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

Question Paper with Solutions

Conducted by the National Testing Agency (NTA)

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

General Instructions

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

(ii) The paper has 77 questions: Mathematics (25), Aptitude Test (50), Drawing Test (2), in that order. Maximum marks: 400.

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

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

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

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

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

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

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

(A) 13

(B) 14

(C) 15

(D) 16

Correct Answer: (D) 16

Solution:

Concept:

- A relation on A is a set of ordered pairs in $A \times A$. Reflexivity requires every diagonal pair (x, x), for $x \in A$.
- Symmetry requires (y, x) whenever (x, y) is present. The minimum additions are precisely the required pairs absent from the original relation.

Step 1: List the pairs satisfying the defining equation From $2x = 3y$, the positive integer coordinates have the form $x = 3k$, $y = 2k$. Both coordinates must belong to $A = \{1, \ldots, 12\}$, so $k = 1, 2, 3, 4$. Therefore

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

Larger values of k make $x > 12$, so this list is complete.

Step 2: Count the pairs required for reflexivity A diagonal pair would satisfy $2x = 3x$, which forces $x = 0$. Since zero is not in A, none of the twelve required diagonal pairs is present. Each must be added, giving $l = 12$. Adding fewer cannot work because at least one element would lack its own diagonal pair.

Step 3: Count the reverse pairs required for symmetry The four missing reverse pairs are

$$(2, 3),\ (4, 6),\ (6, 9),\ (8, 12).$$

They are distinct and none belongs to R. Adding all four is sufficient: each original pair then has its reverse and each added pair has its original partner. Hence $m = 4$, and $l + m = 12 + 4 = 16$. Options (A), (B) and (C) are too small; symmetry alone already requires four additions alongside the twelve counted for reflexivity.

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

Quick Tip to Solve: List the relation first. Count missing diagonal pairs for reflexivity and missing reversed pairs for symmetry separately.

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

[4 marks]

(A) 8

(B) 10

(C) 12

(D) 13

Correct Answer: (B) 10

Solution:

Concept:

- A real logarithm requires a strictly positive argument, and a logarithm in a denominator must also be nonzero.
- A real square root requires a nonnegative radicand. The domain is the intersection of every restriction, not their union.

Step 1: Apply the logarithm restrictions For $\log_{10}(1-2x)$ to be defined, its argument must satisfy

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

Since the logarithm is a denominator, exclude its zero. A base-ten logarithm is zero precisely when its argument equals one, so

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

The point $x = \frac{1}{2}$ is excluded because its logarithm argument is zero.

Step 2: Intersect with the square-root condition The second term gives

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

Equality is allowed: the square root is zero at $x = -\frac{1}{2}$, while the logarithm there is $\log_{10} 2$, which is defined and nonzero. Combining all conditions, the domain is

$$\left[-\frac{1}{2}, \frac{1}{2}\right) \setminus \{0\}.$$

Thus $\alpha = -\frac{1}{2}$ and $\beta = \frac{1}{2}$.

Step 3: Evaluate the requested expression Square the two endpoints before adding:

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

The negative lower endpoint does not cancel the upper endpoint after squaring. Options (A), (C) and (D), namely 8, 12 and 13, do not equal this endpoint expression.

Step 4: Conclusion The domain is $[-\frac{1}{2}, \frac{1}{2}) \setminus \{0\}$, and the required value is 10. Hence, the correct option is (B).

Quick Tip to Solve: For a logarithm in the denominator, impose both positive argument and argument unequal to one before intersecting with other conditions.

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

(A) 22

(B) 24

(C) 26

(D) 29

Correct Answer: (C) 26

Solution:

Concept:

- For $z = \alpha + i\beta$, with real α, β, $|z|^2 = \alpha^2 + \beta^2$.
- The modulus is multiplicative: $|z^2| = |z|^2$. Therefore the squared modulus of a square root equals the modulus of the number under the root.

Step 1: Square the stated complex number Write $z = \alpha + i\beta$. The given equation implies

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

Taking moduli gives $|z|^2 = |-24 - 10i|$. This operation avoids having to choose between the two square roots: changing the signs of both α and β leaves their squared sum unchanged.

Step 2: Calculate the modulus For a complex number $u + iv$, the modulus is $\sqrt{u^2 + v^2}$, so

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

The square root in this formula is essential. The value 676 is the square of the modulus of the original number, whereas the required quantity is its modulus.

Step 3: Check by matching real and imaginary parts Expanding $(\alpha + i\beta)^2$ also gives $\alpha^2 - \beta^2 = -24$ and $2\alpha\beta = -10$. Combining the first relation with $\alpha^2 + \beta^2 = 26$ gives $\alpha^2 = 1$, $\beta^2 = 25$. For example, $\alpha = 1$, $\beta = -5$ satisfies both equations because $(1 - 5i)^2 = -24 - 10i$. This confirms the result independently. Options (A), (B) and (D), namely 22, 24 and 29, are incompatible with the modulus 26.

Step 4: Conclusion $\alpha^2 + \beta^2 = 26$, independent of which square root is chosen. Hence, the correct option is (C).

Quick Tip to Solve: When asked for the squared components of a complex square root, take moduli before explicitly finding its real and imaginary parts.

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

(A) $4\sqrt{14}$

(B) 14

(C) $2\sqrt{14}$

(D) 18

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

Solution:

Concept:

- The conjugate positive numbers $3+2\sqrt{2}$ and $3-2\sqrt{2}$ have product one, so their powers are reciprocals.
- For a fixed positive base different from one, the real exponential function is one-to-one. An equation in its value can first be solved as a quadratic.

Step 1: Replace the exponential by a positive variable Let $a=3+2\sqrt{2}>1$ and $t=x^4-15$. Since

$$(3+2\sqrt{2})(3-2\sqrt{2})=9-8=1,$$

the equation becomes $a^t+a^{-t}=6$. Set $u=a^t>0$. Multiplication by u is valid and gives

$$u^2-6u+1=0.$$

Step 2: Recover the possible exponents The quadratic formula yields

$$u=\frac{6\pm\sqrt{36-4}}{2}=3\pm2\sqrt{2}.$$

Both values are positive. They are exactly a and a^{-1}, so the one-to-one property of a^t gives $t=1$ or $t=-1$. Consequently $x^4=16$ or $x^4=14$.

Step 3: Multiply every real root The real roots are $2,-2,\sqrt[4]{14},-\sqrt[4]{14}$. Each equation has exactly these two real roots; the other fourth roots are nonreal and are excluded by the question. Their product is

$$(2)(-2)\left(\sqrt[4]{14}\right)\left(-\sqrt[4]{14}\right)=(-4)(-\sqrt{14})=4\sqrt{14}.$$

There are two negative roots, so the product is positive. Option (C) omits a factor of two, while the rational values in (B) and (D) cannot equal the resulting irrational product.

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

Quick Tip to Solve: For conjugate bases with product one, substitute one exponential and solve a reciprocal quadratic; then count all real roots of the exponent equation.

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

(A) 4

(B) 1

(C) 2

(D) 3

Correct Answer: (D) 3

Solution:

Concept:

- An infinite solution set requires a consistent dependent system. After eliminating a variable, the remaining equations must express the same restriction.
- If an elimination gives a nonzero coefficient determining the last variable, the solution is unique; if it gives zero equal to a nonzero constant, there is no solution.

Step 1: Eliminate the variable x Label the three equations E_1, E_2, E_3. Subtracting $2E_1$ from E_2 gives

$$-y + (4 - 6a)z = -7,$$

or $y + (6a - 4)z = 7$. Similarly, $E_3 - 3E_1$ gives

$$y + (2 - 9a)z = b - 12.$$

These operations preserve the solution set.

Step 2: Impose dependence and consistency together Both reduced equations have coefficient one for y. For them to be the same equation, their coefficients of z and their right sides must agree:

$$6a - 4 = 2 - 9a, \qquad 7 = b - 12.$$

Thus $15a = 6$, so $a = \frac{2}{5}$, and $b = 19$. If the z coefficients differed, subtraction would determine z and hence all three variables uniquely. Equal coefficients with unequal constants would instead be inconsistent.

Step 3: Confirm an infinite family and calculate the answer At these values the reduced equation is $y - \frac{8}{5}z = 7$, hence $y = 7 + \frac{8}{5}z$. Substitution into E_1 yields $x = -10 - \frac{22}{5}z$. The real value of z is arbitrary, proving infinitely many solutions rather than merely a zero determinant. Finally,

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

The other proposed values 4, 1 and 2 do not follow from the uniquely required parameters.

Step 4: Conclusion $a = \frac{2}{5}$, $b = 19$, so $b - 40a = 3$. Hence, the correct option is (D).

Quick Tip to Solve: For infinite solutions, check the right sides after making the coefficient rows dependent; a zero determinant alone does not guarantee consistency.

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

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

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

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

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

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

Solution:

Concept:

- Consecutive terms of an arithmetic progression differ by the same real number d. Expressing all terms through d reduces the conditions to one variable.
- Every algebraic candidate must satisfy positivity of all stated positive quantities. Only then can the largest admissible value be selected.

Step 1: Express the progression using its common difference The consecutive terms are $a, 7, c, b$. Taking the common difference as d, write

$$a = 7 - d, \qquad c = 7 + d, \qquad b = 7 + 2d.$$

In particular, $a + b = 14 + d$. The given product relation now involves just d.

Step 2: Solve the product condition Substitute into $ab = 3(a + b)$:

$$(7 - d)(7 + 2d) = 3(14 + d).$$

Expansion gives $49 + 7d - 2d^2 = 42 + 3d$, hence

$$2d^2 - 4d - 7 = 0.$$

The quadratic formula therefore yields

$$d = \frac{4 \pm \sqrt{16 + 56}}{4} = 1 \pm \frac{3\sqrt{2}}{2}.$$

It follows that $b = 7 + 2d = 9 \pm 3\sqrt{2}$.

Step 3: Check positivity and compare the candidates For the larger value of d, the other terms are $a = 6 - \frac{3\sqrt{2}}{2} > 0$ and $c = 8 + \frac{3\sqrt{2}}{2} > 0$, while $b = 9 + 3\sqrt{2} > 0$. The smaller value of d also gives positive a, c, b. Both candidates are admissible, and the larger is $9 + 3\sqrt{2}$. Option (B) is the smaller valid root. Options (A) and (D) are not roots: equivalently the allowed values satisfy $(b - 9)^2 = 18$, whereas their squared differences from 9 are 2 and 72.

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

Quick Tip to Solve: Anchor the progression at its known term and express the others with a common difference. Check positivity before choosing the larger quadratic root.

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

(A) 4983

(B) 4997

(C) 5016

(D) 5049

Correct Answer: (C) 5016

Solution:

Concept:

- A triangle requires three distinct non-collinear vertices. Three points chosen from the same straight line cannot form a triangle.
- The combination $\binom{n}{r}$ counts an unordered selection of r points from n; ordering the vertices does not produce a new triangle.

Step 1: Separate the two possible distributions The vertices lie on two distinct parallel lines. A valid triangle therefore has either two vertices on L_1 and one on L_2, or one on L_1 and two on L_2. Every such choice is non-collinear: the line through the two vertices on one given line is that line itself, so it cannot contain the third vertex on the other parallel line. These two cases are disjoint and exhaust all valid triangles.

Step 2: Count and add the choices For two vertices from the 19 points and one from the 16 points, the count is

$$N_1 = \binom{19}{2}\binom{16}{1} = 171 \times 16 = 2736.$$

For the opposite distribution, the count is

$$N_2 = \binom{19}{1}\binom{16}{2} = 19 \times 120 = 2280.$$

The addition rule gives $N = N_1 + N_2 = 5016$. There is no division by an additional factorial: each pair was already selected without order.

Step 3: Check the count independently Choose any three of the 35 points, then remove the selections lying entirely on one line:

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

This confirms the direct count. The values 4983, 4997 and 5049 in (A), (B) and (D) disagree with both exhaustive counts.

Step 4: Conclusion The total number of triangles is $\boxed{5016}$. Hence, the correct option is (C).

Quick Tip to Solve: For points on two parallel lines, count the two distributions $(2,1)$ and $(1,2)$; no other distribution makes a triangle.

8. If the mean of the frequency distribution

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

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

(A) 5

(B) 5.1

(C) 5.2

(D) 5.3

Correct Answer: (C) 5.2

Solution:

Concept:

- For a frequency distribution, $\bar{x} = \frac{\sum f_i x_i}{N}$, where $N = \sum f_i$ is the total frequency.
- The variance of the distribution is $\sigma^2 = \frac{\sum f_i x_i^2}{N} - \bar{x}^2$. Use the population denominator N, not the sample denominator $N - 1$.

Step 1: Determine the two missing frequencies The total frequency is 10, so

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

The stated mean is 5, giving

$$\frac{1 + 3a + 4b + 21 + 9}{10} = 5 \quad \Rightarrow \quad 3a + 4b = 19.$$

Subtract $3(a + b) = 15$ from the second equation to obtain $b = 4$, and then $a = 1$. Both frequencies are non-negative integers, as required.

Step 2: Compute the second moment and variance Weight the square of each variable by its frequency:

$$\begin{aligned}\sum f_i x_i^2 &= 1(1)^2 + 1(3)^2 + 4(4)^2 + 3(7)^2 + 1(9)^2 \\ &= 1 + 9 + 64 + 147 + 81 = 302.\end{aligned}$$

Thus the mean square is $302/10 = 30.2$, whereas the square of the mean is $5^2 = 25$. Their difference is

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

These are different quantities; subtracting the mean rather than its square would be incorrect.

Step 3: Verify using deviations from the mean A direct check gives

$$\begin{aligned}\sum f_i (x_i - 5)^2 &= 1(16) + 1(4) + 4(1) + 3(4) + 1(16) \\ &= 52.\end{aligned}$$

Dividing by 10 again gives 5.2. The alternatives 5, 5.1 and 5.3 fail this exact calculation; no rounding is needed to select among them.

Step 4: Conclusion The variance is $\boxed{5.2}$. Hence, the correct option is (C).

Quick Tip to Solve: Find missing frequencies from the total and mean first; then verify variance by either weighted squares or weighted squared deviations.

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

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

Correct Answer: No unique answer follows from the stated overlap-free data; the intended independent-event calculation yields (B), 3/20.

Solution:

Concept:

- The chance that neither person can solve a question is $1 - P(S_A \cup S_B)$, where S_A and S_B denote their respective sets of solvable questions.
- Marginal probabilities alone do not specify the overlap. Multiplying failure probabilities requires independence, which must be supplied or justified.

Step 1: Translate the percentages into fixed sets There are ten equally likely questions. A can solve seven and B can solve five. Let k be the number of questions that both can solve. Inclusion-exclusion gives

$$|S_A \cup S_B| = 7 + 5 - k = 12 - k.$$

Consequently, the number that neither can solve is $10 - (12 - k) = k - 2$, and

$$P(\text{neither}) = \frac{k-2}{10}.$$

At least two questions must be in the intersection, and at most all five of B's solvable questions can be there. Hence $k \in \{2, 3, 4, 5\}$.

Step 2: Show why the printed information is insufficient The possible probabilities are therefore

$$0, \quad \frac{1}{10}, \quad \frac{1}{5}, \quad \frac{3}{10}.$$

For example, if all five questions B can solve are among A's seven, then $k = 5$ and the probability is $3/10$, option (A). If the two sets have four questions in common, it is $1/5$, option (C). Both configurations satisfy the stated percentages. Option (D), $2/5$, is impossible because only three questions are unsolvable by A.

Step 3: Identify the conventional product and its limitation If the two failure events were indepen-

dently modelled, one would calculate

$$(1-0.70)(1-0.50) = 0.30 \times 0.50 = \frac{3}{20},$$

which is option (B), the conventional intended answer. However, independence is absent from the wording. Moreover, for a fixed set of ten equally likely questions the probability must be an integer multiple of $1/10$; $3/20$ would correspond to 1.5 questions. Thus that product cannot be justified by the literal fixed-paper data.

Step 4: Conclusion The literal question does not determine a unique probability: (A) and (C) are both possible for different valid overlaps. The conventional intended option (B), $3/20$, requires an additional independent-event model and does not follow from the stated fixed-paper information.

Quick Tip to Solve: Before multiplying probabilities, check independence. With a finite fixed question paper, count the overlap and ensure the resulting count is an integer.

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

(A) 4

(B) 6

(C) 8

(D) 12

Correct Answer: (C) 8

Solution:

Concept:

- The parabola $x^2 = 4ay$ has focus $(0, a)$. Comparing coefficients here gives $a = 1$.
- The area of a triangle is half its base times the perpendicular height. A horizontal side allows the height to be read directly from the other vertex.

Step 1: Find the two intersection points At an intersection, both $y = x + 3$ and $x^2 = 4y$ hold. Substitution gives

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

Factor the quadratic:

$$(x-6)(x+2) = 0.$$

Thus the two abscissae are 6 and -2. In the line equation these give $y = 9$ and $y = 1$, respectively. We can label the points $A = (6, 9)$ and $B = (-2, 1)$; exchanging their names would leave the area unchanged.

Step 2: Use a horizontal base through the focus The focus is $F = (0, 1)$. Since both B and F have ordinate 1, the segment BF is horizontal and its length is

$$BF = |0 - (-2)| = 2.$$

The perpendicular distance from A to the line $y = 1$ is $|9 - 1| = 8$. Therefore

$$[AFB] = \frac{1}{2} \times 2 \times 8 = 8.$$

The foot of this perpendicular need not lie inside the segment BF; the base-height formula uses the line containing the base and remains valid.

Step 3: Check with the coordinate determinant Using vectors from F,

$$\overrightarrow{FA} = (6, 8), \qquad \overrightarrow{FB} = (-2, 0),$$

we obtain

$$[AFB] = \frac{1}{2} |6(0) - 8(-2)| = 8.$$

Thus 4, 6 and 12 in the other options are incompatible with the exact determinant as well as the base-height calculation.

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

Quick Tip to Solve: After finding the focus and intersections, look for a horizontal or vertical side before using the full determinant formula.

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

(A) $2\sqrt{3}$

(B) $3\sqrt{3}$

(C) $6\sqrt{3}$

(D) $8\sqrt{3}$

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

Solution:

Concept:

- In an equilateral triangle of side s, the incentre is also the centroid, and the inradius is $r = s\sqrt{3}/6$.
- The perpendicular from the centre to a side of an equilateral triangle bisects that side. A diagonal can split the required quadrilateral into two right triangles.

Step 1: Find the side length from the given coordinates Since the triangle is equilateral, computing AB determines every side:

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

The two possible locations of C are mirror images across AB. Reflection preserves lengths and areas, so we do not need to determine which location was chosen.

Step 2: Find the perpendicular lengths and half-sides The altitude of the equilateral triangle is $s\sqrt{3}/2 = 3\sqrt{3}$. The common centre lies one-third of this altitude above a side, so its distance from either AC or BC is

$$DP = DQ = r = \frac{3\sqrt{3}}{3} = \sqrt{3}.$$

By symmetry the perpendicular feet P and Q are the midpoints of AC and BC. Thus

$$CP = CQ = \frac{s}{2} = 3.$$

These equalities use the equilateral condition; they would not hold for a general triangle merely because D is its incentre.

Step 3: Add the two right-triangle areas The diagonal CD divides quadrilateral CPDQ into triangles CPD and CQD. Their right angles are at P and Q because DP and DQ are perpendicular to the corresponding sides. Hence

$$\begin{aligned}[CPDQ] &= \tfrac{1}{2}(CP)(DP) + \tfrac{1}{2}(CQ)(DQ) \\ &= \tfrac{1}{2}(3)(\sqrt{3}) + \tfrac{1}{2}(3)(\sqrt{3}) \\ &= 3\sqrt{3}.\end{aligned}$$

As a check, the complete equilateral triangle has area $9\sqrt{3}$, and its three congruent corner quadrilaterals each occupy one-third of it. The values in (A), (C) and (D) do not equal this third.

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

Quick Tip to Solve: Exploit the common centre and midpoint symmetry in an equilateral triangle; the three corner quadrilaterals have equal area.

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

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

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

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

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

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

Solution:

Concept:

- For $x^2/a^2 + y^2/b^2 = 1$ with $a > b > 0$, the foci are $(\pm c, 0)$, where $c^2 = a^2 - b^2$ and $e = c/a$.
- The full latus rectum of this ellipse has length $2b^2/a$. Its half-length is b^2/a, so the distinction matters.

Step 1: Use the focal separation to find the semimajor axis The distance between the two foci is $2c$,

not c. The given distance 4 therefore implies

$$2c = 4 \quad \Rightarrow \quad c = 2.$$

Since the eccentricity is $1/\sqrt{3}$,

$$\frac{c}{a} = \frac{1}{\sqrt{3}} \quad \Rightarrow \quad a = 2\sqrt{3}.$$

Thus $a^2 = 12$. This positive value is appropriate because a is a length.

Step 2: Determine the semiminor axis and latus rectum Apply the identity relating the axes and focal distance:

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

Consequently, the length of the full latus rectum is

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

The relation $b^2 = 8 < 12 = a^2$ also confirms the prescribed ordering of the semiaxes.

Step 3: Verify the chord endpoints and reject the distractors A latus rectum passes through a focus and is perpendicular to the major axis. Put $x = c = 2$ into the ellipse:

$$\frac{4}{12} + \frac{y^2}{8} = 1 \quad \Rightarrow \quad y^2 = \frac{16}{3}.$$

Its endpoints have ordinates $\pm 4/\sqrt{3}$, whose separation is $8/\sqrt{3}$, confirming the formula. Option (A) gives only half this chord. Options (B) and (D) give neither the endpoint separation nor $2b^2/a$, so they cannot be correct.

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

Quick Tip to Solve: Convert the distance between foci to c by halving it first, and distinguish the full latus rectum from its half-length.

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

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

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

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

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

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

Solution:

Concept:

- A circle through the origin has equation $X^2 + Y^2 + 2gX + 2fY = 0$. Its centre is $(-g, -f)$ and its radius is $\sqrt{g^2 + f^2}$.
- The centroid coordinates are the arithmetic means of the coordinates of the three vertices. Expressing the circle parameters in terms of these coordinates gives the required locus.

Step 1: Express the radius condition and intercepts Since the circle passes through $O = (0, 0)$, its constant term is zero. Its prescribed radius gives

$$g^2 + f^2 = 9.$$

On the horizontal axis, put $Y = 0$. Then $X(X + 2g) = 0$, so the second intersection is $A = (-2g, 0)$. Similarly, putting $X = 0$ gives $Y(Y + 2f) = 0$, and hence $B = (0, -2f)$. The zero roots in these equations represent the common point O, not the other intercepts.

Step 2: Eliminate the circle parameters Write the centroid as $G = (x, y)$. Averaging the vertices gives

$$x = \frac{-2g}{3}, \qquad y = \frac{-2f}{3}.$$

Thus $g = -3x/2$ and $f = -3y/2$. Substitute these into the radius condition:

$$\frac{9x^2}{4} + \frac{9y^2}{4} = 9 \quad \Longrightarrow \quad x^2 + y^2 = 4.$$

This is a circle of radius 2 centred at the origin. Conversely, its points determine parameters satisfying the required radius condition. The points on the coordinate axes correspond to degenerate triangles and are excluded if the triangle is required to be nondegenerate; the locus equation remains the stated circle. Options (A), (C) and (D) give different squared radii, namely 1, $4/3$ and 12, and fail the substitution.

Step 3: Conclusion The required locus equation is $\boxed{x^2 + y^2 = 4}$. Hence, the correct option is (B).

Quick Tip to Solve: For a circle through the origin, keep its constant term zero: the other axis intercepts are then read directly from the linear coefficients.

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

(A) 5

(B) 6

(C) 4

(D) 7

Correct Answer: (D) 7

Solution:

Concept:

- A line in symmetric form determines a point Q on it and a direction vector $\mathbf{d}$. Every point on the line is $Q + t\mathbf{d}$.
- If H is the perpendicular foot from P, then $(P - H) \cdot \mathbf{d} = 0$. Solving this condition gives the nearest point and therefore the shortest distance.

Step 1: Locate the perpendicular foot Here $P = (1, 2, 3)$, $Q = (6, 7, 7)$ and $\mathbf{d} = (3, 2, -2)$. Write

$$H = (6 + 3t,\ 7 + 2t,\ 7 - 2t).$$

Perpendicularity requires

$$\begin{aligned} (P - Q - t\mathbf{d}) \cdot \mathbf{d} &= 0, \\ (-5, -5, -4) \cdot (3, 2, -2) - 17t &= 0, \\ -15 - 10 + 8 - 17t &= 0. \end{aligned}$$

Thus $t = -1$, so $H = (3, 5, 9)$. Substitution into the three symmetric ratios gives -1 in every case, confirming that the foot lies on the given line.

Step 2: Calculate and check the distance The displacement from the foot to the given point is $P - H = (-2, -3, -6)$. Its dot product with the direction vector is $-6 - 6 + 12 = 0$, confirming the right angle. Therefore

$$PH = \sqrt{(-2)^2 + (-3)^2 + (-6)^2} = \sqrt{4 + 9 + 36} = 7.$$

As a second check, the squared distance equals the squared length of $P - Q$ minus its squared projection along the line:

$$PH^2 = 66 - \frac{(-17)^2}{17} = 49.$$

The three other proposed distances, 5, 6 and 4, have squares 25, 36 and 16 respectively; none equals the perpendicular squared distance 49.

Step 3: Conclusion The length of the perpendicular is $\boxed{7}$ coordinate units. Hence, the correct option is (D).

Quick Tip to Solve: To find a point-to-line distance, first project onto the direction vector; check that the resulting residual vector has zero dot product with it.

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

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

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

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

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

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

Solution:

Concept:

- A vector perpendicular to two nonparallel direction vectors is parallel to their cross product. The coordinates of points on the lines do not affect their mutual angle.
- For direction vectors $\mathbf{a}$ and $\mathbf{b}$, the acute angle between the corresponding lines satisfies $\cos\theta = |\mathbf{a}\cdot\mathbf{b}|/(|\mathbf{a}||\mathbf{b}|)$.

Step 1: Find a direction vector for the first line The two given symmetric equations have direction vectors $\mathbf{u} = (3, -16, 7)$ and $\mathbf{v} = (3, 8, -5)$. Therefore the direction of L_1 is parallel to

$$\begin{aligned}\mathbf{u}\times\mathbf{v} &= \big(80-56,\ 21+15,\ 24+48\big)\\ &= (24, 36, 72) = 12(2, 3, 6).\end{aligned}$$

Use the simpler vector $\mathbf{a} = (2, 3, 6)$. It indeed obeys $\mathbf{a}\cdot\mathbf{u} = 6-48+42 = 0$ and $\mathbf{a}\cdot\mathbf{v} = 6+24-30 = 0$. The prescribed point fixes the position of L_1, while these perpendicularity conditions fix its direction.

Step 2: Apply the dot-product angle formula The coefficient of λ in L_2 is its direction vector $\mathbf{b} = (1, 2, 2)$. Now

$$\begin{aligned}\mathbf{a}\cdot\mathbf{b} &= 2+6+12 = 20,\\ |\mathbf{a}| &= \sqrt{4+9+36} = 7,\\ |\mathbf{b}| &= \sqrt{1+4+4} = 3.\end{aligned}$$

Consequently $\cos\theta = 20/21$. The cosines of the angles in options (A), (B) and (C) are respectively $\sqrt{3}/2$, $(\sqrt{6}+\sqrt{2})/4$ and $4/5$; none equals $20/21$. Reversing either direction vector gives the supplementary oriented angle, but the listed acute angle is determined by the absolute dot product.

Step 3: Conclusion An angle between the lines is $\boxed{\cos^{-1}(20/21)}$. Hence, the correct option is (D).

Quick Tip to Solve: For a line perpendicular to two directions, take their cross product and cancel common factors before calculating the angle with a third direction.

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

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

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

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

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

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

Solution:

Concept:

- The fundamental theorem of calculus gives $\frac{d}{dx}\int_0^x f(t)\,dt = f(x)$. Differentiating an integral relation can determine an algebraic relation for the unknown function.
- The standard antiderivative $\int du/\sqrt{1+u^2} = \log(u+\sqrt{1+u^2})+C$ follows by differentiating the expression on the right.

Step 1: Determine the even powers of the function Setting $x = 0$ in the given relation yields $0 = 2f(0)^3$, hence $f(0) = 0$. Thus the non-zero condition is used for positive x, where we divide by $f(x)$; it cannot mean non-zero at the lower endpoint itself. Differentiating for $x > 0$ gives

$$3f(x) = 6f(x)^2 f'(x) \quad \Longrightarrow \quad 2f(x)f'(x) = 1.$$

Therefore $\frac{d}{dx}(f(x)^2) = 1$, so $f(x)^2 = x + C$. Continuity at the lower endpoint, where $f(0) = 0$, gives $C = 0$. In particular,

$$f(x)^4 = x^2, \qquad f(x)^{12} = x^6.$$

Either sign of the non-zero branch gives these same even powers. The calculation only uses differentiability in the interior and continuity at the integration endpoint.

Step 2: Transform and evaluate the definite integral Substituting these powers into the required integral gives

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

Put $u = x^3$, so $du = 3x^2\,dx$; the limits remain 0 and 1. Hence

$$\begin{aligned} I &= \int_0^1 \frac{du}{\sqrt{1+u^2}} \\ &= \left[\log\left(u+\sqrt{1+u^2}\right)\right]_0^1 \\ &= \log(1+\sqrt{2}) - \log 1. \end{aligned}$$

Option (B) is negative and cannot equal this positive integral. Option (A) uses the wrong upper-end expression, replacing $1+\sqrt{2}$ by $2+\sqrt{2}$. Option (D) also differs from the evaluated logarithm. Only (C) has the correct transformed upper limit.

Step 3: Conclusion The integral is $\boxed{\log_e(1+\sqrt{2})}$. Hence, the correct option is (C).

Quick Tip to Solve: When an integral equation contains a power of its own integrand, differentiate first; determine the integration constant from the original lower-limit condition.

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

[4 marks]

(A) 0

(B) 1

(C) 2

(D) not defined

Correct Answer: (B) 1

Solution:

Concept:

- For the principal inverse cotangent, $\cot^{-1} u \to 0$ as $u \to +\infty$. A finite sum of functions tending to zero also tends to zero.
- The functions $\tan t$ and $\sec^2 t$ are continuous near $t = 0$, because $\cos 0 = 1 \neq 0$. Their limiting values can therefore be found after computing the limit of the inner function.

Step 1: Find the limit of each summand For a fixed index r between 1 and 10, write

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

This argument is positive for every permitted x, and tends to positive infinity as $x \to \infty$. Thus each principal inverse-cotangent term is positive and tends to zero. There are exactly ten summands, a number independent of x, so the finite-sum limit rule gives

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

No infinite-series interchange is involved. In particular, it is unnecessary to expand or telescope the inverse-cotangent sum merely to determine this limit.

Step 2: Use continuity of the outer functions Since $f(x) \to 0$, it lies in a neighbourhood of zero for all sufficiently large x. In that neighbourhood $\cos f(x)$ is nonzero, so both outer functions are defined and continuous. Hence

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

Option (A) forgets the nonzero limit of the secant-squared term. Option (C) would require an extra unit that the tangent term does not supply. Option (D) is false because the expression is defined throughout a sufficiently far tail of the domain and its limit exists.

Step 3: Conclusion The required limit is $\boxed{1}$. Hence, the correct option is (B).

Quick Tip to Solve: Before seeking a telescoping inverse-trigonometric identity, check whether every term in the fixed finite sum already has an immediate limit.

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

(A) 3

(B) 5

(C) 6

(D) 12

Correct Answer: (C) 6

Solution:

Concept:

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

Step 1: Identify the intervals contributing area The zeros of cosine in $[0, 3\pi]$ are $\pi/2$, $3\pi/2$ and $5\pi/2$. Cosine is negative on

$$\left(\frac{\pi}{2}, \frac{3\pi}{2}\right) \quad \text{and} \quad \left(\frac{5\pi}{2}, 3\pi\right].$$

On the remaining subintervals the graphs coincide, so no area is added there. On each negative subinterval the absolute-value curve is the upper one. We must integrate their difference, which is twice the magnitude of cosine, rather than just the area between cosine and the horizontal axis.

Step 2: Integrate the vertical separation Splitting at the sign changes gives

$$A = -2\int_{\pi/2}^{3\pi/2} \cos x\, dx - 2\int_{5\pi/2}^{3\pi} \cos x\, dx.$$

The first integral covers a complete negative lobe and the second covers the remaining half-lobe. Evaluate each with the antiderivative $\sin x$:

$$\begin{aligned} A &= -2\,[\sin x]_{\pi/2}^{3\pi/2} - 2\,[\sin x]_{5\pi/2}^{3\pi} \\ &= -2(-1-1) - 2(0-1) \\ &= 4 + 2 = 6. \end{aligned}$$

The endpoint 3π supplies the boundary of the final partial region within the prescribed interval. Option (A), 3, counts only the negative area relative to the axis and misses the factor of two. Option (D), 12, doubles the already correct separation again. Option (B), 5, does not equal the sum of the two evaluated contributions.

Step 3: Conclusion The enclosed area over the given interval is $\boxed{6}$ square units. Hence, the correct option is (C).

Quick Tip to Solve: Between $y = g(x)$ and $y = |g(x)|$, count only the intervals where $g(x) < 0$, and double their area below the horizontal axis.

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

(A) 9/4

(B) 16/9

(C) 4/9

(D) 4/3

Correct Answer: (B) 16/9

Solution:

Concept:

- A square-root substitution $t = \sqrt{x}$ changes x to t^2 and the differential to $dx = 2t\,dt$. The integration limits must change with the variable.
- Factor before integrating: $t^2 - 1 = (t-1)(t+1)$. On the given interval $2 \le t \le 3$, the cancelled factors are nonzero, so cancellation preserves the integrand.

Step 1: Change the variable and limits Take $t = \sqrt{x}$. Since x runs from 4 to 9, the positive square root runs from 2 to 3. Substituting the numerator, denominator and differential together gives

$$\alpha = \int_2^3 \frac{t^2 - t}{t^2(t^2-1)}\, 2t\, dt.$$

The factor $2t$ comes from the differential; omitting it would change both the logarithmic coefficient and the answer.

Step 2: Cancel and integrate Factor the numerator as $t(t-1)$ and the denominator as $t^2(t-1)(t+1)$. Thus

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

All logarithm arguments are positive. Therefore the absolute-value notation in the antiderivative can be omitted on this interval.

Step 3: Exponentiate and compare the options Combine the logarithms before applying the exponential:

$$\alpha = 2\ln\frac{4}{3} = \ln\frac{16}{9}, \qquad e^{\alpha} = \frac{16}{9}.$$

Option (D), $4/3$, misses the factor 2 in the exponent. Option (C), $4/9$, is below 1, although the integrand is positive and hence $e^{\alpha} > 1$. Option (A), $9/4$, is not the endpoint ratio $((3+1)/(2+1))^2$.

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

Quick Tip to Solve: When substituting $t = \sqrt{x}$, change the bounds and dx immediately; then factor before attempting an antiderivative.

20. If the function $f(x)$ defined by $f(x) = \begin{cases} \dfrac{\log_e(1+5x) - \log_e(1-2x)}{x}, & x \neq 0, \\ l, & x = 0 \end{cases}$ is continuous at $x = 0$, then the value of l is : [4 marks]

(A) 3

(B) 2

(C) 5

(D) 7

Correct Answer: (D) 7

Solution:

Concept:

- Continuity at zero requires the assigned value $f(0) = l$ to equal the two-sided limit $\lim_{x\to 0} f(x)$. The formula for nonzero x alone does not specify $f(0)$.
- The standard natural-logarithm limit is $\lim_{u\to 0} \ln(1+u)/u = 1$. Consequently $\lim_{x\to 0} \ln(1+ax)/x = a$ for any fixed real a.

Step 1: Check the expression near zero Both logarithms are real when $1+5x > 0$ and $1-2x > 0$, that is, $-1/5 < x < 1/2$. This interval contains points on both sides of zero. Thus a two-sided continuity condition is meaningful. Substituting zero into the quotient gives the indeterminate form $0/0$, so evaluate a limit rather than divide by zero.

Step 2: Apply the logarithmic limit to each term For nonzero x close to zero, write

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

In the first ratio put $u = 5x$; in the second put $u = -2x$. Each ratio tends to 1 from either side. The second contribution is positive because the negative coefficient from $\ln(1-2x)/x$ is subtracted. Therefore

$$\lim_{x\to 0} f(x) = 5 + 2 = 7.$$

Step 3: Impose continuity and eliminate the other values The limit exists and is finite, so continuity requires $l = 7$. Choosing 5 would retain only the first logarithm; choosing 2 would retain only the second contribution. Choosing 3 would incorrectly subtract 2 after the minus sign has already been accounted for. Hence none of options (A), (B) or (C) equals the two-sided limit.

Step 4: Conclusion The continuous extension has $\boxed{l = 7}$. Hence, the correct option is (D).

Quick Tip to Solve: For $[\ln(1+ax) - \ln(1+bx)]/x$ at zero, the limit is $a - b$; keep the sign of b intact.

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

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

Solution:

Concept:

- Matrix multiplication is associative: $(AP)v = A(Pv)$. To calculate a scalar $v^T Pv$, it is enough to find the vector Pv; the complete matrix P is unnecessary.
- An upper-triangular linear system is solved by back-substitution from the last row upwards. Here $\det A = 1 \cdot 2 \cdot 1 = 2 \neq 0$, so the required vector is uniquely determined.

Step 1: Multiply the known product by the column vector Let $B = AP$, $v = (1, 0, 2)^T$, and $u = Pv$. The scalar in the question is $k = v^T u$. From the supplied matrix B,

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

The middle entry is 1, because its row gives $1 \cdot 1 + 1 \cdot 0 + 0 \cdot 2$, while the last entry is 2.

Step 2: Solve for the three components Writing $u = (u_1, u_2, u_3)^T$, the triangular system is

$$\begin{aligned} u_1 + 2u_2 + 3u_3 &= 3, \\ 2u_2 + 3u_3 &= 1, \\ u_3 &= 2. \end{aligned}$$

The last equation gives $u_3 = 2$. Substitute into the second:

$$2u_2 + 6 = 1 \quad \Rightarrow \quad u_2 = -\frac{5}{2}.$$

Then the first gives $u_1 - 5 + 6 = 3$, so $u_1 = 2$. Substitution checks the first two right-hand sides as $2 - 5 + 6 = 3$ and $-5 + 6 = 1$.

Step 3: Take the required row-column product The left row is $(1, 0, 2) = v^T$. It selects the first component and twice the last component of u; the middle component has coefficient zero. Hence

$$k = \begin{bmatrix} 1 & 0 & 2 \end{bmatrix} \begin{bmatrix} 2 \\ -5/2 \\ 2 \end{bmatrix} = 2 + 0 + 4 = 6.$$

This calculation uses the given multiplication order throughout; interchanging A and P would lead to a different system.

Step 4: Conclusion The required dimensionless scalar is $\boxed{k = 6}$.

Quick Tip to Solve: For an expression rPv with AP known, solve $Au = (AP)v$, then compute ru; this avoids finding all nine entries of P.

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

Solution:

Concept:

- The identity $r\binom{N}{r} = N\binom{N-1}{r-1}$ follows by cancelling factorials. It moves the weight r into a binomial coefficient with upper index one smaller.
- Vandermonde convolution adds complementary lower indices: $\sum_j \binom{a}{j}\binom{b}{s-j} = \binom{a+b}{s}$. It counts selections of s objects from two disjoint groups.

Step 1: Express the sum with a general index The coefficients before the squared binomial terms run from 1 to 10. Denote the sum by

$$S = \sum_{r=1}^{10} r\binom{10}{r}^2.$$

Apply the weighted identity to one copy of the binomial coefficient:

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

Only one of the two copies is transformed, so the factor outside the sum is 10, not 100.

Step 2: Apply the convolution with complementary indices Use symmetry $\binom{10}{r} = \binom{10}{10-r}$, and put $j = r-1$. The index j runs from 0 to 9, while $10 - r = 9 - j$. Thus

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

The lower indices in each product add to 9 and the upper indices add to 19. This also counts choosing 9 objects from groups containing 9 and 10 objects, partitioned by how many come from the first group.

Step 3: Match the requested representation The conventional binomial-identity representation uses symmetry once more:

$$10\binom{19}{9} = 10\binom{19}{10}.$$

This identifies $m = 10$ and $n = 19$, giving the intended value

$$m + n = 10 + 19 = 29.$$

However, the unrestricted equality alone does not determine m, n uniquely. Indeed, the same sum is 923780, and

$$1\binom{923780}{1} = 923780$$

also satisfies it, with $m + n = 923781$. Therefore 29 corresponds to the conventional identity representation, rather than being forced by the numerical equality without an additional restriction.

Step 4: Conclusion The conventional binomial-identity representation gives $\boxed{m+n=29}$, the intended answer. The unrestricted equation as written also admits other pairs, so it does not by itself

specify a unique sum.

Quick Tip to Solve: For $\sum r\binom{N}{r}^2$, first replace $r\binom{N}{r}$ by $N\binom{N-1}{r-1}$, then align complementary lower indices.

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

[4 marks]

Solution:

Concept:

- For $\theta=\cot^{-1}x$ with $x>0$, the principal angle is acute. Therefore $\sin\theta=1/\sqrt{1+x^2}$ and $\cos\theta=x/\sqrt{1+x^2}$, both positive.
- The square root denotes the nonnegative root: $\sqrt{x^2}=|x|$. Also, the sum of the first N positive integers is $N(N+1)/2$.

Step 1: Rewrite the trigonometric combination Each summation index satisfies $x\geq 1$. Put $\theta=\cot^{-1}x$, so $\cot\theta=x$. A right triangle with adjacent side x and opposite side 1 has hypotenuse $\sqrt{x^2+1}$. Hence

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

The positive signs are justified by the acute principal angle, rather than chosen arbitrarily after squaring.

Step 2: Simplify the square root in each summand Substitute this expression into the entire radical:

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

Because the index runs through positive integers, $|x|=x$. Thus the apparently trigonometric expression contributes exactly its index to the sum. The restriction $x\geq 1$ is essential for removing the absolute value without a minus sign.

Step 3: Sum and compare coefficients There are n^2 terms, so use $N=n^2$ in the arithmetic-sum formula:

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

Comparing with An^4+Bn^2 gives $A=B=1/2$. In particular the leading power is n^4, since the upper limit itself is n^2. Therefore

$$2(A+B)=2\left(\frac{1}{2}+\frac{1}{2}\right)=2.$$

Step 4: Conclusion The coefficients are $A=B=1/2$, giving the dimensionless answer $\boxed{2(A+B)=2}$.

Quick Tip to Solve: Convert inverse-trigonometric expressions into triangle ratios first, and check the sign of the index before replacing $\sqrt{x^2}$ by x.

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

Solution:

Concept:

- Cross products distribute over linear combinations, and a vector crossed with itself is zero: $\vec{b} \times (\lambda\vec{a} + \mu\vec{b}) = \lambda(\vec{b} \times \vec{a})$. The order of the factors determines the sign.
- Dot products also distribute: $\vec{a} \cdot \vec{c} = \lambda|\vec{a}|^2 + \mu(\vec{a} \cdot \vec{b})$. The squared magnitude of (c_x, c_y, c_z) is $c_x^2 + c_y^2 + c_z^2$.

Step 1: Determine the coefficient using the cross product With $\vec{a} = (2, 1, -1)$ and $\vec{b} = (3, 2, 4)$, compute in the given order:

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

Since $\vec{b} \times \vec{c} = \lambda(\vec{b} \times \vec{a})$, comparison with $(-12, 22, -2)$ gives $\lambda = 2$. All three components agree with the same multiplier.

Step 2: Use the dot product to find the other coefficient Evaluate the two scalar products:

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

The stated condition now becomes

$$16 = 6\lambda + 4\mu = 12 + 4\mu,$$

so $\mu = 1$. Both coefficients are uniquely determined because $\vec{b} \times \vec{a} \neq \vec{0}$ and $\vec{a} \cdot \vec{b} \neq 0$.

Step 3: Construct the vector and square its magnitude Substitute the coefficients into the original linear combination:

$$\vec{c} = 2\vec{a} + \vec{b} = (4, 2, -2) + (3, 2, 4) = (7, 4, 2).$$

Check the scalar condition directly: $\vec{a} \cdot \vec{c} = 14 + 4 - 2 = 16$. The cross product is $(4 - 16, 28 - 6, 12 - 14) = (-12, 22, -2)$, also as required. Consequently,

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

The question asks for the squared magnitude, so no square root is needed.

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

Quick Tip to Solve: Cross the linear combination with a known vector first: its self-cross-product vanishes and isolates one coefficient before the dot-product equation is used.

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

Solution:

Concept:

- A circle has equation $x^2 + y^2 + 2gx + 2fy + c = 0$; substituting its fixed points determines the constrained coefficients.
- Eliminate the remaining arbitrary constant between the family equation and its differential. The differential equation is first order because only one arbitrary parameter remains.

Step 1: Determine the circle family Substitute the two fixed points separately:

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

Subtracting gives $76g = 0$, so $g = 0$, and either equation then gives $c = -361$. Thus every circle in the family can be written as

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

The centre lies on the y-axis, as expected from the perpendicular bisector of the chord joining the two fixed points.

Step 2: Differentiate and eliminate the parameter Treat f as the constant specifying a particular circle. Differentiating implicitly gives

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

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

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

Multiplication avoids dividing by y, so the algebra does not introduce an unnecessary denominator at the fixed points.

Step 3: Compare the coefficients The coefficient of $\mathrm{d}x$ already has the prescribed normalization $2xy$. Hence direct comparison gives

$$\alpha = -1, \qquad \beta = 1, \qquad \gamma = 361.$$

The opposite signs of the two squared terms follow from eliminating the circle parameter; they are not both positive as in the original circle equation.

Step 4: Conclusion Therefore $\alpha + \beta + \gamma = -1 + 1 + 361 = \boxed{361}$. This is a dimensionless numerical answer.

Quick Tip to Solve: For circles through two symmetric points on the x-axis, first set the coefficient of x to zero and find the constant term; only then differentiate.

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

(A) Micro scale

(B) Human scale

(C) Monumental scale

(D) Nano scale

Correct Answer: (C) Monumental scale

Solution:

Concept:

- Architectural scale describes the perceived size of a building or space relative to people and its surroundings.
- Monumental scale uses imposing overall dimensions and a strong silhouette to create grandeur, including when the structure is seen from a distance.

Step 1: Identify the visual intention The decisive words are "impressive and wonderful from a far distance". At a distant viewpoint, small details are less apparent; the observer mainly perceives the overall mass, height, outline and relationship to the landscape. A structure intended to command attention at that distance therefore uses a grand, imposing scale. This is the architectural meaning of monumental scale, rather than merely having intricate decoration.

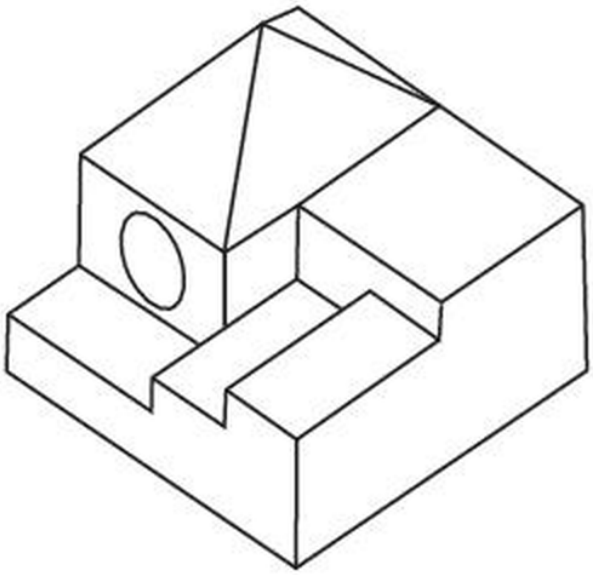
Step 2: Compare all four scales Option (C), monumental scale, describes the intended grandeur and distant visual impact. Option (B), human scale, relates dimensions and proportions to the human body and everyday experience, making spaces comfortable and approachable; that is not the special effect described here. Option (A), micro scale, concerns very small dimensions or fine detail, which cannot explain an imposing distant presence. Option (D), nano scale, concerns still smaller dimensions and is likewise unsuitable for describing the perceived grandeur of a building. These distinctions concern the intended perceptual relationship, rather than a requirement for one particular building shape.

Step 3: Conclusion The structure is designed with monumental scale to produce an imposing distant impression. Hence, the correct option is (C).

Quick Tip to Solve: When a scale question stresses grandeur, awe or a landmark visible from far away, match that intention with monumental scale rather than human scale.

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

[4 marks]



(A) 11

(B) 14

(C) 12

(D) 13

Correct Answer: (D) 13

Solution:

Concept:

- Count the distinct surface regions visible in the given three-dimensional view, rather than the number of edges or corners.
- A change of face direction or a drawn internal surface boundary separates regions. Hidden back and bottom surfaces are excluded.

Step 1: Separate the upper part from the base Start with the pitched upper portion, and follow each outline once. Three roof regions are visible: the broad sloping face on the left, the triangular face towards the right, and the narrow triangular region at the rear ridge. Below the roof, the upright face carrying the circular feature and the adjoining upright side give two more regions. The circular surface region contributes one separately bounded region. Thus this upper assembly contributes six visible regions in the supplied view.

Step 2: Count the base without repeating its outlines Now move around the stepped base in a fixed order. Its visible regions are the rear-right upper platform, the upright riser immediately in front of that platform, the left foreground upper platform, the right foreground upper platform, the recessed central strip, the large front outside face and the large right outside face. These give seven regions. The front outline has steps in it, but a single continuous planar outside face must not be counted again at each turn of that outline.

Step 3: Add and compare the options Adding the two groups gives

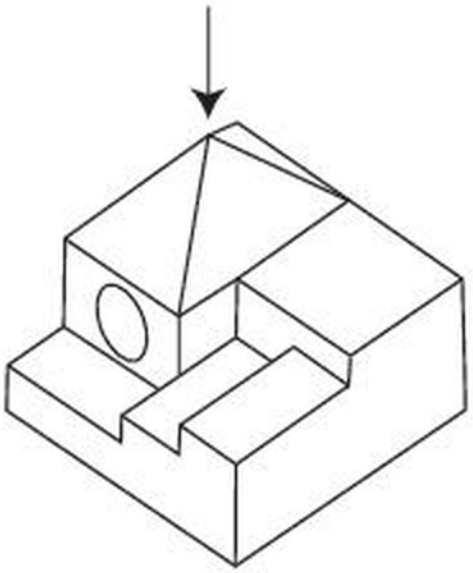
$$N = 6 + 7 = 13.$$

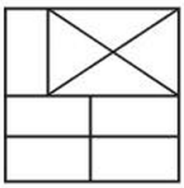
A count of 11 or 12 leaves out visible regions, such as the narrow roof region or the circular bounded region. A count of 14 introduces an extra split or includes a hidden face. Counting every edge as a new surface would also overcount the stepped outline. The required total is therefore the value in option (D).

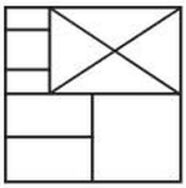
Step 4: Conclusion The object has $\boxed{13}$ visible surface regions in this view. Hence, the correct option is (D).

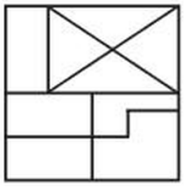
Quick Tip to Solve: Count the roof, upright portion and base separately, then check that a notched outline has not made you count one continuous planar face twice.

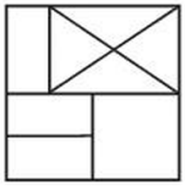
28. The question figure shows the 3D view of an object. Identify the correct view looking in the direction of arrow. [4 marks]

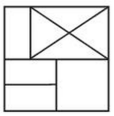


(A) 

(B) 

(C) 

(D) 

Correct Answer: (D) 

Solution:

Concept:

- An orthographic view is formed by looking parallel to the indicated arrow; depth along that viewing direction collapses.
- In a top view, compare the footprint, roof edges and boundaries between the horizontal platforms. Vertical heights do not become extra plan divisions by themselves.

Step 1: Interpret the direction and roof pattern The arrow points down onto the object, so the required drawing is its top view. The outside footprint is rectangular. The roof occupies the upper-right portion of the answer drawings and its ridges and sloping-face boundaries project as diagonals meeting within that portion. A narrow strip remains along its left side. These features establish the orientation before considering the stepped base; rotating or mirroring only one part would give an inconsistent view.

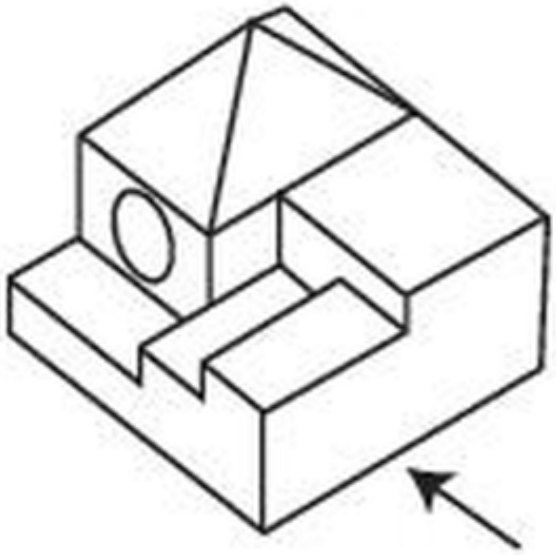
Step 2: Project the stepped foreground Follow the edges of the foreground platforms and the central recessed strip vertically into the plan. The lower part is divided into a left group and a larger unbroken region on the right. Within the left group, the change of level produces the horizontal division shown in the answer. The narrow strip at the upper left remains unbroken. A boundary visible on a vertical face in the three-dimensional drawing is not extended across unrelated top surfaces merely because it appears horizontal on the page.

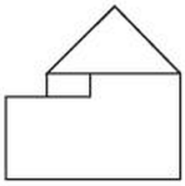
Step 3: Eliminate the mismatching plans Option (A) extends the horizontal foreground division across the right-hand region, adding a boundary not present there. Option (B) divides the narrow upper-left strip into extra bands, which the top view does not show. Option (C) introduces an additional stepped boundary within the right-hand foreground region. Option (D) alone preserves the undivided upper-left strip, the roof diagonals and the correct lower platform divisions simultaneously.

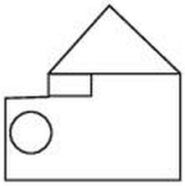
Step 4: Conclusion The required top view is the fourth drawing. Hence, the correct option is (D).

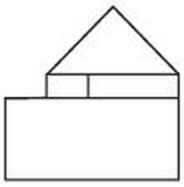
Quick Tip to Solve: First fix the viewing direction and roof position; then reject any plan that extends a platform edge through an unrelated surface.

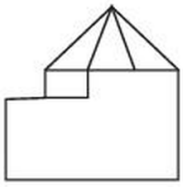
29. The question figure shows the 3D view of an object. Identify the correct view looking in the direction of arrow. [4 marks]

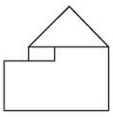


(A) 

(B) 

(C) 

(D) 

Correct Answer: (A) 

Solution:

Concept:

- A directional elevation retains heights and widths perpendicular to the viewing arrow while collapsing depth along that arrow.
- Only edges exposed from the chosen direction appear as ordinary visible lines; a feature on a face turned away from the observer is not transferred onto the elevation.

Step 1: Locate the side being viewed The arrow approaches the large right side of the object. We therefore view this side face-on, rather than looking at the wall with the circular feature. The stepped base determines the lower outline, while the pitched roof produces a triangular upper outline. The circular feature lies on the adjacent wall, so it must not appear as a circle in this side elevation.

Step 2: Trace the silhouette and the exposed step Project the extreme heights of the foreground base, the raised block and the roof. The resulting outside boundary rises from the lower left platform to the

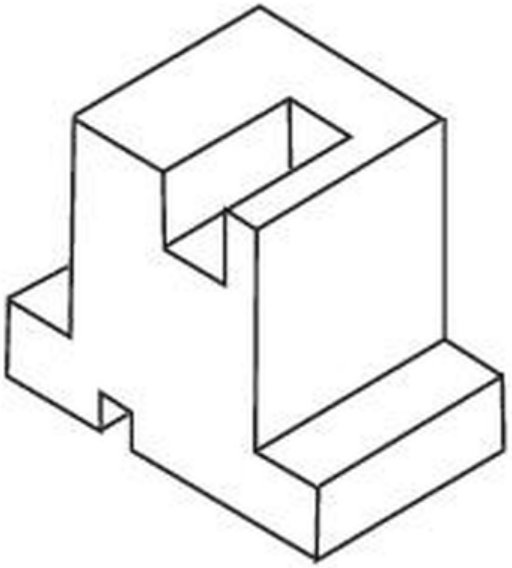
raised roof support and then to the roof apex. Below the roof, the nearer side mass hides the longer continuation of the inner wall. Only the short exposed rectangular step beneath the left part of the roof remains visible. The roof is seen as a plain triangular elevation, without projecting every oblique edge from the original perspective drawing into it.

Step 3: Check each alternative Option (A) has the correct stepped silhouette, plain triangular roof and short exposed rectangle. Option (B) incorrectly carries the circular wall feature onto this side. Option (C) continues a horizontal division across the entire area below the roof, although that division is hidden by the nearer side mass. Option (D) retains extra diagonal roof subdivisions that do not appear as visible boundaries from this direction. These discrepancies rule out the other three drawings.

Step 4: Conclusion The first drawing is the correct view along the arrow. Hence, the correct option is (A).

Quick Tip to Solve: A circle on an adjacent wall is a useful orientation check: do not copy it into a side view when that wall is turned away from the viewing direction.

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



(A) 9

(B) 10

(C) 11

(D) 12

Correct Answer: (B) 10

Solution:

Concept:

- A visible surface is a distinct exposed region bounded by the drawn edges. A complicated outline can still enclose one continuous plane.
- Count recessed surfaces only where they are actually visible; do not add the unseen underside or back of the object.

Step 1: Count the main upright portion and its recess The continuous front face counts as one region even though it has notches in its outline. The large right upright face and the U-shaped upper face contribute one each. Inside the upper recess, three more regions are visible: the larger inner vertical wall, the small inner end wall at the back, and the triangular-looking floor of the recess. These six regions account for the principal upright block, its front face and its top opening.

Step 2: Add the remaining base regions At the base, the exposed ledge on the left and the broad ledge on the right contribute two horizontal surface regions. The right outside vertical face of the base contributes a third. Finally, the small lower notch in the front outline reveals one additional inner surface. Thus four further regions remain beyond the six already counted. The front base area is continuous with the previously counted front plane and must not be counted as a separate face again.

Step 3: Check the total against the options The count is

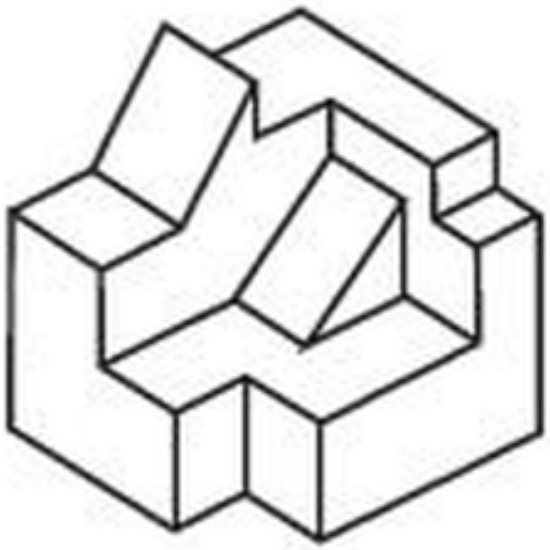
$$N = 6 + 4 = 10.$$

Option (A), 9, omits a visible region, often the small face within the lower notch. Options (C) and (D), 11 and 12, arise from adding extra splits to continuous surfaces or counting hidden faces. The correct count includes all visible recess faces but excludes such duplications.

Step 4: Conclusion There are $\boxed{10}$ visible surfaces. Hence, the correct option is (B).

Quick Tip to Solve: For a block with cut-outs, count the exposed recess walls explicitly, but keep the continuous front plane as one surface despite its notched boundary.

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



(A) 13

(B) 14

(C) 15

(D) 18

Correct Answer: (B) 14

Solution:

Concept:

- A visible surface is one exposed face bounded by the object's actual edges. Count faces, not the number of edges or corners.
- Classifying faces as horizontal, vertical and inclined gives disjoint groups and prevents an exposed recess wall from being missed. Hidden rear and bottom faces are excluded.

Step 1: Count the horizontal faces Start at the back and move towards the front. The horizontal faces are the raised strip across the back, the small ledge at the right, the platform at the left, and the connected lower floor surrounding the central inclined piece. The floor changes direction around the projection but remains one continuous plane; do not count its arms separately. Thus there are four visible horizontal faces.

Step 2: Count the vertical faces Now trace the upright faces around the outside and inside. There are four around the lower front boundary: the broad left exterior face, the two faces of the central front notch, and the broad right exterior face. Inside and above these are the broad left recess wall, the right recess wall, the short exposed face beneath the raised back strip at the right, and the triangular side face beside the central ramp. These give eight visible vertical faces. A triangular outline does not make a face inclined: its plane can still be vertical.

Step 3: Add the inclined faces and compare The tall sloping face at the upper left and the central sloping ramp give two further faces. The total is therefore

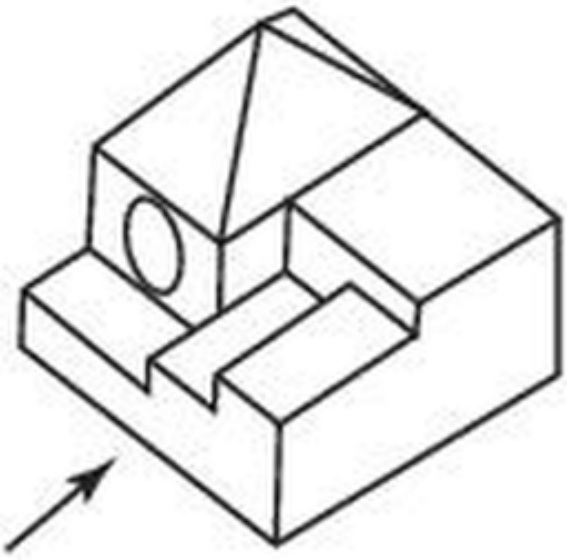
$$N = 4 + 8 + 2 = 14.$$

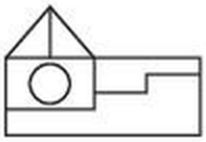
Option (A), 13, misses an exposed face; option (C), 15, requires splitting a continuous face or adding a hidden one; option (D), 18, overcounts still more surfaces. None equals the systematic count.

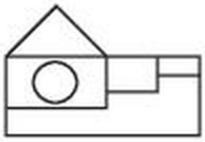
Step 4: Conclusion There are 14 visible surfaces. Hence, the correct option is (B).

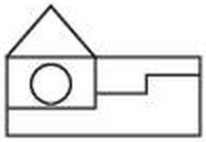
Quick Tip to Solve: Count horizontal, vertical and sloping faces separately. In a recess, include the visible upright walls but do not split a connected flat floor merely because its outline bends.

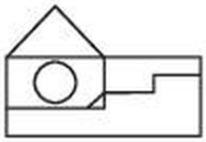
32. The question figure shows the 3D view of an object. Looking in the direction of arrow identify the correct view. [4 marks]

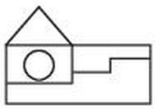


(A) 

(B) 

(C) 

(D) 

Correct Answer: (C) 

Solution:

Concept:

- An orthographic view along an arrow collapses depth along that direction while retaining width and height.
- Only genuine visible edges are drawn. An apparent line between projected roof faces disappears if both project onto the same outline.

Step 1: Project the main features Look from the lower-left arrow towards the object. The circular opening is on the face turned towards the observer, so it remains a circle in the required view. The upper roof forms a triangular outline above this rectangular face. The base gives a long rectangular overall outline, extending to the right of the roofed block. Features lying behind one another must be compared along this same viewing direction, without rotating the object to another side.

Step 2: Trace the right-hand steps Follow the visible ledges from the right side of the roofed block. The lower line runs horizontally to the right and then rises by a short vertical step before continuing to the outer right edge. The higher horizontal edge continues above this stepped line. The roof projects

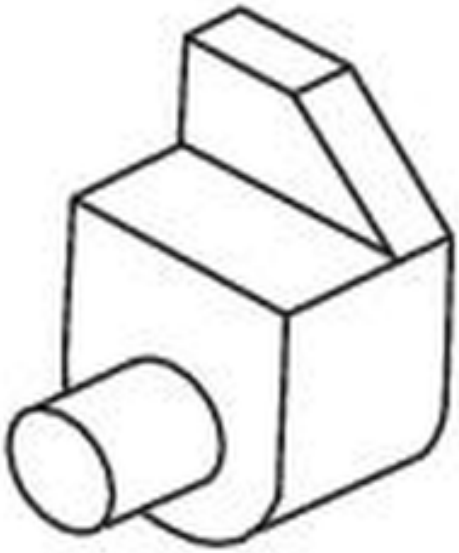
as a plain triangle: there is no separate visible vertical line from its apex down to the eaves. These observations fix both the interior line pattern and the silhouette.

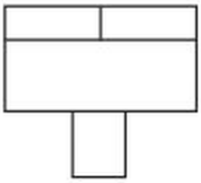
Step 3: Eliminate the altered projections Option (A) inserts an additional vertical division inside the triangular roof, which this view does not show. Option (B) changes the positions and relationship of the vertical step and the upper ledge, giving the wrong right-hand subdivisions. Option (D) adds a small diagonal at the lower-right corner of the circular-opening block. That diagonal is not a visible edge in the required projection. Option (C) preserves the circular opening, undivided triangular roof and correct stepped ledge together.

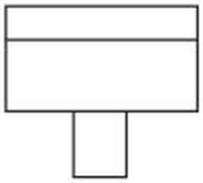
Step 4: Conclusion The required view is the figure in option (C). Hence, the correct option is (C).

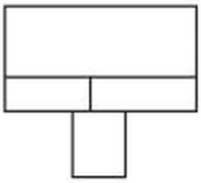
Quick Tip to Solve: Use the circular opening to fix the viewing side first; then compare the roof interior and the right-hand step rather than judging only the outer silhouette.

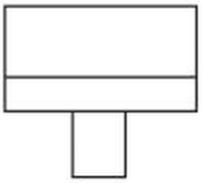
33. The question figure shows the 3D view of an object. Identify the correct top view. [4 marks]

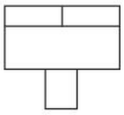


(A) 

(B) 

(C) 

(D) 

Correct Answer: (A) 

Solution:

Concept:

- A top view is a vertical projection onto a horizontal plane: vertical height disappears while the horizontal footprint is retained.
- A horizontal cylinder projects as a rectangle from above. A change between a flat top and an inclined top remains a visible edge if neither surface hides it.

Step 1: Form the plan outline View the object straight down. Its main body has a rectangular footprint. The cylindrical peg projects outwards from the front face, so from above it appears as a narrow rectangular extension centred on that side. Its circular end is seen edge-on in this view; it must not be drawn as a circle. The rounding at the bottom of the main body does not replace the rectangular upper outline seen from above.

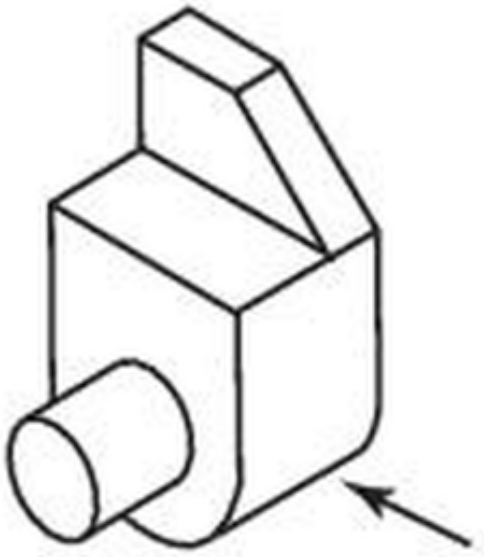
Step 2: Locate the raised top feature The raised feature occupies a strip along the back of the main body. In plan, its front boundary forms a horizontal line across that strip. The feature has a flat higher portion and an adjoining sloping portion, and the edge between these produces the short dividing line within the back strip. The broad unobstructed top surface of the main body lies between this rear strip and the front-mounted peg. Thus the dividing strip must be opposite the peg, with its internal subdivision visible.

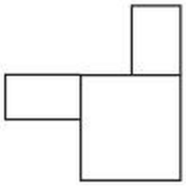
Step 3: Compare the four plans Option (A) contains the rectangular body, the front rectangular peg, and the subdivided strip along the opposite edge. Option (B) retains the body, projecting peg and rear strip, but omits the internal dividing line between the flat and sloping portions within that rear strip. Option (C) places the divided strip beside the peg, reversing the front-to-back placement of the upper feature. Option (D) also puts its strip at the peg side and omits the internal division between the upper surfaces. These changes do not follow the supplied object.

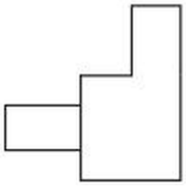
Step 4: Conclusion The correct top view is option (A). Hence, the correct option is (A).

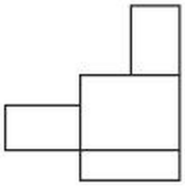
Quick Tip to Solve: In plan questions, first place any projecting peg. A feature behind the body must remain on the opposite side of the plan, even though its height disappears.

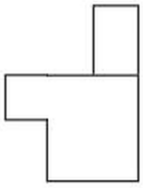
34. The question figure shows the 3D view of an object. Identify the correct view looking in the direction of arrow. [4 marks]

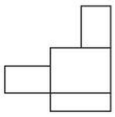


(A) 

(B) 

(C) 

(D) 

Correct Answer: (C) 

Solution:

Concept:

- Projecting along the indicated side direction removes the corresponding depth but preserves the vertical levels of visible edges.
- A cylinder viewed perpendicular to its axis has a rectangular projection; a circular projection would require looking along its axis.

Step 1: Fix the side view The arrow points from the lower right towards the object. From this side, the horizontal peg extends to the left of the main body and projects as a rectangle. The body has a rectangular side outline, and the raised feature appears above it on the right. Its apparent sloping face in the pictorial drawing collapses into the rectangular upper projection along this viewing direction. Keep the location of this raised part fixed while comparing the answers.

Step 2: Retain the visible horizontal boundary The visible boundary near the lower portion of

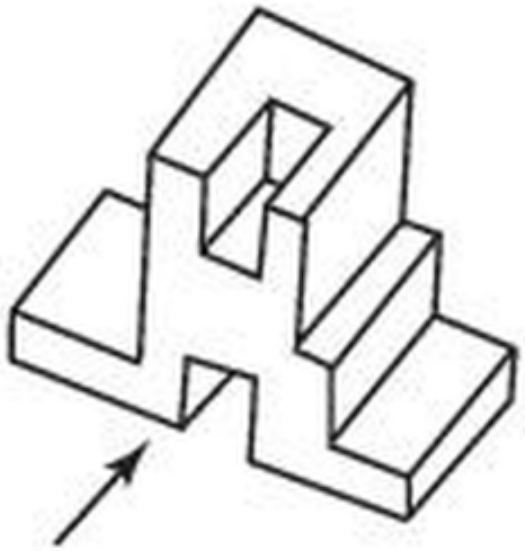
the body projects as a horizontal line across the body, aligned with the lower edge of the peg's rectangular projection. This is an interior edge, not an interruption in the outside boundary. The upper raised rectangle also retains its lower horizontal junction with the body. Consequently the correct drawing needs the left rectangular peg, the upper-right rectangular projection, and the horizontal line continuing across the lower body.

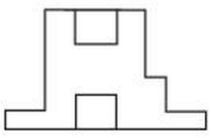
Step 3: Check every option Option (A) has the broad outline and the upper junction but leaves out the lower horizontal edge across the main body. Option (B) omits the horizontal junction under the raised feature as well as the required lower subdivision. Option (D) changes the peg/body junction into part of a stepped outer silhouette and does not preserve the necessary interior line across the body. Option (C) retains all the visible projected edges at their proper levels without adding a new outer step.

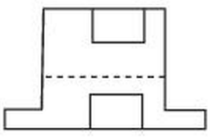
Step 4: Conclusion The correct side projection is option (C). Hence, the correct option is (C).

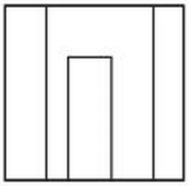
Quick Tip to Solve: After matching the silhouette, compare each horizontal edge level. Two options can have the same outline while only one preserves the visible interior boundaries.

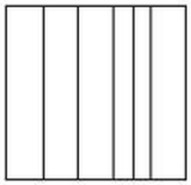
35. The question figure shows the 3D view of an object. Identify the correct view of the object looking in the direction of arrow. [4 marks]

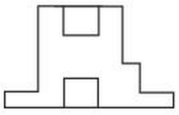


(A) 

(B) 

(C) 

(D) 

Correct Answer: (A) 

Solution:

Concept:

- In an orthographic elevation, the widths and heights facing the viewing direction remain, while recession into depth disappears.
- A visible recess must be shown by continuous lines. The front elevation of a stepped object need not be symmetric merely because the central openings are aligned.

Step 1: Read the outer profile from the arrow The arrow faces the broad end of the object. Begin at the left end of the base and follow the outline upwards: a low left platform rises directly to the tall central portion. On the right, the outline descends first to an intermediate ledge and then to the low right platform. This intermediate right-hand step is important; it makes the two sides different in elevation. Lines receding away from the observer do not become extra vertical strips in this view.

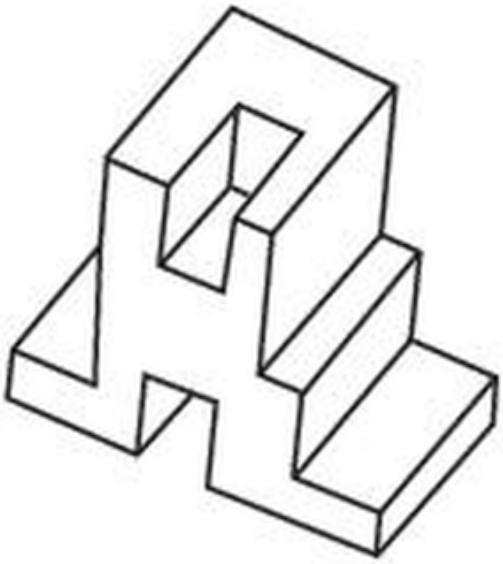
Step 2: Project the two openings The opening cut down from the top appears as a rectangular notch bounded by two vertical sides and its lower horizontal edge. The opening rising from the bottom likewise appears as a rectangular notch, aligned below the top opening. Both are on the face towards the observer and are visible, so their boundaries are continuous. The tall central face remains between the two notches; it is not replaced by a set of full-height parallel bands.

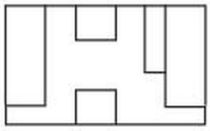
Step 3: Select the complete elevation Option (A) has both aligned rectangular notches, the low base extensions and the extra step on the right. Option (B) makes the outer steps more symmetric, omits the intermediate right-hand ledge and includes a dashed horizontal line not required for this visible front profile. Option (C) is a plan-like rectangular outline with longitudinal divisions rather than the stepped elevation. Option (D) also shows a rectangular banded projection and loses the upper and lower notches. Only option (A) preserves both silhouette and openings.

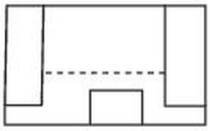
Step 4: Conclusion The view along the arrow is option (A). Hence, the correct option is (A).

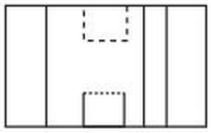
Quick Tip to Solve: Trace the outer elevation before the recesses. Here the extra right-hand ledge eliminates a tempting symmetric answer immediately.

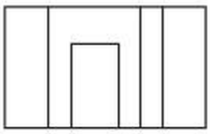
36. In a question figure a 3D object is given. Identify the correct top view of the object amongst the answer figures. [4 marks]

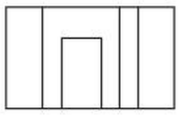


(A) 

(B) 

(C) 

(D) 

Correct Answer: (D) 

Solution:

Concept:

- The top view retains the horizontal footprint of an object and its exposed changes in level, not its front elevation.
- From above, a top opening is visible, whereas a lower opening covered by solid material above cannot appear as a visible cut-out in the top outline.

Step 1: Project the stepped footprint Look vertically down on the object. The low platforms, intermediate right-hand ledge and tall central portion all extend in depth. Their parallel boundaries therefore appear as longitudinal lines within one rectangular overall footprint. The additional ledge on the right produces an extra strip on that side. Height differences do not make a stepped outer elevation when viewed from above; they produce internal level-change boundaries.

Step 2: Identify the visible recess The slot cut down from the top of the tall central portion is open to the top view. It appears as a rectangular recess entering from the front, with two parallel sides and a transverse end line. The low opening seen in the front face is below intervening material, so it cannot become an additional visible opening at the opposite edge of the plan. Do not transfer both front

notches directly into the top view.

Step 3: Reject the other drawings Option (A) keeps the two opposing notches characteristic of the front elevation and mixes them with horizontal ledges, so it is not a consistent top projection. Option (B) also retains an elevation-style lower notch and includes a transverse dashed line rather than the correct visible top recess. Option (C) replaces the top opening's visible boundary by dashed lines and introduces a second hidden-notch pattern. Option (D) shows the rectangular footprint, the parallel strips including the additional right strip, and the single visible U-shaped recess in the central region.

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

Quick Tip to Solve: In a top view, follow a vertical sight line into each recess. Draw an opening as visible only if no material above it blocks that sight line.

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

(A) 8

(B) 10

(C) 6

(D) 12

Correct Answer: (D) 12

Solution:

Concept:

- An edge is a line segment where two faces of a solid meet. A cube has six square faces, eight vertices and twelve edges; these are different kinds of elements.
- To count edges without duplication, divide them into the four edges of the top face, the four edges of the bottom face, and the four edges joining these faces.

Step 1: Count the two opposite square boundaries Imagine placing the cube on one square face. The upper square has four boundary edges and the lower square has another four. These two faces are disjoint, so their edges give $4 + 4 = 8$ distinct edges. This subtotal does not yet include the edges that connect the upper and lower corners.

Step 2: Add the connecting edges and check the count Each of the four upper vertices joins the corresponding lower vertex by one edge. Adding these four connectors gives

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

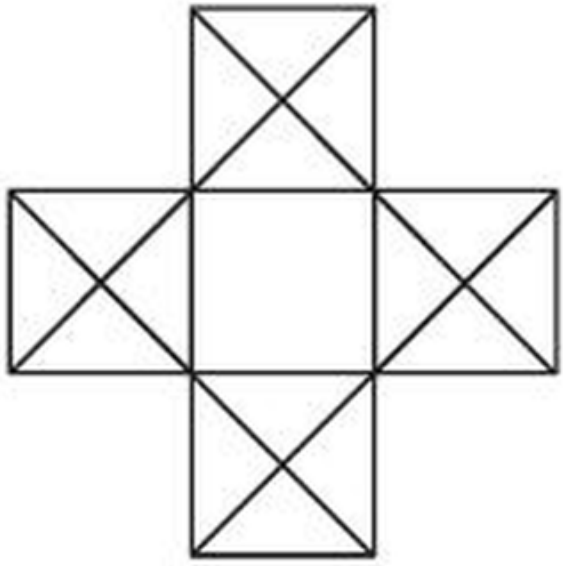
An independent check counts face-edge incidences: six square faces each have four edges, but every cube edge belongs to exactly two faces. Thus $E = 6 \times 4/2 = 12$, agreeing with the first count.

Step 3: Distinguish the distractors Option (A), eight, is the number of vertices, not edges. Option (C), six, is the number of square faces. Option (B), ten, misses two edges and cannot result from counting all four edges in each of the three directional families. Option (D) alone includes the complete set of edges.

Step 4: Conclusion A cube has $\boxed{12}$ edges. Hence, the correct option is (D).

Quick Tip to Solve: For a cube, remember the separate counts: six faces, eight vertices and twelve edges. Counting four edges in each of three directions avoids double-counting.

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



(A) 5

(B) 8

(C) 6

(D) 7

Correct Answer: (C) 6

Solution:

Concept:

- A square must have four equal sides and four right angles. Its sides may be horizontal and vertical or inclined to the page.
- Count figures by orientation and size. A square is valid only when all four of its sides lie on drawn line segments; do not extend short segments mentally.

Step 1: Count the upright squares The figure consists of a central square and four equal squares attached to its top, bottom, left and right sides. These are five distinct upright squares. Each arm square contains two diagonals, but a diagonal does not divide a square into smaller upright squares. There is no larger upright square: the corners of a surrounding two-unit or three-unit square would fall in blank regions, where the necessary boundary segments are absent.

Step 2: Find the inclined square Mark mentally the intersection of the diagonals in each of the four arm squares. Joining these four intersection points in order gives a diamond surrounding the central square. Its top-to-right, right-to-bottom, bottom-to-left and left-to-top sides are each complete

straight paths formed from two adjoining diagonal segments. The four sides have equal lengths and consecutive sides have opposite diagonal slopes, hence meet at right angles. This supplies exactly one inclined square.

Step 3: Check completeness and the options The remaining diagonal segments end at the outer arm corners; there are no matching parallel segments to close another inclined square. Therefore

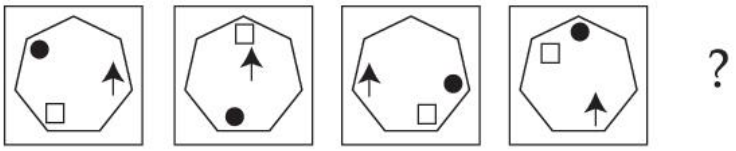
$$N = 5 + 1 = 6.$$

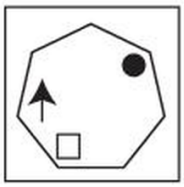
The count 5 omits the diamond. The counts 8 and 7 would require additional closed squares whose sides are not present. Counting triangles or open combinations as squares would overcount the figure.

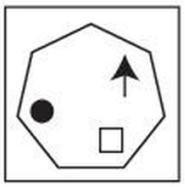
Step 4: Conclusion There are 6 squares. Hence, the correct option is (C).

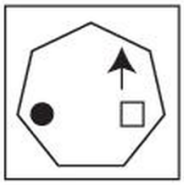
Quick Tip to Solve: After counting the obvious upright squares, follow every diagonal through its junctions; the four arm centres here form one extra square.

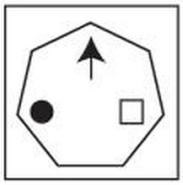
39. Which of the given shapes would complete the sequence ? [4 marks]

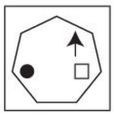


(A) 

(B) 

(C) 

(D) 

Correct Answer: (C) 

Solution:

Concept:

- Track each symbol separately around the polygon. A fixed cyclic displacement can be tested against every transition, rather than guessed from the last frame.
- Label the seven vertices clockwise from the top as 0, 1, 2, 3, 4, 5 and 6. Arithmetic on these positions wraps around after 6.

Step 1: Track the circle and square The filled circle occupies positions 6, 4, 2 and 0 in the four frames. It moves two vertices anticlockwise each time, so its next position is 5, the lower-left vertex. The

hollow square occupies positions 4, 0, 3 and 6. It moves three vertices clockwise each time, so its next position is 2, the right-side lower vertex. These two independent sequences already fix two parts of the missing diagram.

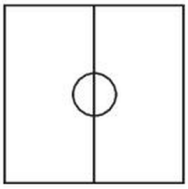
Step 2: Track the arrow The arrow occupies positions 2, 0, 5 and 3. Like the circle, it moves two vertices anticlockwise in each transition. Its next position must therefore be 1, the upper-right vertex. Its arrowhead continues to point upwards: the sequence moves the symbol around the polygon but does not rotate its orientation. Retain this distinction between the position of the arrow and the direction in which it points.

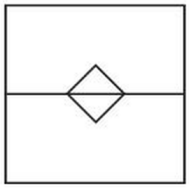
Step 3: Compare the complete arrangement The missing frame needs the circle at lower left, the square at the right-side lower vertex, and an upward arrow at upper right. Option (C) shows all three. Option (A) puts the circle on the right and the arrow on the left. Option (B) has the square at the lower-right bottom vertex rather than the required right-side vertex. Option (D) places the arrow at the top vertex, one position away from the required upper-right position. Thus only one option follows all three movements.

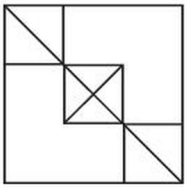
Step 4: Conclusion The missing diagram is option (C). Hence, the correct option is (C).

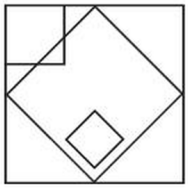
Quick Tip to Solve: Number polygon vertices and make a separate position sequence for each symbol; use the most easily confused symbol to distinguish the final two options.

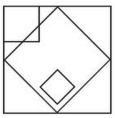
40. Identify the figure which is odd from rest : [4 marks]

(A) 

(B) 

(C) 

(D) 

Correct Answer: (D) 

Solution:

Concept:

- A figure has half-turn rotational symmetry when rotating the entire design through 180° about its centre reproduces every line and shape.
- Test a common structural property of the whole design. The particular central motif may change while the symmetry property remains the same.

Step 1: Test the first two designs In option (A), the vertical central divider maps onto itself after a

half-turn. The centred circle and outside square also map onto themselves, so the whole figure is unchanged. In option (B), the horizontal central divider, central diamond and outside square likewise remain in place under the same rotation. The different shapes of their inner motifs do not destroy their common half-turn symmetry.

Step 2: Check the third design In option (C), the upper-left corner square maps to the lower-right corner square. Their corresponding diagonal segments exchange places. The central small square with its two diagonals maps onto itself, and the unmarked upper-right and lower-left regions exchange. Every line therefore has a matching line after the half-turn. This design shares the same rotational symmetry as the first two.

Step 3: Locate the failure in the fourth design In option (D), the small axis-aligned square occupies the upper-left corner, but no corresponding small square occurs at the lower-right corner. Likewise the small diamond inside the large diamond lies near the bottom and has no matching diamond near the top. Rotating the figure by a half-turn moves these details to locations where no identical detail is drawn. Its large outside square and diamond alone are symmetric, but its complete design is not. Options (A), (B) and (C) therefore belong together, leaving (D) as the odd figure.

Step 4: Conclusion Only the fourth complete design lacks half-turn rotational symmetry. Hence, the correct option is (D).

Quick Tip to Solve: Rotate all the details mentally, not just the outside boundary; an unmatched small shape can break the symmetry of an otherwise symmetric frame.

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



(A) 

(B) 

(C) 

(D) 

Correct Answer: (A)

Solution:

Concept:

- Reflection in a vertical mirror line reverses left and right while preserving top and bottom.
- For a word, reflection reverses the order of the letters and reflects the shape of every individual letter. Reversing the letter order alone is insufficient.

Step 1: Determine the mirror direction The mirror axis X-X' is vertical and lies to the right of DAYLIGHTING. The last letter G is nearest the mirror, so its reflected image must be the first letter when the mirrored word is read from left to right. The full order must therefore correspond to G, N, I, T, H, G, I, L, Y, A, D. Each of these is a reflected glyph, not necessarily its ordinary printed form.

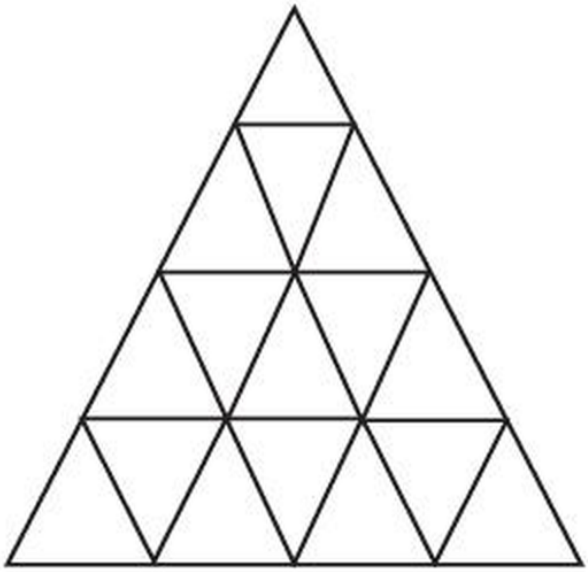
Step 2: Check asymmetric letters Examine the two G letters, the N, the L and the final D in the proposed image. Each must face the opposite way horizontally from its counterpart in the original word, while staying upright. Letters such as A, H, I, T and Y are vertically symmetric in the given simple lettering and can look unchanged. Their symmetry should not be mistaken for permission to rotate the whole word upside down.

Step 3: Eliminate the incorrect transformations Option (A) puts the letters in the required reversed order and gives the asymmetric letters the correct lateral reversal. Option (B) changes the vertical orientation of letters, including the A-shaped form, so it is not reflection in the shown vertical line. Option (C) reverses the order but retains incorrectly oriented asymmetric letter shapes. Option (D) also contains incorrectly oriented glyphs and mixes the transformations. Only the first answer consistently reflects both position and shape across X-X'.

Step 4: Conclusion The required mirror image is option (A). Hence, the correct option is (A).

Quick Tip to Solve: Check an asymmetric letter at each end, such as G and D, then check an interior L or N; letter order and glyph reversal must both agree.

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



(A) 27

(B) 26

(C) 23

(D) 22

Correct Answer: (A) 27

Solution:

Concept:

- Count triangles by their orientation and side length so that the same triangle is never counted twice.
- The supplied equilateral triangular grid has four unit divisions along each outer side. A triangle may point upwards or downwards, but all its sides must follow drawn grid lines.

Step 1: Count all upward triangles For a side of one unit, the upward triangles occur in rows containing 1, 2, 3 and 4, giving 10. For a side of two units, their possible apex positions form rows of 1, 2 and 3, giving 6. With side three units, there are 1+2=3 positions. Finally the entire outside triangle is the one triangle of side four units. Thus the upward subtotal is

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

Counting by side length includes composite triangles that span several small cells.

Step 2: Count the downward triangles The downward unit triangles occur in rows of 1, 2 and 3, giving 6. There is also one larger downward triangle of side two units: its top side lies on the second horizontal grid line, and its lower vertex lies on the centre of the bottom edge. A larger downward triangle cannot fit within the outer boundary. Thus the downward subtotal is

$$6 + 1 = 7.$$

Step 3: Combine the disjoint counts Every triangle in this grid belongs to exactly one of the two orientations and one of the listed side lengths, so the counts do not overlap. The required total is

$$20 + 7 = 27.$$

Option (B), 26, misses one triangle, commonly the larger downward triangle. Options (C), 23, and (D), 22, omit several composite triangles. Counting only the smallest cells cannot answer a question asking for the total number of triangles.

Step 4: Conclusion The diagram contains 27 triangles. Hence, the correct option is (A).

Quick Tip to Solve: Use a table with upward and downward rows and side-length columns; remember the single downward triangle of side two as well as the six small ones.

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

(A) 

(B) 

(C) 

(D) 

Correct Answer: (C) 

Solution:

Concept:

- A water image is a reflection in a horizontal line. It interchanges top and bottom while preserving the left-to-right positions of the letters.
- Each letter must undergo the same reflection. Reversing the spelling alone, or rotating the word through a half-turn, is not a water reflection.

Step 1: Keep the letters in their original order The word is FROG. On reflection in a horizontal water surface, F remains the leftmost letter, followed by R, O and G. Thus the required image must preserve this order of positions even though the individual letters appear upside down. The left vertical stroke of F stays on the left; its long upper horizontal stroke becomes the lower horizontal stroke.

Step 2: Check the asymmetric letter R R is especially useful for distinguishing the similar options. Its vertical stem remains on the left, its upper bowl moves below the middle, and its lower slanting leg moves above the middle on the right. Option (C) shows precisely this form. O is unchanged by the reflection because its oval outline has horizontal symmetry; G has its upper and lower details interchanged.

Step 3: Eliminate the other figures Option (A) displays the letters in the reverse order GORF without the required top-bottom inversion. Option (B) incorrectly places the reflected R stem on the right, so it does not apply a horizontal reflection consistently. Option (D) also reverses the left-to-right arrangement. Only option (C) preserves positions and reflects all letter details correctly.

Step 4: Conclusion The water image is the word with its letter positions unchanged and every letter reflected top to bottom, as in option (C). Hence, the correct option is (C).

Quick Tip to Solve: For a water image, keep the spelling positions fixed and check one asymmetric letter: the stem of R stays left while its bowl and leg exchange vertical positions.

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



(A) ENTABLATURE

(B) ƎЯUTAJBATNƎ

(C) ƎЯUTALBATNƎ

(D) ƎЯUTALBATNƎ

Correct Answer: (B) ƎЯUTAJBATNƎ

Solution:

Concept:

- Reflection in a vertical mirror interchanges left and right while preserving the top and bottom of every letter.
- The image must reverse both the order of the letters and each asymmetric letter shape. Letters with vertical symmetry, such as A, T and U in this font, retain their shape.

Step 1: Read outward from the mirror The vertical axis X–X′ is to the right of ENTABLATURE. The terminal E is closest to the mirror, so it becomes the leftmost letter in the reflected image. Moving through the original word from right to left gives the positional sequence E, R, U, T, A, L, B, A, T, N, E. These are positions only: each character also needs its own left-right reflection.

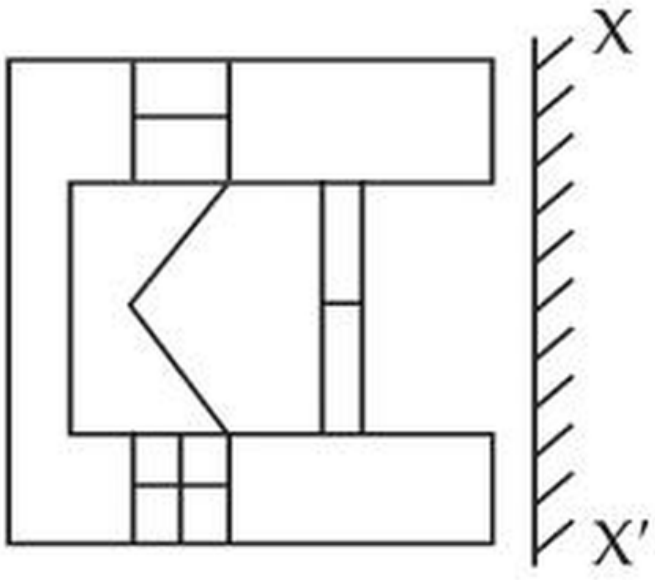
Step 2: Inspect the asymmetric characters Both E letters must have their vertical stroke on the right and their three strokes pointing left. R must have its stem on the right and its bowl and slanting leg toward the left. The L becomes a right-hand vertical stroke with a foot extending left. B must have its stem on the right with both rounded lobes on the left, and the diagonal of N must also reverse. Option (B) satisfies these checks.

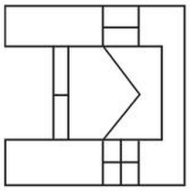
Step 3: Compare all four options Option (A) is simply the original readable word and has neither reversal. Option (C) leaves asymmetric letters such as its leading E and the central B in their ordinary orientations. Option (D) reverses some letters but retains an ordinary central B and L. These mixed orientations cannot result from one plane mirror. Option (B) alone consistently reflects the entire word.

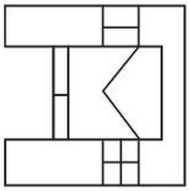
Step 4: Conclusion Option (B) reverses the letter order and all asymmetric letter shapes across the vertical axis. Hence, the correct option is (B).

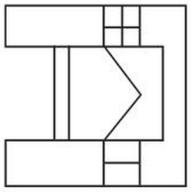
Quick Tip to Solve: After reversing the letter order, inspect E, L, B and R; symmetric A, T and U cannot distinguish a correct reflection from many distractors.

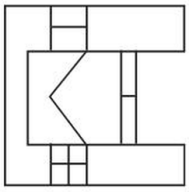
45. **Identify the correct mirror image of the given figure along X-X' axis :** [4 marks]

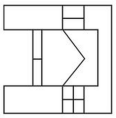


(A) 

(B) 

(C) 

(D) 

Correct Answer: (A) 

Solution:

Concept:

- A vertical mirror reverses horizontal positions and directions. Heights, vertical order, lengths and the number of subdivisions are preserved.
- To compare complex figures, track a few asymmetric landmarks rather than trying to recognise the complete outline at once.

Step 1: Reflect the outline and central chevron The original has its continuous outer upright on the left. Reflection in the vertical X–X′ line moves that upright to the right, with the projecting upper and lower bars extending left. The central bent line has its point directed left in the original; its image must point right. Option (A) has both the required right-hand outer upright and the right-pointing central chevron.

Step 2: Preserve the subdivision pattern The upper small strip of the original is divided into two cells by a horizontal line. It moves to the upper right in the image and must still contain just these two

vertically arranged cells. The lower small strip has both horizontal and vertical subdivisions, forming four cells. It moves to the lower right while retaining all four cells. The narrow divided strip originally on the right of the central region moves to its left. All these details agree with option (A).

Step 3: Reject the inconsistent transformations Option (B) has a central chevron pointing left, contrary to horizontal reversal. Option (C) has a right-pointing chevron but exchanges the upper and lower subdivision patterns: the four-cell block is at the top. A vertical mirror cannot swap heights. Option (D) retains the original left-hand upright and left-pointing chevron. Therefore none of these three represents the specified reflection.

Step 4: Conclusion Option (A) preserves the vertical order of all subdivisions while reversing every horizontal position and direction. Hence, the correct option is (A).

Quick Tip to Solve: For a vertical mirror, check one direction and one height-dependent detail: here use the chevron and the top two-cell versus bottom four-cell blocks.

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

(A) Royal Palm

(B) Rose

(C) Shisham

(D) Accacia

Correct Answer: (C) Shisham

Solution:

Concept:

- Furniture timber should combine strength and durability with suitable grain, workability and the ability to take a good finish.
- Shisham, also known as Indian rosewood and botanically Dalbergia sissoo, is an established hardwood used for furniture and cabinet work.

Step 1: Identify the recognised furniture hardwood Shisham supplies dense, strong timber with an attractive grain. It can be worked and polished to produce durable furniture, including tables, chairs, cabinets and similar joinery. Its combination of structural strength and decorative appearance makes it the standard match to the description of an excellent furniture hardwood. The botanical identity is useful because the trade name Indian rosewood should not be confused with the flowering rose plant.

Step 2: Distinguish the plant names in the options Royal Palm is a palm rather than a conventional hardwood timber tree with the wood structure normally used in furniture joinery. Rose ordinarily names the flowering shrub, not Shisham; the fact that Shisham is called rosewood does not make the option Rose equivalent to it. Neither (A) nor (B) is therefore the intended furniture timber.

Step 3: Assess the remaining timber option The option printed as Accacia refers to acacia. Various acacias do yield useful, sometimes durable timber, and some are used for furniture; it would be inaccurate to claim that no acacia can serve this purpose. Nevertheless, among the listed names, Shisham is the specific and conventional answer to this general building-materials identification

question. Its well-established furniture use distinguishes option (C) as the expected selection.

Step 4: Conclusion Shisham is the recognised furniture hardwood intended here. Hence, the correct option is (C).

Quick Tip to Solve: Remember the timber name together with its use: Shisham or Indian rosewood is a furniture hardwood; Rose by itself refers to a different plant.

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

(A) Warm colours (red, orange)

(B) Cool colours (blue, green)

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

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

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

Solution:

Concept:

- In conventional interior-design colour associations, blue and green are cool colours and are commonly associated with calm, freshness and restfulness.
- Warm colours such as red and orange tend to appear more energetic. A scheme classification does not by itself fix brightness or saturation, which also influence the mood.

Step 1: Match the room function to the colour effect Bedrooms are commonly designed to encourage rest, while bathrooms often aim for a quiet, fresh atmosphere. Blue and green are the conventional cool-colour choices associated with these effects. Their visual association with water, sky and vegetation helps explain why a cool scheme is the usual answer when a question asks for a calming interior palette. This is a typical design association rather than a claim that every person responds identically.

Step 2: Compare the warm and triadic choices Option (A) groups red and orange, which are normally associated with warmth, activity and stimulation rather than the restful quality specified. Option (C) lists a triadic combination of green, orange and purple. A triad combines separated hues around the colour wheel and can create a lively, varied contrast; it is not the specific cool palette described by the question.

Step 3: Distinguish primary colours from a cool palette Option (D) mixes red, blue and yellow. Calling these primary colours classifies their role in a traditional colour system, not a uniformly calming temperature or mood. It includes both warm and cool hues. Option (B), by contrast, explicitly groups the two cool colours blue and green, matching the requested effect. Muted saturation and appropriate lighting can further support a calm interior, but no such extra choice is required here.

Step 4: Conclusion The typically calming scheme is cool colours, especially blue and green. Hence, the correct option is (B).

Quick Tip to Solve: For questions about mood, distinguish colour temperature from colour-wheel relationships: cool blue-green schemes suggest calm, whereas a triad describes hue spacing.

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

(A) Archohm

(B) Arcop

(C) C.P. Kukreja

(D) Hafeez Contractor

Correct Answer: (B) Arcop

Solution:

Concept:

- Architectural-awareness questions require the correct association between a named building and its design practice.
- Bharat Mandapam, the international exhibition and convention complex at Pragati Maidan in New Delhi, is associated with ARCOP, working in collaboration with Aedas.

Step 1: Identify the project being named Bharat Mandapam refers to the exhibition and convention complex at Pragati Maidan, New Delhi. Identifying this project precisely matters because a familiar building name must be matched to its own design team, rather than to an architect merely known for other large Indian projects. The question asks for the architecture firm, so the required answer is a practice name rather than a contractor, government organisation or individual client.

Step 2: Match the building to its practice The relevant practice in the given list is ARCOP, printed as Arcop in option (B). ARCOP worked on the project in association with Aedas. This collaborative attribution is compatible with selecting Arcop: the option names a firm in the actual design team and the question does not state that the listed firm worked alone. The recognition task is therefore resolved by the building-to-practice association.

Step 3: Eliminate the other named practices Archohm in option (A), C.P. Kukreja in option (C), and Hafeez Contractor in option (D) are distinct architectural practices. None is the matching practice for this project in the alternatives presented. General familiarity with their names does not establish authorship of Bharat Mandapam. Select the directly associated firm, Arcop, rather than inferring authorship from the scale of the project or the prominence of another architect.

Step 4: Conclusion Bharat Mandapam is associated with ARCOP, in collaboration with Aedas; the matching listed firm is Arcop. Hence, the correct option is (B).

Quick Tip to Solve: Learn landmark associations as building–place–practice triples: Bharat Mandapam–Pragati Maidan, New Delhi–ARCOP, with Aedas.

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

(A) Door

(B) Column

(C) Railing

(D) Floor

Correct Answer: (B) Column

Solution:

Concept:

- An architectural analogy is solved by identifying the function or building element associated with each term, rather than matching the sounds of the words.
- A gable is the usually triangular upper part of an end wall between the sloping edges of a pitched roof. A pier is a substantial vertical support, commonly of masonry, that carries a load from above.

Step 1: Identify the first association The word gable belongs to roof construction: its outline is formed by the two slopes of a pitched roof at the end of a building. Thus the first pair connects a named architectural feature with the building element to which it is closely related. It does not describe a material, colour or decorative pattern.

Step 2: Match the corresponding support A pier is a vertical load-bearing member used to support an arch, beam or other construction above it. In its structural role it corresponds most closely to a column. Both transfer loads downward, although a pier is often more massive or built of masonry and need not have the slender proportions of a classical column.

Step 3: Eliminate the other elements A door is an opening closure that permits access; it is not a vertical structural support of the kind described. A railing is primarily a protective barrier at an edge or stair. A floor is a horizontal surface that supports occupants and activities. None has the same direct structural association with a pier that a column has.

Step 4: Conclusion The corresponding architectural element is a column. Hence, the correct option is (B).

Quick Tip to Solve: For building-element analogies, identify whether each term concerns a roof, an opening, a vertical support or a horizontal surface before comparing the choices.

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

[4 marks]

(A) Gothic

(B) Baroque

(C) Mughal

(D) Renaissance

Correct Answer: (C) Mughal

Solution:

Concept:

- A chhatri is a small elevated, often domed pavilion or canopy supported on columns. Its umbrella-like form makes it a recognisable architectural feature.
- Chhatris occur prominently in Indian architecture, including Rajput and Mughal buildings; a feature need not belong exclusively to one tradition to identify the best option.

Step 1: Recognise the architectural feature The term chhatri describes a pavilion-like element with a roof, often a dome, supported by columns. Chhatris may appear at roof level, on terraces or at the corners of a monumental building. Their light, open-sided form provides a decorative silhouette above heavier walls and larger masses.

Step 2: Associate it with the listed tradition Mughal architecture makes extensive use of domes, arches and rooftop pavilions, including chhatris. Among the four architectural styles listed, Mughal is therefore the direct match. The presence of chhatris in Rajput architecture does not undermine this choice, since Rajput is not a competing option here.

Step 3: Rule out the European styles Gothic architecture is characteristically associated with pointed arches, ribbed vaults and flying buttresses. Baroque architecture is associated with dramatic movement, elaborate ornament and spatial effects. Renaissance architecture emphasises classical orders, proportion and revived ancient forms. Chhatris are not the characteristic decorative element of any of these three styles.

Step 4: Conclusion Chhatris are most likely to be encountered in Mughal architecture among the given choices. Hence, the correct option is (C).

Quick Tip to Solve: Remember the umbrella-shaped, column-supported pavilion when you encounter the word chhatri; distinguish it from the main dome and from a minaret.

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

[4 marks]

(A) Golden ratio

(B) Newton's constant

(C) Moore's law

(D) Symmetry ratio

Correct Answer: (A) Golden ratio

Solution:

Concept:

- Proportion describes a relationship between dimensions, such as the length and width of a rectangle or the larger and smaller divisions of a line.
- The golden ratio is the positive ratio for which the whole is to the larger part as the larger part is to the smaller part. It is conventionally denoted by φ.

Step 1: Express the proportional relationship Let the larger segment have length a and the smaller segment length b, with $a > b > 0$. The defining relationship is

$$\frac{a+b}{a} = \frac{a}{b} = \varphi.$$

This describes a specific dimensionless proportion, so it can be applied to lengths without depending on their units.

Step 2: Find and identify the ratio Since $a/b = \varphi$, the same relationship gives $1 + 1/\varphi = \varphi$. Therefore

$$\varphi^2 - \varphi - 1 = 0, \qquad \varphi = \frac{1+\sqrt{5}}{2} \approx 1.618.$$

The positive root is the relevant one because both lengths are positive. This is the well-known golden ratio used in discussions of aesthetics, art and architectural proportion.

Step 3: Distinguish the distractors Newton's constant is a physical constant associated with gravitation, not a proportion for composing building forms. Moore's law concerns a trend in semiconductor technology, not a geometric division. Symmetry describes correspondence under a transformation such as reflection; the phrase symmetry ratio does not name the specific celebrated proportion asked for here.

Step 4: Conclusion The golden ratio is the named architectural proportion in the question. Hence, the correct option is (A).

Quick Tip to Solve: Recognise the golden ratio from whole : larger = larger : smaller, or from its approximate value 1.618; symmetry alone is a different design concept.

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

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

(A) To increase the interior space

(B) To act as a wind breaker

(C) To provide thermal comfort

(D) To support the weight of the roof

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

Solution:

Concept:

- A roof truss is a framework of connected members, commonly arranged in triangles, that spans between supports and carries loads from the roof.
- Its primary role is structural: loads pass through the truss members and then into the supporting walls or columns. Secondary design benefits should not be confused with this main function.

Step 1: Identify the load to be supported A roof has weight from its covering and other permanent components. It can also experience imposed and environmental loads. The roof truss provides the framework needed to carry the roof across a span and transfer its loads to suitable supports instead of leaving the covering unsupported.

Step 2: Follow the load path In an idealised pin-jointed truss, individual members act mainly in axial tension or compression. The triangular arrangement resists changes of shape and distributes forces through the framework. Loads are delivered to the truss bearings and from there to the walls or columns and ultimately the foundations. This directly matches supporting the weight of the roof.

Step 3: Separate primary function from other effects A truss may allow a useful clear span, but increasing interior space is not its primary structural purpose. Although the whole roof system must resist wind effects, a truss is not principally a wind-breaking screen. Thermal comfort mainly depends on factors such as insulation, ventilation and roof construction; the truss alone does not provide that function.

Step 4: Conclusion The primary function of a roof truss is to support the weight of the roof. Hence, the correct option is (D).

Quick Tip to Solve: For questions about a structural member, trace the load it receives and the supports to which it transfers that load before considering architectural benefits.

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

(A) Maharaja Jai Singh - II

(B) Ushtad Ahmad Lahouri

(C) Maharaja Sawai Pratap Singh

(D) Ustad Khalil

Correct Answer: (C) Maharaja Sawai Pratap Singh

Solution:

Concept:

- Identifying a monument requires distinguishing its location, the ruler who commissioned it and the architect who designed it. These names need not be the same.
- Hawa Mahal is the celebrated palace facade in Jaipur associated with Maharaja Sawai Pratap Singh. Its construction dates to 1799.

Step 1: Identify the monument named The question specifies Hawa Mahal at Jaipur, so the answer must refer to that particular building rather than to the founding of Jaipur or to another royal monument. Hawa Mahal is widely recognised for its elaborate facade with numerous small windows, known as jharokhas.

Step 2: Match the patron to the options Hawa Mahal was built under the patronage of Maharaja Sawai Pratap Singh. The phrase built by in this question refers to the ruler responsible for commissioning the monument. This identifies the third option directly; it does not require interpreting the ruler as personally carrying out its design or masonry.

Step 3: Check the competing names Maharaja Jai Singh II is associated with founding Jaipur, but that is a different achievement from commissioning Hawa Mahal. Ustad Ahmad Lahouri is associated with Mughal architecture and the Taj Mahal, not with the patronage of this Jaipur palace. Ustad Khalil is likewise not the ruler who commissioned Hawa Mahal. The named patron in option (C) therefore provides the specific historical match, while the other choices confuse different persons and associations.

Step 4: Conclusion Hawa Mahal at Jaipur was built by Maharaja Sawai Pratap Singh. Hence, the correct option is (C).

Quick Tip to Solve: Keep monument, city and patron together in revision: Hawa Mahal–Jaipur–Sawai Pratap Singh. Do not substitute the founder of the city for the patron of a later building.

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

(A) Polishing the surface

(B) Adding artificial pigments

(C) Using high grade cement

(D) Using stones in the mix

Correct Answer: (D) Using stones in the mix

Solution:

Concept:

- Concrete contains aggregate particles held in a cementitious matrix. In an exposed-aggregate finish, the outer appearance is dominated by visible particles such as stones or pebbles.
- The distinctive texture results from exposing the aggregate at the surface, usually by removing some surface mortar. The aggregate supplies the visible texture and colour variation.

Step 1: Interpret the name of the finish Exposed aggregate means that the aggregate is visible instead of being completely hidden by the smooth cement-paste surface. Stones at or near the surface create a granular, irregular appearance. Their size, shape and colour determine much of the finished visual effect.

Step 2: Connect the appearance to the material Of the listed choices, using stones in the mix supplies the particles responsible for the exposed texture. After placement, a controlled finishing process reveals those particles by removing a thin layer of surface mortar. Simply including stones is not the complete finishing procedure, since ordinary concrete also contains aggregate, but it identifies the relevant material among the alternatives.

Step 3: Exclude the other proposed causes Polishing is primarily a smoothing process and is not what produces the rough relief of a typical exposed-aggregate surface. Artificial pigments change colour but do not themselves create the texture of visible stones. Using high-grade cement concerns the binder and its performance; it does not expose the aggregate or generate the characteristic particle pattern. The stone aggregate is therefore the decisive choice.

Step 4: Conclusion The appearance comes from stone aggregate made visible at the surface; among the given choices, using stones in the mix is the appropriate answer. Hence, the correct option is (D).

Quick Tip to Solve: When a finish is called exposed aggregate, focus on the visible stone particles. Remember that surface mortar must be removed to reveal them; pigment alone changes colour, not particle texture.

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

(A) Is derived from ancient Greek architecture

(B) Focuses on decoration and ornamentation

(C) Focuses on functionality and simple geometric forms

(D) Uses traditional building materials

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

Solution:

Concept:

- The International Style is a modern architectural approach associated with simple geometric volumes, functional planning and little applied ornament.
- Its visual character comes from proportion, regularity, open space and the expression of modern construction, rather than the copying of historical decoration.

Step 1: Identify the defining design approach Look for the option describing the way the building is organised and expressed. International Style buildings commonly use clear rectangular forms, flat roofs and relatively unadorned surfaces. Their plans respond to use, while structural frames can allow open interiors and broad areas of glazing. Functionality and simple geometric forms therefore match the description in option (C).

Step 2: Eliminate the historical and ornamental descriptions Option (A) points towards classical or Greek-derived architecture, with its historical orders and related formal vocabulary; that is not the defining basis of the International Style. Option (B) makes decoration and ornamentation central, whereas this style generally avoids applied historical ornament. Option (D) does not identify the style: traditional materials may occur in a particular building, but their use is not its defining principle. Modern steel, reinforced concrete and glass are much more closely associated with its development.

Step 3: Conclusion The International Style is characterised by functional planning and simple geometric forms. Hence, the correct option is (C).

Quick Tip to Solve: Associate International Style with clear volumes, functional planning and minimal applied ornament; do not confuse it with classical revival architecture.

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

(A) Glass

(B) Stucco

(C) Steel

(D) Timber

Correct Answer: (B) Stucco

Solution:

Concept:

- A facade finish forms the visible outer surface of a building and can influence its texture, appearance and protection from weather.
- Stucco is a plaster-like coating applied to a suitable substrate; its surface can be worked into characteristic rough, patterned or textured finishes.

Step 1: Match the material to the surface description The question joins two clues: a textured surface and common use as a facade finish. Stucco is applied as a workable coating and finished with tools or other techniques before it hardens. This allows a range of textures, including coarse and patterned surfaces. It therefore directly matches the architectural finishing material described in the question. Its role as a surface coating is particularly relevant to the word finishing.

Step 2: Compare the remaining materials Glass in ordinary facade glazing is associated mainly with smooth transparent or reflective surfaces, so option (A) is not the intended textured coating. Steel, option (C), is used structurally and as metal cladding; a textured plaster finish is not its characteristic identity. Timber, option (D), has visible grain and can form textured cladding, but it is a wood product rather than the applied render commonly identified by this description. These materials can be specially treated, yet stucco is the most direct match to the stated conventional use.

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

Quick Tip to Solve: When a facade question describes an applied textured plaster or render, look for stucco; distinguish it from glass, metal and timber cladding.

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

(A) B.V. Doshi

(B) Bimal Patel

(C) Charles Correa

(D) U.C. Jain

Correct Answer: (B) Bimal Patel

Solution:

Concept:

- Architect-identification questions require the correct association between a named project and its designer, rather than a general association with Indian architecture.
- The Central Vista Redevelopment Project in New Delhi is associated with architect Bimal Patel and his practice, HCP Design, Planning and Management.

Step 1: Identify the project named in the question The decisive word is Redevelopment. It refers to the modern Central Vista project rather than the original planning and construction of the colonial capital. The architect associated with this redevelopment is Bimal Patel. Thus the relevant project-designer pair is Central Vista Redevelopment–Bimal Patel, which is exactly the association offered by option (B).

Step 2: Distinguish the other architects B.V. Doshi, option (A), is a major Indian architect associated with projects such as Sangath and Aranya housing, but he is not the designer identified with this redevelopment. Charles Correa, option (C), is associated with works such as Jawahar Kala Kendra and the Gandhi Smarak Sangrahalaya, rather than the Central Vista Redevelopment Project. U.C. Jain, option (D), is also an Indian architect, but the project named here is not attributed to him. Being a prominent architect alone does not establish the required project association; the specific attribution selects Bimal Patel.

Step 3: Conclusion The Central Vista Redevelopment Project was designed by Bimal Patel. Hence, the correct option is (B).

Quick Tip to Solve: Keep the original planning of New Delhi separate from its Central Vista redevelopment; the redevelopment cue points to Bimal Patel.

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

(A) Gustave Eiffel

(B) Frank Llyod Wright

(C) John Russel Pope

(D) Tom Wright

Correct Answer: (B) Frank Llyod Wright

Solution:

Concept:

- A landmark must be identified together with its location, because museums sharing a name can occupy buildings designed by different architects.
- The Solomon R. Guggenheim Museum in Manhattan, New York, was designed by Frank Lloyd Wright and is recognised for its spiral interior ramp and curved form.

Step 1: Use the location to identify the building The question specifies Manhattan in New York City. This identifies the Solomon R. Guggenheim Museum, whose design is by Frank Lloyd Wright. Its continuous ramp winds around a central open space, linking the visitor's movement with the museum's distinctive architecture. Option (B), despite the spelling used in the question, names this architect. The location is essential: a reference to another Guggenheim museum would require checking a different designer.

Step 2: Reject the other architect associations Gustave Eiffel, option (A), is associated with the Eiffel Tower and engineering works, not the design of this New York museum. John Russell Pope, named in option (C), is associated with monumental classical buildings such as the Jefferson Memorial; he did not design the Manhattan Guggenheim. Tom Wright, option (D), is associated with the Burj Al Arab in Dubai, not this museum. None of these alternatives gives the correct landmark-designer pairing.

Step 3: Conclusion Frank Lloyd Wright designed the Guggenheim Museum in Manhattan, New York City. Hence, the correct option is (B).

Quick Tip to Solve: Remember New York Guggenheim–Frank Lloyd Wright–spiral ramp. Always check the city before matching a Guggenheim museum to its architect.

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

(A) Indian Institute of Architects

(B) Council of Architecture

(C) Council of Indian Architects

(D) Institute of Architect of India

Correct Answer: (B) Council of Architecture

Solution:

Concept:

- Professional registration is maintained by a statutory regulatory body; it is distinct from membership of a professional association.
- The Council of Architecture is the statutory body responsible for maintaining the register of architects in India under the Architects Act, 1972.

Step 1: Identify the function asked about The question asks which organisation maintains registration, so the relevant function is the formal register of architects. The Council of Architecture performs this role in India. The answer follows from the body's statutory responsibility, rather than from whether an organisation provides professional meetings, publications or representation. This makes option (B) the direct match to the function described.

Step 2: Distinguish registration from professional membership The Indian Institute of Architects, option (A), is a professional organisation. Membership of such an association is not the same as entry in the statutory register maintained by the Council of Architecture, so (A) does not answer the question. Council of Indian Architects, option (C), is not the name of the statutory registration body. Institute of Architect of India, option (D), likewise does not name that body. Similar-sounding words such as council, institute and architects cannot replace the exact institutional name and its function.

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

Quick Tip to Solve: Link registration with the Council of Architecture; keep statutory registration separate from membership of the Indian Institute of Architects.

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

(A) The layout of columns

(B) Materials used for roofing

(C) Windows and openings

(D) Construction of walls

Correct Answer: (C) Windows and openings

Solution:

Concept:

- Fenestration describes the arrangement and design of windows and other openings in a building's external envelope.
- The size, spacing, proportion and placement of openings affect the appearance of a facade as well as daylight, views and ventilation.

Step 1: Interpret the architectural term To discuss fenestration is to discuss a building's windows and openings: where they occur, how large they are and how they are arranged on the facade. A regular series of windows, for example, establishes a visible rhythm, while their size and position influence the light entering rooms. The description in option (C), windows and openings, captures this meaning directly. It concerns the treatment of openings rather than the complete structural system of the building.

Step 2: Separate openings from other building elements Option (A), the layout of columns, concerns the arrangement of structural supports or a column grid. Option (B), materials used for roofing, concerns the construction and covering of the roof. Option (D), construction of walls, concerns how the enclosing wall itself is made. Windows may be located within walls and coordinated with structural bays, but neither wall construction nor column layout is the definition of fenestration. The specific term remains the arrangement and treatment of openings.

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

Quick Tip to Solve: Recall fenestration by thinking of the pattern of windows across a facade: their number, size, proportions and spacing are the relevant features.

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

(A) I.M. Pie

(B) Louis XII

(C) F.L. Wright

(D) Le Corbusier

Correct Answer: (A) I.M. Pie

Solution:

Concept:

- A building-identification question is answered by matching the named project to its architect, rather than by choosing a famous architect at random.
- The National Gallery of Art in Washington, D.C., has distinct buildings. I. M. Pei designed its East Building; this is the project associated with the architect in the choices.

Step 1: Identify the relevant project The association tested here is the National Gallery of Art East Building and I. M. Pei. Its strongly geometric design is characteristic of this project. The name printed as I.M. Pie in option (A) refers to I. M. Pei. The distinction between the East Building and the original West Building matters: the West Building was designed by John Russell Pope, so Pei should not be described as the architect of every part of the gallery.

Step 2: Eliminate the other names Louis XII, option (B), was a French monarch and is not the architect of this gallery building. Frank Lloyd Wright, option (C), is associated with the Solomon R. Guggenheim Museum in New York, a different museum. Le Corbusier, option (D), is a major modern architect but is not the designer of the National Gallery of Art East Building. Thus none of these three alternatives supplies the project–architect pairing required here.

Step 3: Conclusion The intended architect is I. M. Pei, specifically for the East Building of the National Gallery of Art. Hence, the correct option is (A).

Quick Tip to Solve: For museum questions, remember the full building name and city; different buildings of one museum can have different architects.

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

(A) International Standard of Instruments

(B) Indian Standards of Isometrics

(C) International Standards of Isometrics

(D) Indian Standards Institute

Correct Answer: (D) Indian Standards Institute

Solution:

Concept:

- ISI is the historical abbreviation for the Indian Standards Institution, the predecessor of the Bureau of Indian Standards.

- Expand an institutional abbreviation using the actual organisation name. Similar-sounding technical words such as instruments or isometrics do not identify that organisation.

Step 1: Recall the institution behind the abbreviation ISI refers to the Indian Standards Institution, which was established in 1947. Its name remains familiar through the ISI certification mark associated with conformity to Indian product standards. The expansion therefore begins with Indian Standards and ends with the name of an institution, rather than naming a branch of engineering drawing.

Step 2: Compare the printed expansions Option (D), Indian Standards Institute, is the intended answer among the supplied choices, although the precise historical name uses Institution, not Institute. Option (A) incorrectly substitutes International and Instruments. Option (B) begins with Indian Standards but ends with Isometrics, which refers to a drawing or projection context and is not the institution name. Option (C) also uses Isometrics and wrongly begins with International. These are not alternative official expansions of ISI.

Step 3: Conclusion ISI correctly expands to Indian Standards Institution. Option (D) is the intended choice, with Institute used there in place of Institution. Hence, the correct option is (D).

Quick Tip to Solve: Remember ISI as the former Indian standards institution; do not confuse its name with an international body or with isometric drawing.

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

(A) Cairo

(B) Athens

(C) Paris

(D) Rome

Correct Answer: (B) Athens

Solution:

Concept:

- The Parthenon is an ancient Greek temple on the Acropolis of Athens, associated with the goddess Athena.
- Monument-location questions require the city containing the particular building; a city with other ancient monuments is not enough.

Step 1: Locate the Parthenon The Parthenon stands on the Acropolis, the elevated historic citadel of Athens in Greece. Its identification belongs to Greek classical architecture. The combination of the names Parthenon, Acropolis and Athena therefore points directly to Athens, the city in option (B). This is a location association, not a comparison of the ages or architectural importance of the four cities.

Step 2: Check each alternative city Cairo in option (A) is in Egypt and is not the location of this Greek temple. Paris in option (C) is in France; do not confuse the Parthenon in Athens with the similarly named Pantheon in Paris. Rome in option (D) is in Italy and also has a building called the Pantheon, but the Pantheon and Parthenon are different monuments. Athens is the only listed city that contains the Parthenon itself, so the other three choices can all be rejected without changing the building

named in the question.

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

Quick Tip to Solve: Keep the names separate: Parthenon goes with the Acropolis of Athens, while the Pantheon is a different building name.

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

(A) Perception and Rejuvenation And Spiritual Association Drive

(B) Pilgrimage Rejuvenation and Spiritual Augmented Drive

(C) Pilgimage Regeneration and Social Association Drive

(D) Perception and Reform Analysis in social and Demography

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

Solution:

Concept:

- PRASAD is the abbreviation for Pilgrimage Rejuvenation and Spiritual Augmentation Drive.
- The scheme concerns pilgrimage destinations and their tourism infrastructure. Its expansion must retain both the pilgrimage and spiritual components.

Step 1: Expand the scheme name Read the abbreviation through its meaningful words: P for Pilgrimage, R for Rejuvenation, A for And, S for Spiritual, A for Augmentation and D for Drive. The expansion links the renewal of pilgrimage destinations with improvement of the visitor experience. The official word is Augmentation, a noun meaning enhancement, rather than the adjective Augmented.

Step 2: Evaluate the printed options Option (B) is the intended choice because it contains Pilgrimage, Rejuvenation, Spiritual and Drive in the required order; its word Augmented is an imprecise rendering of Augmentation. Option (A) starts with Perception and substitutes Association, so it does not name the pilgrimage scheme. Option (C) substitutes Regeneration and Social Association, which are not the expansion. Option (D) uses Perception, Reform, Analysis and Demography, none of which gives the required scheme name. Thus the intended matching alternative is identifiable even though its wording is not exact.

Step 3: Conclusion The exact expansion is Pilgrimage Rejuvenation and Spiritual Augmentation Drive. Option (B) is the intended answer, with Augmented printed in place of Augmentation. Hence, the correct option is (B).

Quick Tip to Solve: Remember PRASAD through pilgrimage and spiritual development, and retain the exact noun Augmentation in its expansion.

65. **Match List - I with List - II.**

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

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

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

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

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

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

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

Solution:

Concept:

- Match each architect to the year in which that architect received the Pritzker Architecture Prize.
- The letters (A)–(D) identify people in List I, while the Roman numerals (I)–(IV) identify award years in List II. The final option letter is a separate label.

Step 1: Match all four laureates B. V. Doshi received the prize in 2018, giving (A)–(III). Philip Johnson received the first Pritzker Architecture Prize in 1979, giving (B)–(IV). Tadao Ando received the prize in 1995, giving (C)–(II). Zaha Hadid received the prize in 2004, giving (D)–(I). Therefore the Roman-numeral sequence, read in the order of List I, is (III), (IV), (II), (I).

Step 2: Test the offered sequences Option (A) gives precisely this sequence. Option (B) incorrectly assigns Philip Johnson to 1995 and Tadao Ando to 1979. Option (C) begins by assigning Doshi to 1995, which already contradicts his 2018 award; it also misassigns the other laureates. Option (D) likewise assigns Doshi to 1995 and places Johnson in 2004, so it cannot be correct. Checking every pairing avoids selecting a sequence merely because one familiar person is matched correctly.

Step 3: Conclusion The correct matching is Doshi–2018, Johnson–1979, Ando–1995 and Hadid–2004. Hence, the correct option is (A).

Quick Tip to Solve: Use Johnson–1979 as an anchor, then verify the remaining three years in List I order before choosing the option.

66. **Match List - I with List - II.**

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

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

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

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

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

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

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

Solution:

Concept:

- Match a monument with its function or the figure it represents, not just with its geographical location.
- A temple, cathedral, amphitheatre and symbolic statue have different architectural or commemorative roles. These differences make the four descriptions distinguishable.

Step 1: Identify each monument The Colosseum in Rome is an amphitheatre, so (A) matches (IV). The Parthenon in Athens is the temple dedicated to Athena, so (B) matches (I). Milan Cathedral is a Christian church in Italy, so (C) matches (II). The Statue of Liberty represents Liberty in a personification associated with the Roman goddess Libertas, so (D) matches (III). The last pairing describes what the statue represents, not a claim that the modern statue is an ancient Roman construction.

Step 2: Check the complete sequence Reading the matches in List I order gives (IV), (I), (II), (III), which appears in option (C). Option (A) wrongly calls the Colosseum the goddess of freedom and makes the Statue of Liberty an amphitheatre. Option (B) gets the Colosseum right but incorrectly matches the Parthenon to the Italian church. Option (D) assigns the Colosseum to the goddess description and the Parthenon to the amphitheatre. Hence no other option preserves all four identities.

Step 3: Conclusion In List I order, the matching descriptions are Roman amphitheatre, temple of Athena, church in Italy and Roman goddess of freedom. Hence, the correct option is (C).

Quick Tip to Solve: First separate building functions from symbolic figures: amphitheatre, temple, church and Liberty give four distinct matches.

67. Match List - I with List - II.

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

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

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

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

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

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

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

Solution:

Concept:

- Architectural terms distinguish an element by its position, form and function. A column capital, a railing member and a roof ornament are different parts of a building.
- A matching question requires a consistent one-to-one association of all four entries, not merely a familiar word in one pair.

Step 1: Identify the upper part of the column An abacus is the slab forming the uppermost part of a classical column capital. It lies above the moulded or decorated portion of the capital and immediately below the member carried by the column. Thus, among the descriptions provided, Abacus matches (II), top part of column. It is not the tapered roof ornament described by (III).

Step 2: Distinguish the two upright members A bollard is a short, freestanding post or column, commonly used to restrict vehicle access or mark an edge. Therefore Bollard matches (IV). A baluster is one of the repeated vertical members supporting the handrail of a railing or balustrade. Thus Baluster matches (I). Being upright does not make these two members interchangeable: the railing function identifies the baluster.

Step 3: Complete the match and check the options A pinnacle is a tapered upright architectural feature rising above a roof or parapet, so Pinnacle matches (III). The complete correspondence is A–II, B–IV, C–I, D–III. The second option gives this sequence. The first assigns a roof feature to the abacus; the third assigns the freestanding post description to it. The fourth starts with the correct abacus match but wrongly makes the bollard a tapered roof feature and the baluster a freestanding column.

Step 4: Conclusion The matches are Abacus–II, Bollard–IV, Baluster–I and Pinnacle–III. Hence, the correct option is (B).

Quick Tip to Solve: Use location to separate similar upright forms: a baluster belongs to a railing, a bollard stands free, and a pinnacle rises above a roof.

68. **Match List - I with List - II.**

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

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

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

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

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

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

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

Solution:

Concept:

- Gloss describes the degree of specular shine from a surface. A high-gloss coating produces stronger mirror-like reflections than a matt coating.
- The conventional order of increasing sheen is matt, satin, semi-gloss and glossy. The names describe surface appearance, not the hue of the paint.

Step 1: Match the two extremes Matt has the lowest level of gloss among the listed finishes. Its subdued appearance gives little specular shine, so A matches (IV). Glossy is the shiniest of these four finishes and has the highest level of gloss; hence D matches (II). These two endpoint matches establish the direction of the scale before the intermediate finishes are considered.

Step 2: Place the intermediate finishes Satin has a soft lustre resembling the sheen of silk rather than a strongly mirror-like reflection. Therefore Satin matches (I), silk like gloss. Semi-gloss is visibly shinier than satin while remaining below a fully glossy finish. Therefore Semi-gloss matches (III), more gloss than a satin finish. The two middle descriptions must not be interchanged.

Step 3: Check every proposed sequence The required sequence for A, B, C and D is IV, I, III, II. The fourth option alone gives that order. The first and third options both assign the highest gloss to matt, contradicting its low-sheen character. The second correctly identifies matt and glossy, but gives satin the description belonging to semi-gloss and semi-gloss the silk-like description belonging to satin; it therefore fails the complete matching test.

Step 4: Conclusion The correct correspondence is A–IV, B–I, C–III, D–II. Hence, the correct option is (D).

Quick Tip to Solve: Anchor the extremes first: matt is least shiny and glossy is most shiny. Then place satin below semi-gloss.

69. Given below are two statements :

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

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

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

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

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

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

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

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

Solution:

Concept:

- Human scale relates architectural dimensions and proportions to human body size, movement, reach and perception.
- Monumental scale deliberately exceeds ordinary human dimensions to suggest grandeur, ceremony or institutional importance. Intimacy instead depends on a more personally relatable enclosure.

Step 1: Evaluate Statement I A space designed at human scale allows people to use and understand its elements comfortably. Door openings, steps, handrails, seating and room proportions can be related to bodily dimensions and everyday activity. The statement describes design dimensions that are comfortable for human interaction, which captures this relationship between architecture and its users. Statement I is therefore correct.

Step 2: Evaluate Statement II An intimate, cozy space usually uses dimensions and an enclosure that feel close and familiar to its occupants. Monumental scale, with unusually large heights, broad approaches or massive elements, is normally used to evoke awe and grandeur. It can be appropriate for ceremonial halls and public monuments, but it is not the scale most suitable for intimacy. Statement II reverses these associations and is incorrect.

Step 3: Select the required truth combination The truth values are: I is correct and II is incorrect. Option (A) wrongly accepts the claim about cozy spaces. Option (B) wrongly rejects the correct definition of human scale, and option (D) reverses both truth values. Only option (C) preserves the distinction between dimensions related to everyday human use and dimensions intended to appear grand.

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

Quick Tip to Solve: Associate human scale with comfortable everyday interaction, and monumental scale with grandeur rather than coziness.

70. Given below are two statements :

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

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

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

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

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

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

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

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

Solution:

Concept:

- Additive colour mixing combines light. Its standard three primaries are red, green and blue; adding their light in suitable proportions produces white.
- Traditional artists use a red-yellow-blue primary system for pigments. Its elementary secondary colours are orange, green and violet, formed by mixing pairs of primaries.

Step 1: Test the mixing system named in Statement I A triangular arrangement can display three primaries and mixtures between them. However, the statement explicitly describes an additive combination and then names yellow, red and blue as the primaries. These claims do not describe the same standard colour system. Additive light mixing uses red, green and blue, whereas red, yellow and blue belong to the traditional artists' pigment system. The word additive makes Statement I incorrect as written; the triangular arrangement alone does not remove that error.

Step 2: Evaluate the definition in Statement II In the elementary artists' colour model invoked by the listed primaries, equal mixtures of two primaries produce a secondary colour: red and yellow give orange, yellow and blue give green, and blue and red give violet. Thus Statement II correctly states the basic rule for secondary colours. Mixing unequal proportions can shift a mixture toward one constituent, which is why equal amounts are specified in the elementary definition.

Step 3: Check the answer against the literal wording Statement I is incorrect and Statement II is correct, giving option (D). Option (A) would require overlooking the incompatible additive terminology in Statement I. Option (B) rejects the valid secondary-colour rule, and option (C) both accepts the mixing-system error and rejects that rule. Retaining the exact word additive is decisive; replacing it by a pigment-mixing description would change the question.

Step 4: Conclusion As worded, the additive-primary claim in Statement I is incorrect, while Statement II is correct. The reason is that yellow-red-blue is not the standard additive-light primary set. Hence, the correct option is (D).

Quick Tip to Solve: Before judging a colour-mixing claim, identify the medium: additive light uses RGB; traditional artists' pigment theory uses RYB.

71. Given below are two statements :

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

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

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

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

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

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

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

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

Solution:

Concept:

- The Sun supplies the energy that drives Earth's weather and supports photosynthesis. Daylight and seasonal solar variation also depend on Earth's motions and axial orientation.
- Latitude expresses angular position north or south of the equator. The equatorial plane is the reference plane, with the equator assigned zero latitude.

Step 1: Evaluate the solar statement in its intended sense Sunlight illuminates the side of Earth facing the Sun, while Earth's rotation produces the daily alternation of day and night. Earth's axial tilt and revolution cause seasonal changes in the distribution of solar energy. Solar heating drives evaporation and atmospheric circulation, contributing to rain and wind. Plants use sunlight for photosynthesis, and human life depends on the resulting energy supply directly or through food chains. Thus the Sun is fundamental to the listed processes, although rotation and tilt are also necessary to explain their patterns. Statement I is correct in this broad sense.

Step 2: Check the angular reference for latitude Latitude is measured with respect to the equatorial plane, toward the north or south. In the usual spherical-Earth picture, it is the angle between the line from Earth's centre to the place and that plane. It is zero at the equator and increases toward ninety degrees at a pole. The statement identifies the correct equatorial reference and therefore correctly describes latitude; it does not confuse it with longitude, which uses a reference meridian.

Step 3: Compare the options Both statements are correct. Option (B) rejects both correct descriptions. Option (C) rejects the correct reference plane for latitude, while option (D) rejects the broad role of solar energy and illumination. Neither of these mixed combinations agrees with the two evaluations.

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

Quick Tip to Solve: Keep the angular references separate: latitude is north or south of the equator; longitude is east or west of a reference meridian.

72. Given below are two statements :

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

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

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

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

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

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

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

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

Solution:

Concept:

- Humidity concerns water vapour present in air. Precipitation is water falling from the atmosphere to the surface, such as rain, snow, sleet or hail.
- Rainfall measurement converts the collected water into an equivalent depth over a horizontal area. A rain gauge measures this depth, commonly in millimetres, over a specified interval.

Step 1: Distinguish precipitation from humidity Prevailing humidity conditions describe the moisture content of the air, or quantities such as relative humidity. They do not define precipitation. Humid air can exist without rain, and falling rain is an event involving liquid drops rather than merely water vapour held in the atmosphere. Precipitation is the collective term for water falling in liquid or solid forms. Statement I therefore gives the definition of a different atmospheric property and is incorrect.

Step 2: Interpret the measurement in Statement II A rain gauge collects precipitation over a known opening, and the collected quantity is expressed as the equivalent depth of water. For example, rainfall can be reported as a number of millimetres over a day; dividing depth by the duration gives an average rate in millimetres per time unit. Solid precipitation is expressed by its water equivalent where appropriate. The statement's reference to rain gauges and millimetres per time unit is consistent with precipitation measurement over a specified interval. Statement II is correct.

Step 3: Select the truth combination The evaluations give I incorrect and II correct. Option (A) wrongly treats precipitation as prevailing humidity. Option (B) wrongly rejects the rain-gauge measurement statement. Option (C) reverses both evaluations by accepting the incorrect definition and rejecting the valid measurement description. Option (D) alone represents the literal meanings of the two statements.

Step 4: Conclusion Statement I is incorrect and Statement II is correct. The reason is that precipitation is falling water, not prevailing humidity. Hence, the correct option is (D).

Quick Tip to Solve: Distinguish moisture in the air from water falling out of it: humidity describes the former, while a rain gauge measures the latter.

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



(A) Nagara style

(B) Dravidian style

(C) Orissan style

(D) Vesara style

Correct Answer: (B) Dravidian style

Solution:

Concept:

- The form of the tower above the shrine is a principal clue for identifying an Indian temple style. Inspect its overall silhouette before the smaller carved details.
- A Dravidian vimana rises in successive, diminishing horizontal storeys, producing a stepped pyramidal outline. A Nagara shikhara usually has a predominantly curvilinear rising profile.

Step 1: Identify the dominant tower form The tall tower on the left of the photograph has clearly separated horizontal tiers. Each upper tier is narrower than the tier below it, so the sides rise in a stepped, pyramidal profile. A comparatively small crowning element completes the summit. The lower portions also contain dense sculptural detailing and pillared architectural elements.

Step 2: Match the visible form to the style This tiered pyramidal vimana is the decisive feature of Dravidian temple architecture. The identification rests on the structure visible in the photograph, rather than merely on the presence of carvings: elaborate ornament occurs in several Indian traditions and cannot by itself distinguish them.

Step 3: Eliminate the remaining styles Option (A), Nagara, is associated with the northern curvilinear shikhara, which is not the main tower outline here. Option (C), Orissan, belongs to the Kalinga tradition, whose characteristic soaring rekha-deul sanctum tower differs from this tiered southern vimana; a stepped roof on an Orissan hall alone should not be confused with the whole temple style. Option (D), Vesara, denotes a mixed Deccan tradition; the photograph instead displays the clear pyramidal, storeyed form used to recognize Dravidian architecture.

Step 4: Conclusion The stepped pyramidal vimana identifies the temple as Dravidian style. Hence, the correct option is (B).

Quick Tip to Solve: Compare the main shrine tower: a clearly tiered pyramid points to Dravidian architecture, while a curved shikhara points to Nagara architecture.

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



(A) Qutub Minar

(B) Jama Masjid

(C) Taj Mahal

(D) Hagia Sophia

Correct Answer: (B) Jama Masjid

Solution:

Concept:

- A building is recognized by the combination of its overall massing, towers, domes, entrance and facade. One isolated feature, such as a dome, may occur in many monuments.
- The photographed mosque has a broad red-sandstone facade, a tall central arched entrance, pale domes and two slender flanking minarets.

Step 1: Read the photograph as a whole The image shows a long, symmetrical mosque facade. Its central gateway rises above the lower arcade and contains a large pointed arch. Three pale domes rise behind the facade, and two tall minarets stand at its outer sides. The red sandstone surfaces and lighter decorative bands provide a further identifying contrast.

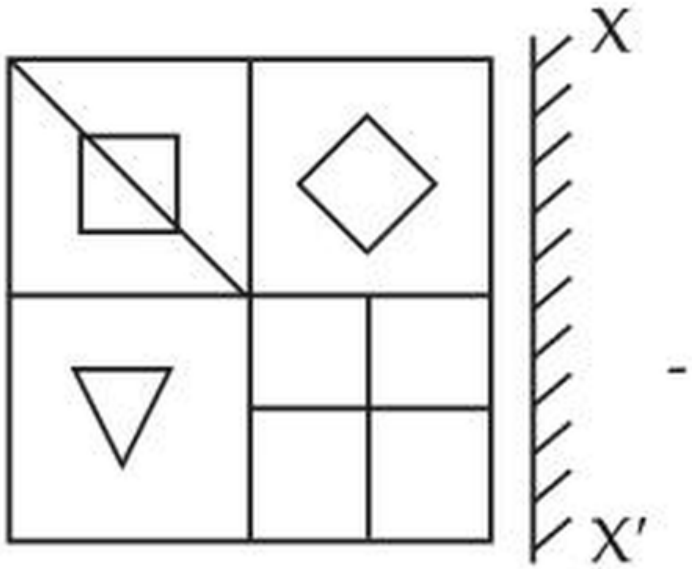
Step 2: Identify the monument These features match the Jama Masjid in Delhi: the broad prayer-hall facade, central projecting entrance, three domes and pair of tall minarets appear together in the photograph. The answer depends on this complete arrangement, rather than on simply choosing any building associated with Islamic architecture.

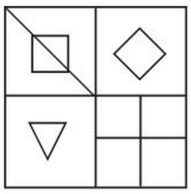
Step 3: Check the other options Option (A), Qutub Minar, is principally a single tall tapering tower and does not match the wide domed prayer-hall front shown here. Option (C), Taj Mahal, is a white-marble mausoleum dominated by a large central dome and four detached corner minarets; its overall form and material differ from this photograph. Option (D), Hagia Sophia, has a massive central dome supported by a composition of semi-domes and buttressed volumes, rather than this three-domed red-sandstone facade. Thus none of these alternatives matches the building pictured.

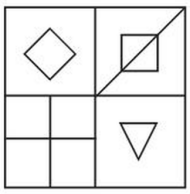
Step 4: Conclusion The photograph shows Jama Masjid. Hence, the correct option is (B).

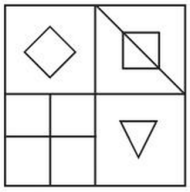
Quick Tip to Solve: Identify the combination of three pale domes, a red facade, a prominent central arch and two tall outer minarets; do not decide from a dome alone.

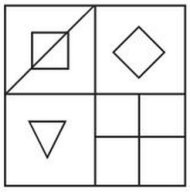
75. Identify the correct mirror image of the given figure along X-X' axis : [4 marks]

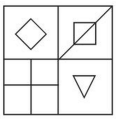


(A) 

(B) 

(C) 

(D) 

Correct Answer: (B) 

Solution:

Concept:

- Reflection in a vertical mirror exchanges left and right positions while preserving height. Relative to a vertical axis at $x = a$, a point (x, y) maps to $(2a - x, y)$.
- A reflected figure must preserve every internal detail as well as the positions of its larger parts. A diagonal reverses its left-to-right slope under a vertical reflection.

Step 1: Exchange the left and right quadrants The X-X' mirror line is vertical and lies to the right of the given square. Therefore the original upper-right diamond moves to the upper-left quadrant of the image. The original lower-right four-cell grid moves to the lower-left. The downward-pointing triangle moves from the lower-left to the lower-right; it still points down because reflection in a vertical line does not interchange top and bottom.

Step 2: Reflect the detailed upper-left quadrant The original upper-left quadrant contains a small

square crossed by a diagonal descending from the outer upper-left corner to the central junction. After reflection this whole quadrant lies at the upper-right. Its diagonal must rise from the central junction toward the outer upper-right corner, and must pass through the corresponding opposite corners of the small square. Option (B) has exactly this configuration.

Step 3: Reject the near matches Option (A) leaves the arrangement unchanged, so its diamond and grid remain on the wrong side. Option (C) exchanges the main quadrants, but its upper-right diagonal still descends from left to right, which is not the reflected diagonal. Option (D) reverses the diagonal while leaving the diamond, triangle and grid in their original quadrants. Only option (B) reflects both the positions and the internal detail correctly.

Step 4: Conclusion The correct reflection along the vertical X-X' axis has the diamond at upper-left, the grid at lower-left, the triangle at lower-right and the rising diagonal at upper-right. Hence, the correct option is (B).

Quick Tip to Solve: For a vertical mirror, check the quadrant positions first, then one asymmetric detail such as a diagonal. Correct positions alone do not guarantee the right image.

Drawing Test (100 marks)

76. Use monochromatic colour rendering technique, light and shadow to represent its depth and intensity. Draw the sketch of the given image using the above instructions. [50 marks]



Solution:

Concept:

- Monochromatic rendering uses one hue with a range of light and dark values. Depth comes from the contrast between raised surfaces, recessed areas, highlights and shadows, rather than from changing the hue.
- A faithful study of a detailed image begins with its large shapes, proportions and visible crop. Small decorative patterns are added only after the main masses and tonal relationships are established.

- The supplied image contains an elaborate ornamental headdress above the visible upper part of a face. Its curved horizontal bands, floral motifs and circular side ornaments organize the composition.

Step 1: Establish the frame and major proportions Plan the sketch within a rectangle matching the proportions of the reference. Lightly place a vertical centre line and mark the main horizontal levels: the broad headdress, its lower decorative band, the forehead and the visible eyes. Preserve the reference crop: the image continues beyond the frame, so do not invent a complete head or body. Block in the large central headdress mass and the two curved side regions before drawing any ornament.

Step 2: Construct the main decorative forms Map the curved, approximately horizontal bands across the headdress, keeping their spacing and curvature consistent with the reference. Place the larger flower-like motifs and the circular side ornaments at the appropriate heights. Establish the forehead outline, eyebrows and visible facial features with light construction lines. Check the widths of the central crown and side ornaments against the face, and correct these proportions before strengthening the contours.

Step 3: Choose one hue and organize the values Use a single hue, such as a neutral graphite grey or a brown monochrome, throughout the rendering. Reserve the paper or the lightest tint for the brightest raised edges. Establish a light middle value for illuminated surfaces, a darker middle value for turned planes and a deep value for recesses and narrow gaps. The reference already provides the tonal arrangement: follow its bright ridges and dark recesses consistently rather than introducing conflicting highlights. Keep the overall light-dark pattern clear when the sketch is viewed from a distance.

Step 4: Model relief with light and shadow Render the crown bands as curved relief forms. Let their upper or exposed ridges remain relatively light and deepen the narrow recesses below and between them. Around the floral ornaments, use a dark background or small contact shadows to separate the raised petals and beads. Gradually change tone across rounded forms, while keeping a sharper edge where one form overlaps another. Apply the darkest values selectively to deep grooves and occluded areas; making every outline equally black would flatten the relief.

Step 5: Develop texture without losing the hierarchy Add the repeated beads, petal shapes, wavy bands and small incised patterns after the large tonal masses are secure. Reduce the strength of tiny marks in less prominent areas so that the face and major ornaments remain readable. Use controlled strokes that follow the curvature of a band or circular ornament. Preserve small highlights between dark details and avoid filling every gap with the same tone. Recheck the facial features against the reference so that decorative detail does not distort the expression.

Step 6: Unify and finish the monochrome study Compare the final sketch with the reference for the visible silhouette, placement of the circular ornaments, curvature of the crown and alignment of the eyes. Strengthen only the darkest recesses that are needed to create depth, lift or lighten selected highlights and soften intermediate transitions on rounded surfaces. Remove unnecessary construction lines. Keep the background subordinate and maintain one consistent hue across the whole image, using tonal intensity to distinguish the decorative planes and shadows.

Step 7: Conclusion The finished composition should reproduce the visible ornamental headdress

and upper face in a single hue, with clear proportional structure and a controlled range from light highlights to deep recess shadows. Curved tonal transitions and contact shadows should make the relief appear three-dimensional while preserving the supplied framing.

Quick Tip to Solve: Build the large light-dark masses before the tiny ornaments. Keep one hue throughout, and save the deepest shadows and brightest highlights for the relief details that establish depth.

77(a). Use five different types of crackers and make a beautiful 3D sculpture for Diwali mela. You can scale each cracker to any size of your choice. Usage of minimum 4 colours is compulsory. [50 marks]

Solution:

Concept:

- A successful three-dimensional composition combines recognisable forms into one balanced sculptural arrangement, with depth shown through perspective, overlap, shading and cast shadows.
- The composition must use five different cracker types, may change their relative scale, and must visibly use at least four colours. A clear hierarchy makes the sculpture readable at a glance.

Step 1: Choose five distinct forms Plan a festival sculpture using an upright conical flowerpot cracker, a cylindrical sky rocket, a circular ground wheel, a string of small cylindrical crackers and a slender sparkler. Make their visual identities distinct: show the rocket with its pointed cap and stick, the ground wheel as a circular disc with radial divisions, the string as a linked succession of short cylinders, and the sparkler as a thin rod with a textured upper portion. These are visual elements of the proposed sculpture rather than five unrelated pictures.

Step 2: Arrange a balanced three-dimensional structure Place a broad enlarged ground wheel as a low circular base, drawn as an ellipse in perspective. Build the main group above it, with the conical flowerpot slightly left of centre and the taller rocket rising behind and to the right. Curve the cracker string around the lower group to connect the forms and direct the eye upwards. Let the sparkler form a lighter diagonal accent. Vary the scales deliberately, keeping the broad base large enough to support the appearance of the taller elements. Show clear overlaps and contact points so the arrangement reads as one sculpture for the Diwali mela.

Step 3: Set perspective, lighting and colour Choose a viewpoint slightly above the base so its top surface and the sides of the main forms are visible. Keep receding edges consistent and draw circular cross-sections as ellipses with matching orientation. Use a single light source from the upper left: leave lit surfaces lighter, darken the opposite sides gradually, and add contact shadows where forms meet. Use at least four clearly distinct colours, for example red, yellow, blue and green, repeated in a controlled rhythm. Add limited orange accents if desired, without losing the four-colour requirement or the visibility of each cracker type.

Step 4: Finish the festive presentation Keep the background quiet, with a simple ground plane and a cast shadow anchoring the sculpture. Small decorative bands or a restrained festival setting can suggest the mela without competing with the central object. Strengthen the nearest contours, keep distant edges lighter, and clean construction lines. Finally check that all five types remain identifiable, the arrangement looks three-dimensional rather than flat, no component appears accidentally

disconnected, and at least four colours are unmistakable.

Step 5: Conclusion A coherent solution is a balanced festive sculpture built from the five distinct cracker forms, unified by scale, overlap, consistent perspective and light, and finished with at least four visible colours.

Quick Tip to Solve: Make a small silhouette thumbnail first. If the five forms merge into one unreadable mass, adjust their scale or spacing before developing colour and shading.

OR

77(b). Draw a beautiful sketch of a basket ball court where players are playing a match and audience are enjoying. Use suitable colours of your choice. [50 marks]

Solution:

Concept:

- A convincing activity scene combines a consistent perspective setting with human figures whose poses explain the action.
- The question requires a basketball court, players actively playing, an audience enjoying the match, and suitable colour. Composition, scale and colour should make all four demands visible.

Step 1: Establish the viewpoint and court Choose a viewpoint from a raised corner beside the court so that the playing surface, a basket and the audience are all visible. Lay out the rectangular court in perspective, with its long edges converging consistently towards a vanishing point. Include the halfway line, centre circle shown as an ellipse, and the key area and arc near the visible basket. Draw the backboard, ring and support with proportions consistent with the chosen viewpoint. Keep court markings subordinate to the action, but clear enough to identify the setting immediately.

Step 2: Compose an active moment Make the focal action a player approaching the basket or jumping for a shot, with the ball clearly visible above the hands. Place a defender reaching or turning towards the ball and teammates moving into supporting positions. Use bent knees, angled torsos and outstretched arms to communicate motion; avoid arranging every figure in the same upright pose. Show overlapping bodies carefully so each limb belongs to the correct player. Players farther across the court should be smaller and slightly less detailed than those in the foreground.

Step 3: Include an engaged audience Arrange seated and standing spectators beyond the sideline or in low stands, separate from the playing area. Show enjoyment through several readable gestures, such as clapping, raised hands and people leaning forward to follow the ball. Group the audience into varied clusters rather than a rigid row of identical heads. Their scale must decrease with distance, and their strongest outlines should not compete with the main players. Preserve an uncluttered space around the focal ball-and-basket action so it remains easy to read.

Step 4: Apply colour and finish the depth Use contrasting but coordinated team colours, for example blue and red jerseys, so the two sides are distinguishable. Give the court a warm neutral surface and use lighter or more subdued colours for the distant spectators and background. Keep one consistent light direction; add contact shadows under shoes and soft cast shadows to anchor players to the

ground. Model forms with a few controlled tonal changes rather than heavy outlines everywhere. Check the perspective of court and backboard together, remove stray construction lines, and ensure the final sketch includes both the match action and visibly enthusiastic spectators.

Step 5: Conclusion The final composition should show a recognisable basketball court in consistent perspective, an energetic match as the focal point, an enjoying audience, and a coordinated colour scheme with convincing depth.

Quick Tip to Solve: Place the ball, attacking player and basket as a clear visual triangle; then build the defenders and spectators around that action without blocking it.