choice must satisfy every visible edge and every fold or projection together. An attractive outer silhouette cannot compensate for a missing corner or an additional face.

Step 1: Trace the defining edges Trace the stepped boundary from the short attachment edge beside the central strip. Follow the horizontal arm, its vertical return, the upper upright, the outer side, the

narrow lower projection and the bottom return. Every corner separates two lateral faces. Preserve this cyclic order, including the short faces at the changes of level; merging adjacent rectangles removes a bend needed to recover the solid.

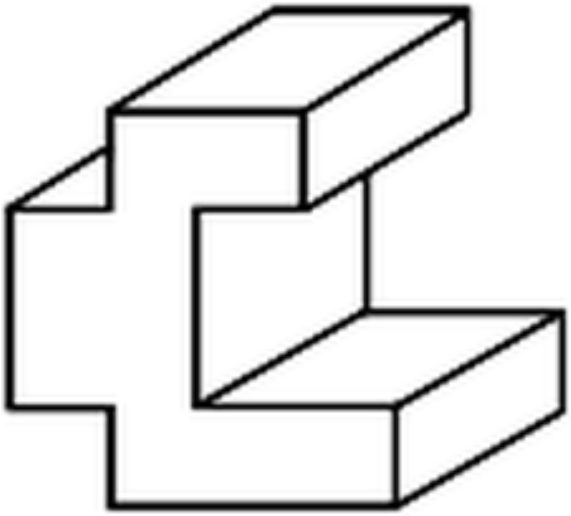
Step 2: Compare the complete alternatives Option (D) supplies the full sequence of transverse divisions for these successive faces. The long portions form the upright and arm surfaces, while the short end portions turn around the projections. The matching stepped ends can therefore close against the band without omitting an edge. In (A), divisions needed for the lower stepped return are missing. In (B), separate faces near the upper return are combined. In (C), the long lower rectangle likewise lacks a necessary intermediate bend. None of those three bands reproduces every change of direction of the end boundary.

Step 3: Conclusion The correct development is the one in option (D). Hence, the correct option is (D).

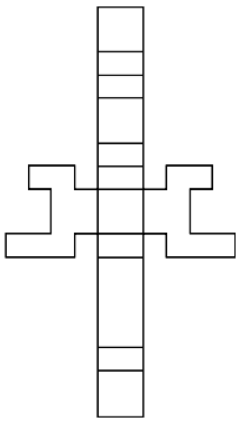
Quick Tip to Solve: Trace the perimeter in one direction and mark each corner as a fold; do not compare only the two matching end outlines.

51. Directions : (For Q. No. 48 to 53). Which one of the answer figures shows the correct view of the 3–D problem figure after the problem figure is opened up ?

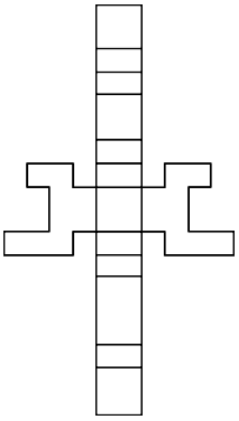
[4 marks]



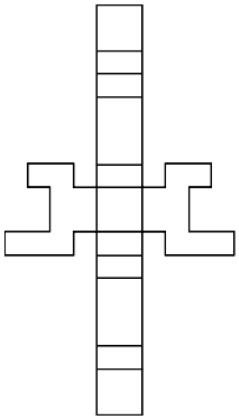
(A)



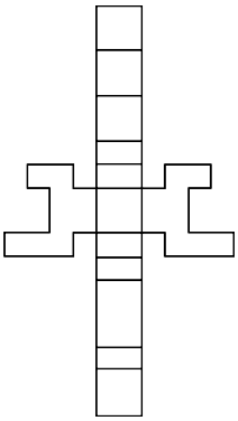
(B)



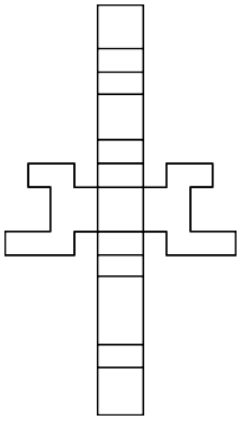
(C)



(D)



Correct Answer: (B)



Solution:

Concept:

- This prism has a recessed middle and projecting lips on both the upper and lower parts of its end profile. Both end faces must be identical after reflection, and every straight edge of that profile needs a corresponding rectangular lateral face.
- A valid choice must satisfy every visible edge and every fold or projection together. An attractive outer silhouette cannot compensate for a missing corner or an additional face.

Step 1: Trace the defining edges Choose the short vertical edge at which an end face meets the middle strip as the starting edge. Walk around the profile without jumping across the recess. Notice the two successive short turns near the upper shoulder, the longer ledge, the returns around the notch and the extended lower ledge. Count each straight segment separately: an inward corner is just as important as an outward corner.

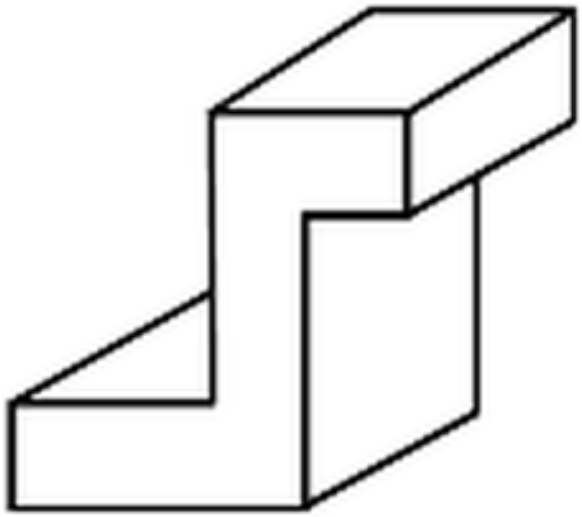
Step 2: Compare the complete alternatives Option (B) keeps the two short subdivisions near the upper shoulder and also retains the pair of short panels just below the end faces before the longer panel. These are the fold positions needed to recover the two stepped returns. Option (A) omits one of the lower short divisions and replaces it by a single longer region. Option (C) loses an upper division by joining neighbouring panels. Option (D) also combines the two upper short faces into a larger panel. Those changes prevent the strip edges from matching the profile all the way round.

Step 3: Conclusion The correct development is the one in option (B). Hence, the correct option is (B).

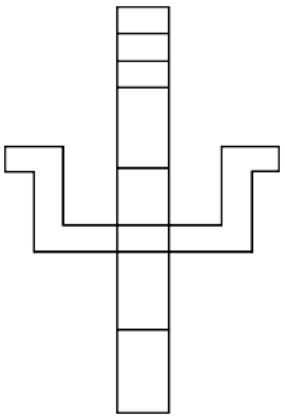
Quick Tip to Solve: Trace the perimeter in one direction and mark each corner as a fold; do not compare only the two matching end outlines.

52. Directions : (For Q. No. 48 to 53). Which one of the answer figures shows the correct view of the 3–D problem figure after the problem figure is opened up ?

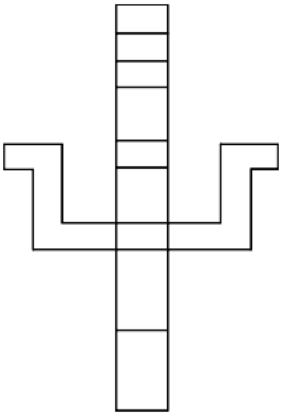
[4 marks]



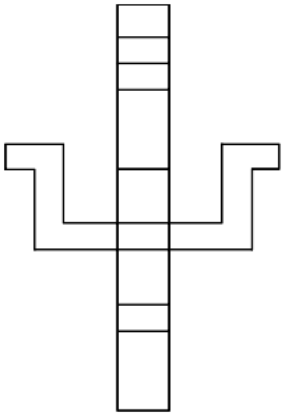
(A)



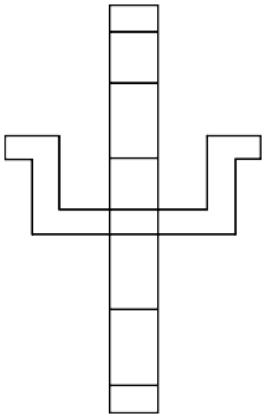
(B)



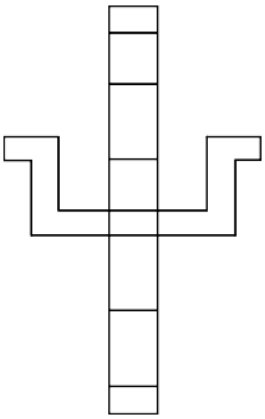
(C)



(D)



Correct Answer: (D)



Solution:

Concept:

- The solid has an offset end profile: an upper projection faces one way and the lower projection faces the other. Development preserves the complete perimeter of that profile, rather than merely its bounding rectangle. The two ends in the net must be mirror-related across the connecting strip.
- A valid choice must satisfy every visible edge and every fold or projection together. An attractive outer silhouette cannot compensate for a missing corner or an additional face.

Step 1: Trace the defining edges Begin at the narrow horizontal attachment beside the central band. Trace one end outline through the short horizontal ledge, the long vertical side, the upper projection, its short thickness, the returning ledge, the other long side and the lower return. The lateral band must contain these lengths in that same cyclic order. In particular, a thickness face cannot be moved into the middle of a long wall.

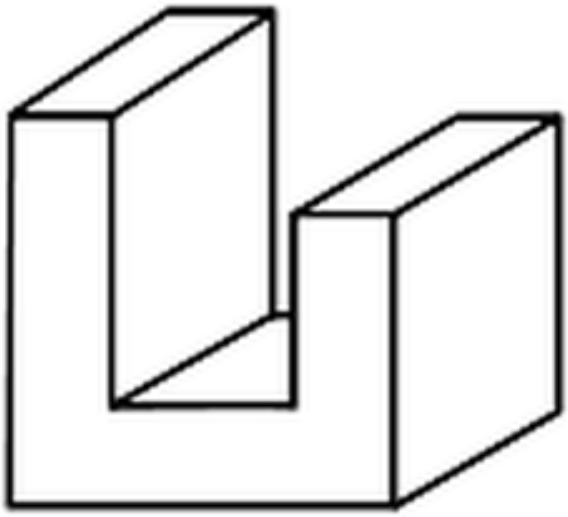
Step 2: Compare the complete alternatives In (D), the panels above the end faces follow the ledge, tall wall, projection and narrow thickness in the required order. Below them, the two longer panels and the final short panel complete the remaining return. Thus both the number and placement of the small thickness panels agree with the solid. Option (A) places extra short subdivisions in the upper part of the strip. Option (B) breaks a long upper wall at an incorrect position. Option (C) moves a short division to the lower run instead of preserving the corresponding long face. Folding these alternatives changes the stepped profile.

Step 3: Conclusion The correct development is the one in option (D). Hence, the correct option is (D).

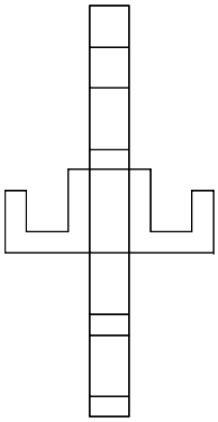
Quick Tip to Solve: Trace the perimeter in one direction and mark each corner as a fold; do not compare only the two matching end outlines.

53. Directions : (For Q. No. 48 to 53). Which one of the answer figures shows the correct view of the 3–D problem figure after the problem figure is opened up ?

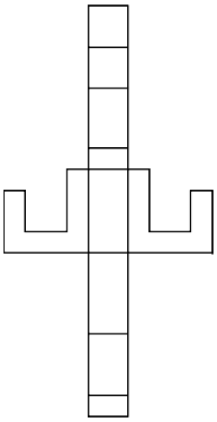
[4 marks]



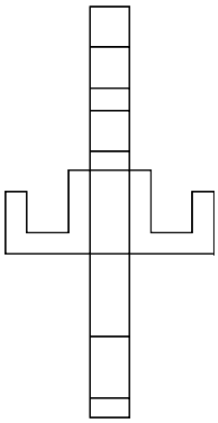
(A)



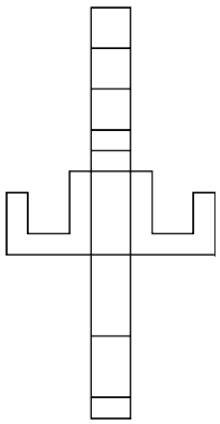
(B)



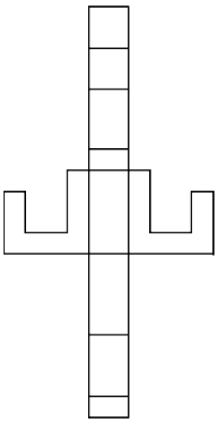
(C)



(D)



Correct Answer: (B)



Solution:

Concept:

- The prism has a U-shaped section with unequal upright heights. A development must preserve the taller upright, the lower upright and the recessed connecting floor. A symmetric-looking arrangement of panels is not sufficient when the original end section is asymmetric.
- A valid choice must satisfy every visible edge and every fold or projection together. An attractive outer silhouette cannot compensate for a missing corner or an additional face.

Step 1: Trace the defining edges Take the lower outside edge of an end face as the reference. Trace the section around the taller wall, across its thickness, down to the inner floor, across the floor, up the

shorter wall and around its outside return. Each of these portions becomes one rectangular panel of the lateral band. Keep the short thickness panels separate from the long vertical walls.

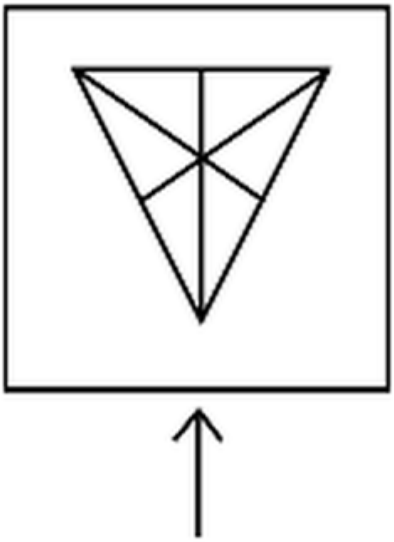
Step 2: Compare the complete alternatives Option (B) retains the required sequence of the small thickness face, the long wall, and the two intermediate portions above the end faces. Below the end faces its uninterrupted long outside-wall panel is followed by the remaining base and thickness panels. The end profiles can therefore close in the correct orientation. Option (A) inserts an extra lower fold in a wall that should remain a single face. Option (C) inserts an additional upper division. Option (D) shifts the upper subdivisions so that the recess and unequal upright heights are no longer reproduced by the band.

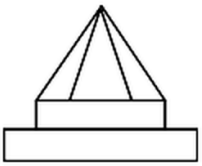
Step 3: Conclusion The correct development is the one in option (B). Hence, the correct option is (B).

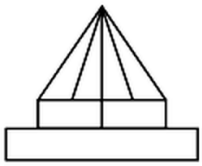
Quick Tip to Solve: Trace the perimeter in one direction and mark each corner as a fold; do not compare only the two matching end outlines.

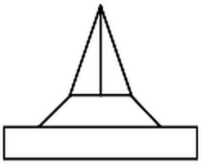
54. Directions : (For Q. No. 54 to 57). The problem figure shows the top view of objects. Looking in the direction of the arrow, identify the correct elevation, from amongst the answer figures.

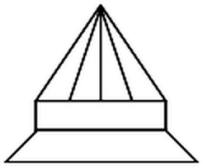
[4 marks]

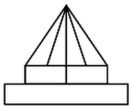


(A) 

(B) 

(C) 

(D) 

Correct Answer: (B) 

Solution:

Concept:

- An elevation is an orthographic view in the direction of the arrow. Depth is removed, while the left-to-right positions of the visible corners and ridges remain. The triangular plan points towards the observer, so its forward corner lies on the centre line of the elevation.
- A valid choice must satisfy every visible edge and every fold or projection together. An attractive outer silhouette cannot compensate for a missing corner or an additional face.

Step 1: Trace the defining edges Look from the bottom of the plan towards the triangular object. The outside square becomes the wide rectangular base in elevation. The triangle above it gives a pointed roof with its apex over the middle. Its front vertex projects to the middle of the narrower supporting body, and the visible ridge towards that vertex produces a central vertical line. The other visible roof divisions slope outwards on either side of this line.

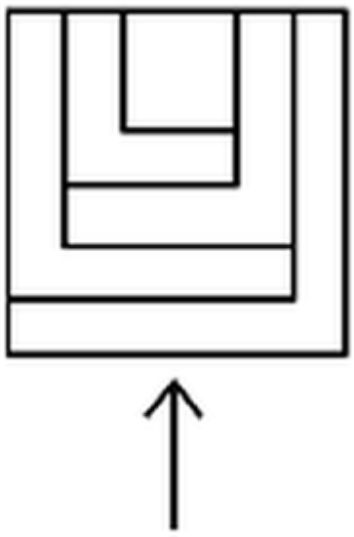
Step 2: Compare the complete alternatives Option (B) has a rectangular lower base, a narrower upright supporting portion and the pointed roof with a central ridge continuing down the visible front corner. Option (A) omits that central visible edge. Option (C) replaces the main support by a sloping-sided transition and shows too few roof divisions. Option (D) also introduces a flared lower transition absent from the plan. Only (B) preserves both the projected centre line and the straight-sided support while retaining the visible roof edges.

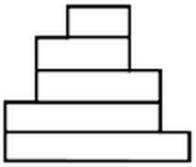
Step 3: Conclusion The required elevation is the one in option (B). Hence, the correct option is (B).

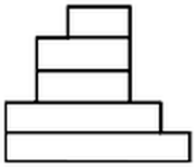
Quick Tip to Solve: Project the corner nearest the viewing arrow first: its central visible edge quickly distinguishes these otherwise similar elevations.

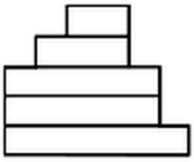
55. Directions : (For Q. No. 54 to 57). The problem figure shows the top view of objects. Looking in the direction of the arrow, identify the correct elevation, from amongst the answer figures.

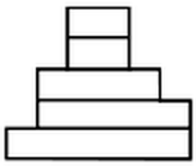
[4 marks]

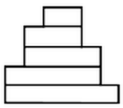


(A) 

(B) 

(C) 

(D) 

Correct Answer: (A) 

Solution:

Concept:

- An elevation is an orthographic view along the indicated arrow. Depth is suppressed, while the horizontal positions and widths of successive levels are retained.
- Nested rectangular outlines with no diagonal corner connections describe successive vertical steps. Compare the left and right setbacks independently; similar overall outlines can conceal a wrong intermediate level.

Step 1: Read the plan from the viewing edge The arrow points upward from the bottom of the plan. Start with the outermost, widest rectangle as the bottom level. The next level shares its left edge but stops short of its right edge. The following level is set back from the left while retaining that reduced right edge. Thus the first two setbacks occur on opposite sides, rather than making a symmetrical staircase.

Step 2: Trace the remaining upper levels The next smaller outline keeps the preceding left edge and retreats on the right. Finally, the innermost rectangle retreats on the left and keeps that right edge. Consequently the left and right vertical boundaries of successive levels must follow the alternating sequence shown in option (A). All visible ledges remain horizontal in the elevation.

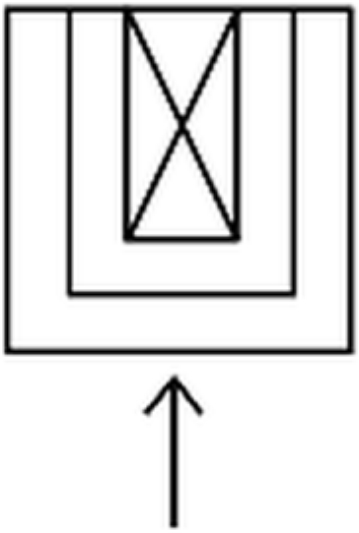
Step 3: Eliminate the other profiles Option (B) gives the wrong width and right edge to the intermediate level. Option (C) retains the broad lower-level width for too many successive tiers. Option (D) makes the narrow upper stack continue downward where the plan still shows a wider level. These changes alter the stated plan, whereas (A) preserves each left and right alignment in order.

Step 4: Conclusion The complete figure comparison selects option (A). Hence, the correct option is (A).

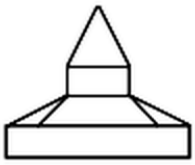
Quick Tip to Solve: Track left and right setbacks as two separate lists, beginning with the outermost rectangle; do not select an elevation merely because its total number of steps looks right.

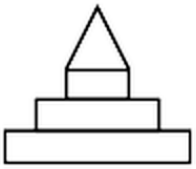
56. Directions : (For Q. No. 54 to 57). The problem figure shows the top view of objects. Looking in the direction of the arrow, identify the correct elevation, from amongst the answer figures.

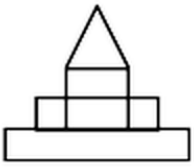
[4 marks]

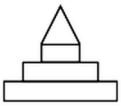


(A) 

(B) 

(C) 

(D) 

Correct Answer: (C) 

Solution:

Concept:

- The direction arrow selects the front elevation: horizontal widths survive projection, but front-to-back distances do not.
- A rectangular outline inside another gives a raised block with vertical sides. Crossing diagonals on the smallest rectangle indicate a pointed roof whose front outline is triangular.

Step 1: Identify the stacked widths Viewed from the bottom along the arrow, the outer rectangle supplies the widest base. The next nested rectangle supplies a centered, narrower block, and the innermost rectangle supplies the narrow upper component. Their left and right edges are parallel and centered, so the elevation must have rectangular lower stages rather than tapering lower sides.

Step 2: Project the roof and its support The diagonals are confined to the innermost rectangle. They

indicate sloping roof faces meeting above that upper component. The front silhouette therefore rises through a narrow rectangular support into a triangular roof. There is no diagonal corner connection between either pair of larger outlines, so the lower two stages cannot become sloping roof-like surfaces.

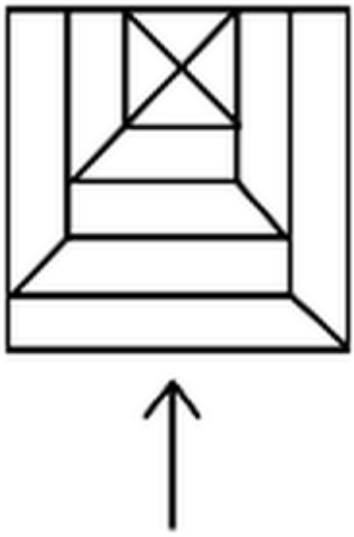
Step 3: Compare all four answer figures Option (C) has a broad rectangular base, a centered rectangular middle stage and the narrow pointed top. Option (A) incorrectly slopes the sides through the lower stages. Option (B) introduces a sloping shoulder above the base although the plan shows a vertical step there. Option (D) extends vertical lines through the middle stage which should be hidden by its front face. Only (C) preserves both the silhouette and the visible edges.

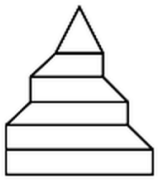
Step 4: Conclusion The complete figure comparison selects option (C). Hence, the correct option is (C).

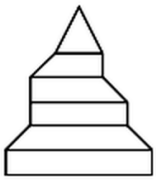
Quick Tip to Solve: Locate the diagonal roof lines first. Slopes belong only to the level whose plan actually contains those diagonals; the larger nested rectangles remain vertical-sided blocks.

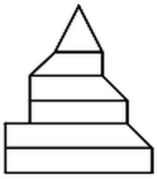
57. Directions : (For Q. No. 54 to 57). The problem figure shows the top view of objects. Looking in the direction of the arrow, identify the correct elevation, from amongst the answer figures.

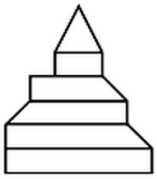
[4 marks]

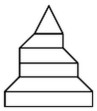


(A) 

(B) 

(C) 

(D) 

Correct Answer: (B) 

Solution:

Concept:

- In an elevation, a diagonal joining corresponding corners of nested plan outlines represents a sloping transition. A shared aligned boundary instead produces a vertical side.
- The indicated view must preserve the sequence of widths and the side on which each setback occurs, from the broad base to the pointed top.

Step 1: Project the broad lower transition Look upward along the arrow. The outside rectangle gives the widest bottom block. Diagonals connect both its lower corners to the next inner outline. Therefore the elevation above the rectangular base narrows on both the left and right sides through sloping shoulders. This two-sided lower slope is an especially useful feature for distinguishing the choices.

Step 2: Follow the asymmetric upper transitions Above that shoulder is a rectangular stage. The next transition narrows on the right while retaining the left alignment, so its right boundary slopes inward. At the following level the setback occurs on the left while the right alignment is retained. The smallest crossed rectangle supplies the final triangular roof. Following these changes gives the outline and horizontal divisions drawn in (B).

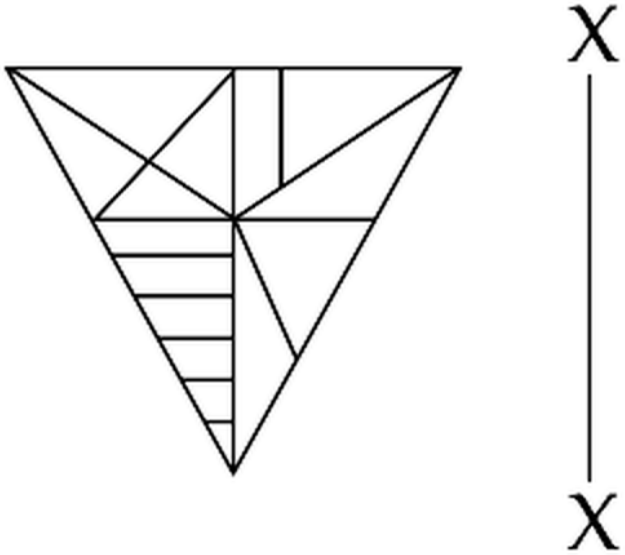
Step 3: Reject the remaining alternatives Option (A) does not reproduce the two-sided lower taper: its left boundary remains too far out at that transition. Option (C) replaces that lower taper with a vertical step, losing the plan diagonals. Option (D) introduces a vertical left boundary at an upper transition that should slope. Option (B) alone keeps the bottom bilateral taper and the successive asymmetric shoulders in their correct order.

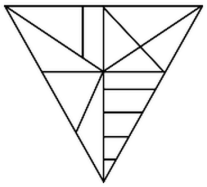
Step 4: Conclusion The complete figure comparison selects option (B). Hence, the correct option is (B).

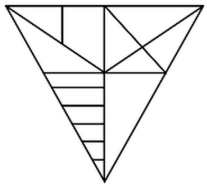
Quick Tip to Solve: For each band in the plan, mark whether its left and right corner connections are diagonal or vertical. Read those pairs upward to reconstruct the elevation without guessing heights.

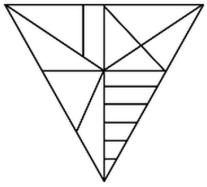
58. Directions : (For Q. No. 58 to 61). Which one of the answer figures is the correct mirror image of the problem figure with respect to X - X ?

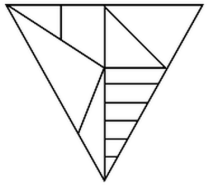
[4 marks]

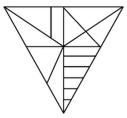


(A) 

(B) 

(C) 

(D) 

Correct Answer: (C) 

Solution:

Concept:

- Reflection in the vertical line X–X reverses left and right but preserves every height. A diagonal reverses its slope, and horizontal and vertical lines keep their respective orientations.
- Every internal subdivision must be reflected with the outline. Correct outer shape alone is insufficient for a mirror-image answer.

Step 1: Reflect the main asymmetric regions The downward-pointing triangle remains downward-pointing. The original ladder of horizontal subdivisions lies below the central junction on the left; after reflection that ladder must lie on the right. The pair of crossed diagonals in the upper-left region must move to the upper-right region. The long diagonal through the opposite lower region also changes its slope.

Step 2: Check the short upper vertical segment The original has a short vertical partition just to the right of the central vertical line, ending on an oblique segment. Its image must be just to the left of the central line at the same height. Option (C) places this short segment in the correct reflected location and preserves the upper crossed diagonals and the lower-right ladder.

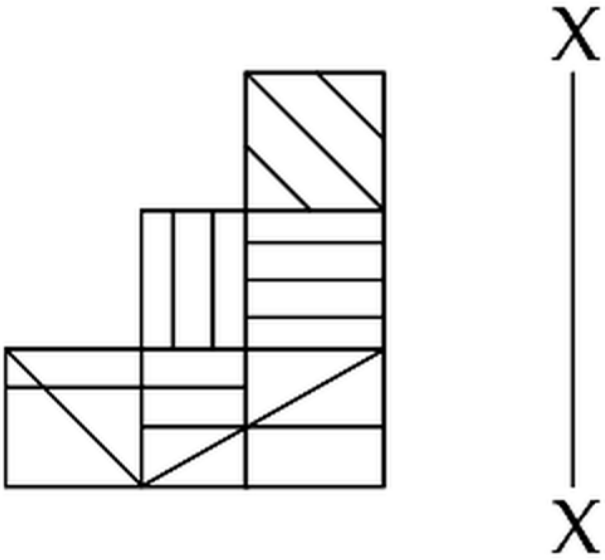
Step 3: Eliminate each inconsistent subdivision Option (A) moves the short upper vertical partition too far toward the left outer corner; its endpoint does not match the reflected junction. Option (B) leaves the lower horizontal ladder on the left instead of moving it to the right. Option (D) lacks one of the reflected crossing diagonals in the upper-right part and also misplaces the short upper partition. Only (C) reflects every region consistently.

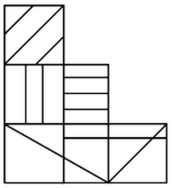
Step 4: Conclusion The complete figure comparison selects option (C). Hence, the correct option is (C).

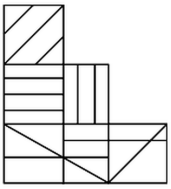
Quick Tip to Solve: Use three landmarks: the striped region, a short isolated partition, and a diagonal crossing. A true reflection must put all three on the opposite side at unchanged heights.

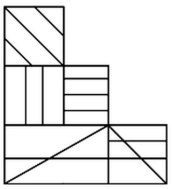
59. Directions : (For Q. No. 58 to 61). Which one of the answer figures is the correct mirror image of the problem figure with respect to X - X ?

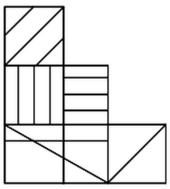
[4 marks]

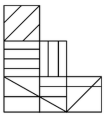


(A) 

(B) 

(C) 

(D) 

Correct Answer: (B) 

Solution:

Concept:

- A vertical mirror reverses the horizontal ordering of regions without rotating the figure. Horizontal stripes stay horizontal, vertical stripes stay vertical, and diagonal slopes reverse.
- For a stepped composite figure, compare both its outside staircase and the pattern inside every square or rectangular region.

Step 1: Reverse the stepped outline The original staircase rises toward the right. Its reflected outline must rise toward the left, placing the tallest column at the left and the shortest at the right. The top square therefore moves from the upper right to the upper left, and its descending diagonal stripes become ascending diagonal stripes.

Step 2: Transfer the middle and lower patterns The horizontally striped middle region originally on the right must move to the left immediately below the top square. The vertically striped region originally on its left must move to the right. The short horizontal subdivisions in the lower central region remain horizontal, while the lower diagonal segments reverse their slopes and join the corresponding reflected corners. Option (B) satisfies all of these positional checks.

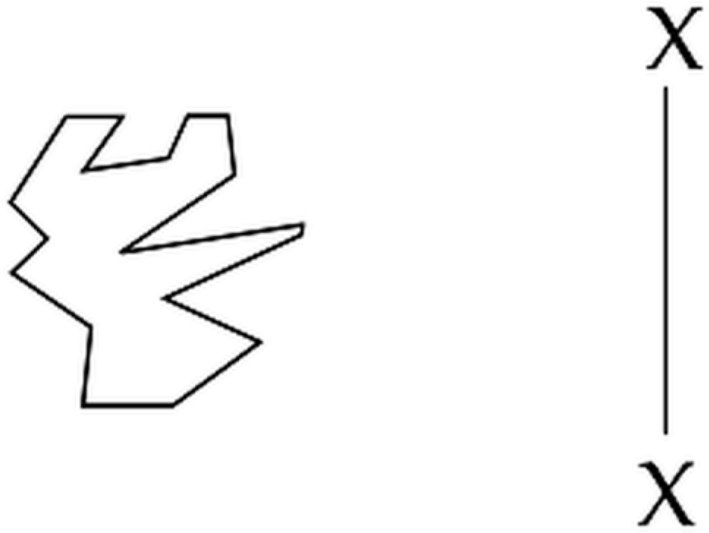
Step 3: Rule out the distractors Option (A) puts vertical stripes below the top square and horizontal stripes in the adjacent middle region, interchanging the two required patterns. Option (C) retains the wrong diagonal slope in the top square and also rearranges the lower connections. Option (D) again places vertical stripes below the top square and changes the lower horizontal subdivisions. Although several choices have the correct stepped outline, only (B) mirrors its internal linework as well.

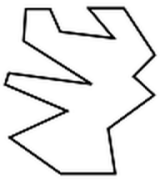
Step 4: Conclusion The complete figure comparison selects option (B). Hence, the correct option is (B).

Quick Tip to Solve: For a composite mirror figure, name each region by its pattern before reflecting it: diagonal top, horizontal middle, vertical neighbour. The patterns move; they do not rotate.

60. Directions : (For Q. No. 58 to 61). Which one of the answer figures is the correct mirror image of the problem figure with respect to X - X ?

[4 marks]



(A) 

(B) 

(C) 

(D) 

Correct Answer: (D) 

Solution:

Concept:

- A mirror image across vertical X–X reverses the horizontal direction of every protrusion and indentation while preserving its vertical level.
- An irregular outline is best checked by tracing its boundary in sequence. One correct long projection cannot compensate for an incorrect notch or a changed bottom edge.

Step 1: Reflect the prominent features The long narrow point which projects to the right in the original must project to the left. The small pair of upper projections must exchange left and right positions while remaining at the same top level. The deep zigzag indentation below the long point also changes sides; it does not move to a different height.

Step 2: Trace the lower and upper boundary The original lower outline has an approximately

horizontal base and a sloping edge leading up toward the right-hand lower point. The reflected base remains horizontal, with that slope now on the opposite side. Continue around the upper outline: the narrow inward notch between the two top projections must reverse its slant without changing the relative heights of those projections. Option (D) preserves this whole boundary sequence.

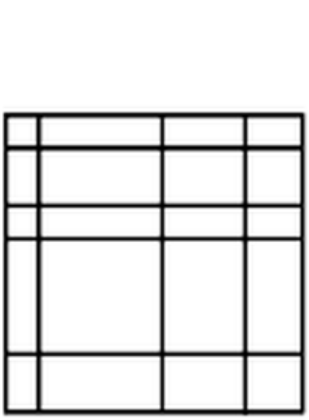
Step 3: Check why the other outlines fail Option (A) changes the lower outline and gives the bottom of the figure a different slant and proportion. Option (B) lowers one of the two top projections, whereas reflection preserves their heights. Option (C) alters the lower-left indentation beneath the long projecting point, replacing the required zigzag with a different edge. Option (D) has the correctly reversed long point, upper notch, lower indentation and base simultaneously.

Step 4: Conclusion The complete figure comparison selects option (D). Hence, the correct option is (D).

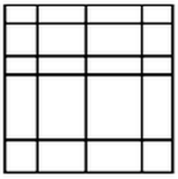
Quick Tip to Solve: Trace an irregular silhouette from its top-left corner around the edge. At a vertical mirror, reverse every left/right turn location while retaining the heights of all corners.

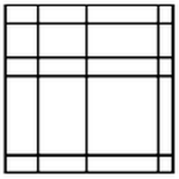
61. Directions : (For Q. No. 58 to 61). Which one of the answer figures is the correct mirror image of the problem figure with respect to X - X ?

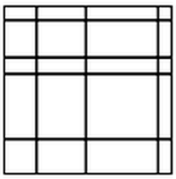
[4 marks]

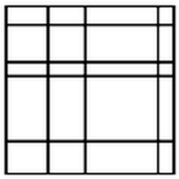


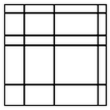


(A) 

(B) 

(C) 

(D) 

Correct Answer: (C) 

Solution:

Concept:

- A mirror placed along a vertical line reverses left and right. It does not reverse top and bottom: every horizontal line remains at its original height.
- Compare the intervals between grid lines rather than merely counting lines. Reflection preserves each interval, but reverses the order of the column widths.

Step 1: Reverse the vertical strips The problem grid has its narrowest column at the extreme left. After reflection this narrow column must lie at the extreme right. The broad interior column originally near the left must consequently move to the right of the centre. This immediately excludes (A), whose rightmost strip is not the reflected narrow strip, and (D), whose interior vertical divisions do not match the reversed order.

Step 2: Keep the horizontal strips in place Read the horizontal divisions downwards. There is a narrow top band, two further relatively narrow bands, a much taller middle region, and a bottom band that is visibly broader than the top band. These heights must stay in that same top-to-bottom order. Option (B) has a very narrow bottom band and an enlarged tall middle region; that is not a horizontal reflection of the displayed problem grid.

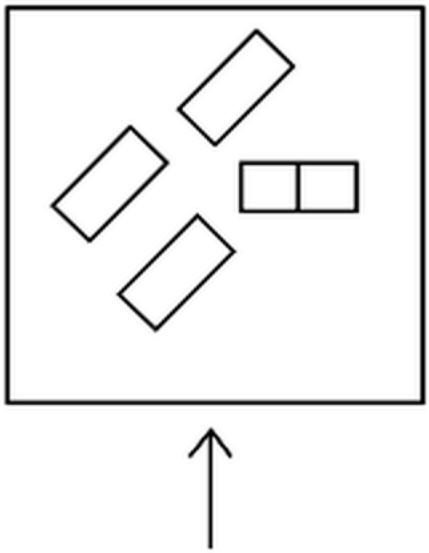
Step 3: Match both sets of divisions Option (C) places the narrow outside column on the right and retains the broad bottom band and the tall region directly above it. It is the only offered figure consistent with both the horizontal-strip pattern and the reversed vertical-strip pattern. Matching only the vertical divisions would overlook the decisive difference between (B) and (C).

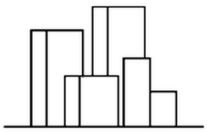
Step 4: Conclusion The displayed grid reflects to (C). The supplied answer key chooses a different figure, but that figure changes the bottom-band height; a vertical mirror cannot change that height. Hence, the correct option is (C).

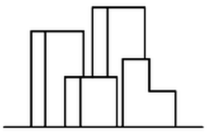
Quick Tip to Solve: For a vertical grid mirror, check the narrowest column first, then check that the bottom row has kept its original height.

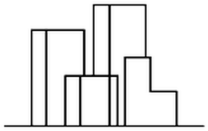
62. Directions : (For Q. No. 62 to 65). The problem figure shows the top view of objects. Looking in the direction of the arrow, identify the correct elevation, from amongst the answer figures.

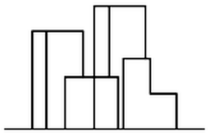
[4 marks]

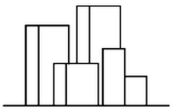


(A) 

(B) 

(C) 

(D) 

Correct Answer: (A) 

Solution:

Concept:

- An elevation is the orthographic view along the indicated arrow. Objects nearer the observer hide the portions of objects directly behind them.
- An obliquely placed rectangular prism can show an internal vertical corner in elevation. A joint between two adjacent separate blocks must also be retained.

Step 1: Establish the viewing direction The arrow points upwards from the lower edge of the plan. Thus the lowest oblique rectangle is in front, the upper oblique rectangle is behind it, and the rectangle at the left lies farther back than the front rectangle. The paired rectangular footprints at the right form two adjacent blocks with their dividing line clearly shown in the plan.

Step 2: Follow the visible vertical edges Project the horizontal extents of each footprint onto the elevation. The front oblique block covers the lower central part of the objects behind it, while its own visible corner remains as a vertical line within its front silhouette. The rear left and rear upper blocks

also retain their visible corners above the areas hidden by the nearer object.

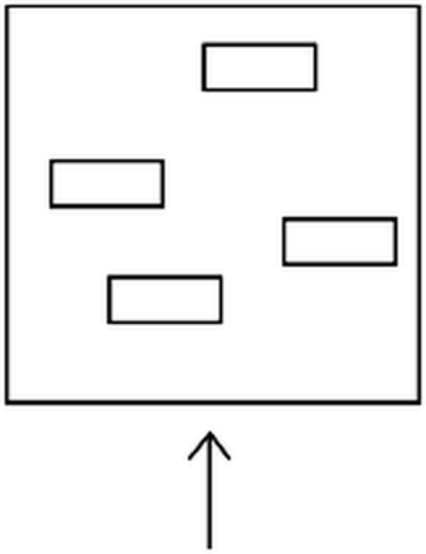
Step 3: Eliminate inconsistent elevations Option (A) retains the appropriate corners of the three oblique blocks and the vertical joint between the two adjacent blocks at the right. Option (B) removes the right-hand joint and merges the two right footprints into a single stepped outline. Option (C) adds a central line through the foreground block where the rear edge is hidden. Option (D) places the foreground corner incorrectly and also omits the right-hand division. These differences concern visible edges, rather than simply overall height.

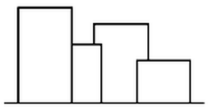
Step 4: Conclusion Only (A) preserves the foreground occlusion, the oblique-block corners and the joint between the right-hand blocks. Hence, the correct option is (A).

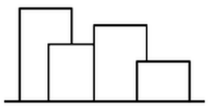
Quick Tip to Solve: For this plan, use the foreground oblique rectangle as the occluding object, then check the seam between the two blocks on the right.

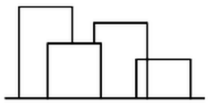
63. Directions : (For Q. No. 62 to 65). The problem figure shows the top view of objects. Looking in the direction of the arrow, identify the correct elevation, from amongst the answer figures.

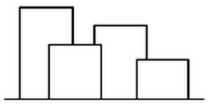
[4 marks]

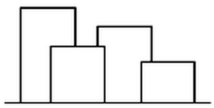


(A) 

(B) 

(C) 

(D) 

Correct Answer: (D) 

Solution:

Concept:

- In an orthographic elevation, the left-to-right position and the horizontal width of each footprint are preserved.
- A nearer rectangular object hides any overlapping lower portion of an object behind it. Hidden rear edges are not drawn through the nearer object.

Step 1: Order the objects by depth Looking upwards along the arrow, the rectangle nearest the lower edge is the foreground object. The left rectangle lies behind it, the upper rectangle lies farthest back, and the right rectangle is nearer than the upper one. The left-to-right order of the footprints is therefore not the same as their front-to-back order.

Step 2: Determine the overlaps The foreground rectangle overlaps the right portion of the left-hand footprint. Consequently its left boundary must visibly interrupt the left object, while its right boundary must be displaced to the right of the rear upper rectangle's left edge. At the right, the nearer rectangle overlaps the right portion of the upper footprint and hides its lower edge in that interval. The picture should show clean uninterrupted faces of the nearer blocks.

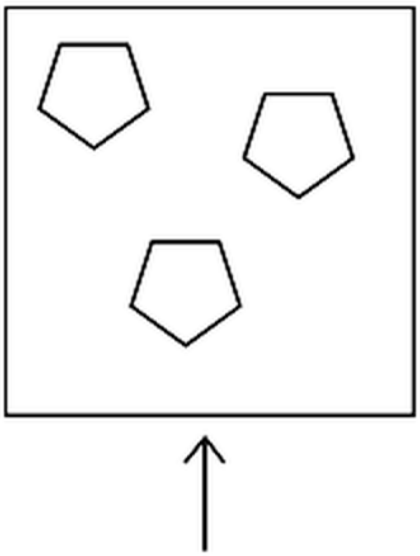
Step 3: Compare the answer figures Option (D) shows the required arrangement: the foreground block covers part of the left block, its right edge extends beyond the left edge of the upper rear block, and the right foreground block hides the lower part of that rear block. In (A), the first overlap has the wrong edge relationship. In (B), the central foreground right edge is incorrectly aligned with the rear block's left edge. In (C), a vertical line is carried through the right foreground object even though it should be hidden. Thus the overlap boundaries select (D).

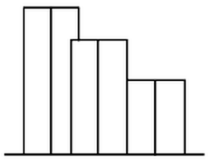
Step 4: Conclusion The visible overlap boundaries agree with elevation (D). Hence, the correct option is (D).

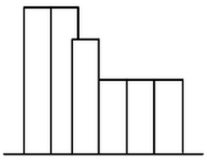
Quick Tip to Solve: Check where the foreground central rectangle ends relative to the left edge of the upper rectangle; that small offset distinguishes the closest choices.

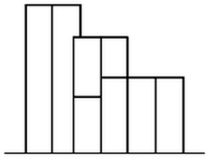
64. Directions : (For Q. No. 62 to 65). The problem figure shows the top view of objects. Looking in the direction of the arrow, identify the correct elevation, from amongst the answer figures.

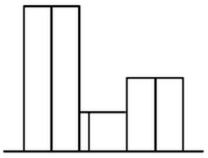
[4 marks]

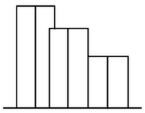


(A) 

(B) 

(C) 

(D) 

Correct Answer: (A) 

Solution:

Concept:

- A pentagonal footprint represents a prism whose visible vertical corners are determined by the viewing direction.
- The nearest prism hides only the overlapping portions of prisms behind it. An internal corner cannot continue through a nearer solid face.

Step 1: Locate the three footprints The viewing arrow points from bottom to top. The pentagon at the bottom is nearest, the pentagon on the left is behind it, and the pentagon on the right is farther to the right and behind the foreground prism. Each footprint has a downward-pointing vertex, so each projected prism has a central visible vertical corner, rather than a completely featureless rectangular face.

Step 2: Track the foreground overlap The foreground pentagon projects over part of the right-hand

prism. Its visible face must remain continuous and its own central corner must be retained. The part of the right prism behind that face cannot be drawn through it. The left prism remains largely visible, including its middle vertical corner; the three silhouettes are not three unrelated rectangles.

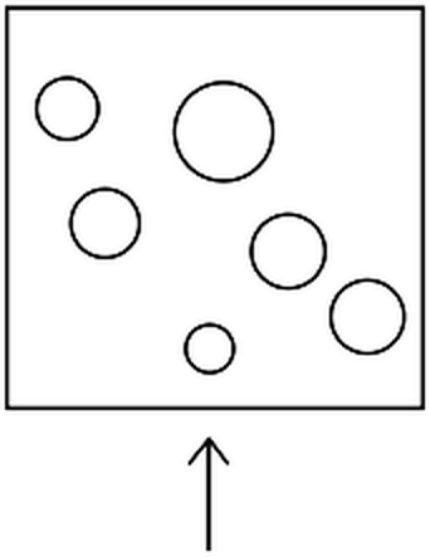
Step 3: Choose the consistent edge pattern Option (A) shows three prisms with the expected visible central corners and the appropriate overlap: the left prism is tallest in the offered elevation, the central foreground prism overlaps it and the right prism, and the right prism retains its visible corner outside the overlap. Option (B) removes the foreground prism's proper width and merges edges. Option (C) carries extra rear edges across the foreground face, producing an impossible horizontal division. Option (D) makes the front prism a low narrow strip and does not reproduce the projected foreground footprint.

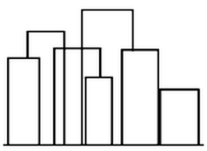
Step 4: Conclusion The projected corners and occlusion pattern agree with (A). Hence, the correct option is (A).

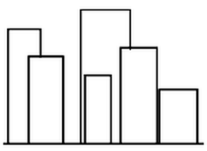
Quick Tip to Solve: In this view, identify the central vertical corner of each pentagonal prism before comparing the silhouettes; hidden edges must stop at the foreground face.

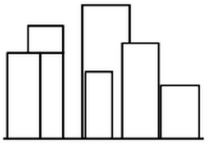
65. Directions : (For Q. No. 62 to 65). The problem figure shows the top view of objects. Looking in the direction of the arrow, identify the correct elevation, from amongst the answer figures.

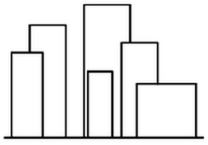
[4 marks]

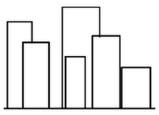


(A) 

(B) 

(C) 

(D) 

Correct Answer: (B) 

Solution:

Concept:

- A vertical cylinder appears as a circle in plan and as a rectangle in elevation. Its diameter determines its projected horizontal width.
- Where cylinders overlap in horizontal projection, the one closer to the observer hides the lower part of the one behind. Only visible outlines are retained.

Step 1: Read the six circular footprints The arrow indicates a view upwards from below the square. The small circle nearest the bottom is in front of the large central circle. At the left, the lower circle is in front of the upper circle. At the right, the lower-right circle is in front of the circle above and to its left. These positions establish the overlap order before any answer figure is considered.

Step 2: Project the widths and hide rear portions Each circle gives one rectangular cylinder elevation of corresponding width. The very small foreground circle gives a narrow rectangle in front of the large, broad central cylinder. The lower left circle must cover the lower right portion of the upper left cylinder. At the right, the outermost cylinder stays to the right of the intermediate one, rather than moving in front of the whole central group. Rear vertical edges should terminate where a nearer cylinder obscures them.

Step 3: Compare the six-object arrangements Option (B) retains six cylindrical silhouettes with the correct left overlap, broad central rear cylinder, narrow central foreground cylinder and two right-hand cylinders. Option (A) introduces visible lines through the central grouping that should be hidden. Option (C) gives the wrong overlap boundary in the left pair. Option (D) makes the outer right foreground rectangle excessively wide and shifts its left boundary across the intermediate cylinder. The diameters and overlap order together select (B), rather than an answer based on height alone.

Step 4: Conclusion The cylinder widths and foreground occlusions agree with (B). Hence, the correct option is (B).

Quick Tip to Solve: Use the smallest circle as an anchor: its elevation must be the narrow foreground rectangle overlapping the large central cylinder.

66. Which out of the following is the country called the "Roof of the World" ? [4 marks]

(A) Japan

(B) Tibet

(C) Mongolia

(D) Uzbekistan

Correct Answer: (B) Tibet

Solution:

Concept:

- The expression Roof of the World refers to an exceptionally high plateau region, rather than to a country merely having one tall mountain.

- Tibet occupies the Tibetan Plateau, whose extensive high elevation explains the geographical nickname.

Step 1: Identify the geographical feature The Tibetan Plateau is a very extensive high-altitude region north of the Himalayas. Because such a broad area lies at great elevation, Tibet is conventionally associated with the description Roof of the World. The name refers to the elevation of the region as a whole, not to the height of one isolated summit or building.

Step 2: Distinguish the offered locations Japan is an island nation with mountains, including Mount Fuji, but it is not the extensive high plateau described by this nickname. Mongolia is associated with the Mongolian Plateau and the Gobi region; that does not make it the location intended by Roof of the World. Uzbekistan lies in Central Asia and includes plains, deserts and mountain margins, but it is not the Tibetan high plateau. Tibet is the option directly corresponding to the conventional geographical expression.

Step 3: Select the matching name The decisive association is therefore Tibet and the high Tibetan Plateau. Although the question uses the word country loosely, its geographical identification is clear among the given choices. The task is to match the familiar epithet to its intended region, and the presence of other mountainous places in the options does not change that match.

Step 4: Conclusion Tibet is the place conventionally called the Roof of the World in this question. Hence, the correct option is (B).

Quick Tip to Solve: Associate Roof of the World with the broad Tibetan Plateau, rather than choosing a place solely because it contains mountains.

67. Which one of the following has a better insulation value ? [4 marks]

(A) A concrete wall

(B) A brick wall

(C) A cavity wall

(D) A stone wall

Correct Answer: (C) A cavity wall

Solution:

Concept:

- A wall provides thermal insulation by resisting heat flow between its two sides. For conduction, a larger thermal resistance means a smaller heat-transfer rate for the same temperature difference.
- A cavity wall contains two masonry leaves separated by an air space. Relatively still air conducts heat poorly, so the cavity adds thermal resistance to the wall assembly.

Step 1: Identify the insulating feature The distinctive feature of a cavity wall is the air gap between its leaves. Heat must pass through the first leaf, across the cavity and then through the second leaf. In the usual construction comparison, the air space interrupts the continuous solid path through the wall. Keeping the air relatively still limits the circulation that would otherwise carry heat across the gap.

Step 2: Compare the four wall types A concrete wall, a brick wall and a stone wall are solid masonry

alternatives. Their materials can store heat, but heat storage is not the same property as resistance to heat transmission. A cavity wall makes deliberate use of a poorly conducting air layer as well as its masonry leaves. Thus the intended wall-type comparison favours the cavity wall; it does not favour concrete merely because it is strong, brick merely because it is common, or stone merely because it is massive.

Step 3: Conclusion The cavity wall has the better insulation value in this comparison. Hence, the correct option is (C).

Quick Tip to Solve: For insulation questions, look for an enclosed air gap; distinguish resistance to heat flow from the ability of a heavy wall to store heat.

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68. Which one of the following is a renewable source of energy ? [4 marks]

(A) Coal

(B) Natural Gas

(C) Ocean waves

(D) Oil

Correct Answer: (C) Ocean waves

Solution:

Concept:

- A renewable energy source is replenished by ongoing natural processes on a human timescale. Using the available energy does not require waiting for a new geological deposit to form.
- Coal, natural gas and oil are fossil fuels. Ocean-wave energy is mechanical energy continually supplied to sea waves, mainly through the action of winds.

Step 1: Classify ocean-wave energy Winds transfer energy to the sea surface and generate waves. Wind itself is continually driven by atmospheric processes associated with solar heating. A wave-energy device extracts part of this continually renewed motion. It therefore uses a renewable energy flow, even though wave height and the available power vary with the weather and location.

Step 2: Eliminate the fossil-fuel choices Coal forms from ancient organic matter over geological periods. Natural gas and oil likewise come from finite underground deposits formed over very long times. Burning any of these fuels consumes a stored resource much faster than natural processes replace it. Consequently, coal in (A), natural gas in (B) and oil in (D) are non-renewable choices. Only ocean waves satisfy the question's renewable-source classification; variability of supply does not make a source non-renewable.

Step 3: Conclusion Ocean waves are a renewable source of energy. Hence, the correct option is (C).

Quick Tip to Solve: Ask whether nature renews the energy flow during human use; coal, oil and natural gas are finite geological stocks.

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69. Charles Correa was which of the following ? [4 marks]

(A) A British Architect

(B) An Indian Architect

(C) An American Architect

(D) A Brazilian Architect

Correct Answer: (B) An Indian Architect

Solution:

Concept:

- An architect's national identity is distinct from the countries in which the architect studied or carried out individual commissions. Overseas education does not by itself determine nationality.
- Charles Correa was an Indian architect and urban planner, associated with modern architecture in India and with responses to local climate and ways of living.

Step 1: Identify Charles Correa Charles Correa belongs to the group of major architects associated with modern India. His architectural work addressed housing, public institutions and urban design. The question asks for his identity as an architect rather than the stylistic origin of one building, the location of one commission or the university where he trained.

Step 2: Match that identity to the choices The description "An Indian Architect" in (B) correctly identifies him. The British description in (A), American description in (C), and Brazilian description in (D) do not. In particular, studying in the United States should not be confused with being an American architect. Likewise, the wider international influence and recognition of an architect do not change the national identification asked for here. The appropriate reasoning is to recall the person and then match the country, rather than infer a country from the sound of the surname.

Step 3: Conclusion Charles Correa was an Indian architect. Hence, the correct option is (B).

Quick Tip to Solve: Keep an architect's nationality separate from the place of education; Charles Correa is associated with modern Indian architecture.

70. Who amongst the following is not a qualified architect ? [4 marks]

(A) Remo Fernandes

(B) Arundhati Roy

(C) Satish Gujral

(D) B.V. Doshi

Correct Answer: (C) Satish Gujral

Solution:

Concept:

- The word "qualified" asks about formal architectural training, rather than whether a person has designed a building or is famous primarily in another creative field.
- Satish Gujral was a painter, sculptor and muralist who also designed buildings, but approached

architecture as a self-taught practitioner rather than through a formal architectural qualification.

Step 1: Apply the qualification criterion Satish Gujral's architectural achievements do not imply that he held a formal architectural qualification. His artistic training and his self-taught approach to building design distinguish him from the formally trained people in the other options. The negative word "not" is crucial: selecting a well-known architect without checking the qualification criterion would answer a different question.

Step 2: Check the apparently tempting alternatives Remo Fernandes is best known as a musician, but he obtained a degree in architecture, so (A) is not the answer. Arundhati Roy is best known as a writer, but trained at the School of Planning and Architecture, so (B) is also excluded. B. V. Doshi was a formally trained architect and is excluded as well. Thus public recognition in music or literature is not evidence of lacking architectural training. Conversely, Gujral's ability to design buildings does not by itself establish a formal architectural qualification.

Step 3: Conclusion Satish Gujral was not a formally qualified architect. The supplied key selects Remo Fernandes, but he held an architecture degree whereas Gujral was self-taught in architecture; the qualification criterion therefore supports Satish Gujral. Hence, the correct option is (C).

Quick Tip to Solve: Read "not qualified" literally: compare formal training, not the profession for which each person is most famous.

71. Ellora group of temples represent which of the following ? [4 marks]

(A) Hindu Religion

(B) Buddhist Religion

(C) Jain Religion

(D) All of the above

Correct Answer: (D) All of the above

Solution:

Concept:

- Ellora is a rock-cut cave complex containing monuments associated with more than one religious tradition. The name of the whole complex must not be reduced to that of a single famous monument.
- The Ellora groups include Buddhist caves, Hindu caves and Jain caves. The presence of all three determines the combined answer in this question.

Step 1: Identify the represented traditions The Buddhist caves at Ellora include monastic and worship spaces. The Hindu group includes the celebrated Kailasa temple. The Jain caves form another group within the same complex. These are not three names for the same religion: they are distinct religious traditions represented by different monuments at Ellora.

Step 2: Test the scope of each option Option (A) correctly names one tradition, Hinduism, but it leaves out the Buddhist and Jain monuments. Option (B) likewise describes only the Buddhist part, and option (C) only the Jain part. Since the question asks about the Ellora group as a whole, none of

those single-tradition choices gives the full classification. Option (D), "All of the above", includes all the traditions actually represented. The fame of the Kailasa temple should therefore not lead to the narrower answer "Hindu Religion" when the entire group of temples and caves is being considered.

Step 3: Conclusion Ellora represents Hindu, Buddhist and Jain religious traditions. Hence, the correct option is (D).

Quick Tip to Solve: When a question names the whole Ellora complex, remember all three traditions; Kailasa alone is a Hindu monument within it.

72. Parthenon is located in which country ? [4 marks]

(A) Romania

(B) Russia

(C) Greece

(D) Japan

Correct Answer: (C) Greece

Solution:

Concept:

- The Parthenon is an ancient Greek temple on the Acropolis of Athens. Identifying the city provides a direct route to identifying its country.
- Athens is in Greece. The Parthenon is associated with the classical architecture of ancient Greece and was dedicated to Athena.

Step 1: Locate the monument Start with the fixed landmark association: Parthenon, Acropolis, Athens. The Acropolis is the elevated historic site overlooking Athens, and the Parthenon is one of its principal ancient monuments. The question asks for the modern country containing the building, not for the geographical reach of ancient Greek cultural influence.

Step 2: Translate the city into the country Athens is in Greece, so Greece in (C) is the required choice. Romania in (A) and Russia in (B) are different countries and do not contain the Athenian Acropolis. Japan in (D) is also unrelated to this location. A resemblance between architectural styles or the existence of copied classical columns elsewhere does not relocate the original monument. Matching the monument first to its city and then to its country avoids confusing the Parthenon with another building whose name is similar, such as the Pantheon in Rome.

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

Quick Tip to Solve: Remember the chain Parthenon–Acropolis–Athens–Greece; distinguish the Parthenon from Rome's Pantheon.

73. Which of the following is equivalent to the Nobel Prize in architecture ? [4 marks]

(A) Academy Award

(B) Padma Shree

(C) Pritzker Prize

(D) Star of Architecture

Correct Answer: (C) Pritzker Prize

Solution:

Concept:

- The Pritzker Architecture Prize is an international honour for achievement in architecture. It is commonly described as the Nobel Prize of architecture.
- An award is identified by the professional field it principally recognises. A famous award from a different field is not equivalent to an architectural honour.

Step 1: Identify the architectural award The question uses "equivalent" in the sense of a prestigious international distinction in the same profession, rather than claiming that the Nobel organisation awards an architecture category. The Pritzker Prize honours the work of architects. Its standing in that profession explains the familiar comparison with a Nobel Prize. Thus Pritzker Prize directly matches both the subject, architecture, and the level of recognition suggested by the question.

Step 2: Eliminate the other descriptions The Academy Award recognises achievements in cinema, so it belongs to a different creative field. Padma Shree is a broad Indian civilian honour covering many areas of service; although an architect can receive it, it is not the architecture-specific international prize asked for. "Star of Architecture" is not the recognised name of the international honour represented by this comparison. These distinctions leave the Pritzker Prize as the appropriate choice.

Step 3: Conclusion The Pritzker Prize is commonly regarded as the Nobel Prize of architecture. Hence, the correct option is (C).

Quick Tip to Solve: For architectural honours, connect Pritzker with architecture; connect the Academy Awards with cinema.

74. An escalator looks like which one of the following ? [4 marks]

(A) Ladder

(B) Staircase

(C) Ramp

(D) Lift

Correct Answer: (B) Staircase

Solution:

Concept:

- An escalator transports people between building levels by means of a continuously moving set of steps.

- Identify a circulation device by the surface on which the passenger stands and by how that surface moves, rather than by the destination alone.

Step 1: Recognise the stepped form An escalator has a sequence of horizontal treads at successive heights along an inclined route. At its entrance and exit the steps level out, but along the main run the visible arrangement is a flight of steps. The passenger stands on a tread while the mechanism carries it upward or downward. This makes its overall appearance that of a moving staircase, so staircase is the matching description.

Step 2: Distinguish the other devices A ladder has narrow rungs and normally requires the user to climb using hands and feet; it is not the broad moving stepped surface of an escalator. A ramp provides a continuous sloping surface without the repeated treads and risers visible on an escalator. A lift carries passengers in a cabin or platform travelling vertically, rather than along an exposed flight of moving steps. All four can assist a change of level, but only the staircase has the form asked about here.

Step 3: Conclusion An escalator looks like a staircase whose steps move continuously. Hence, the correct option is (B).

Quick Tip to Solve: Look for repeated horizontal treads: steps indicate a staircase, a continuous slope indicates a ramp, and a cabin indicates a lift.

75. Who amongst the following is an architect ? [4 marks]

(A) Vikram Seth

(B) Lauri Baker

(C) Khushwant Singh

(D) Ruskin Bond

Correct Answer: (B) Lauri Baker

Solution:

Concept:

- Laurie Baker was an architect associated with economical building design, appropriate materials and sensitivity to local climate.
- For a question about a person's profession, distinguish architects from authors even when all the names are associated with cultural achievement.

Step 1: Identify the architect in the list The option written as "Lauri Baker" refers to Laurie Baker, the architect known for practical, economical construction and work in India. His professional association is with the design and construction of buildings. That association directly answers the question asking which listed person is an architect. The shortened spelling in the option does not change the intended identity.

Step 2: Check the remaining names Vikram Seth is known as a novelist and poet, rather than as an architect. Khushwant Singh was a writer and journalist, so his principal professional identification is literary and journalistic. Ruskin Bond is an author known particularly for stories and other prose

writing. These three names therefore belong to the literary group in this set of options. Baker is the only listed person whose established profession is architectural design, which makes the selection unambiguous.

Step 3: Conclusion Lauri Baker, referring to architect Laurie Baker, is the architect in the list. Hence, the correct option is (B).

Quick Tip to Solve: Remember Laurie Baker through economical, climate-sensitive buildings; distinguish him from the three authors listed here.

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76. Burj Khalifa is located in which one of the following countries ? [4 marks]

(A) Saudi Arabia

(B) Dubai

(C) Turkey

(D) Afghanistan

Correct Answer: (B) Dubai

Solution:

Concept:

- Burj Khalifa is located in the city of Dubai, in the United Arab Emirates. Dubai is also the name of the emirate containing that city.
- A location question may mix cities and countries among its choices. Establish the landmark's actual city and country, then evaluate the geographical names as printed.

Step 1: Locate the building precisely Burj Khalifa stands in Dubai. The correct country is the United Arab Emirates, commonly abbreviated UAE. Thus the precise city-and-country description is Dubai, United Arab Emirates. Among the printed options, Dubai is the geographical location that identifies the building, even though the question loosely asks for a country. The wording should not lead us to move the building to a different country.

Step 2: Compare the listed locations Saudi Arabia is a separate country on the Arabian Peninsula and is not the country containing Burj Khalifa. Turkey and Afghanistan are also countries, but neither contains this tower. Dubai, by contrast, is the city and emirate in which the building actually stands. Therefore the intended answer among the supplied choices is Dubai. The geographical qualification matters: choosing Dubai here identifies the correct location without treating Dubai as an independent sovereign country.

Step 3: Conclusion Burj Khalifa is in Dubai, United Arab Emirates; Dubai is a city and emirate rather than a country. Among the printed choices, the correct option is (B).

Quick Tip to Solve: Learn a landmark as a city-country pair: Burj Khalifa is in Dubai, UAE. This avoids confusing an emirate with a country.

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77. Which of the following is the most striking feature of the Sydney Opera House ? [4 marks]

(A) Entrance Hall

(B) Interior Design

(C) Sail shaped roof

(D) Location

Correct Answer: (C) Sail shaped roof

Solution:

Concept:

- The Sydney Opera House is distinguished visually by its prominent series of white, curved roof shells, commonly described as sail-shaped.
- A landmark's striking architectural feature is the physical element that most clearly identifies its exterior form, rather than simply a useful internal space.

Step 1: Identify the characteristic silhouette The roof of the Sydney Opera House rises in a sequence of curved forms resembling billowing sails. These repeated shell-like elements dominate its exterior profile and make the building immediately recognisable. The phrase "sail shaped roof" in the options describes that distinctive silhouette. It therefore gives the architectural feature most directly associated with the building.

Step 2: Evaluate the alternatives An entrance hall is an important functional space, but it is not the feature by which this building is most widely recognised. Interior design describes the treatment of internal spaces and does not identify the distinctive exterior profile asked about. Its waterfront location contributes strongly to the setting and visual experience, but a location is different from the building's characteristic architectural form. The sail-shaped roof is the specific, visible design element that distinguishes this option from these broader descriptions.

Step 3: Conclusion The most striking architectural feature is the sail-shaped roof. Hence, the correct option is (C).

Quick Tip to Solve: Identify a famous building first by its silhouette: the Sydney Opera House is recognised by its repeated sail-like roof shells.

78. Which one of the following is an odd combination ? [4 marks]

(A) Forts and Jaipur

(B) Lakes and Udaipur

(C) Temples and Madurai

(D) Rain and Kutch

Correct Answer: (D) Rain and Kutch

Solution:

Concept:

- In an odd-combination question, test every pair using the same relationship: here, whether the place is notably associated with the stated feature.
- The first three pairs link Indian places with characteristic monuments or landscape features. The odd pair does not share this familiar association.

Step 1: Check the three consistent associations Jaipur and its surroundings are strongly associated with forts, making "Forts and Jaipur" a familiar place-feature pair. Udaipur is known for its lakes, so "Lakes and Udaipur" fits the same relationship. Madurai is prominently associated with temples, including the Meenakshi temple complex, so "Temples and Madurai" also matches. Each of these pairs names a feature for which the place is especially recognised.

Step 2: Identify the inconsistent association Kutch is characteristically associated with an arid landscape and the Rann, rather than with abundant rain. Therefore "Rain and Kutch" does not follow the pattern established by the other three pairs. This does not mean that Kutch never receives rainfall: an odd-pair question concerns the characteristic association, not the absolute absence of a weather event. Options A, B and C all preserve the prominent place-feature relationship, while option D is the outlier under that same test.

Step 3: Conclusion Rain and Kutch is the odd combination. Hence, the correct option is (D).

Quick Tip to Solve: Use one relationship for every option: ask whether the feature is characteristic of the place, rather than whether it could ever occur there.

79. Tsunami is a result of which of the following ? [4 marks]

(A) Sea storms

(B) Earthquakes in coastal areas

(C) Earthquakes in the sea bed

(D) Strong ocean waves

Correct Answer: (C) Earthquakes in the sea bed

Solution:

Concept:

- A tsunami is a train of long ocean waves produced when a large volume of seawater is displaced suddenly. The decisive cause is movement of the water column, rather than ordinary wind acting on the sea surface.
- A large submarine earthquake can raise or lower a part of the sea bed. This vertical displacement transfers energy to the water above it, and the disturbance travels outward across the ocean.

Step 1: Identify the displacement mechanism When an earthquake occurs beneath the sea and displaces the sea bed vertically, the overlying water is lifted or depressed. Gravity then acts to restore the displaced surface, setting a succession of long waves in motion. As these waves reach shallow coastal water, their speed decreases and their height can increase greatly. Thus a sea-bed earthquake directly supplies the mechanism required by the question.

Step 2: Compare all four choices Option (C), earthquakes in the sea bed, names the characteristic triggering event. A sea storm in (A) principally generates wind waves and may produce a storm surge; this is a different process. A coastal earthquake in (B) is not sufficient merely because it is near a coast: it must displace a large body of water to generate a tsunami. Strong ocean waves in (D) describe a possible disturbance of the sea, not the underlying event that creates a tsunami. Although other events such as submarine landslides can also generate tsunamis, the listed cause that fits is (C).

Step 3: Conclusion Earthquakes in the sea bed can suddenly displace the ocean water and generate a tsunami. Hence, the correct option is (C).

Quick Tip to Solve: Distinguish the trigger from the visible wave: tsunami points to sudden displacement of the sea bed, whereas storm surge points to wind and atmospheric pressure.

80. Chandigarh was planned by an architect who was which of the following ? [4 marks]

(A) American

(B) French

(C) German

(D) Australian

Correct Answer: (B) French

Solution:

Concept:

- Architectural-awareness questions connect a city or building with the designer responsible for its recognised plan. Chandigarh is strongly associated with the modernist architect Le Corbusier.
- Le Corbusier was born in Switzerland and later became a French citizen. He is therefore commonly described as a Swiss-born French architect; the nationality represented among these options is French.

Step 1: Identify the architect associated with the plan The architect intended by the question is Le Corbusier, whose name is associated with the master plan of Chandigarh and the design of its Capitol Complex. The question asks for his nationality rather than the location of the city or its architectural style. Recognising this association is the essential first step: Chandigarh leads to Le Corbusier, and Le Corbusier leads to the French option.

Step 2: Match the nationality with the available choices Choose (B), French. The fact that Le Corbusier was Swiss-born does not make any of the other listed choices correct: Switzerland is not Germany, and birthplace and later citizenship need not be the same. Option (A), American, does not describe Le Corbusier; (C), German, also does not describe him; and (D), Australian, is unrelated to his nationality. The plan developed through contributions from a team, but that does not change the identity of the architect conventionally intended by this singular-name architectural-awareness question.

Step 3: Conclusion The architect intended is Le Corbusier, the Swiss-born French architect. Hence, the correct option is (B).

Quick Tip to Solve: Remember the association as a pair: Chandigarh master plan – Le Corbusier – French. Keep his Swiss birthplace separate from his French citizenship.

Drawing Test (70 marks)

81. (a) Draw the graphic image shown below to double its size in the space provided for the answer of this questions. Each component line should be drawing double its length and correctly position direction wise as shown in the figure.

(b) Draw your home & surroundings from memory. [40 marks]



Solution:

Concept:

- An enlargement by a scale factor of two doubles every linear distance while preserving all angles, proportions, relative positions and the shape of every component. A reference grid provides corresponding points for copying curved or irregular outlines.
- A memory drawing communicates a familiar place through a coherent viewpoint, recognisable spatial relationships and a clear foreground, middle ground and background. Perspective, overlap and tonal contrast establish depth.
- The two tasks require different approaches: part (a) is faithful graphic enlargement, while part (b) is a personal composition based on remembered surroundings.

Step 1: Plan the enlarged graphic for part (a) Use the supplied stylised rose as the reference. It contains a broad flower head at the top, curved white separations within dark petal shapes, a long slender curving stem, and leaves projecting to either side near the lower part. First estimate the complete bounding rectangle, including the outermost petals, leaves and the bottom of the stem. Reserve a target rectangle with twice its width and twice its height, keeping enough clear space around the image. This prevents the stem or an outer leaf from being cut off when the enlarged flower is completed.

Step 2: Transfer the contours at twice the scale Divide the reference bounding rectangle into equal squares, then lightly construct a corresponding grid whose squares have twice the side length. Locate the top of the flower, the widest points of the flower head, the junction with the stem, the tips of both leaves and the lower end of the stem in the matching target cells. Transfer each contour through

these points while retaining the direction of its tangent and the same relationship to neighbouring shapes. A component of length l becomes $2l$; a horizontal or vertical offset d becomes $2d$. Angles and the orientation of the rose stay unchanged. Follow the actual outline instead of replacing the rose with a generic flower.

Step 3: Finish the graphic and check its proportions Refine the curved edges and preserve every visible white gap between the dark petal and leaf shapes. These negative spaces are part of the graphic and must enlarge with the black forms. Fill the dark regions consistently, keeping the contour crisp and the white channels open. Check the overall height and width, the size of the flower head relative to the stem, and the leaf positions against the reference. Remove the construction grid after the contours are secure. Do not add a pot, extra leaves or a new petal arrangement.

Step 4: Compose the home and surroundings for part (b) Choose a familiar view of your own home, for example from the approach road looking toward the entrance. Make a small mental layout before drawing: place the home as the principal middle-ground element, the gate or path in the foreground, and remembered neighbouring buildings or trees behind it. Include only features that belong to the remembered setting. Establish an eye-level horizon and choose a consistent perspective. Receding edges of the building, path and boundary should converge consistently, while vertical edges remain upright in a normal level view.

Step 5: Develop depth and complete the memory scene Build the house from its major masses, then add the entrance, windows, roof or terrace, boundary and approach in their correct relationships. Overlap nearby objects in front of more distant ones, reduce apparent sizes with distance and keep distant details quieter. Use a single lighting direction: shade the sides turned away from the light, add restrained cast shadows and vary line weight to emphasise the home. Trees, paving, utility features or people may establish context and scale when remembered. Finish with a clear focal area at the home and avoid crowding every space with equally dark detail.

Step 6: Conclusion For part (a), reproduce the supplied rose graphic with every linear dimension multiplied by 2, preserving its contours, orientation and negative spaces. For part (b), present a coherent memory composition of your home and its surroundings with consistent perspective, depth and lighting.

Quick Tip to Solve: For the rose, compare matching grid intersections before darkening any shape. For the home, settle the viewpoint and largest building masses before adding windows, foliage and surface textures.

82. Draw a Visually appealing design using triangles. [30 marks]

Solution:

Concept:

- A visually appealing design organises shapes through a deliberate balance of repetition, variation, rhythm and emphasis. Triangles can be repeated, rotated, reflected and resized while remaining the dominant visual vocabulary.
- Positive shapes and the negative spaces between them must be planned together. Controlled contrast and a limited colour or tonal scheme make a composition unified and readable.

- The task permits many successful compositions. State an organising idea and coordinate shape, spacing and finish to realise it.

Step 1: Choose a clear organising idea Plan a triangular pinwheel or crystalline rosette as one possible response. Reserve a square or rectangular drawing area and leave a clean margin. Place the visual centre slightly inside the central region so that the design feels balanced and has room to develop. Build the main motif from a ring of elongated triangles pointing around this centre. Their common directional movement creates a sense of rotation without needing a literal object or scene.

Step 2: Arrange a hierarchy of triangular forms Use a small group of larger triangles to establish the dominant motif. Rotate successive triangles through a regular angular interval and keep their tips and bases aligned with the same underlying radial framework. Add smaller triangles in the gaps or toward the outside to echo the movement. Vary the sizes deliberately rather than randomly: the larger shapes hold attention, medium shapes connect the composition, and the smallest shapes provide accents. Keep the contour of each component clearly triangular.

Step 3: Balance filled shapes and open spaces Inspect the spaces between adjacent triangles before committing to the outlines. Leave consistent breathing room around the main motif and avoid tiny accidental slivers at the edges. Balance a dense cluster on one side with a related cluster or sufficient visual weight on the other. The composition may use rotational balance rather than a rigid left-right mirror image. Keep a clear focal point and allow the outer areas to remain calmer so that the design does not become a uniform tangle of equal emphasis.

Step 4: Apply a controlled colour or tonal scheme Choose a restrained palette, such as a dark blue, a medium blue and a pale neutral, or use three distinct grey values if working without colour. Repeat these values in an intentional sequence around the motif to reinforce its rhythm. Put the strongest contrast near the focal area and use lighter values for subsidiary triangles. Fill each triangular field evenly and keep adjacent edges clean. A limited repeating scheme unifies the design more effectively than an unrelated colour for every shape.

Step 5: Refine the final composition Check that the arrangement reads as one design from a distance and that individual triangles remain distinct up close. Refine uneven outlines, remove construction marks and separate corners that almost meet accidentally. Keep the planned margin clear and avoid clipping a major triangle. Finish the surfaces consistently, retaining the intended balance of dark, medium and light areas.

Step 6: Conclusion One effective response is a balanced triangular rosette or pinwheel with a dominant central motif, repeated rotated triangles, smaller supporting forms, clean negative spaces and a restrained repeating colour or tonal scheme.

Quick Tip to Solve: Thumbnail the arrangement first in three values: dark, medium and light. If the focal point and rhythm are clear at that small size, refine the triangular edges and apply colour consistently.