JEE Main 2024 Paper 2A (B.Arch) Apr 12 Single sitting Question Paper with Solutions PDF

Question Paper with Solutions

Conducted by the National Testing Agency (NTA)

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

General Instructions

(i) This paper is Paper 2A (B.Arch.) of JEE (Main) 2024, Session 2 (April), conducted by the National Testing Agency (NTA) in Computer Based Test (CBT) mode on 12 April 2024, Shift 1. The total duration is 3 hours.

(ii) The paper has 82 questions: Mathematics (30), Aptitude Test (50), Drawing Test (2), in that order. Maximum marks: 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 10 numerical value questions; attempt any 5 of them. 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.

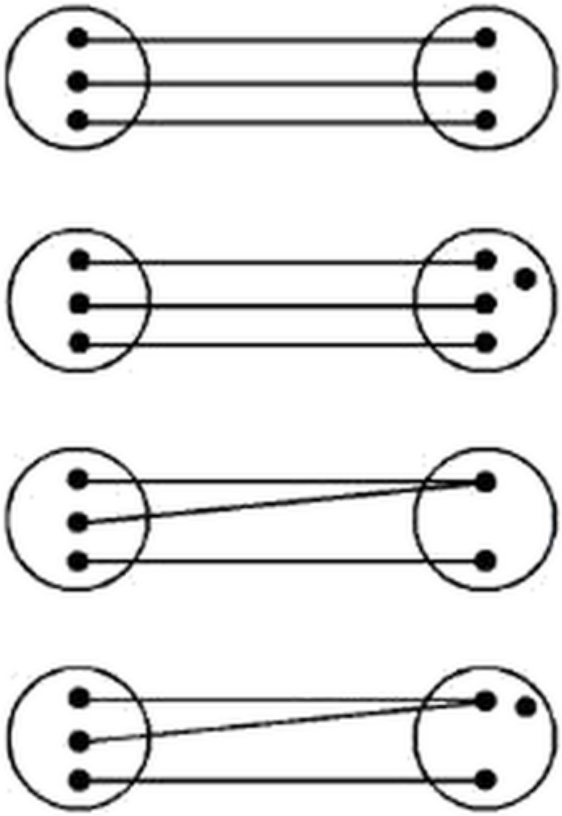
(vii) Calculators, log tables, slide rules and electronic gadgets are not allowed.

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

1. Match List I with List II. In List I, A, B, C and D are the four diagrams shown below, in order from top to bottom.

List II	
I.	Neither surjective nor injective
II.	Surjective but not injective
III.	Injective but not surjective
IV.	Injective and surjective

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



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

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

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

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

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

Solution:

Concept:

- A function is injective (one-one) when different domain elements have different images. If two domain elements reach the same codomain element, it is not injective.

- A function is surjective (onto) when every codomain element is the image of at least one domain element. An unused codomain element makes the function non-surjective.

Step 1: Classify diagrams A and B In A, the three domain elements reach three distinct codomain elements, and all three codomain elements are reached. Thus A is both injective and surjective, giving A–IV. In B, the three domain elements again have distinct images, but the additional point on the right has no preimage. Thus B is injective but not surjective, giving B–III. The unused point affects surjectivity, not injectivity.

Step 2: Classify diagrams C and D In C, the upper two domain elements have the same image, while the lowest domain element reaches the other codomain element. Every codomain point is reached, but distinct inputs share an output. Thus C is surjective but not injective, giving C–II. In D, the upper two domain elements again share an image, and the extra point at the right is not reached. Both tests fail: D is neither injective nor surjective, giving D–I.

Step 3: Compare the proposed matches The complete matching is A–IV, B–III, C–II, D–I. Option (A) interchanges the classifications of B and C. Option (B) incorrectly makes A neither injective nor surjective. Option (D) incorrectly treats C as non-surjective and D as surjective. Only option (C) agrees with all four diagrams.

Step 4: Conclusion $\boxed{\text{A–IV, B–III, C–II, D–I}}$. Hence, the correct option is (C).

Quick Tip to Solve: Check shared outputs for injectivity and unused codomain points for surjectivity; these are two independent tests.

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2. A college awarded 38 medals for cricket, 15 for tennis and 20 for football. If these medals were bagged by a total of 58 students and only 3 students got medals for all the three games, then how many students received medals for exactly two of the three games? [4 marks]

(A) 9

(B) 18

(C) 12

(D) 6

Correct Answer: (A) 9

Solution:

Concept:

- A student receiving medals in several sports belongs to several sets, but is counted only once in their union. The sum of the three set sizes counts each such membership separately.
- If x_j students receive medals in exactly j sports, the excess of the membership total over the union total is $x_2 + 2x_3$.

Step 1: Count memberships and distinct recipients The sum of the three medal counts is

$$38 + 15 + 20 = 73.$$

The union contains 58 students. A recipient in exactly one sport contributes one to each count and hence no excess. A recipient in exactly two sports contributes two memberships but only one student, producing an excess of one. A recipient in all three produces an excess of two. Thus the difference is not itself the requested number.

Step 2: Remove the excess due to three-sport recipients Let x be the number receiving medals in exactly two games. The three students receiving medals in all three games account for an excess of $2 \times 3 = 6$. Therefore

$$x + 2(3) = 73 - 58 = 15, \qquad x = 9.$$

As a consistency check, the remaining $58 - 9 - 3 = 46$ students receive exactly one medal category, and $46 + 2(9) + 3(3) = 73$. Options 18, 12 and 6 do not satisfy this membership count; in particular, 6 counts the excess from triple recipients rather than the two-game students.

Step 3: Conclusion Exactly 9 students received medals for exactly two games. Hence, the correct option is (A).

Quick Tip to Solve: Subtract the union from the sum of set sizes, then subtract twice the number in all three sets to get the exactly-two count.

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3. If α and β are the roots of $ax^2 + bx + c = 0$, then the value of $\frac{1}{(a\alpha+b)^2} + \frac{1}{(a\beta+b)^2}$ is [4 marks]

(A) $\frac{b^2-2c}{c^2}$
(B) $\frac{b^2-2ac}{(ac)^2}$
(C) $\frac{b^2-2c}{c}$
(D) $\frac{b^2-2ac}{ac}$

Correct Answer: (B) $\frac{b^2-2ac}{(ac)^2}$

Solution:

Concept:

- For $ax^2 + bx + c = 0$, with $a \neq 0$, Vieta's relations give $\alpha + \beta = -b/a$ and $\alpha\beta = c/a$.
- The expression requires nonzero denominators; equivalently here $c \neq 0$. Use the sum of the roots to replace each linear denominator by a multiple of the other root.

Step 1: Rewrite both denominators From $a(\alpha + \beta) = -b$, we get

$$a\alpha + b = -a\beta, \qquad a\beta + b = -a\alpha.$$

Squaring eliminates the minus signs. Consequently the required sum becomes

$$S = \frac{1}{a^2\beta^2} + \frac{1}{a^2\alpha^2} = \frac{\alpha^2 + \beta^2}{a^2\alpha^2\beta^2}.$$

This approach avoids explicitly finding the two roots and works for real or complex roots.

Step 2: Substitute the symmetric root expressions The numerator is

$$\alpha^2+\beta^2=(\alpha+\beta)^2-2\alpha\beta=\frac{b^2-2ac}{a^2}.$$

The denominator is

$$a^2\alpha^2\beta^2=a^2\left(\frac{c}{a}\right)^2=c^2.$$

Therefore

$$S=\frac{b^2-2ac}{a^2c^2}=\frac{b^2-2ac}{(ac)^2}.$$

Options A and C omit the factor a in the cross term; option D has an unsquared denominator. For a quick test, roots 1 and 2 with $a=1, b=-3, c=2$ give $1/4+1=5/4$, agreeing with the derived formula.

Step 3: Conclusion The value is $\frac{b^2-2ac}{(ac)^2}$, whenever the original expression is defined. Hence, the correct option is (B).

Quick Tip to Solve: Use $a\alpha+b=-a\beta$ before expanding: the denominators then become symmetric in the two roots.

4. Let $A=\begin{bmatrix}1&2&3&4\\5&6&7&8\\9&9&9&9\\8&8&8&8\end{bmatrix}$**, then determinant of** $A=$ [4 marks]

(A) -1

(B) 0

(C) 1

(D) 72

Correct Answer: (B) 0

Solution:

Concept:

- A determinant is zero if two rows are proportional, since its rows are then linearly dependent.
- Replacing a row by itself plus a multiple of another row leaves the determinant unchanged. A matrix with a zero row has determinant zero.

Step 1: Identify proportional rows The last two rows are

$$R_3=(9,9,9,9),\qquad R_4=(8,8,8,8).$$

Every entry of R_3 is $9/8$ times the corresponding entry of R_4. Thus

$$R_3=\frac{9}{8}R_4.$$

This single relation suffices to establish dependence; there is no need to expand the fourth-order determinant into minors or use the first two rows.

Step 2: Create a zero row and evaluate Perform the determinant-preserving operation

$$R_3 \longleftarrow R_3 - \frac{9}{8}R_4.$$

The new third row is $(0, 0, 0, 0)$. Expanding the resulting determinant along this row gives zero, because each cofactor is multiplied by a zero entry. Since the operation preserves the determinant, the original matrix also has determinant zero. The values -1, 1, and 72 are all nonzero and therefore cannot be compatible with the displayed proportional rows. Notice that the product $9 \times 8 = 72$ has no determinant significance: individual entries cannot replace a dependence test. As another check, every column has identical third and fourth coordinates across the columns, so subtracting the first column from the others makes their last two entries vanish, consistent with deficient rank.

Step 3: Conclusion $\det A = 0$. Hence, the correct option is (B).

Quick Tip to Solve: Before expanding a large determinant, scan for equal or proportional rows and columns; one such pair makes it zero.

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5. In how many ways can we select four cards from an ordinary pack of playing cards so that two of them are of the same denomination and the remaining two are of some other same denomination?

[4 marks]

(A) 78

(B) 150

(C) 715

(D) 5616

Correct Answer: 2808; none of the listed options is correct.

Solution:

Concept:

- An ordinary pack contains 13 denominations, with 4 suits of each denomination. Selecting a hand means order of the four cards is irrelevant.
- A two-pair hand uses two distinct denominations and two distinct suits within each chosen denomination. Independent choices multiply, while identical descriptions of the same hand must not be counted twice.

Step 1: Choose the denominations and suits Choose the two denominations as an unordered pair:

$$\binom{13}{2} = 78.$$

For each denomination, choose two of its four cards, giving $\binom{4}{2} = 6$ choices independently. Hence the

number of hands is

$$\binom{13}{2}\binom{4}{2}\binom{4}{2} = 78 \times 6 \times 6 = 2808.$$

Choosing two different denominations ensures that a four-of-a-kind hand is excluded and that the two pairs have the required distinct ranks.

Step 2: Check for duplicate counting and compare options Alternatively, first name a denomination, then another: there are 13×12 ordered choices. Choosing two cards of each gives $13\times12\times6\times6 = 5616$ descriptions. But every actual hand appears twice, once with either denomination named first. Dividing by $2!$ again gives 2808. Thus option D, 5616, is the ordered-description count, not the number of selections. Option A, 78, chooses only denominations and ignores suits. Options B and C likewise do not equal the complete count. No ordering condition or distinguished first pair appears in the question, so the factor of two cannot be retained.

Step 3: Conclusion The number of selections is 2808. None of the printed options equals this value; option (D) counts every selection twice. Therefore the printed question has no correct listed option.

Quick Tip to Solve: For two pairs, choose the two ranks with $\binom{13}{2}$, not 13×12; the latter orders the pairs and doubles the hand count.

6. If the coefficient of x^7 and x^8 in the expansion of $\left(2+\frac{x}{3}\right)^n$ are equal, then n is [4 marks]

(A) 56

(B) 55

(C) 45

(D) 15

Correct Answer: (B) 55

Solution:

Concept:

- The coefficient of x^r in $(2+x/3)^n$ is $c_r = \binom{n}{r}2^{n-r}3^{-r}$, for a nonnegative integer exponent n.
- For adjacent nonzero coefficients, a ratio cancels most factors: $c_{r+1}/c_r = (n-r)/(6(r+1))$.

Step 1: Write the two coefficient formulas The coefficients under consideration are

$$c_7 = \binom{n}{7}\frac{2^{n-7}}{3^7}, \qquad c_8 = \binom{n}{8}\frac{2^{n-8}}{3^8}.$$

We take $n \geq 8$, as required for both stated powers to occur in the expansion. Equating these expressions and dividing by the positive coefficient c_7 gives

$$1 = \frac{c_8}{c_7} = \frac{\binom{n}{8}}{\binom{n}{7}}\frac{1}{2}\frac{1}{3}.$$

Both the constant 2 and the divisor 3 must be retained in this ratio.

Step 2: Simplify and verify the exponent The ratio of the combinatorial factors is

$$\frac{\binom{n}{8}}{\binom{n}{7}} = \frac{n-7}{8}.$$

It follows that

$$1 = \frac{n-7}{48}, \qquad n-7 = 48, \qquad n = 55.$$

Substitution gives $c_8/c_7 = (55-7)/48 = 1$, verifying equality. The other proposed values give ratios $49/48$ for 56, $38/48$ for 45, and $8/48$ for 15, all different from one. The answer is therefore unique among the printed choices. The ratio method also avoids computing either enormous coefficient separately, reducing the problem to a linear equation in the exponent.

Step 3: Conclusion $n = 55$. Hence, the correct option is (B).

Quick Tip to Solve: For equal adjacent coefficients, divide the later coefficient by the earlier one; include the ratio of both binomial terms and constant powers.

7. The sum of all those terms of the arithmetic progression 2, 6, 10, 14, ... , 598 which are not divisible by 3, is equal to [4 marks]

(A) 30300

(B) 30000

(C) 29400

(D) 30600

Correct Answer: (B) 30000

Solution:

Concept:

- For an arithmetic progression with first term a, common difference d, and last term l, the number of terms is $N = (l-a)/d + 1$ and its sum is $N(a+l)/2$.
- The required sum equals the sum of all terms minus the sum of those divisible by 3. The latter terms also form an arithmetic progression.

Step 1: Find the sum of the whole progression The first term is 2, the common difference is 4, and the last term is 598. Hence

$$N = \frac{598-2}{4} + 1 = 150.$$

The total sum is therefore

$$S = \frac{150}{2}(2+598) = 75(600) = 45000.$$

This includes both the permitted terms and the terms that must be excluded.

Step 2: Identify and subtract the multiples of three The general term is $a_k = 2 + 4(k-1) = 4k-2$. Divisibility by 3 requires $k - 2 \equiv 0 \pmod 3$, so the relevant indices are $2, 5, 8, \ldots, 149$. The excluded

terms are consequently $6, 18, 30, \ldots, 594$, with common difference 12. Their count and sum are

$$M = \frac{594 - 6}{12} + 1 = 50, \qquad S_3 = \frac{50}{2}(6 + 594) = 15000.$$

Thus the required sum is

$$S - S_3 = 45000 - 15000 = 30000.$$

As a count check, exactly 100 terms remain. The values 30300, 29400, and 30600 do not result from subtracting this complete progression; in particular, neither endpoint 2 nor 598 should be excluded.

Step 3: Conclusion The sum of the terms not divisible by 3 is $\boxed{30000}$. Hence, the correct option is (B).

Quick Tip to Solve: For a divisibility restriction in an AP, find the first and last excluded terms before subtracting their AP sum from the total.

8. The first two terms of a G.P. are x^{-3} and x^n, respectively. If x^{42} is the sixth term of the same progression, then n^2 is equal to [4 marks]

(A) 16

(B) 9

(C) 36

(D) 25

Correct Answer: (C) 36

Solution:

Concept:

- In a geometric progression, $T_k = ar^{k-1}$, where a is the first term and r is the common ratio.
- When all terms are expressed as powers of the same nondegenerate base, their exponents form an arithmetic progression.

Step 1: Express the common ratio The first and second terms are $a = x^{-3}$ and $T_2 = x^n$. Since the first term contains a negative power, $x \neq 0$. Their quotient gives

$$r = \frac{x^n}{x^{-3}} = x^{n+3}.$$

The exponent increment is $n + 3$, not $n - 3$: dividing powers subtracts the denominator exponent, which here is negative.

Step 2: Use the sixth term and solve for the exponent There are five common-ratio factors between the first and sixth terms. Therefore

$$T_6 = x^{-3}\left(x^{n+3}\right)^5 = x^{-3+5n+15} = x^{5n+12}.$$

Comparing this with the stated sixth term x^{42} gives the intended exponent identity

$$5n + 12 = 42, \qquad 5n = 30, \qquad n = 6.$$

Hence $n^2 = 36$. To check, the successive exponents are

$$-3,\ 6,\ 15,\ 24,\ 33,\ 42,$$

whose common difference is 9. The squared alternatives $16, 9, 25$ would give $n = \pm 4, \pm 3, \pm 5$, none satisfying $5n + 12 = 42$. As usual for a symbolic GP of powers, exponent comparison treats the relation as an identity in x; choosing a special base such as $x = 1$ would erase the exponent information and is not the interpretation of the question.

Step 3: Conclusion We obtain $n = 6$, so $\boxed{n^2 = 36}$. Hence, the correct option is (C).

Quick Tip to Solve: Write the exponents as an AP: the sixth exponent is the first exponent plus five times the increment.

9. Suppose L is the line joining the points $(0, 0)$ and $(1, 2)$. If a line parallel to L meets the curve $y = 2x^2 + 3x + 1$ only at a single point P, then the point P is [4 marks]

(A) $\left(\frac{1}{4}, \frac{3}{8}\right)$
(B) $(2, 15)$
(C) $\left(\frac{-1}{4}, \frac{3}{8}\right)$
(D) $\left(\frac{-3}{4}, \frac{5}{16}\right)$

Correct Answer: (C) $\left(\frac{-1}{4}, \frac{3}{8}\right)$

Solution:

Concept:

- The slope of a line through (x_1, y_1) and (x_2, y_2) is $(y_2 - y_1)/(x_2 - x_1)$. Parallel lines have equal slopes.
- A nonvertical line meeting this parabola at just one point gives a repeated root after substitution. Equivalently, its slope equals the derivative at tangency.

Step 1: Find the slope and tangency condition The line L joins $(0, 0)$ and $(1, 2)$, so its slope is

$$m = \frac{2 - 0}{1 - 0} = 2.$$

Write the parallel line as $y = 2x + c$. Substituting into the parabola gives

$$2x + c = 2x^2 + 3x + 1 \quad \Longrightarrow \quad 2x^2 + x + (1 - c) = 0.$$

Only one intersection means that this quadratic has a repeated real root. Thus its discriminant must vanish:

$$1 - 8(1 - c) = 0 \quad \Longrightarrow \quad c = \frac{7}{8}.$$

Step 2: Calculate and verify the point The repeated root is

$$x_P = -\frac{1}{2(2)} = -\frac{1}{4}.$$

Substitution into the original parabola, rather than an approximate reading, gives

$$y_P = 2\left(\frac{1}{16}\right) - \frac{3}{4} + 1 = \frac{1}{8} + \frac{1}{4} = \frac{3}{8}.$$

The derivative provides an independent slope check:

$$\frac{dy}{dx} = 4x + 3, \qquad 4\left(-\frac{1}{4}\right) + 3 = 2.$$

Option (A) changes the sign of the abscissa and does not lie on this tangent. Option (B) lies on the parabola but has slope 11, not 2; option (D) has derivative 0 and also its listed ordinate is not the parabola value. Thus only the stated negative-quarter point meets all conditions.

Step 3: Conclusion The point is $\boxed{P = (-\frac{1}{4}, \frac{3}{8})}$. Hence, the correct option is (C).

Quick Tip to Solve: For a tangent parallel to a given line, equate the derivative to that line's slope, then substitute the abscissa into the curve.

10. A manufacturer can sell x items at a price of ₹ $\left(5 - \frac{x}{100}\right)$ each. The cost price of x items is ₹ $\left(\frac{x}{5} + 500\right)$. The number of items he should sell to reach maximum profit is [4 marks]

(A) 100

(B) 240

(C) 500

(D) 480

Correct Answer: (B) 240

Solution:

Concept:

- Revenue is quantity multiplied by selling price per item. Profit is revenue minus the total cost, including fixed cost.
- A stationary profit occurs where $P'(x) = 0$. A negative second derivative confirms a maximum; here the profit is a concave quadratic.

Step 1: Form the profit function The given price is the price of each item, whereas the stated cost is already the cost of all x items. Thus revenue and cost, in rupees, are

$$R(x) = x\left(5 - \frac{x}{100}\right) = 5x - \frac{x^2}{100}, \qquad C(x) = \frac{x}{5} + 500.$$

Subtracting gives

$$P(x) = R(x) - C(x) = \frac{24x}{5} - \frac{x^2}{100} - 500.$$

The constant 500 reduces the profit but will not affect the quantity at which it is maximised.

Step 2: Locate and confirm the maximum Differentiate with respect to quantity:

$$P'(x) = \frac{24}{5} - \frac{x}{50}.$$

The stationary condition is therefore

$$\frac{24}{5} - \frac{x}{50} = 0 \quad \Longrightarrow \quad x = 240.$$

Since $P''(x) = -1/50 < 0$, this is the unique maximum of the concave quadratic. It is also an admissible whole number of items and gives a positive selling price $5 - 240/100 = 2.6$. Completing the square independently confirms the result:

$$P(x) = 76 - \frac{(x - 240)^2}{100}.$$

For options $100, 500, 480$, the squared subtraction is strictly positive, so each gives a lower profit than $x = 240$. In particular, 500 makes the unit selling price zero, and 480 confuses the coefficient in the derivative with the final quantity.

Step 3: Conclusion The manufacturer should sell $\boxed{240}$ items to maximise profit. Hence, the correct option is (B).

Quick Tip to Solve: Multiply the unit price by quantity before subtracting total cost; fixed cost shifts the profit graph vertically without moving its vertex.

11. The value of $\int_0^1 \log_e\left(\frac{1}{x} - 1\right) dx$ is [4 marks]

(A) 0

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

(C) 1

(D) 2

Correct Answer: (A) 0

Solution:

Concept:

- For $0 < x < 1$, $\ln(1/x - 1) = \ln(1 - x) - \ln x$, since both factors in the logarithmic quotient are positive.
- The change of variable $u = 1 - x$ interchanges $\int_0^1 \ln(1 - x)\, dx$ and $\int_0^1 \ln x\, dx$. Both are convergent improper integrals.

Step 1: Split the logarithm and check endpoint convergence Let

$$I = \int_0^1 \ln\left(\frac{1}{x} - 1\right) dx.$$

On the open interval the argument equals $(1-x)/x > 0$, so

$$I = \int_0^1 \ln(1-x)\, dx - \int_0^1 \ln x\, dx.$$

The integrand is not defined at the endpoints, so these are interpreted as improper integrals. The primitive $x\ln x - x$, together with $\lim_{x\to 0^+} x\ln x = 0$, shows that $\int_0^1 \ln x\, dx = -1$ is finite. Substitution gives the same convergence for the other integral; hence splitting and subtracting is legitimate.

Step 2: Use the endpoint symmetry In the first integral put $u = 1-x$, giving $dx = -du$ and reversing the limits. It becomes

$$\int_0^1 \ln(1-x)\, dx = \int_0^1 \ln u\, du = -1.$$

Consequently

$$I = (-1) - (-1) = 0.$$

The cancellation can also be seen directly: replacing x by $1-x$ changes the logarithm to $\ln(x/(1-x))$, the negative of the original integrand. Thus $I = -I$ and $I = 0$, with convergence already justified. The integrand is positive before $1/2$ and negative after $1/2$; these signed areas cancel, so the positive alternatives $1/2, 1, 2$ cannot be the value.

Step 3: Conclusion The improper integral has value $\boxed{0}$. Hence, the correct option is (A).

Quick Tip to Solve: For a logarithm of $(1-x)/x$ over $[0,1]$, try $x \mapsto 1-x$: it makes the integrand its negative.

12. If $(1+\cos x)\frac{dy}{dx} - (y-3)\sin x = 0$ and $y(0) = 0$, then the value of $y\left(\frac{\pi}{2}\right)$ is [4 marks]

(A) -3

(B) 3

(C) 9

(D) 6

Correct Answer: (A) -3

Solution:

Concept:

- For a product $v(x)w(x)$, the derivative is $v'w + vw'$. Recognising a product derivative can solve a first-order equation directly.
- The expression $(1+\cos x)y' - (y-3)\sin x$ is the derivative of $(y-3)(1+\cos x)$. A zero derivative means the product is constant.

Step 1: Integrate the product derivative The equation can be written

$$\frac{d}{dx}\left[(y-3)(1+\cos x)\right] = 0.$$

Indeed, differentiating the product yields $(1+\cos x)y' + (y-3)(-\sin x)$, exactly the given left-hand side. Integration therefore gives

$$(y-3)(1+\cos x) = C.$$

This avoids unnecessary division by $y-3$, and so does not inadvertently discard the constant solution $y=3$, although that solution will not satisfy the given initial condition.

Step 2: Apply the initial condition and evaluate At $x=0$, the given value is $y=0$ and $\cos 0 = 1$. Hence

$$C = (0-3)(1+1) = -6.$$

On the interval containing 0 and $\pi/2$, the factor $1+\cos x$ is positive. Thus the required solution is

$$y(x) = 3 - \frac{6}{1+\cos x}.$$

It satisfies $y(0) = 3 - 6/2 = 0$. At the requested argument, $\cos(\pi/2) = 0$, so

$$y\left(\frac{\pi}{2}\right) = 3 - 6 = -3.$$

The option 3 is the equilibrium solution but violates the initial condition, while 6 and 9 correspond to incorrect constants or signs. Retaining the negative constant from the initial data is essential. As a further check, differentiating the solution gives $y' = -6\sin x/(1+\cos x)^2$, which makes both terms of the original equation cancel.

Step 3: Conclusion The requested value is $\boxed{y(\pi/2) = -3}$. Hence, the correct option is (A).

Quick Tip to Solve: When the coefficient of y' differentiates to the coefficient of $y-3$, combine them into one product derivative.

13. If a straight line passing through point P $(3, -5)$ is such that its intercepted portion between the co-ordinate axes is bisected at P, then the equation of the line is [4 marks]

(A) $5x + 3y + 30 = 0$

(B) $5x - 3y - 30 = 0$

(C) $5x - 3y + 30 = 0$

(D) $-5x - 3y + 30 = 0$

Correct Answer: (B) $5x - 3y - 30 = 0$

Solution:

Concept:

- For intercepts a and b on the coordinate axes, the endpoints are $A(a, 0)$ and $B(0, b)$, and the line is $x/a + y/b = 1$.
- The midpoint of a segment is obtained by averaging corresponding coordinates. Signed intercepts must be retained when an endpoint lies on a negative axis.

Step 1: Use the midpoint condition The intercepted portion is the segment joining the two axis intersections, not an arbitrary segment on the line. Since its midpoint is $P(3, -5)$, the midpoint formula gives

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

Thus $a = 6$ and $b = -10$. The negative second coordinate places the vertical intercept below the origin; replacing it by its magnitude would change the required line.

Step 2: Insert the signed intercepts Use the intercept form with the values just found:

$$\frac{x}{6} + \frac{y}{-10} = 1.$$

Multiplying by 30 gives

$$5x - 3y = 30, \qquad 5x - 3y - 30 = 0.$$

Its intersections are indeed $(6, 0)$ and $(0, -10)$, whose midpoint is $(3, -5)$.

Step 3: Check the alternatives At P, option (B) gives $15 + 15 - 30 = 0$. Options (A), (C) and (D) give respectively 30, 60 and 30, so none even passes through the specified point. The midpoint check also establishes the stronger intercepted-segment condition.

Step 4: Conclusion The required line is $\boxed{5x - 3y - 30 = 0}$. Hence, the correct option is (B).

Quick Tip to Solve: When an axis-intercept segment is bisected at (h, k), use intercepts $2h$ and $2k$, keeping their signs.

14. The intercept on the line $x = y$ by the circle $x^2 + y^2 - 2y = 0$ is AB. The equation of the circle with AB as a diameter is [4 marks]

(A) $x^2 + y^2 + x + y = 0$

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

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

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

Correct Answer: (B) $x^2 + y^2 - x - y = 0$

Solution:

Concept:

- Find the ends of a chord by solving the equations of the circle and the line simultaneously.
- A circle whose diameter endpoints are (x_1, y_1) and (x_2, y_2) has equation $(x - x_1)(x - x_2) + (y - y_1)(y - y_2) = 0$. This follows from the right angle subtended by a diameter.

Step 1: Find the chord endpoints On the line $x = y$, substitute $y = x$ in the given circle:

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

Therefore the two intersections are $A(0, 0)$ and $B(1, 1)$. Both satisfy the original circle, so they are the required ends of its intercepted segment.

Step 2: Form the circle on this diameter Using the diameter-endpoint equation gives

$$(x - 0)(x - 1) + (y - 0)(y - 1) = 0,$$

which simplifies to

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

Equivalently, its centre is the midpoint $(1/2, 1/2)$, and its radius is half of $AB = \sqrt{2}$. Completing squares yields $(x - 1/2)^2 + (y - 1/2)^2 = 1/2$, confirming this centre and radius.

Step 3: Exclude the other circles All four proposed equations pass through the origin, so checking only that endpoint cannot select the answer. At the other endpoint $(1, 1)$, the left sides of (A), (C) and (D) are 4, 2 and 2 respectively, whereas (B) gives zero. Thus only (B) has both ends of the specified diameter.

Step 4: Conclusion The circle is $\boxed{x^2 + y^2 - x - y = 0}$. Hence, the correct option is (B).

Quick Tip to Solve: First find both line-circle intersections; then use the diameter-endpoint formula to avoid separately calculating the radius.

15. If the foot of the perpendicular from the point $(0,0,0)$ on the line $\frac{x+2}{5} = \frac{y+2}{2} = \frac{z+8}{3}$ is (a,b,c), then $a^2+b^2+c^2$ is [4 marks]

(A) 34

(B) 14

(C) 24

(D) 44

Correct Answer: (A) 34

Solution:

Concept:

- A point on the line $(x+2)/5 = (y+2)/2 = (z+8)/3 = t$ has position vector $\mathbf{r}(t) = (-2,-2,-8) + t(5,2,3)$.
- At the perpendicular foot from the origin, the position vector of the foot is orthogonal to the line direction. Hence $\mathbf{r}(t) \cdot (5,2,3) = 0$.

Step 1: Parametrise the foot Write its coordinates as

$$a = 5t - 2, \qquad b = 2t - 2, \qquad c = 3t - 8.$$

The direction vector is $\mathbf{d} = (5,2,3)$. Because the segment from the origin to the foot meets the line at a right angle, its direction (a,b,c) must have zero scalar product with $\mathbf{d}$.

Step 2: Apply perpendicularity The scalar-product condition becomes

$$5(5t-2) + 2(2t-2) + 3(3t-8) = 0.$$

Collecting terms gives

$$(25+4+9)t - 10 - 4 - 24 = 0, \qquad 38t - 38 = 0.$$

Consequently $t = 1$, so the foot is $(a,b,c) = (3,0,-5)$. Its position satisfies both the parametric line and the perpendicularity check $5(3) + 2(0) + 3(-5) = 0$.

Step 3: Calculate the requested squared distance The question asks for the sum of squares, not its square root:

$$a^2 + b^2 + c^2 = 3^2 + 0^2 + (-5)^2 = 9 + 25 = 34.$$

The actual distance is $\sqrt{34}$, but that is not the requested quantity. Values 14, 24 and 44 do not equal the squared norm of the uniquely determined perpendicular foot.

Step 4: Conclusion $\boxed{a^2+b^2+c^2 = 34}$. Hence, the correct option is (A).

Quick Tip to Solve: For the foot from the origin to $\mathbf{p} + t\mathbf{d}$, solve $(\mathbf{p} + t\mathbf{d}) \cdot \mathbf{d} = 0$ before calculating its norm.

16. If the vectors $\overrightarrow{AB} = 3\hat{i} + 8\hat{k}$ and $\overrightarrow{AC} = 5\hat{i} - 2\hat{j} + 6\hat{k}$ are the sides of a triangle ABC, then the length of the median through A is [4 marks]

(A) $\sqrt{33}$

(B) $\sqrt{66}$

(C) $\sqrt{56}$

(D) $\sqrt{72}$

Correct Answer: (B) $\sqrt{66}$

Solution:

Concept:

- If M is the midpoint of BC, then relative to vertex A, $\overrightarrow{AM} = (\overrightarrow{AB} + \overrightarrow{AC})/2$.
- The length of a vector $u\hat{i} + v\hat{j} + w\hat{k}$ is $\sqrt{u^2 + v^2 + w^2}$, since the coordinate unit vectors are mutually perpendicular.

Step 1: Identify the median endpoint The median through A joins A to the midpoint M of the opposite side BC. Taking A as the reference point, the two given side vectors are the position vectors of B and C. Averaging them therefore produces the vector to M; subtracting them would instead produce a vector along BC.

Step 2: Calculate the median vector Add corresponding components, treating the absent $\hat{j}$ component of $\overrightarrow{AB}$ as zero:

$$\overrightarrow{AB} + \overrightarrow{AC} = (3+5)\hat{i} + (0-2)\hat{j} + (8+6)\hat{k} = 8\hat{i} - 2\hat{j} + 14\hat{k}.$$

Thus

$$\overrightarrow{AM} = 4\hat{i} - \hat{j} + 7\hat{k}.$$

Step 3: Take its magnitude and check the choices The squared length is

$$|\overrightarrow{AM}|^2 = 4^2 + (-1)^2 + 7^2 = 16 + 1 + 49 = 66.$$

Since length is nonnegative, $|\overrightarrow{AM}| = \sqrt{66}$. As a separate check, the squared magnitude of the side-vector sum is $8^2 + (-2)^2 + 14^2 = 264$; dividing its magnitude by 2 again gives $\sqrt{66}$. The proposed squared lengths 33, 56 and 72 are inconsistent with this component calculation.

Step 4: Conclusion The median through A has length $\boxed{\sqrt{66}}$. Hence, the correct option is (B).

Quick Tip to Solve: Average the two side vectors starting at the same vertex, then take the magnitude; do not average their lengths.

17. If $\vec{a} = 6\hat{i} + 2\hat{j} - \lambda_1\hat{k}$, $\vec{b} = 3\hat{i} + (3 - \lambda_2)\,\hat{j} + 2\hat{k}$ and $\vec{c} = 2\hat{i} + (1 + \lambda_3)\,\hat{j} - 3\hat{k}$ are three vectors such that $\vec{a} = 3\vec{c}$ and $\vec{b}$ is perpendicular to $\vec{c}$ then $(\lambda_1, \lambda_2, \lambda_3)$ is [4 marks]

(A) $\left(9, 21, -\frac{1}{3}\right)$

(B) $\left(9, 3, -\frac{1}{3}\right)$

(C) $\left(\frac{1}{3}, -\frac{1}{3}, \frac{1}{3}\right)$

(D) $(3, 3, 1)$

Correct Answer: (B) $\left(9, 3, -\frac{1}{3}\right)$

Solution:

Concept:

- Equality of vectors requires equality of each corresponding component. Apply this first to $\vec{a} = 3\vec{c}$.
- Two nonzero vectors are perpendicular precisely when their scalar product is zero: $\vec{b} \cdot \vec{c} = 0$. This yields the remaining parameter after vector equality is used.

Step 1: Compare the components of the equal vectors Triple the components of $\vec{c}$:

$$3\vec{c} = 6\hat{i} + 3(1 + \lambda_3)\hat{j} - 9\hat{k}.$$

Comparing this with $\vec{a} = 6\hat{i} + 2\hat{j} - \lambda_1\hat{k}$, the $\hat{i}$ components already agree, while the other components give

$$2 = 3(1 + \lambda_3), \qquad -\lambda_1 = -9.$$

It follows that $\lambda_3 = -1/3$ and $\lambda_1 = 9$.

Step 2: Use the perpendicularity condition With $\lambda_3 = -1/3$, the vector $\vec{c}$ is $2\hat{i} + (2/3)\hat{j} - 3\hat{k}$. Therefore

$$\vec{b} \cdot \vec{c} = 3(2) + (3 - \lambda_2)\frac{2}{3} + 2(-3) = 0.$$

The first and last terms cancel, leaving

$$\frac{2}{3}(3 - \lambda_2) = 0, \qquad \lambda_2 = 3.$$

Step 3: Check the parameter triple The resulting vectors are $\vec{a} = (6, 2, -9)$, $\vec{b} = (3, 0, 2)$, and $\vec{c} = (2, 2/3, -3)$. Directly, $3\vec{c} = \vec{a}$ and $\vec{b} \cdot \vec{c} = 6 - 6 = 0$. Option (A) gives $\lambda_2 = 21$, producing a nonzero dot product. Options (C) and (D) fail the component equality, since in particular they do not have $\lambda_1 = 9$.

Step 4: Conclusion $\boxed{(\lambda_1, \lambda_2, \lambda_3) = (9, 3, -1/3)}$. Hence, the correct option is (B).

Quick Tip to Solve: Use vector equality before the dot-product equation so that only one unknown remains in the perpendicularity condition.

18. **Let x_1, x_2, x_3, x_4, x_5 be observations with mean m and standard deviation s. Then, which of the following statements are correct:**

A. Mean of the observations $x_1 + k, x_2 + k, x_3 + k, x_4 + k, x_5 + k$ is $m + 5k$

B. Mean of the observations $kx_1, kx_2, kx_3, kx_4, kx_5$ is km.

C. The standard deviation of the observations $x_1 + k, x_2 + k, x_3 + k, x_4 + k, x_5 + k$ is s.

D. The standard deviation of the observations $kx_1, kx_2, kx_3, kx_4, kx_5$ is $k^5 s$.

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

(A) A, B, C, D

(B) A, C only

(C) B, D only

(D) B, C only

Correct Answer: (D) B, C only

Solution:

Concept:

- The mean is $m = \frac{1}{5}\sum_{i=1}^{5} x_i$, and the variance is $s^2 = \frac{1}{5}\sum_{i=1}^{5}(x_i - m)^2$.
- Adding the same constant translates all observations and their mean equally, leaving deviations unchanged. Scaling by k multiplies variance by k^2, so standard deviation scales by $|k|$.

Step 1: Test the two mean statements After adding k to each observation, the new mean is

$$\frac{\sum x_i + 5k}{5} = m + k.$$

The five added constants are averaged over five observations; they do not produce $m + 5k$. Thus statement A is false as a general rule. After multiplying each observation by k, the mean becomes

$$\frac{\sum kx_i}{5} = k\frac{\sum x_i}{5} = km.$$

Thus B is true.

Step 2: Test the two standard-deviation statements For translated data, the new deviations from the new mean are

$$(x_i + k) - (m + k) = x_i - m.$$

Their squares and their average are unchanged, so the standard deviation remains s, proving C. For scaled data, the deviations are $kx_i - km = k(x_i - m)$. Hence

$$s_{\text{new}}^2 = \frac{1}{5}\sum k^2(x_i - m)^2 = k^2 s^2, \qquad s_{\text{new}} = |k|s.$$

This is not $k^5 s$, so D is false. Even if k is taken positive, the correct factor is k, not its fifth power.

Step 3: Match the true statements to the options Only B and C hold for arbitrary observations and constant k. Option (A) incorrectly includes both A and D; option (B) includes the false A and omits the true B; option (C) includes the false D and omits the true C. Special cases such as $k = 0$ do not make a false general transformation rule valid.

Step 4: Conclusion The correct statements are B and C only. Hence, the correct option is (D).

Quick Tip to Solve: For transformed data $y = ax + b$, remember mean $am + b$ and standard deviation $|a|s$; the translation does not affect spread.

19. Let the area of the region enclosed between the two circles $x^2 + y^2 = a^2$ and $(x - a)^2 + y^2 = a^2$ be $\frac{m}{3}(4\pi - 3\sqrt{3})$ sq. units for some $a \geq 2$. If a is a root of $x^3 - 3x^2 - 6x + 8 = 0$, then [4 marks]

(A) $m^2 = a^4$

(B) $m^2 = a^3$

(C) $m^4 = a^2$

(D) $m^3 = a^2$

Correct Answer: (B) $m^2 = a^3$

Solution:

Concept:

- The common region of two equal circles is a lens formed by two equal circular segments. A segment area is its sector area minus its triangular area.
- For a sector of radius a and angle θ radians, the area is $a^2\theta/2$. The distance between the two centres determines the angle subtended by their common chord.

Step 1: Determine the permitted radius Factor the polynomial using the root $x = 1$:

$$x^3 - 3x^2 - 6x + 8 = (x - 1)(x^2 - 2x - 8) = (x - 1)(x - 4)(x + 2).$$

Thus its roots are $1, 4, -2$. The condition $a \geq 2$ leaves only $a = 4$; the negative root cannot represent a radius and the root 1 violates the stated bound.

Step 2: Calculate the common area The centres are $O = (0, 0)$ and $C = (a, 0)$, so their separation equals their common radius. Each intersection point forms an equilateral triangle with the centres. Consequently, the common chord subtends $120^\circ = 2\pi/3$ at either centre. The lens contains two segments, giving

$$S = 2\left(\frac{a^2}{2}\frac{2\pi}{3} - \frac{1}{2}a^2 \sin\frac{2\pi}{3}\right) = \frac{a^2}{6}(4\pi - 3\sqrt{3}).$$

The subtracted triangles each have area $\sqrt{3}a^2/4$.

Step 3: Compare the coefficient and test the options Comparison with $S = \frac{m}{3}(4\pi - 3\sqrt{3})$ gives $m = a^2/2 = 8$. Therefore $m^2 = 64 = a^3$. The other expressions fail: $a^4 = 256$, whereas $m^4 = 4096$ and $m^3 = 512$ are both different from $a^2 = 16$.

Step 4: Conclusion The radius is $a = 4$ and the coefficient is $m = 8$. Hence $m^2 = a^3$, and the correct option is (B).

Quick Tip to Solve: When two equal circles have centre separation equal to their radius, use two 120° segments for their overlap, then compare coefficients before substituting.

20. Suppose $\begin{vmatrix} f'(x) & f(x) \\ f''(x) & f'(x) \end{vmatrix} = 0$**, where** $f(x)$ **is continuously differentiable function with** $f'(x) \neq 0\ \forall x \in \mathbb{R}$ **and satisfies** $f(0) = 1$ **and** $f'(0) = 4$**. If** $f(x) = e^{\lambda x} + \mu$**, where** $\lambda, \mu \in \mathbb{R}$ **then the value of** $\lambda^2 + \mu^2$ **is** [4 marks]

(A) 2

(B) 4

(C) 8

(D) 16

Correct Answer: (D) 16

Solution:

Concept:

- A two-by-two determinant vanishes when the product of its diagonal entries equals the product of its off-diagonal entries. Here this gives $(f\prime)^2 - ff\prime\prime = 0$.
- The proposed exponential form may be substituted directly. The initial value specifies the vertical shift, while the initial derivative fixes the exponential rate.

Step 1: Use the initial value The given form is $f(x) = e^{\lambda x} + \mu$. At $x = 0$, the exponential is 1 for every real λ, so

$$f(0) = 1 + \mu = 1 \quad \Longrightarrow \quad \mu = 0.$$

Hence there is no constant vertical displacement and $f(x) = e^{\lambda x}$. This initial condition already eliminates any nonzero value of μ.

Step 2: Use the derivative condition Differentiate the given expression with respect to x:

$$f\prime(x) = \lambda e^{\lambda x}, \qquad f\prime\prime(x) = \lambda^2 e^{\lambda x}.$$

At the origin the derivative is λ, so $f\prime(0) = 4$ yields $\lambda = 4$. Thus $f(x) = e^{4x}$ and $f\prime(x) = 4e^{4x}$, which is nonzero for every real number, as required.

Step 3: Check the differential equation and evaluate With these constants the determinant is

$$(4e^{4x})^2 - e^{4x}(16e^{4x}) = 16e^{8x} - 16e^{8x} = 0.$$

Thus both the differential equation and the two initial conditions hold. The requested sum is

$$\lambda^2 + \mu^2 = 4^2 + 0^2 = 16.$$

The values 2, 4 and 8 in the other options do not equal the sum of the squares; in particular 4 is the rate itself, not its square.

Step 4: Conclusion We obtain $\lambda = 4$, $\mu = 0$, and hence $\lambda^2 + \mu^2 = 16$. Hence, the correct option is (D).

Quick Tip to Solve: For $e^{\lambda x} + \mu$, first use the function value at zero to find μ, then the derivative at zero to find λ.

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

Attempt any 5 of the 10 questions in this section.

21. The equations $ax^2 + bx + a = 0$, $(a, b \in \mathbb{R})$ and $x^3 - 2x^2 + 2x - 1 = 0$ have two common roots. Then the value of $a + b$ is _____. [4 marks]

Solution:

Concept:

- A polynomial with real coefficients has nonreal roots in conjugate pairs. A genuine quadratic has a nonzero leading coefficient and exactly two roots counted with multiplicity.
- If two polynomials have the same two distinct roots, their quadratic factors differ by a nonzero constant multiplier. Compare the coefficients after factoring the cubic.

Step 1: Factor the cubic The value of the cubic at 1 is zero. Division by $x - 1$ gives

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

The quadratic factor has discriminant $(-1)^2 - 4 = -3$, so its roots are the distinct nonreal conjugates $(1 + i\sqrt{3})/2$ and $(1 - i\sqrt{3})/2$. The only real root of the cubic is 1.

Step 2: Identify the pair shared by the quadratic The coefficients a, b are real. If the quadratic shared the real root 1 and one nonreal root, conjugacy would force it also to contain the other nonreal root, which is impossible for a genuine quadratic. Therefore the shared roots are exactly the conjugate pair from $x^2 - x + 1$. Notice that $a \neq 0$ is implicit in the statement that the first equation has two common roots as a quadratic; with $a = 0$, a nonzero linear equation cannot have two distinct roots.

Step 3: Compare coefficients The required quadratic is a nonzero scalar multiple of that factor:

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

Comparing the coefficient of x gives $b = -a$. The scale a is not individually fixed, but it cancels from the expression asked for:

$$a + b = a - a = 0.$$

This also agrees with the product of the conjugate roots, which is 1, matching constant term divided by leading coefficient.

Step 4: Conclusion The common roots force $b = -a$. Therefore the requested numerical value is $a + b = 0$.

Quick Tip to Solve: When a real quadratic shares two roots with a cubic having one real root and a conjugate pair, the shared roots must be the conjugate pair.

22. Let A be a matrix satisfying $A^3 = 3A+2I$ where A $\neq nI$, $n \in \mathbb{Z}$. If $A^2+\alpha A+\beta I = O$, then maximum value of $|\alpha+\beta|$ is _____. [4 marks]

Solution:

Concept:

- A matrix identity can be multiplied by the same matrix and combined with another identity to eliminate higher powers. All scalar multiples of the identity commute with the matrix.
- For a non-scalar matrix, A and I are linearly independent: $cA+dI = O$ forces $c = d = 0$. Otherwise a nonzero c would make A a scalar matrix.

Step 1: Reduce the cubic using the quadratic From the additional relation we have $A^2 = -\alpha A - \beta I$. Multiply by A and then substitute again:

$$\begin{aligned} A^3 &= -\alpha A^2 - \beta A \\ &= -\alpha(-\alpha A - \beta I) - \beta A \\ &= (\alpha^2 - \beta)A + \alpha\beta I. \end{aligned}$$

The original identity gives another expression, $A^3 = 3A + 2I$. Equating the two produces

$$(\alpha^2 - \beta - 3)A + (\alpha\beta - 2)I = O.$$

Step 2: Justify coefficient comparison The hypothesis excludes $A = nI$ for integer n. In fact no other scalar matrix can satisfy the cubic: if $A = cI$, then $c^3 - 3c - 2 = 0$, whose factorisation is $(c-2)(c+1)^2 = 0$. Its only scalar possibilities are the excluded integer values $c = 2, -1$. Thus A is non-scalar, so the coefficients of A and I in the preceding identity must vanish separately:

$$\alpha^2 - \beta = 3, \qquad \alpha\beta = 2.$$

Step 3: Solve the scalar equations Substitute $\beta = \alpha^2 - 3$ into $\alpha\beta = 2$:

$$\alpha^3 - 3\alpha - 2 = 0, \qquad (\alpha - 2)(\alpha + 1)^2 = 0.$$

Therefore $(\alpha, \beta) = (2, 1)$ or $(-1, -2)$. In both cases $|\alpha + \beta| = 3$. The non-scalar matrix $\mathrm{diag}(2, -1)$ satisfies the cubic and the second quadratic relation, so this value is attained.

Step 4: Conclusion Every permitted quadratic relation gives $|\alpha + \beta| = 3$; hence its maximum value is 3.

Quick Tip to Solve: Reduce A^3 with the given quadratic and compare its coefficients of A and I; justify independence by first excluding scalar matrices.

23. An equilateral triangle is inscribed in the ellipse $\frac{x^2}{3} + y^2 = 1$ such that one of the vertex of the triangle is $(0, 1)$ and one of the altitude of the triangle is along the y-axis. If A is the area of the equilateral triangle. Then $625A^2$ is equal to _____. [4 marks]

Solution:

Concept:

- An equilateral triangle of side s has altitude $\sqrt{3}s/2$ and area $\sqrt{3}s^2/4$. Its altitude through a vertex bisects the opposite side.
- The given ellipse is symmetric about the y-axis. An altitude on that axis with top vertex $(0, 1)$ places the remaining vertices at (u, v) and $(-u, v)$, where $u > 0$.

Step 1: Express the equilateral condition The horizontal base has length $2u$, and the vertical altitude has length $1 - v$, since every point of the ellipse has $v \leq 1$. The equilateral relation is

$$1 - v = \frac{\sqrt{3}}{2}(2u) = \sqrt{3}u, \qquad u = \frac{1 - v}{\sqrt{3}}.$$

This specifies the relative size of the base and altitude, rather than assuming the triangle is centred at the origin.

Step 2: Place a base vertex on the ellipse Substitute (u, v) into $x^2/3 + y^2 = 1$, then insert the expression for u:

$$\frac{(1 - v)^2}{9} + v^2 = 1.$$

Multiplying by 9 and collecting terms gives

$$10v^2 - 2v - 8 = 0, \qquad (v - 1)(5v + 4) = 0.$$

The value $v = 1$ gives $u = 0$, a collapsed triangle, so discard it. Thus $v = -4/5$, $1 - v = 9/5$, and $u = 3\sqrt{3}/5$. Both base vertices therefore lie on the ellipse and are distinct.

Step 3: Compute the area and its square Using one half times base times altitude,

$$A = \frac{1}{2}(2u)(1 - v) = \frac{3\sqrt{3}}{5}\frac{9}{5} = \frac{27\sqrt{3}}{25}.$$

Consequently

$$A^2 = \frac{27^2 \cdot 3}{25^2} = \frac{2187}{625}, \qquad 625A^2 = 2187.$$

As a check, the squared distance from the top vertex to either base vertex is $u^2 + (1 - v)^2 = 4u^2$, equal to the squared base length.

Step 4: Conclusion The triangle has area $A = 27\sqrt{3}/25$ square units, and therefore $625A^2 = 2187$.

Quick Tip to Solve: Use the altitude to write the symmetric base vertices first, then eliminate their horizontal coordinate using the equilateral height relation.

24. The volume of the greatest cylinder that can be inscribed in a cone of height $\frac{3}{\sqrt[3]{\pi}}$ and semi-vertical angle 45° is _____. [4 marks]

Solution:

Concept:

- For a coaxial cylinder inscribed in a right circular cone, similar triangles relate the cylinder radius to its height. The volume is $V = \pi r^2 h$.
- A differentiable volume function on the closed interval from zero to the cone height attains its greatest value at an interior stationary point or at an endpoint.

Step 1: Relate the dimensions Let the cone height be $H = 3/\sqrt[3]{\pi}$, its base radius be R, and the cylinder height and radius be h, r. The semi-vertical angle is 45°, so

$$R/H = \tan 45^\circ = 1, \qquad R = H.$$

In the axial cross-section the small cone above the cylinder has height $H - h$. Similar triangles give

$$\frac{r}{R} = \frac{H-h}{H}, \qquad r = H - h.$$

Thus a taller cylinder has a smaller radius; the two dimensions cannot be maximised independently.

Step 2: Optimise the volume For $0 \le h \le H$, the volume is

$$V(h) = \pi h(H-h)^2.$$

Differentiating and factoring,

$$V\prime(h) = \pi(H-h)(H-3h).$$

The interior stationary height is $h = H/3$. For $0 < h < H/3$, both factors are positive, so the volume increases. For $H/3 < h < H$, the first is positive and the second negative, so the volume decreases. Both endpoints give zero volume. Hence the stationary value is the global maximum.

Step 3: Substitute the cone height At the maximum, $h = H/3$ and $r = 2H/3$, so

$$V_{\max} = \pi\left(\frac{2H}{3}\right)^2 \frac{H}{3} = \frac{4\pi H^3}{27}.$$

Since $H^3 = (3/\sqrt[3]{\pi})^3 = 27/\pi$, the factors of π cancel and

$$V_{\max} = \frac{4\pi}{27}\frac{27}{\pi} = 4.$$

The optimum cylinder uses one third of the cone height and two thirds of its base radius.

Step 4: Conclusion The greatest cylinder volume is 4 cubic units.

Quick Tip to Solve: For a cylinder inside a cone, substitute the similar-triangle radius into $\pi r^2 h$ before differentiating; the optimal height is one third of the cone height.

25. If the function $f(x)$ is defined as $f(x) = \begin{vmatrix} \frac{1}{1+e^{\sin x}} & \sin x \\ \sqrt{1-x^2} & 2 \end{vmatrix}$. Then the value of $\frac{1}{\pi}\int_{-\pi/2}^{\pi/2} f(x)dx$ is equal to _____. [4 marks]

Solution:

Concept:

- A real square root $\sqrt{1-x^2}$ is defined only when $|x| \le 1$. The domain must be checked before applying symmetry over an interval.
- For $h(x) = 1/(1+e^{\sin x})$, the identity $h(x) + h(-x) = 1$ follows from $\sin(-x) = -\sin x$. An odd integrable term has zero integral over a symmetric interval.

Step 1: Expand the determinant and check its real domain Expanding along the first row gives

$$f(x) = \frac{2}{1+e^{\sin x}} - \sin x\sqrt{1-x^2}.$$

The limits are $-\pi/2$ and $\pi/2$, and $\pi/2 > 1$. On the nonempty subintervals where $1 < |x| < \pi/2$, the quantity $1 - x^2$ is negative. The formula therefore has no real-valued definite integral as written; symmetry cannot remove this domain requirement.

Step 2: State the interpretation under which the keyed value is obtained If complex values are allowed, define the square root explicitly by

$$r(x) = \begin{cases} \sqrt{1-x^2}, & |x| \le 1, \\ i\sqrt{x^2-1}, & 1 < |x| \le \pi/2, \end{cases} \qquad i^2 = -1.$$

This is the principal complex square root of $1 - x^2$. It is even and continuous on the interval, including at $x = \pm 1$. Thus $\sin x\, r(x)$ is odd and has zero integral, integrating real and imaginary parts separately.

Step 3: Evaluate the remaining symmetric integral exactly Put $a = \pi/2$ and $J = \int_{-a}^{a} h(x)\,dx$. Substitution $x = -t$ and addition give

$$2J = \int_{-a}^{a} \big(h(x) + h(-x)\big)\,dx = \int_{-a}^{a} 1\,dx = 2a = \pi.$$

Therefore $J = \pi/2$. Under the explicitly defined complex interpretation the required expression equals

$$\frac{1}{\pi}\left(2J - \int_{-a}^{a} \sin x\, r(x)\,dx\right) = \frac{1}{\pi}(\pi - 0) = 1.$$

Both integrals converge since their integrands are continuous.

Step 4: Conclusion As a real integral the expression is undefined. With the principal complex square root, its value is $\boxed{1}$, agreeing with the answer key. These two interpretations must be distinguished.

Quick Tip to Solve: Check a radical's real domain against both integration limits before using symmetry. An odd-looking term may cancel only after its integral has been defined.

26. A line touches the curve $y = y(x)$ at a point (x, y) having slope $\frac{1+y^2}{1+x^2}$, where $x > 0$. If $y(2) = 1$, $y(3) = \frac{\alpha}{\beta}$ and $gcd\{\alpha, \beta\} = 1$, then the value of $\alpha + \beta$ is _____. [4 marks]

Solution:

Concept:

- The slope of the tangent is the derivative, so the given curve satisfies $dy/dx = (1 + y^2)/(1 + x^2)$. Since both denominators are positive for real variables, the variables can be separated.
- Use $\int du/(1 + u^2) = \tan^{-1} u + C$. The initial condition selects the particular solution, while the tangent subtraction identity converts it into a rational expression.

Step 1: Separate and integrate Writing the slope condition in differential form gives

$$\frac{dy}{1 + y^2} = \frac{dx}{1 + x^2}.$$

Hence

$$\tan^{-1} y = \tan^{-1} x + C.$$

The integration constant must be found from the given point rather than chosen arbitrarily.

Step 2: Use the initial condition At $x = 2$, the curve passes through $y = 1$, so

$$C = \frac{\pi}{4} - \tan^{-1} 2.$$

Taking the tangent and using the subtraction formula,

$$\tan C = \frac{1 - 2}{1 + 2} = -\frac{1}{3}.$$

Therefore the same solution branch satisfies

$$y = \frac{x - 1/3}{1 + x/3} = \frac{3x - 1}{x + 3}.$$

For positive x, the denominator is nonzero, so evaluation at $x = 3$ is valid.

Step 3: Evaluate the required fraction Substitute $x = 3$:

$$y(3) = \frac{9 - 1}{3 + 3} = \frac{8}{6} = \frac{4}{3}.$$

The integers 4 and 3 are relatively prime. Thus $\alpha = 4$, $\beta = 3$. As a direct check, differentiating the rational solution gives $y' = 10/(x + 3)^2$, and substituting it into the stated slope produces the same expression.

Step 4: Conclusion The reduced fraction is $y(3) = 4/3$. Consequently,

$$\boxed{\alpha + \beta = 4 + 3 = 7}.$$

Quick Tip to Solve: After integrating the separated equation, take the tangent of the constant first; this often turns the particular solution into a simple rational function.

27. The equation of the base of an equilateral triangle is $x + y = 1$ and the opposite vertex has co-ordinates $(-3, 2)$. The area of the triangle (in square units) is represented by A, then the value of $\sqrt{3}A$ is _____. [4 marks]

Solution:

Concept:

- The perpendicular distance from (x_0, y_0) to $ax + by + c = 0$ is $|ax_0 + by_0 + c|/\sqrt{a^2 + b^2}$. Here that distance is the altitude from the opposite vertex to the base line.
- An equilateral triangle of side s has altitude $h = \sqrt{3}s/2$ and area $A = sh/2 = h^2/\sqrt{3}$. These relations determine its area without finding the endpoints of the base.

Step 1: Find the perpendicular altitude Write the base line as $x + y - 1 = 0$. For the opposite vertex $(-3, 2)$, the perpendicular distance is

$$h = \frac{|-3 + 2 - 1|}{\sqrt{1^2 + 1^2}} = \frac{2}{\sqrt{2}} = \sqrt{2}.$$

Use the absolute value because distance is positive, regardless of which side of the line contains the vertex.

Step 2: Relate the altitude to the side The altitude of an equilateral triangle bisects its base. Applying the Pythagorean theorem to either resulting right triangle gives

$$h^2 = s^2 - \left(\frac{s}{2}\right)^2 = \frac{3s^2}{4}.$$

Thus

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

Only the length of the side matters; locating the two base vertices individually would add unnecessary coordinate calculations.

Step 3: Calculate the area and requested multiple The area is half the product of the base and its perpendicular altitude:

$$A = \frac{1}{2}\left(\frac{2\sqrt{2}}{\sqrt{3}}\right)\sqrt{2} = \frac{2}{\sqrt{3}}.$$

It follows that

$$\sqrt{3}A = \sqrt{3} \cdot \frac{2}{\sqrt{3}} = 2.$$

Equivalently, the requested quantity equals the square of the altitude, h^2.

Step 4: Conclusion The area is $A = 2/\sqrt{3}$ square units, so the requested numerical value is

$$\boxed{\sqrt{3}A = 2}.$$

Quick Tip to Solve: For an equilateral triangle whose altitude is known, use $\sqrt{3}A = h^2$ directly; the perpendicular distance to the base line supplies h.

28. Let R be the point $(13, -8, 10)$ and P(α, β, λ) be the image of the point Q $(5, 2, 1)$ in the line $x - 2 = 3 - y = z + 1$. Then the square of the area of the triangle PQR is _____. [4 marks]

Solution:

Concept:

- The image of a point in a line is obtained by taking its perpendicular foot on the line as the midpoint of the original point and its image. If the foot is H, then $P = 2H - Q$.
- For a line through A with direction vector $\mathbf{d}$, the perpendicular foot is $H = A + t\mathbf{d}$, where $t = (Q - A) \cdot \mathbf{d}/(\mathbf{d} \cdot \mathbf{d})$. The triangle area satisfies $A_{\triangle}^2 = |\overrightarrow{PQ} \times \overrightarrow{PR}|^2/4$.

Step 1: Locate the perpendicular foot Let the common value in the line equation be t. Then

$$x = 2 + t, \quad y = 3 - t, \quad z = -1 + t.$$

Thus take $A = (2, 3, -1)$ and $\mathbf{d} = (1, -1, 1)$. Since $Q = (5, 2, 1)$,

$$Q - A = (3, -1, 2), \qquad t = \frac{3 + 1 + 2}{1 + 1 + 1} = 2.$$

The perpendicular foot is therefore $H = (4, 1, 1)$.

Step 2: Find the reflected point Because H is the midpoint of P and Q,

$$P = 2H - Q = (8, 2, 2) - (5, 2, 1) = (3, 0, 1).$$

Indeed, $Q - H = (1, 1, 0)$ has dot product zero with $(1, -1, 1)$, confirming that the segment between the point and its image is perpendicular to the line.

Step 3: Compute the square of the triangle area Using P as a common starting point,

$$\overrightarrow{PQ} = (2, 2, 0), \qquad \overrightarrow{PR} = (10, -8, 9).$$

Their cross product is

$$\overrightarrow{PQ} \times \overrightarrow{PR} = (18, -18, -36).$$

Hence

$$A_{\triangle}^2 = \frac{18^2 + (-18)^2 + (-36)^2}{4} = \frac{1944}{4} = 486.$$

The factor of one quarter appears because the cross-product magnitude is twice the triangle area.

Step 4: Conclusion The reflected point is $P = (3, 0, 1)$, and the square of the area of triangle PQR is

$$\boxed{486}.$$

Quick Tip to Solve: Find the projection foot first and reflect by $P = 2H - Q$; square the cross-product magnitude before dividing by four to avoid an unnecessary radical.

29. A hospital conducts a free eye check-up drive at 3 different locations A, B and C of a city. The number of people that came for test at A is thrice as much as that at B, and number of people that came at B is same as that at C. The results show that 4% population at A, 2% at B and 3% at C have poor eye-sight. If a person from the city goes for an army job and is found to have poor eye-sight, and the probability that he is not from location C is $\frac{p}{q}$, where $\frac{p}{q}$ is in simplest form, then value of $(p+q)$ is _____.

[4 marks]

Solution:

Concept:

- Bayes' theorem weights each location by both its population proportion and its poor-eyesight rate. The rates alone cannot be compared because location A contributes three times as many tested people.
- If E denotes poor eyesight, then $P(C \mid E) = P(C)P(E \mid C)/P(E)$. The complementary conditional probability is $P(C^c \mid E) = 1 - P(C \mid E)$.

Step 1: Set the location proportions Let the numbers tested at B and C each be n. The number tested at A is then $3n$, giving a total of $5n$. Thus

$$P(A) = \frac{3}{5}, \quad P(B) = \frac{1}{5}, \quad P(C) = \frac{1}{5}.$$

The conditional poor-eyesight probabilities are respectively $4/100$, $2/100$, and $3/100$.

Step 2: Calculate the weighted poor-eyesight total By the law of total probability,

$$\begin{aligned} P(E) &= \frac{3}{5} \cdot \frac{4}{100} + \frac{1}{5} \cdot \frac{2}{100} + \frac{1}{5} \cdot \frac{3}{100} \\ &= \frac{12+2+3}{500} = \frac{17}{500}. \end{aligned}$$

These weighted contributions correspond to 12, 2 and 3 poor-eyesight cases per common population scale. Counting each location equally would incorrectly ignore the larger attendance at A.

Step 3: Condition on poor eyesight The contribution from C is $P(C \cap E) = 3/500$. Therefore

$$P(C \mid E) = \frac{3/500}{17/500} = \frac{3}{17}.$$

The question asks for a person who is not from C, so

$$P(C^c \mid E) = 1 - \frac{3}{17} = \frac{14}{17}.$$

Since 14 and 17 have no common factor, this is already the required simplest form.

Step 4: Conclusion Here $p = 14$ and $q = 17$. The required value is

$$\boxed{p + q = 31}.$$

Quick Tip to Solve: Weight the three percentages by the attendance ratio $3 : 1 : 1$, giving $12 : 2 : 3$; the first two contributions form the numerator for not being from C.

30. The number of pairs (x, y) satisfying the equations $\sin x + \sin y = \sin(x + y)$ and $|x| + |y| = 1$ is _____.

[4 marks]

Solution:

Concept:

- Use sum-to-product identities to factor a trigonometric equation before counting its solutions. In particular, $\sin x + \sin y = 2\sin((x + y)/2)\cos((x - y)/2)$.
- The constraint $|x| + |y| = 1$ implies $|x| \le 1$, $|y| \le 1$, and $|x + y| \le 1$. These bounds exclude all nonzero multiples of 2π, preventing spurious periodic solutions.

Step 1: Factor the trigonometric condition Write $\sin(x + y) = 2\sin((x + y)/2)\cos((x + y)/2)$. Subtracting it from the sum-to-product expression gives

$$2\sin\frac{x+y}{2}\left(\cos\frac{x-y}{2} - \cos\frac{x+y}{2}\right) = 0.$$

The cosine difference is $2\sin(x/2)\sin(y/2)$. Hence the equation is equivalent to

$$4\sin\frac{x+y}{2}\sin\frac{x}{2}\sin\frac{y}{2} = 0.$$

At least one of the three sine factors must vanish.

Step 2: Use the bounds to remove periodic branches Each of $x/2$, $y/2$, and $(x+y)/2$ lies in $[-1/2, 1/2]$. The only zero of sine in this interval is zero. Consequently every solution lies on at least one of

$$x = 0, \qquad y = 0, \qquad x + y = 0.$$

There are no additional solutions coming from other integer multiples of π.

Step 3: List the intersections with the constraint If $x = 0$, then $|y| = 1$, giving $(0, 1)$ and $(0, -1)$. If $y = 0$, we obtain $(1, 0)$ and $(-1, 0)$. If $y = -x$, then $2|x| = 1$, giving $(1/2, -1/2)$ and $(-1/2, 1/2)$. These six ordered pairs are distinct. Each satisfies the original sine equation: either one sine is zero, or the two sine terms cancel.

Step 4: Conclusion The six listed ordered pairs exhaust all possibilities. Therefore the required number of pairs is

$$\boxed{6}.$$

Quick Tip to Solve: After factoring, restrict the sine arguments using $|x| + |y| = 1$ before listing solutions; this avoids counting irrelevant periodic branches.

31. In a certain word code, EXHAUST is written as CZFCSUR. How is NETWORK written in that code ? [4 marks]

(A) LCVYQTI

(B) LGVYQTM

(C) LGRYMTI

(D) LCRYQTM

Correct Answer: (C) LGRYMTI

Solution:

Concept:

- In a position-based letter code, compare each input letter with the output letter in the same position; a shift means moving forward or backward through the alphabet.
- An alternating rule applies one shift to odd positions and another shift to even positions. The position is counted from the left, beginning with position 1.

Step 1: Identify the odd-position shift In EXHAUST, the letters at positions 1, 3, 5 and 7 are E, H, U and T. Their coded letters are C, F, S and R respectively. Each coded letter is two alphabet places before its original letter: E becomes C, H becomes F, U becomes S, and T becomes R. Thus every odd-position letter is shifted backward by two.

Step 2: Identify the even-position shift At positions 2, 4 and 6, the input letters X, A and S become Z, C and U. Each moves forward by two places. The complete shift pattern is therefore backward two, forward two, backward two, forward two, backward two, forward two, backward two. This reproduces every letter of CZFCSUR, rather than relying on a single matching pair.

Step 3: Apply the rule to NETWORK For the odd positions, N becomes L, T becomes R, O becomes M and K becomes I. For the even positions, E becomes G, W becomes Y and R becomes T. Reading the transformed letters in their original order gives L, G, R, Y, M, T, I. Option A changes the second, third and fifth letters incorrectly; option B changes the third, fifth and final letters; option D also breaks the alternating shifts.

Step 4: Conclusion The result for NETWORK is LGRYMTI. Hence, the correct option is (C).

Quick Tip to Solve: Write the seven position numbers first and apply the alternating shifts separately to the odd and even positions.

32. In a code language, if "BRICK" is written as "CQJBL", then "CEMENT" is _____ [4 marks]

(A) DDOFOS

(B) DDODOS

(C) DDNDOS

(D) DDNFOS

Correct Answer: (C) DDNDOS

Solution:

Concept:

- A letter-substitution code can use alternating forward and backward alphabet shifts; compare matching positions instead of rearranging the word.
- The first position is odd. The same position rule must reproduce the complete example before it is applied to another word.

Step 1: Derive the alternating rule Compare BRICK with CQJBL. B becomes C, R becomes Q, I becomes J, C becomes B, and K becomes L. The alphabet shifts are therefore forward one, backward one, forward one, backward one, forward one. Both occurrences of the forward shift and both backward checks agree with a position-based alternating rule.

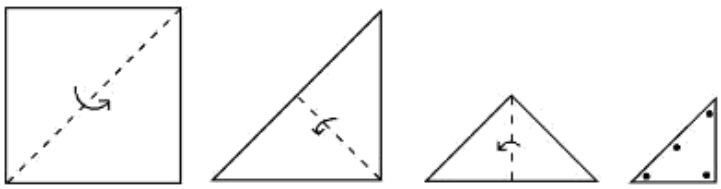
Step 2: Encode the six letters of CEMENT At position 1, C moves forward to D. At position 2, E moves backward to D. At position 3, M moves forward to N. At position 4, E moves backward to D. At position 5, N moves forward to O. At position 6, T moves backward to S. Keeping these letters in order gives D D N D O S. No reversal or additional rearrangement is part of the rule.

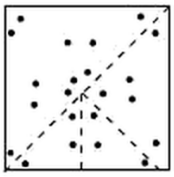
Step 3: Check the alternatives against the shifts DDNDOS matches all six letter transformations. DDOFOS has O instead of N at position 3 and F instead of D at position 4. DDODOS still makes the third letter O, which would require moving M forward by two rather than one. DDNFOS gives F at position 4, moving E forward when the rule requires moving it backward. Thus only one printed option satisfies the example consistently.

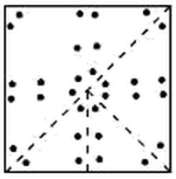
Step 4: Conclusion CEMENT is written as DDNDOS. Hence, the correct option is (C).

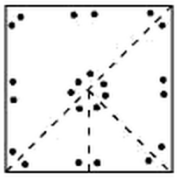
Quick Tip to Solve: For this code, mark successive letters with +1 and -1; repeated input letters can have different outputs when their positions differ.

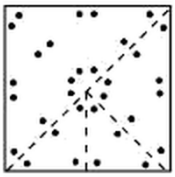
33. When the paper is folded in a given pattern and is cut at the end. Identify which pattern is formed when the paper is unfold? [4 marks]

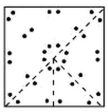


(A) 

(B) 

(C) 

(D) 

Correct Answer: (D) 

Solution:

Concept:

- Unfolding reverses the folds one at a time. Each hole in the folded stack produces reflected holes on the opposite side of each crease.
- Reflection preserves the perpendicular distance from a crease. Both the positions of the holes and the symmetry of the complete pattern must agree with the folding sequence.

Step 1: Reverse the last fold The final folded paper is a right triangle. Its cuts include holes near its three vertices and a hole partway along the sloping side. Open the last fold along the vertical crease of the preceding triangular shape. Each cut is copied to the opposite half at an equal distance from that crease; it is reflected, rather than shifted or rotated arbitrarily.

Step 2: Reverse the remaining folds Now reflect the resulting set across the preceding oblique crease, and finally across the diagonal crease of the original square. The cuts near the vertices generate groups near the corners, side midpoints and centre of the square. The cut partway along the sloping side generates the additional interior pairs along the diagonal directions. These interior holes are essential: checking only the outer corners would miss the distinction between the proposed patterns.

Step 3: Compare the complete patterns Option (D) has the required corner groups, pairs near the side midpoints, central group and additional interior diagonal pairs. Option (C) omits those additional interior pairs. Option (B) puts its extra interior holes along horizontal and vertical alignments instead of at the reflected diagonal positions. Option (A) does not reproduce the full reflected arrangement of the edge and interior groups. Thus only (D) preserves all the cut positions through the three successive unfoldings.

Step 4: Conclusion Reversing the three folds produces the pattern shown in option (D). Hence, the correct option is (D).

Quick Tip to Solve: Follow the most distinctive interior cut through the folds first; then use the corner and edge groups to confirm the complete pattern.

34. Match List I with List II

LIST I (Components/Material)		LIST II (Functions)	
A.	Cement	I.	Load Bearing
B.	Window	II.	Tensile strength
C.	Foundation	III.	Setting time
D.	Steel	IV.	Glazing

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

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

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

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

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

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

Solution:

Concept:

- Matching building components to functions requires identifying their characteristic role, rather than assigning every load-carrying material to the same description.
- Cement has setting characteristics, windows commonly incorporate glazing, foundations transfer loads to the supporting ground, and steel supplies tensile resistance.

Step 1: Match cement and window Cement reacts with water and sets, turning a workable paste into a progressively rigid binding material. Setting time is therefore the characteristic associated with Cement: A-III. A window admits light and often provides a view through glass panes; glazing is the term associated with fitting that glass. Thus Window matches Glazing: B-IV.

Step 2: Match foundation and steel A foundation receives the loads transmitted by the building and spreads them safely to the supporting soil. The load-bearing description therefore belongs to Foundation: C-I. Steel has high tensile strength and is used, for example, as reinforcement where concrete alone is weak in tension. Consequently Steel matches Tensile strength: D-II.

Step 3: Compare the complete mapping with every option The combined sequence is A-III, B-IV, C-I, D-II. Option C gives all four matches in exactly this order. Option A retains the window and steel matches but interchanges the cement and foundation descriptions. Option B incorrectly links a window to tensile strength and steel to glazing, while also missing the cement and foundation matches. Option D assigns the glazing description to cement and the remaining functions to unrelated components.

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

Quick Tip to Solve: Lock in the distinctive pair Window–Glazing first, then distinguish cement setting from the foundation's load-transfer role.

35. Match List I with List II

LIST I(struchture)		LIST II(places)	
A.	Humayun's Tomb	I.	Gujarat
B.	Bibi Ka Maqbara	II.	New Delhi
C.	Hussain Doshi Gufa	III.	Maharashtra
D.	Group of monuments, Mahabalipuram	IV.	Tamilnadu

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

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

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

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

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

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

Solution:

Concept:

- Architectural matching questions distinguish the location of a monument from its style, patron or the monument that inspired its design.
- Humayun's Tomb is in Delhi; Bibi Ka Maqbara is in Maharashtra; Hussain Doshi Gufa is in Gujarat; and Mahabalipuram is in Tamil Nadu.

Step 1: Locate the two tombs Humayun's Tomb is the Mughal garden-tomb complex in Delhi, so A corresponds to II, New Delhi. Bibi Ka Maqbara is located at Aurangabad in Maharashtra. Therefore B corresponds to III. Its resemblance to the Taj Mahal does not put it in the same city or state as that monument.

Step 2: Locate the cave gallery and coastal monuments Hussain Doshi Gufa, also known as Amdavad ni Gufa, is the underground art-gallery structure in Ahmedabad, Gujarat, associated with M. F. Husain and B. V. Doshi. Thus C corresponds to I. The Group of Monuments at Mahabalipuram, also called Mamallapuram, is on the Tamil Nadu coast. Thus D corresponds to IV.

Step 3: Use all four locations to select the code The required sequence is A-II, B-III, C-I, D-IV, which is option C. Option A sends Bibi Ka Maqbara to Tamil Nadu and Mahabalipuram to Maharashtra. Option B puts Humayun's Tomb in Gujarat and the Gufa in New Delhi. Option D places Bibi Ka Maqbara in Gujarat, the Gufa in Tamil Nadu and Mahabalipuram in Maharashtra. Those state assignments contradict the actual locations.

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

Quick Tip to Solve: Remember the two strongest place cues: Amdavad means Ahmedabad in Gujarat, and Mahabalipuram is on the Tamil Nadu coast.

36. Match List I with List II

LIST I		LIST II	
A.	Stairs	I.	Key stone
B.	Door	II.	Toothing
C.	Arch	III.	Jamb
D.	Brick work	IV.	Tread

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

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

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

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

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

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

Solution:

Concept:

- Construction vocabulary identifies particular parts of a building element: a tread belongs to a stair, a jamb to an opening, and a keystone to an arch.
- Toothing describes a stepped or projecting arrangement left in brickwork to help bond adjoining masonry work.

Step 1: Match stairs and door A stair consists of successive steps. The tread is the horizontal upper surface of a step on which a person places the foot, so Stairs matches Tread: A-IV. A jamb is the vertical side of a door or window opening, or the corresponding side member of its frame. Therefore Door matches Jamb: B-III. A tread is not the vertical side of the doorway.

Step 2: Match arch and brickwork The keystone is the central wedge-shaped unit at the crown of a traditional masonry arch. It belongs to Arch, giving C-I. Toothing is associated with brickwork: courses or ends can be left projecting in a toothed form to allow a subsequent adjoining wall to bond with the existing masonry. Therefore Brick work matches Toothing: D-II.

Step 3: Verify the complete alternative Collecting the matches produces A-IV, B-III, C-I, D-II, exactly option A. Option B assigns toothing to stairs, a keystone to a door, a jamb to an arch and a tread to brickwork. Option C preserves the door and brickwork matches but swaps the stair and arch terms. Option D places the jamb, tread, toothing and keystone with unrelated elements. Checking all four terms avoids choosing a code from a single familiar match.

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

Quick Tip to Solve: Visualise one step, one doorway and one masonry arch: the tread is horizontal, the jamb is vertical, and the keystone is at the crown.

37. Give below are two statements :

Statement I : A partition wall is defined as an internal wall whose function is to divide the space within the building.

Statement II : Partition wall could be load bearing or non-load bearing.

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:

- An internal partition separates the floor area of a building into rooms or other usable spaces. Its spatial function must be distinguished from the way loads travel through the building.
- A wall may be classified by location and function as well as by structural action. In the broad functional usage of this question, an internal dividing wall can also perform a load-bearing role.

Step 1: Assess Statement I A partition divides the space inside the building. For example, the wall separating two rooms provides spatial subdivision, privacy and enclosure within the external envelope. Thus the description in Statement I correctly identifies the defining internal, space-dividing function. It does not describe a boundary wall outside the building or merely a decorative finish.

Step 2: Assess Statement II Dividing space and carrying load are different aspects of a wall. An internal dividing wall can carry loads when it forms part of a load-bearing construction; alternatively, in a framed building, a lightweight partition can divide rooms without supporting the floors or roof. Statement II uses partition in this broad functional sense and is therefore correct. In more restrictive construction specifications, the term partition is often reserved for non-load-bearing dividers; that narrower usage is not the intended classification here.

Step 3: Match the two truth values Both statements are accepted in the broad classification used in the question. Option (B) rejects the correct definition of an internal dividing wall. Option (C) accepts the spatial definition but unnecessarily excludes its possible structural role in the terminology used here. Option (D) incorrectly rejects Statement I. The pair of true statements is represented by option (A).

Step 4: Conclusion Both Statement I and Statement II are correct in the broad functional terminology used here. Hence, the correct option is (A).

Quick Tip to Solve: Separate a wall's space-dividing function from its structural role; the term partition can be used more narrowly in a construction specification.

38. Given below are two statements: one is labelled as Assertion A and the other is labelled as Reason R :

Assertion A : Social integration at work place is necessary.

Reason R : There are many backward classes in society.

In the light of the above statements, choose the *correct* answer from the options given below :

[4 marks]

(A) Both **A** and **R** are true and **R** is the correct explanation of **A**

(B) Both **A** and **R** are true but **R** is NOT the correct explanation of **A**

(C) **A** is true but **R** is false

(D) **A** is false but **R** is true

Correct Answer: (B) Both **A** and **R** are true but **R** is NOT the correct explanation of **A**

Solution:

Concept:

- Social integration means including people from different backgrounds in shared activities and institutions with mutual respect and equitable opportunity.
- An assertion-reason question requires three checks: whether the assertion is true, whether the reason is true, and whether the reason actually explains the assertion.

Step 1: Evaluate the assertion Social integration at a workplace is necessary because people must cooperate, communicate and participate as members of a common organisation. Inclusion helps employees work together across differences in social background, language, community and economic circumstances. It supports equal treatment and effective teamwork. Thus Assertion A is true.

Step 2: Evaluate the reason The reason refers to the existence of socially and educationally disadvantaged classes in society, using the terminology of the question. Such groups do exist, so Reason R is treated as a true social observation. Its truth does not, however, automatically establish an explanatory relationship with every statement about inclusion.

Step 3: Test the explanatory link and the options The need for workplace integration follows from inclusive participation, dignity and cooperation among all employees. The bare statement that society contains many disadvantaged classes does not explain this workplace requirement: it gives neither the mechanism of integration nor the general need for employees to work together. Therefore R is not the correct explanation of A. Option (A) incorrectly claims that explanatory link. Option (C) rejects a true reason, while option (D) rejects the true assertion. Only option (B) gives the required combination.

Step 4: Conclusion A and R are both true, but R is not the correct explanation of A. Hence, the correct option is (B).

Quick Tip to Solve: After judging both statements, explicitly ask whether the reason supplies a logical explanation; a related social fact alone is insufficient.

39. Primary colours are _____. [4 marks]

(A) Red, Blue, Yellow

(B) Red, Green, Blue

(C) Red, Violet, Yellow

(D) Red, Green, Yellow

Correct Answer: (A) Red, Blue, Yellow

Solution:

Concept:

- In the traditional colour wheel used in painting and elementary design, the primary colours are red, blue and yellow, commonly abbreviated RYB.
- Colour systems depend on the medium. Additive mixing of coloured light uses red, green and blue; it must be distinguished from the traditional artists' colour wheel tested here.

Step 1: Choose the relevant colour system This aptitude question concerns the basic colour terminology used in art and design. In that traditional system, red, blue and yellow are the three primary colours. They are the starting colours from which the secondary colour groups are introduced on the elementary colour wheel, rather than being obtained by mixing its secondary colours.

Step 2: Check the proposed colour sets Option (A) lists red, blue and yellow, exactly the traditional primary triad. In that framework, blue with yellow gives green, red with yellow gives orange, and red with blue gives violet. Hence green and violet belong to the secondary group of this colour wheel rather than replacing one of its primaries.

Step 3: Distinguish the tempting alternative Option (B), red, green and blue, is familiar because it is the additive primary set used for coloured light and electronic displays. It is not the intended traditional art-colour answer. Option (C) substitutes violet, a secondary colour, for blue. Option (D) substitutes green for blue. These comparisons select option (A) without confusing the painting convention with the light-mixing convention.

Step 4: Conclusion The primary colours in the traditional art colour wheel are red, blue and yellow. Hence, the correct option is (A).

Quick Tip to Solve: Identify the medium first: traditional art questions usually use RYB, whereas coloured-light questions use RGB.

40. The stairs kept in motion by a revolving drum is known as a _____. [4 marks]

(A) Escalator

(B) Lift

(C) Elevator

(D) Revolving stairs

Correct Answer: (A) Escalator

Solution:

Concept:

- An escalator is a moving staircase whose connected steps circulate continuously on an endless mechanism between two levels.
- A lift or elevator transports people in a vertically moving car. Its operating form is different from a continuously circulating flight of steps.

Step 1: Identify the moving element The statement describes stairs that are kept in motion by a revolving driving mechanism. The important identifying feature is that the steps themselves move, allowing a passenger to stand on a step while travelling from one level to another. A continuous moving staircase of this kind is called an escalator.

Step 2: Relate the mechanism to the name The connected steps circulate around the supporting mechanism: the exposed flight carries passengers between landings, while the steps return within the assembly. The drive maintains that circulation. Thus the reference to a revolving drum is a clue to the continuous movement of the staircase, rather than a description of an ordinary fixed stair.

Step 3: Eliminate the alternative terms A lift and an elevator are names for a system with a car or platform moving between floors; neither is a flight of moving stairs. Therefore options (B) and (C) do not match the moving element specified in the question. Option (D), revolving stairs, is merely a descriptive phrase and is not the standard building-services term for this device. Escalator is the precise name and matches option (A).

Step 4: Conclusion The moving staircase described is an escalator. Hence, the correct option is (A).

Quick Tip to Solve: Look at what carries the passenger: circulating steps indicate an escalator, while a moving enclosed car indicates a lift or elevator.

41. Which of the following structure does not have a dome? [4 marks]

(A) Gol Gumbaz

(B) Avicii Arena

(C) St. Paul's Cathedral

(D) The Shard

Correct Answer: (D) The Shard

Solution:

Concept:

- A dome is a curved roof or vault covering a space, usually forming a rounded or approximately hemispherical external profile.
- Architectural identification requires recognising the main form of each named structure: a dome, a spherical arena, or a pointed tower can distinguish the alternatives.

Step 1: Recognise the domed monuments Gol Gumbaz at Vijayapura is particularly noted for its enormous dome over the tomb chamber. St. Paul's Cathedral in London is also a major example of a building crowned by a prominent dome. Consequently neither option (A) nor option (C) can answer a question asking for a structure without a dome.

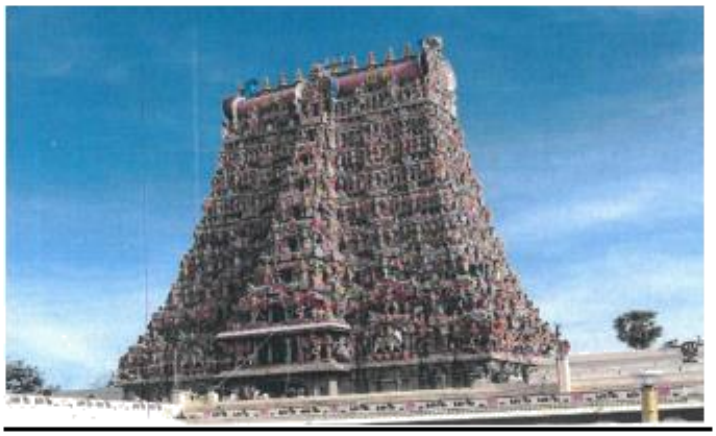
Step 2: Check the arena Avicii Arena in Stockholm is the large globe-shaped arena formerly known as the Ericsson Globe. Its conspicuous spherical, curved enclosure belongs with the dome-type forms in this identification question. Its rounded profile distinguishes it from an angular, pointed skyscraper, so option (B) is also excluded.

Step 3: Identify the contrasting building The Shard in London is a tall glass-clad skyscraper with tapering sides and a pointed, shard-like top. Its defining silhouette is a narrowing angular tower, rather than a rounded dome covering a chamber or arena. It is therefore the structure among the four alternatives that does not have a dome. This conclusion follows by checking all four named examples, rather than selecting a building simply because it is modern.

Step 4: Conclusion The Shard has a tapering, pointed architectural form rather than a dome. Hence, the correct option is (D).

Quick Tip to Solve: Group the landmarks by silhouette: Gol Gumbaz, the globe-shaped arena and St. Paul's are curved; The Shard is pointed.

42. Given below is the famous temple in India. Identify the style of temple architecture adopted in the temple. [4 marks]



(A) Nagara

(B) Dravidian

(C) Vesara

(D) Orissan

Correct Answer: (B) Dravidian

Solution:

Concept:

- Temple styles can be identified from the silhouette and construction of their towers. Dravidian temple complexes characteristically have monumental gateway towers called gopurams.
- A gopuram rises in successively smaller, clearly separated storeys. Its broad rectangular base, stepped pyramidal outline and sculptural decoration distinguish it from a continuously curving shikhara.

Step 1: Inspect the visible tower The photograph shows a very tall entrance tower with a broad base. Numerous horizontal tiers step inward towards the top, and the faces are densely covered with sculptural figures. The elongated crest and sharply tiered profile identify it as a gopuram, a characteristic feature of South Indian Dravidian temple architecture. Identify the architectural form itself; the exact name of the temple is not required.

Step 2: Compare the four styles Dravidian is the matching style. Nagara temples are identified principally by curvilinear shikharas above their sanctums, rather than this tall, tiered entrance gopuram. Vesara denotes a combination of northern and southern architectural features and does not best describe the characteristic tower shown. Orissan temple architecture has distinctive curving sanctuary towers and stepped assembly halls; it is not the style indicated by this monumental, densely sculptured South Indian gateway.

Step 3: Conclusion The temple displays the tiered gopuram characteristic of Dravidian temple architecture. Hence, the correct option is (B).

Quick Tip to Solve: First inspect the tower silhouette: a broad, sculptured gateway tapering through many horizontal storeys is a strong Dravidian gopuram clue.

43. Match List I with List II. The four plans shown below are A, B, C and D, respectively, from top to bottom.

LIST I (Plan)		LIST II (Building Name)	
A.	First plan	I.	Taj Mahal
B.	Second plan	II.	Qutub Minar, New Delhi
C.	Third plan	III.	Matri Mandir, Auroville
D.	Fourth plan	IV.	Sanchi Stupa

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



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

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

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

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

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

Solution:

Concept:

- A plan represents the horizontal arrangement of a building. Distinctive outlines, concentric enclosures and subsidiary elements help identify a monument without seeing its elevation.

- Match each labelled plan separately to its building, then compare the complete sequence with the options. A common match appearing in every option cannot by itself decide the answer.

Step 1: Identify the four plans Plan A has a compact circular centre surrounded by a strongly fluted outer boundary. This is the characteristic fluted cross-section of Qutub Minar, so A matches II. Plan B has a circular centre with a ring of repeated radial compartments, identifying Matri Mandir at Auroville, so B matches III. Plan C has concentric circular boundaries and projections at the cardinal directions, characteristic of the enclosure and gateways of Sanchi Stupa, so C matches IV. Plan D is square with a central circular feature and four smaller circular features near the corners, identifying the Taj Mahal composition; therefore D matches I.

Step 2: Compare the complete matching sequence The required sequence is A-II, B-III, C-IV, D-I, exactly as in option (B). Option (A) incorrectly assigns the fluted Qutub Minar plan A to Sanchi Stupa and plan B to Qutub Minar. Option (C) incorrectly exchanges the identities of plans A and B. Option (D) assigns plan A to Sanchi Stupa and plan C to Qutub Minar. All four options agree on D-I, so identifying the Taj Mahal alone would leave the question undecided; the fluted outline of A and the contrasting circular arrangements of B and C complete the identification.

Step 3: Conclusion A-II, B-III, C-IV and D-I give the correct plan-to-building correspondence. Hence, the correct option is (B).

Quick Tip to Solve: Start with the most distinctive outline: the fluted circular plan identifies Qutub Minar immediately, and the remaining circular plans can then be distinguished by their enclosures.

44. The botanical name of "MANGO" tree is [4 marks]

(A) Azadirachita Indica

(B) Mangifera Indica

(C) Delonux Indica

(D) Delonux Regia

Correct Answer: (B) Mangifera Indica

Solution:

Concept:

- Botanical nomenclature identifies a plant by a two-word scientific name: the genus followed by the specific epithet. This provides a precise identity independently of a local or common name.
- The mango tree belongs to the genus Mangifera and its specific epithet is indica; the accepted scientific name is therefore *Mangifera indica*.

Step 1: Identify the genus of mango The word MANGO is the common name of the fruit-bearing tree. Its botanical genus is Mangifera. Thus a correct answer must begin with Mangifera, rather than a name associated with a different tree. The genus is written with an initial capital, while the species epithet is conventionally lower case.

Step 2: Check the listed species names Option (B), Mangifera Indica, supplies the correct genus and epithet, despite the capitalisation used in the printed option. Azadirachta indica is neem, so option

(A) does not name mango. Delonix regia names the gulmohar or royal poinciana, excluding option (D). The Delonux wording in option (C) likewise does not give the genus Mangifera and cannot be the botanical name of mango. No measurement or visual identification is needed: the decision is the direct association between the common name and its botanical binomial.

Step 3: Conclusion The botanical name of mango is *Mangifera indica*. Hence, the correct option is (B).

Quick Tip to Solve: Associate mango with Mangifera and neem with Azadirachta; the shared epithet indica does not make two plants the same species.

45. Scientific study of human body measurements : [4 marks]

(A) Depth Perception

(B) Anthrology

(C) Axenometry

(D) Anthropometry

Correct Answer: (D) Anthropometry

Solution:

Concept:

- Anthropometry is the systematic study and measurement of the dimensions of the human body, including stature, limb lengths, breadths and reach.
- In architectural design, human measurements help determine the dimensions and clearances of spaces, furniture, openings and working surfaces.

Step 1: Identify what the definition measures The decisive words are human body measurements. They refer to quantitative body dimensions, such as standing height, seated height, shoulder breadth and reach, rather than to the appearance of a drawing. The technical term for this measurement-based field is anthropometry. Such data allow a designer to relate the size of a built element to the people expected to use it.

Step 2: Distinguish the remaining terms Depth perception, option (A), is the ability to perceive spatial distance and three-dimensional relationships; it is not the measurement of body dimensions. The printed term Anthrology in option (B) does not name this measurement science; even anthropology is the broader study of humans rather than the specific term asked here. Axenometry in option (C) refers toward axonometric representation, a method of depicting three-dimensional forms on a plane, not a study of bodily dimensions. Only option (D) directly matches both the human subject and the measurement activity in the question.

Step 3: Conclusion The scientific study of human body measurements is anthropometry. Hence, the correct option is (D).

Quick Tip to Solve: Link anthropometry to body dimensions and ergonomics to the use of those dimensions in comfortable, usable design.

46. FAR stands for [4 marks]

(A) Facade Area Ratio

(B) Floor Area Ratio

(C) Fire Accessible Ramp

(D) Fire Arch Ratio

Correct Answer: (B) Floor Area Ratio

Solution:

Concept:

- Floor Area Ratio is a planning measure relating the total counted floor area of a building to the area of the plot on which it stands.
- Using consistent area units, $\text{FAR} = \dfrac{\text{total counted floor area}}{\text{plot area}}$. As a ratio of two areas, FAR is dimensionless.

Step 1: Expand the abbreviation in its planning context The initials FAR represent Floor Area Ratio. The first term concerns the building floor area rather than the visible facade. In development control, the ratio expresses how much counted floor space is provided relative to the site area. Which floor areas are counted is determined by the relevant rules, but this does not change the expansion of the abbreviation.

Step 2: Use the ratio to exclude the other expansions For example, if a plot measures 500 square metres and its counted floor area over all floors totals 1000 square metres, the FAR is 1000/500 = 2. This illustrates why Floor Area Ratio fits the term. Facade Area Ratio in option (A) refers to the exterior face rather than the counted floors and is not the expansion of FAR. Fire Accessible Ramp in option (C) and Fire Arch Ratio in option (D) do not describe the standard floor-space-to-site-area planning ratio. They therefore fail the meaning as well as the established terminology.

Step 3: Conclusion FAR stands for Floor Area Ratio. Hence, the correct option is (B).

Quick Tip to Solve: For FAR, keep total counted floor area in the numerator and plot area in the denominator; first put both in the same area unit.

47. On an engineer scale, 1 cm = 10 m. Identify the representative fraction (R.F.) [4 marks]

(A) 1/100

(B) 1/10

(C) 1/1000

(D) 1/10000

Correct Answer: (C) 1/1000

Solution:

Concept:

- The representative fraction is the ratio of a distance on a drawing to the corresponding actual distance, with both distances expressed in the same unit.

- Thus $\text{R.F.} = \dfrac{\text{drawing distance}}{\text{actual distance}}$. A reduction scale has a representative fraction smaller than one.

Step 1: Convert the actual distance into centimetres The given scale states that 1 cm on the drawing represents 10 m in reality. The numerator is already in centimetres, so convert the denominator before dividing. Since one metre contains one hundred centimetres, the actual distance is

$$10\,\text{m} = 10 \times 100\,\text{cm} = 1000\,\text{cm}.$$

Using 10 directly in the denominator would compare different units and would not produce the representative fraction.

Step 2: Form the unitless ratio and compare the options Substitute the two distances expressed in the same unit:

$$\text{R.F.} = \frac{1\,\text{cm}}{1000\,\text{cm}} = \frac{1}{1000}.$$

The centimetres cancel, as required for a fraction representing a scale. Option (A), 1/100, would make 1 cm represent only 1 m. Option (B), 1/10, would make it represent 10 cm. Option (D), 1/10000, would instead make 1 cm represent 100 m. Only option (C) reproduces the stated actual length of 10 m.

Step 3: Conclusion The representative fraction is $\boxed{1/1000}$, or the scale $1 : 1000$. Hence, the correct option is (C).

Quick Tip to Solve: Before taking a scale ratio, convert the real length to the drawing unit; metres to centimetres introduces a factor of 100.

48. Identify the iconic Landmark : [4 marks]



(A) Taipei 101

(B) One World Trade Center

(C) Sydney Opera House

(D) Shanghai World Financial Center

Correct Answer: (C) Sydney Opera House

Solution:

Concept:

- A landmark can be identified by its distinctive building form and setting. The silhouette and roof shape are stronger evidence than the colour of a photograph.
- The Sydney Opera House is recognised by its cluster of large curved, sail-like roof shells beside Sydney Harbour.

Step 1: Read the visible architectural features The photograph shows a low waterfront complex whose white roof shells rise in several pointed, curved forms. These overlapping sail-like shells are the distinctive feature of the Sydney Opera House. Water occupies the foreground and a large steel arch bridge appears behind the building, consistent with its Sydney Harbour setting. The identification follows from the visible roof silhouette rather than from a generic association with any modern waterfront building.

Step 2: Eliminate the other landmarks Option (C), Sydney Opera House, matches both the shell-roof architecture and the harbour setting. Taipei 101 in option (A) is a very tall, vertically tiered skyscraper; the photographed building has neither that height nor the stacked tower form. One World Trade Center in option (B) is also a tall tower with a tapering faceted profile and spire, unlike the low cluster of roof shells here. Shanghai World Financial Center in option (D) is a skyscraper distinguished by an opening near its top, which is absent from the photograph. Thus none of the three tower options describes the visible building.

Step 3: Conclusion The iconic landmark is the Sydney Opera House. Hence, the correct option is (C).

Quick Tip to Solve: Identify the silhouette first: a cluster of white sail-like roof shells beside a harbour is the defining visual cue for the Sydney Opera House.

49. Identify the name of the Landmark : [4 marks]



(A) Crystal Palace, London

(B) The Louvre, Paris

(C) German Pavilion for World exibition, Barcelona

(D) Vitra Design Museum, Basel

Correct Answer: (B) The Louvre, Paris

Solution:

Concept:

- Identify a landmark from its characteristic form and its architectural setting together. A distinctive entrance structure can identify the larger complex even when the whole building is not visible.
- The Louvre in Paris is recognised by its glass pyramid entrance standing in the courtyard of the historic palace. The contrast between transparent modern geometry and the ornate stone palace is a useful visual clue.

Step 1: Read the principal features of the photograph The foreground contains a large transparent pyramid formed by a regular metal-and-glass grid. Behind it is a substantial historic stone building with classical architectural details, a steep roof and a richly decorated pavilion. The pyramid stands in an open paved courtyard rather than forming the roof of the entire surrounding building. This combination identifies the Louvre courtyard and its pyramid entrance.

Step 2: Compare the four named landmarks Option (B), The Louvre, Paris, matches both the glass pyramid and the palace setting. Crystal Palace, option (A), is associated with an extensive iron-and-glass exhibition building, not this pyramid in a palace courtyard. The German Pavilion in Barcelona, option (C), is recognised by its low horizontal roof and open modern pavilion composition, so its massing does not fit the photograph. The Vitra Design Museum, option (D), has a sculptural composition of white volumes and curved forms rather than this glass-pyramid entrance. Thus the characteristic shape and its immediate surroundings support the same identification.

Step 3: Conclusion The landmark shown is The Louvre, Paris. Hence, the correct option is (B).

Quick Tip to Solve: Match a landmark's distinctive shape with its setting: the glass pyramid plus the historic palace courtyard identifies the Louvre.

50. Identify the famous Monument in the given picture. [4 marks]



(A) Chand Baoli

(B) Stepped Pyramid

(C) Golden Lily Pond

(D) Airavates-vara Temple

Correct Answer: (A) Chand Baoli

Solution:

Concept:

- A stepwell is recognised by flights of steps descending from ground level towards a water reservoir. Repeated stair geometry distinguishes it from a freestanding pyramid or a temple tower.
- Chand Baoli, also called Chand Baori, has a deep sunken courtyard lined with closely spaced, repeated zigzag stairs. Its descending geometric tiers are its most recognisable feature.

Step 1: Identify the type of structure shown The photograph looks down into a deep rectangular excavation. Dense rows of narrow stair flights descend along the sides, repeatedly changing direction and producing a strong zigzag pattern. Water appears at the lowest level. These features indicate a stepwell: the stairs provide access down to the water rather than forming an elevated external monument. The repetition of many small flights is particularly characteristic of Chand Baoli.

Step 2: Eliminate the alternative identifications Chand Baoli in option (A) fits the sunken reservoir and the tightly repeated stair pattern. A stepped pyramid, option (B), rises above its surroundings through successively smaller tiers; the structure here descends into the ground. The Golden Lily Pond, option (C), is a temple tank and does not have this characteristic dense arrangement of deep zigzag stair flights. Airavates-vara Temple, option (D), is identified through its temple architecture, sculptured stonework and shrine composition rather than this deep stepped well. The direction of the tiers and their relationship to the water therefore distinguish the correct monument from the other three choices.

Step 3: Conclusion The monument in the photograph is Chand Baoli. Hence, the correct option is (A).

Quick Tip to Solve: Check whether the tiers rise above ground or descend towards water; repeated zigzag flights into a deep well are the key clue for Chand Baoli.

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51. A man is facing towards East and turns through 45° anti clockwise, again 180° anticlockwise and than turns through 270° clockwise. In which direction is he facing now? [4 marks]

(A) South-East

(B) South-West

(C) South

(D) North-East

Correct Answer: (A) South-East

Solution:

Concept:

- Directions can be represented by angles measured anticlockwise from East. East is 0°, North is 90°, West is 180°, and South is 270°.
- An anticlockwise turn adds to the direction angle, whereas a clockwise turn subtracts from it. Angles differing by 360° represent the same final facing direction.

Step 1: Apply the two anticlockwise turns Start with the man facing East, so his initial angle is 0°.

The first turn takes him to the North-East direction:

$$0^\circ + 45^\circ = 45^\circ.$$

The next turn is also anticlockwise. Add the full stated angle rather than reversing the sign because the direction of rotation has not changed:

$$45^\circ + 180^\circ = 225^\circ.$$

An angle of 225° is halfway between West and South, so he now faces South-West.

Step 2: Apply the final clockwise turn Subtract 270° from the current direction because the last turn is clockwise:

$$225^\circ - 270^\circ = -45^\circ = 315^\circ.$$

This is 45° clockwise from East, halfway between East and South. Hence it is South-East. As a check, a clockwise turn of 270° has the same final effect as an anticlockwise turn of 90°; applying that to South-West again gives South-East. South-West describes only the intermediate position, South would require a net angle of -90°, and North-East would require $+45^\circ$, so those three options do not give the final orientation.

Step 3: Conclusion The man finally faces South-East. Hence, the correct option is (A).

Quick Tip to Solve: Add anticlockwise angles and subtract clockwise angles, then reduce the total modulo 360° before naming the compass direction.

52. The 'lightness or darkness' of a colour is defined as : [4 marks]

(A) Hue

(B) Brightless

(C) Dullness

(D) Value

Correct Answer: (D) Value

Solution:

Concept:

- A colour is described using distinct attributes. Hue identifies the colour family, such as red, yellow, green or blue; value identifies its relative lightness or darkness.
- A value scale runs from very light tones near white to very dark tones near black. Colours of different hues can have the same value, just as one hue can occur at several values.

Step 1: Match the stated property to its technical term The question asks specifically for the attribute expressed by the words "lightness or darkness". In visual art, design and architectural colour studies, this attribute is called value. For example, a pale blue and a dark blue belong to the same general hue family, but their values differ. The pale blue has a higher or lighter value and the dark blue has a lower or darker value. This comparison concerns tonal lightness rather than which colour family is

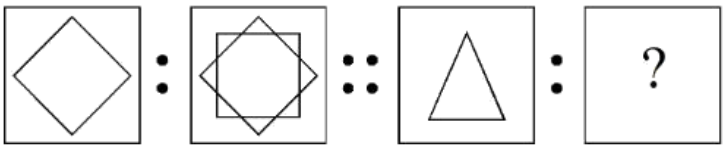
present.

Step 2: Distinguish the alternatives Hue, option (A), answers the question "which colour?" rather than "how light or dark?". The word printed as "Brightless" in option (B) does not name the standard attribute requested here. Brightness in informal descriptions may suggest vividness or perceived intensity, but the precise design term for the quoted light–dark attribute is value. Dullness, option (C), commonly describes a muted or less vivid appearance and is associated with reduced saturation; it does not provide the light–dark coordinate. Thus option (D) matches the definition directly without confusing value with hue or intensity. A useful practical check is to imagine viewing the colours in greyscale: their remaining light and dark distinctions are their values.

Step 3: Conclusion The lightness or darkness of a colour is its value. Hence, the correct option is (D).

Quick Tip to Solve: Use the three questions "which colour?", "how light or dark?", and "how vivid?" to distinguish hue, value and saturation respectively.

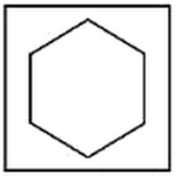
53. Select a figure amongst the answer figures which will continue the same series or pattern as established by the problem figures. [4 marks]



(A) 

(B) 

(C) 

(D) 

Correct Answer: (A) 

Solution:

Concept:

- A figure analogy applies the transformation in the first pair to the second pair. Compare the inner shapes; the surrounding square is only the common frame.
- Superposition retains the original shape and adds a rotated copy at the same centre. It is different from reducing the shape to make a nested copy or translating it to another position.

Step 1: Determine the transformation in the first pair The first problem figure contains a square

in a diamond orientation. In the corresponding second figure this diamond remains, and another square in the upright orientation is superimposed at the same centre. The result shows both outlines crossing one another. The defining operation is therefore to add a differently oriented copy of the same polygon, while retaining its original outline and central position.

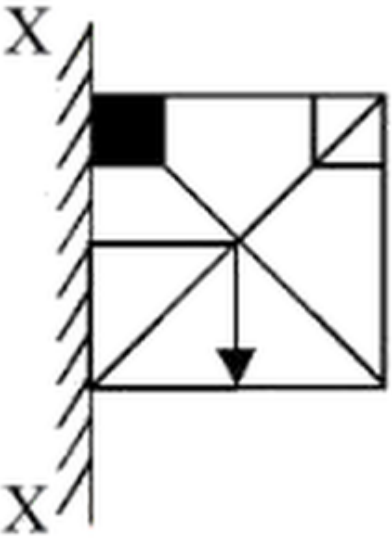
Step 2: Apply the operation to the triangle Retain the upward-pointing triangle and superimpose an inverted triangle at the same centre. Their overlapping outlines form a six-pointed star, as shown in option (A). This uses two triangles in opposite orientations, just as the first pair uses two squares in different orientations. Option (B) instead nests a smaller triangle inside a larger triangle with the same orientation. Option (C) shifts one upright triangle vertically relative to another, so it does not reproduce the centred change of orientation. Option (D) gives only a hexagon and loses the two overlapping triangular outlines. Hence only (A) preserves the relevant construction rule of the example pair.

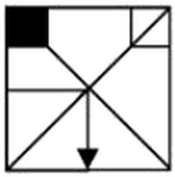
Step 3: Conclusion The required figure is the pair of superimposed upward- and downward-pointing triangles. Hence, the correct option is (A).

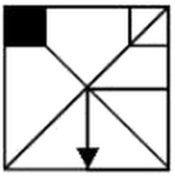
Quick Tip to Solve: In a figure analogy, track what is retained and what is added; here the original polygon stays and a rotated copy overlaps it at the same centre.

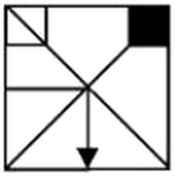
54. Identify the true mirror image of the figure amongst the answer figures with respect to-X-X

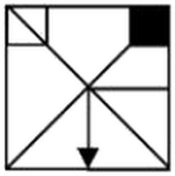
[4 marks]

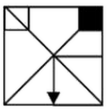


(A) 

(B) 

(C) 

(D) 

Correct Answer: (D) 

Solution:

Concept:

- Reflection in a vertical mirror reverses left and right while preserving top and bottom. Each feature must appear at the same height and at the corresponding distance on the opposite side.
- To distinguish similar answer figures, track asymmetric details separately: the filled corner square, the small diagonal corner square and the horizontal segment through the centre.

Step 1: Reflect the corner details across the vertical mirror The mirror line X–X is vertical and lies beside the left edge of the problem figure. In its mirror image, the black square at the upper left must appear at the upper right. The small outlined square at the upper right must move to the upper left, with its diagonal sloping in the opposite direction. Both changes appear in options (C) and (D); options (A) and (B) retain the filled square on the upper left and therefore cannot be the required reflection.

Step 2: Check the centre line and arrow In the problem figure the horizontal segment runs from the left side to the centre. After left-right reversal it must run from the centre to the right side. Option (C) leaves this segment on the left, whereas option (D) places it on the right. The vertical arrow points downwards in the original. A vertical mirror does not reverse top and bottom, so the reflected arrow must still point downwards, as it does in (D). The large diagonals also join the corresponding reflected corners. Checking these independent details selects (D) without confusing reflection with rotation or with a change to only one of the corner markings.

Step 3: Conclusion Option (D) reverses all left-right features while retaining their vertical positions. Hence, the correct option is (D).

Quick Tip to Solve: For a vertical mirror, check one corner mark and one off-centre line; both must swap sides, while a downward arrow remains downward.

55. Identify the mirror image of given word : [4 marks]



(A) PROGRESS

(B) SSERGOPR

(C) SSERGOPR

(D) SSERGOPR

Correct Answer: (C) SSERGOPR

Solution:

Concept:

- A vertical mirror reverses left and right while preserving the height of every point. The order of the letters and the shape of each asymmetric letter must both be reflected.
- Reading a reflected word from left to right starts with the reflection of the original last letter. Merely reversing the order of ordinary printed letters does not produce a mirror image.

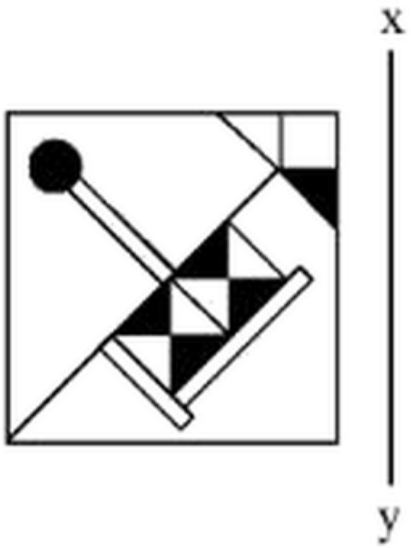
Step 1: Reverse the order of the letters The word is PROGRESS, and the dashed mirror line is vertical on its right. The last S is nearest the mirror and therefore appears at the left end of the answer figure. Moving across the reflected image, the original letters are encountered in the order S, S, E, R, G, O, R, P. These names identify the letters only; their actual printed shapes must also face the opposite way.

Step 2: Check the shapes as well as the sequence Both S shapes must be reflected in the same manner. The E must have its vertical stroke on the right and its three horizontal strokes extending left. The two R shapes and the final P must also face left, while the symmetric O remains visually unchanged. Option (C) satisfies all these tests. Option (A) leaves the original word unchanged. Option (B) does not reflect both initial S shapes consistently. Option (D) retains normally facing asymmetric letters, including the E, R and G, so reversing part of its order is insufficient.

Step 3: Conclusion Option (C) reverses both the order and the shapes of all the letters of PROGRESS. Hence, the correct option is (C).

Quick Tip to Solve: Check the two S shapes and the E first: a correct letter sequence can still hide one letter that has not been reflected.

56. Identify the correct mirror image of the given figure along x-y axis : [4 marks]



(A) 

(B) 

(C) 

(D) 

Correct Answer: (D) 

Solution:

Concept:

- Reflection in a vertical axis reverses horizontal positions but leaves vertical positions unchanged. Corresponding points lie at equal perpendicular distances from the mirror line.
- Every component must undergo the same reflection: the black disk, diagonal lines, shaded triangles and narrow end bars cannot be moved independently.

Step 1: Locate the reflected disk and corner pattern The x-y mirror axis is vertical to the right of the square. The black disk at the upper left must therefore appear at the upper right in the mirror image. Its height remains unchanged. The small white square and adjoining black triangular region near the original upper-right corner move to the upper-left corner. Options (A) and (B) fail immediately because they leave the disk on the left and the corner motif on the right.

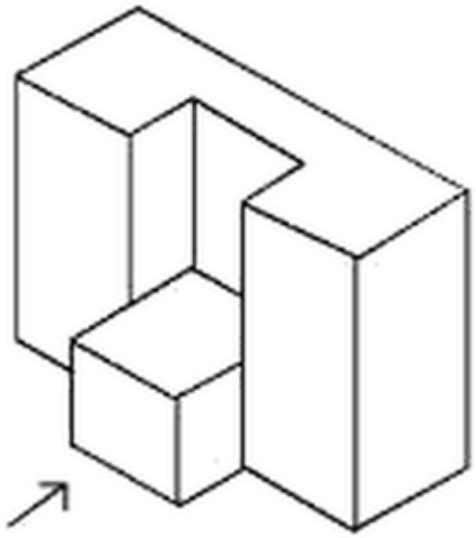
Step 2: Reflect the remaining diagonal assembly The long diagonal that originally rises from the lower-left corner must slope down towards the lower-right corner after reflection. The alternating

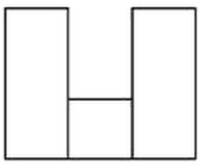
black and white triangles exchange horizontal positions without exchanging their top and bottom levels. Finally, follow the narrow outlined support bars around this triangular assembly. The short bar originally attached at its lower-left end must move to its lower-right end. Option (D) preserves this attachment and the reflected arrangement of the adjoining long strip. Option (C) instead places the short end bar at the upper-left end, altering the assembly rather than reflecting it.

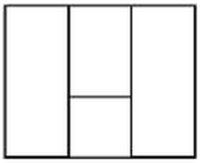
Step 3: Conclusion Only option (D) reflects the disk, corner motif, triangular pattern and end bars consistently about x-y. Hence, the correct option is (D).

Quick Tip to Solve: Use the disk to eliminate the first two figures, then track the short end bar to distinguish the two remaining reflections.

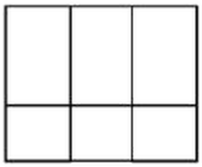
57. The question figure shows the 3D view of an object. Identify the correct view of the object looking in the direction of arrow. [4 marks]

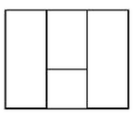


(A) 

(B) 

(C) 

(D) 

Correct Answer: (B) 

Solution:

Concept:

- A view in the arrow's direction is an orthographic projection. Features at different depths can appear on the same vertical line, but visible surfaces behind a recess must still be included.
- A low projecting block creates an edge only across its own width. Its top level does not automatically produce a line across adjacent uninterrupted faces.

Step 1: Determine the outside outline The arrow points towards the opening between the two tall side portions. Each side rises to the same full height. The central front block is lower, but a tall rear connecting portion is visible behind it. Consequently, the central area above the low block is filled by the rear face in this view; it is not an opening to empty space. The complete outer silhouette is therefore a rectangle with a continuous upper edge.

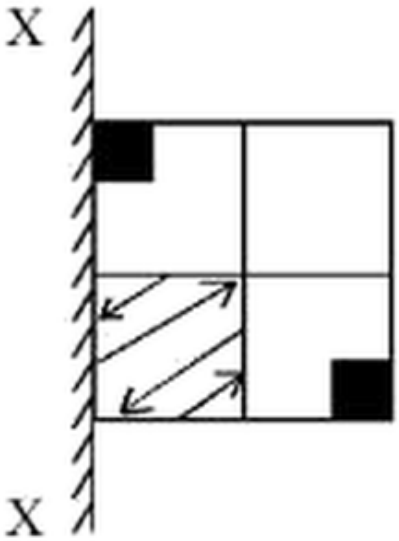
Step 2: Place the visible internal edges The boundaries between the central recess and the two side portions form two vertical lines. Across the centre only, the top edge of the low front block gives one horizontal division. The tall side faces have no corresponding change of surface at that height, so this horizontal line must stop at the two central vertical boundaries. Option (B) shows exactly this arrangement. Option (A) omits the visible upper rear face and creates a notch. Option (C) likewise creates a notch and adds divisions across the sides. Option (D) keeps the rectangular outline but incorrectly extends the low block's horizontal edge through both side faces.

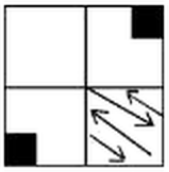
Step 3: Conclusion The required view has a rectangular outline, two vertical internal boundaries and a short horizontal line confined to the centre, as in option (B). Hence, the correct option is (B).

Quick Tip to Solve: Look through a recess for a rear wall before treating it as a gap, and draw a projected horizontal edge only across the face that actually has it.

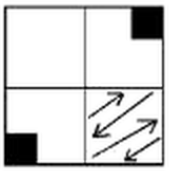
58. Identify the true mirror image of the figure amongst the answer figures with respect to X-X :

[4 marks]

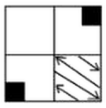


(A) 

(B) 

(C) 

(D) 

Correct Answer: (D) 

Solution:

Concept:

- Reflection about the vertical X-X line exchanges left and right while preserving top and bottom. Arrowheads must be reflected together with their shafts and endpoints.
- A diagonal pointing up-right becomes one pointing up-left; a diagonal pointing down-left becomes one pointing down-right. This follows by reversing only the horizontal component of direction.

Step 1: Reflect the large features The original figure has four equal panels. Its black upper-left corner square must move to the upper-right corner, and its black lower-right corner square must move to the lower-left corner. The arrows in the lower-left panel must move to the lower-right panel. Their heights within that panel must remain unchanged; the mirror does not turn the figure upside down.

Step 2: Track the arrows individually The original arrows slope upwards from left to right, so their reflected shafts must slope downwards from left to right. This excludes (B) and (C), whose arrows retain the original diagonal sense. To distinguish (A) and (D), trace the upper short arrow: its original down-left head lies on the outside left boundary, so its image must have a down-right head on the outside right boundary at the same height. The adjacent long arrow originally points up-right towards the central vertical boundary; its reflection must point up-left towards that boundary. The lower pair follows the same rule. Option (D) preserves these endpoint positions and directions, whereas (A) changes their arrangement within the panel.

Step 3: Conclusion Option (D) alone preserves the reflected positions and directions of all four arrows along with the black corner squares. Hence, the correct option is (D).

Quick Tip to Solve: After checking the black squares, follow one arrowhead on an outer boundary; matching arrow slopes alone cannot distinguish all the options.

59. 'Kuchipudi' is a unique dance from which state ? [4 marks]

(A) Madhya Pradesh

(B) Tamil Nadu

(C) Kerala

(D) Andhra Pradesh

Correct Answer: (D) Andhra Pradesh

Solution:

Concept:

- Indian classical dance forms are associated with particular regional traditions. Kuchipudi belongs to Andhra Pradesh and takes its name from the village of Kuchipudi.
- To identify a dance's state, distinguish its place of origin from the places where it is now performed. National or international popularity does not change its regional association.

Step 1: Identify the regional tradition Kuchipudi is a classical dance and dance-drama tradition associated with the Telugu-speaking region of Andhra Pradesh. Its name refers to Kuchipudi village, where this performance tradition developed. The question asks for the state linked with the dance, so this origin supplies the required identification. Andhra Pradesh appears as option (D).

Step 2: Eliminate the other states Tamil Nadu is associated with Bharatanatyam, rather than the origin of Kuchipudi. Kerala is associated with classical performance traditions such as Kathakali and Mohiniyattam, so option (C) does not identify Kuchipudi's home state. Madhya Pradesh is also not the regional origin of Kuchipudi. Thus options (A), (B) and (C) do not match the named tradition. A performance of Kuchipudi in any of these states would not make that state its place of origin; the relevant association remains Andhra Pradesh.

Step 3: Conclusion Kuchipudi is associated with Andhra Pradesh. Hence, the correct option is (D).

Quick Tip to Solve: Pair Kuchipudi with Andhra Pradesh, Bharatanatyam with Tamil Nadu, and Kathakali and Mohiniyattam with Kerala to distinguish these nearby regional traditions.

60. Which of the below given material is not a plaster type ? [4 marks]

(A) Gypsum

(B) Lime

(C) Cement

(D) MDF

Correct Answer: (D) MDF

Solution:

Concept:

- Plaster is a material applied as a workable coating to walls or ceilings, where it sets or hardens to provide a protective or decorative finish. Common plaster types are classified by their binding material.

- MDF stands for medium-density fibreboard. It is a manufactured wood-based board made from wood fibres and a binder, rather than a mineral plaster coating.

Step 1: Check the three plaster binders Gypsum is used to produce gypsum plaster, which sets after being mixed with water. Lime is the binder in lime plaster, usually combined with a suitable aggregate and water. Cement is the binder in cement plaster, normally mixed with sand and water for finishing masonry surfaces. Therefore gypsum, lime and cement can each name a recognised type of plaster. Options (A), (B) and (C) all satisfy the classification asked about.

Step 2: Classify MDF by its form and use MDF is supplied as a sheet or panel made from bonded wood fibres. It is cut and fixed as a board for uses such as furniture, cabinetry and interior panelling. It is not prepared and spread as a wet plaster layer, and its binding system does not make it gypsum, lime or cement plaster. A surface made with MDF may receive a decorative finish, but that does not convert the board itself into a plaster type. MDF is consequently the single entry that belongs to a different material category.

Step 3: Conclusion MDF is a wood-based fibreboard and is not a plaster type. Hence, the correct option is (D).

Quick Tip to Solve: In a building-material list, separate wet-applied coatings named by their binders from factory-made sheet products: MDF belongs to the latter group.

61. Who initiated the construction of Qutub-Minar, Delhi? [4 marks]

(A) Muhammad Quli Qutub Shah

(B) Muhammad Azam Shah

(C) Qutub-Ud-din-Aibak

(D) Iltutmish

Correct Answer: (C) Qutub-Ud-din-Aibak

Solution:

Concept:

- The Qutub Minar in Delhi belongs to the early Delhi Sultanate. The question asks who initiated its construction, so the founder of the building project must be distinguished from rulers who continued or repaired it.
- A monument can have several patrons over its building history. Identifying the first patron depends on chronology rather than attributing the entire surviving structure to a single ruler.

Step 1: Identify the ruler who began the project Qutub-ud-din Aibak initiated the construction of the Qutub Minar in 1199. His role was to begin the minaret; subsequent stages were built under his successors. Therefore the name in option (C) answers the particular word “initiated” in the question.

Step 2: Distinguish the later patron from the founder Iltutmish continued the construction and added storeys, which makes option (D) a plausible distraction. However, continuing an existing project is different from initiating it. Muhammad Quli Qutub Shah is associated with the Qutb Shahi dynasty

and Hyderabad, rather than the founding of this Delhi Sultanate minaret. Muhammad Azam Shah was a much later Mughal prince, so option (B) does not fit the monument's early Sultanate origin.

Step 3: Conclusion Qutub-ud-din Aibak initiated the construction of Qutub Minar, Delhi. Hence, the correct option is (C).

Quick Tip to Solve: For monument-history questions, underline the action word: "began", "completed" and "restored" can point to different rulers. Remember Aibak as the initiator and Iltutmish as a later builder of Qutub Minar.

62. When is the world Environment Day celebrated? [4 marks]

(A) 5 June

(B) 10 July

(C) 22 March

(D) 15 August

Correct Answer: (A) 5 June

Solution:

Concept:

- World Environment Day is the United Nations observance devoted to environmental awareness and action. Its annual calendar date is fixed, even though the host country and campaign theme can change.
- Questions on awareness days test the association between an observance and its date. Distinguish environmental observances from national holidays and from events concerning a particular environmental resource.

Step 1: Recall the fixed date of the observance World Environment Day is observed every year on 5 June. The day encourages public attention to environmental protection, including conservation, pollution prevention and responsible use of natural resources. The question asks for this recurring date, rather than the theme or venue of a particular year.

Step 2: Check the competing dates Option (A), 5 June, matches the observance. The date 22 March in option (C) belongs to World Water Day, so it is a related environmental date but does not answer this question. The date 15 August in option (D) is India's Independence Day. The remaining date, 10 July in option (B), is also not the date of World Environment Day. Thus the presence of other familiar dates does not alter the fixed association of this observance with June.

Step 3: Conclusion World Environment Day is celebrated on 5 June every year. Hence, the correct option is (A).

Quick Tip to Solve: Keep the two environmental dates distinct: 22 March is World Water Day, while 5 June is World Environment Day. Match the full name of the observance before selecting a date.

63. Visual weight is associated with : [4 marks]

(A) Emphasis

(B) Texture

(C) Balance

(D) Pattern

Correct Answer: (C) Balance

Solution:

Concept:

- Visual weight is the apparent heaviness or attention-attracting strength of an element in a composition. Size, colour, darkness, position and surface treatment can all influence this perceived weight.
- Balance is the distribution of visual weight across a composition. It can be symmetrical or asymmetrical; equal-looking stability does not require identical shapes on both sides.

Step 1: Connect the term to the design principle When judging whether a composition feels stable, the viewer compares the visual weight of its elements. A large dark shape on one side may be balanced by several smaller shapes on the other. This distribution of apparent weight is precisely the concern of balance, so option (C) is the direct association asked for.

Step 2: Separate related terms from the answer Emphasis in option (A) creates a focal point or a dominant element. A focal point may have considerable visual weight, but emphasis does not name the overall distribution of that weight. Texture in option (B) describes surface character and may influence how heavy an element appears. Pattern in option (D) describes an organised recurrence of motifs. These can affect a composition, but none replaces balance as the principle governing the relationship among visual weights.

Step 3: Conclusion Visual weight is associated with balance in a composition. Hence, the correct option is (C).

Quick Tip to Solve: If a design question mentions weight, stability or equal attraction across a layout, first test balance. If it asks which element attracts attention first, test emphasis instead.

64. Lines those branch off of a central point are referred to as : [4 marks]

(A) Rhythm

(B) Repetition

(C) Radiation

(D) Proportion

Correct Answer: (C) Radiation

Solution:

Concept:

- Radiation is an arrangement in which lines or elements spread or branch outward from a common central point. The defining feature is the shared centre rather than equal spacing or a particular number of lines.
- Rhythm and repetition describe recurring visual movement or recurring elements, while proportion describes size relationships. These principles can coexist with a radial design, but they identify different properties.

Step 1: Identify the central geometric relationship The question describes lines branching off a central point. Such lines radiate from that point, like spokes extending from the hub of a wheel. The centre provides a common origin for the directions. This is the design arrangement called radiation, which is listed in option (C).

Step 2: Eliminate the other design principles Rhythm in option (A) concerns the visual movement created by recurring or changing elements; it does not require a centre. Repetition in option (B) means using an element again, whether along a row, on a grid or in another arrangement. Proportion in option (D) concerns the relative dimensions of parts and the whole. Since the question supplies a shared central origin rather than a recurrence rule or a size ratio, those three terms do not describe its distinctive feature.

Step 3: Conclusion Lines branching off a central point form an arrangement described as radiation. Hence, the correct option is (C).

Quick Tip to Solve: Look for a common origin: spokes, rays and branches spreading from one centre indicate radiation. Repeated parallel lines indicate repetition without necessarily being radial.

65. V7 concept of Chandigarh city is associated with which architect? [4 marks]

(A) Patric Geddes

(B) Le Corbusier

(C) Frank O Gehri

(D) Zaha Hadid

Correct Answer: (B) Le Corbusier

Solution:

Concept:

- Chandigarh's modern planning is associated with Le Corbusier. A significant part of the plan is a hierarchy of circulation routes that separates different kinds of traffic and relates the city to its sectors.
- The seven categories of circulation are commonly called the 7Vs. In this context V refers to the road or way hierarchy; it is a town-planning concept rather than a building style or a decorative motif.

Step 1: Recognise the Chandigarh planning reference The expression V7 in the question refers to the 7Vs concept used in Chandigarh's circulation system. The system organises movement by the role of the route, from major vehicular connections to routes serving more local movement. The architect associated with this planning framework is Le Corbusier, which selects option (B).

Step 2: Distinguish the other architects and planners Patrick Geddes, written as Patric Geddes in option (A), is associated with regional and survey-based planning, but he is not the architect identified with Chandigarh's 7Vs framework. Frank Gehry in option (C) is known for expressive sculptural architecture rather than this city plan. Zaha Hadid in option (D) is associated with fluid and dynamic architectural forms. Neither provides the correct association between Chandigarh and its circulation hierarchy.

Step 3: Conclusion The V7 or 7Vs concept of Chandigarh is associated with Le Corbusier. Hence, the correct option is (B).

Quick Tip to Solve: Link Chandigarh with Le Corbusier and the 7Vs circulation hierarchy. In a planning MCQ, identify the city-specific system before relying on an architect's general fame.

66. Who is known as "Father of contemporary architecture" ? [4 marks]

(A) Le Corbusier

(B) Louis Sullivan

(C) Frank Gehry

(D) Norman Foster

Correct Answer: (B) Louis Sullivan

Solution:

Concept:

- Louis Sullivan is conventionally described as a father of modern architecture. The title in this question uses "contemporary architecture" in that historical sense, and the relevant name among the given options is Sullivan.
- Sullivan helped establish an architectural approach appropriate to modern building functions, particularly the tall commercial building. His principle "form follows function" connects a building's appearance with its purpose.

Step 1: Identify the historical attribution Louis Sullivan is the architect associated with the conventional father-of-modern-architecture attribution. His work and architectural thought contributed to the emergence of an American modern architectural language, especially through the design of early tall commercial buildings. The corresponding name in the supplied list is option (B).

Step 2: Compare the remaining candidates Le Corbusier in option (A) was a major pioneer of twentieth-century modern architecture and town planning, but he is not the conventional attribution sought here. Frank Gehry in option (C) and Norman Foster in option (D) are prominent later architects, associated respectively with sculptural forms and technologically expressive design. Their importance does not make either the historical figure indicated by this title. Thus the question should be answered using the established Sullivan attribution, while recognising that modern and contemporary are used loosely in its wording.

Step 3: Conclusion Louis Sullivan is the intended architect, conventionally known as a father of modern architecture. Hence, the correct option is (B).

Quick Tip to Solve: Associate Louis Sullivan with "form follows function" and the historical father-of-modern-architecture title. Distinguish such an attribution from simply naming a famous contemporary architect.

67. Who designed 'India Gate'? [4 marks]

(A) Edwin Luytens

(B) Raj-Rewal

(C) George Writtet

(D) Norman Foster

Correct Answer: (A) Edwin Luytens

Solution:

Concept:

- Architectural awareness questions distinguish the designer of a monument from the person it commemorates or the city where it stands.
- India Gate in New Delhi is the war memorial designed by Sir Edwin Lutyens. Its monumental arch form belongs to the planned imperial capital.

Step 1: Identify the monument India Gate is the large memorial arch on the ceremonial axis of New Delhi. The question asks who designed that monument, so the relevant association is between India Gate and its architect, Sir Edwin Lutyens. The spelling in option (A), Edwin Luytens, is a transposition in the name; it clearly refers to Lutyens.

Step 2: Distinguish the other architects Raj Rewal is associated with modern Indian architecture, including the Hall of Nations in New Delhi. George Wittet, represented by the spelling George Writtet in option (C), designed the Gateway of India in Mumbai. This is the tempting confusion: Gateway of India and India Gate are separate monuments in different cities. Norman Foster is a British architect associated with modern buildings such as the Hong Kong and Shanghai Bank headquarters; he did not design India Gate.

Step 3: Conclusion Sir Edwin Lutyens designed India Gate in New Delhi. Hence, the correct option is (A).

Quick Tip to Solve: Keep the two names separate: India Gate, New Delhi, is Lutyens; Gateway of India, Mumbai, is Wittet.

68. Who among the following architects has not won the Pritzker prize till 2019? [4 marks]

(A) B.V. Doshi

(B) I.M. Pie

(C) Arata Isozki

(D) Moshe Safdie

Correct Answer: (D) Moshe Safdie

Solution:

Concept:

- The Pritzker Architecture Prize honours a living architect for significant achievement in architecture; the award year matters when the question gives a time limit.

- The phrase till 2019 requires checking whether an architect had received the prize by the end of 2019, including the laureate announced in that year.

Step 1: Check the three laureates I. M. Pei received the Pritzker Architecture Prize in 1983. Balkrishna Vithaldas Doshi, abbreviated B. V. Doshi, received it in 2018. Arata Isozaki received it in 2019 itself. Consequently, all three fall within the period specified by the question. The spellings I.M. Pie and Arata Isozki in the options refer to Pei and Isozaki respectively; the intended identities are unambiguous.

Step 2: Apply the negative condition The question asks who has not won, rather than who has won. Moshe Safdie is a prominent architect associated with Habitat 67 in Montreal, but he was not a Pritzker laureate through 2019. His architectural reputation alone does not establish that he received this particular award. Options (A), (B) and (C) must therefore be rejected because their award years are 2018, 1983 and 2019, whereas option (D) satisfies the stated negative condition.

Step 3: Conclusion Moshe Safdie had not won the Pritzker Architecture Prize till 2019. Hence, the correct option is (D).

Quick Tip to Solve: For a negative award question, write the known award years beside the names first; remember that Arata Isozaki is included because he won in 2019.

69. Terra cotta is a type of earthen work which is processed by : [4 marks]

(A) Burning at high temperature

(B) Mixing with lime

(C) Compacting with pressure

(D) Drying in the Sun

Correct Answer: (A) Burning at high temperature

Solution:

Concept:

- Terracotta is shaped clay that is fired to produce a hard, porous ceramic material. The name literally means baked earth.
- Drying removes free water from clay, while firing produces lasting changes in the clay body and gives the ceramic its characteristic hardness and durability.

Step 1: Identify the decisive manufacturing stage Clay is prepared, moulded into the required shape and allowed to dry before it is fired in a kiln. The decisive processing stage that makes the earthen article terracotta is heating, described here as burning at high temperature. Controlled kiln firing transforms the dried clay into a ceramic body. Thus option (A) identifies the essential process, even though preparation and drying also occur during manufacture.

Step 2: Compare the alternative processes Mixing with lime changes the material composition but is not what defines terracotta. Compacting with pressure can shape or densify a clay article, yet pressure alone does not turn it into fired earthenware. Drying in the sun removes moisture without the ceramic transformation caused by firing; a sun-dried clay article remains fundamentally different from a fired terracotta article. Therefore options (B), (C) and (D) describe operations that cannot replace the

kiln-firing stage required by the term.

Step 3: Conclusion Terracotta is earthenware processed by burning or firing at high temperature. Hence, the correct option is (A).

Quick Tip to Solve: Associate terracotta with baked clay: sun drying prepares the shape, but firing is the process that makes it terracotta.

70. Which building material is primarily used as a building material for the Great wall of China?

[4 marks]

(A) Timber

(B) Steel

(C) Brick

(D) Concrete

Correct Answer: (C) Brick

Solution:

Concept:

- The Great Wall of China was constructed and rebuilt over different periods, so its materials vary with place, date and locally available resources.
- Brick masonry is the characteristic material of many well-known surviving sections, especially the later fortified stretches; the answer must be chosen from the listed materials.

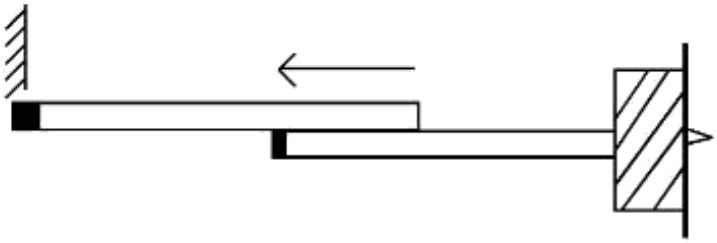
Step 1: Identify the intended material association Among timber, steel, brick and concrete, brick is the appropriate conventional building-material association for the Great Wall. The familiar masonry stretches use fired bricks for substantial wall construction and facing, often together with stone and other core materials. The wall is not a single uniform structure, and earlier sections also used rammed earth; recognising this variation does not make timber, steel or concrete the intended choice here.

Step 2: Eliminate the incompatible options Timber could be used for doors, supports or construction work, but it is not the primary material characterising the surviving defensive masonry wall. Steel is associated with comparatively modern structural systems and is not the principal historic wall fabric. Concrete, particularly modern reinforced concrete, is likewise not the material intended by this historic monument question. Brick is therefore the only listed material that matches its familiar construction, without claiming that every section of the entire wall uses brick exclusively.

Step 3: Conclusion Brick is the intended primary building material among the options given for the Great Wall of China. Hence, the correct option is (C).

Quick Tip to Solve: For monuments built over centuries, choose the characteristic material among the options while remembering that local sections can use other materials.

71. Identify the architectural symbol represented in the given figure. [4 marks]



(A) Window

(B) Sliding door

(C) Revolving door

(D) Rolling shutter

Correct Answer: (B) Sliding door

Solution:

Concept:

- Architectural plan symbols show how a building component occupies an opening and how its moving parts operate. A straight arrow represents movement along a straight track rather than rotation about a hinge or central axis.
- A sliding door opens by moving its leaf sideways, parallel to the opening. Overlapping rectangular leaves and a horizontal travel arrow distinguish this action from a revolving door or a rolling shutter.

Step 1: Read the movement shown in the figure The figure shows long, narrow rectangular panels lying parallel to one another, with their lengths overlapping in plan. A horizontal arrow above the panel points to the left. This indicates that the panel translates sideways along the opening: it does not swing through an arc. The wall or jamb is represented by the hatched portion at the side. Taken together, the sliding panel arrangement and its direction of travel identify a sliding door.

Step 2: Compare the other architectural symbols A window symbol represents a glazed opening and its frame; the illustrated operating arrangement is that of a sliding door leaf, rather than the conventional window representation. A revolving door has leaves rotating about a central pivot, normally shown within a circular enclosure, which is absent here. A rolling shutter rises or lowers and coils around a drum above the opening; it does not use the sideways travel of overlapping door panels shown in this plan. Options (A), (C) and (D) therefore do not match the complete symbol.

Step 3: Conclusion The architectural symbol represents a sliding door. Hence, the correct option is (B).

Quick Tip to Solve: Read the motion before naming the symbol: parallel overlapping panels with a straight sideways arrow indicate a sliding door, while a central pivot and circular path suggest a revolving door.

72. Percentage of lime content in ordinary Portland cement is [4 marks]

(A) 30% – 40%

(B) 40% – 50%

(C) 60% – 70%

(D) 70% – 80%

Correct Answer: (C) 60% – 70%

Solution:

Concept:

- Ordinary Portland cement contains lime, conventionally expressed as calcium oxide, together with silica, alumina, iron oxide and smaller constituents.
- Lime is the largest oxide constituent and is commonly about two-thirds of the cement composition; the question asks for the corresponding percentage range.

Step 1: Locate the usual lime proportion The typical lime content of ordinary Portland cement is roughly 60 to 67 percent by mass, with modest variation in the composition of particular cements. In the broad ranges provided, this lies within 60 to 70 percent. Lime combines with silica and other oxides during clinker formation; its substantial proportion is therefore part of cement chemistry, not the amount of lime separately added to concrete at the building site.

Step 2: Compare all four ranges The range 30 to 40 percent in option (A) is too low to represent the principal lime constituent of ordinary Portland cement. The range 40 to 50 percent in option (B) is also below the usual lime proportion. Option (C), 60 to 70 percent, includes the conventional composition. The range 70 to 80 percent in option (D) is too high for the usual material: excess uncombined lime can cause unsoundness rather than simply improving the cement. We therefore choose the range containing the normal value, not the largest percentage on the list.

Step 3: Conclusion The lime content of ordinary Portland cement is in the range 60 to 70 percent. Hence, the correct option is (C).

Quick Tip to Solve: Remember lime as about two-thirds of Portland cement; this places it in the 60 to 70 percent range immediately.

73. Sill Level is associated with [4 marks]

(A) Roof

(B) Column

(C) Window

(D) Staircase

Correct Answer: (C) Window

Solution:

Concept:

- A sill is the horizontal member or surface at the bottom of a window opening. Sill level describes the elevation of that lower boundary, commonly measured with respect to the finished floor level.
- Building elements have distinct reference levels. Roof level concerns the roof, while the bottom and top boundaries of a window opening are identified by sill level and lintel level respectively.

Step 1: Locate the sill in a wall opening Consider a window installed in an external wall. Its opening has two vertical sides, a top boundary and a bottom boundary. The horizontal member or ledge at the bottom is the window sill. Therefore, when a building drawing specifies sill level, it locates the bottom of the window opening vertically. The term refers to an architectural feature of the opening rather than the height of the roof or the position of a structural column.

Step 2: Match the term with the listed element The window in option (C) is the element that has a sill. A roof has its own roof level and may also have an eaves level, so option (A) does not identify the sill. A column is a vertical support, making option (B) unrelated to this opening detail. A staircase is described using terms such as tread, riser, landing and flight; these do not make sill level a staircase reference. Thus option (D) is also excluded. The distinction between a sill below the window and a lintel above it removes a common terminology confusion.

Step 3: Conclusion Sill level is associated with a window, specifically the bottom of its opening. Hence, the correct option is (C).

Quick Tip to Solve: Associate the sill with the lower edge of a window and the lintel with the upper edge of the opening.

74. What is the terminology for the vertical portion between each tread of the stairs? [4 marks]

(A) Winder

(B) Riser

(C) Nosing

(D) Going

Correct Answer: (B) Riser

Solution:

Concept:

- A stair step consists of a horizontal tread, on which the foot rests, and a vertical riser between successive tread levels. The riser therefore describes the vertical face of the step.
- Other stair terms describe different features: nosing is the projecting front edge of a tread, going is its effective horizontal depth, and a winder is a tapered tread used to change direction.

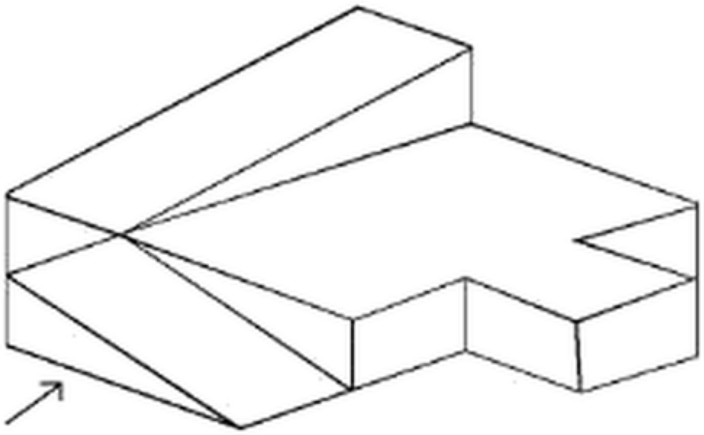
Step 1: Identify the orientation described The question asks specifically for the vertical portion between each tread. Imagine viewing a staircase from the side: the profile alternates between horizontal surfaces and vertical faces. The horizontal surfaces support the feet and are called treads. The face joining the level of one tread to the next is the riser. Its height controls the vertical rise achieved in each step. This directly matches the wording of the question, so the required term is riser.

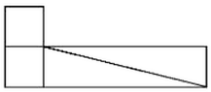
Step 2: Distinguish the remaining staircase terms Option (A), winder, refers to a wedge-shaped or tapered step used in a turning staircase; it is a kind of tread rather than the vertical face between treads. Option (C), nosing, is the front edge of a tread, often projecting over the riser below, so it is an edge detail rather than the whole vertical portion. Option (D), going, is the horizontal distance associated with a step, commonly measured between successive nosings. The question emphasizes vertical orientation, which rules out that horizontal measurement. Only option (B) names the face joining consecutive tread levels.

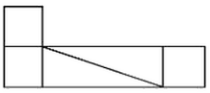
Step 3: Conclusion The vertical portion between consecutive treads is called the riser. Hence, the correct option is (B).

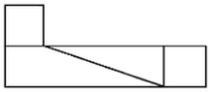
Quick Tip to Solve: Remember that a riser makes the stair rise vertically, while the tread is the horizontal surface under the foot.

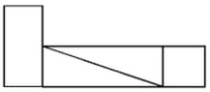
75. The question figure shows the 3D view of an object. Identify the correct view of the object looking in the direction of arrow : [4 marks]

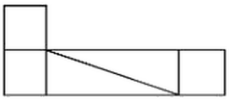


(A) 

(B) 

(C) 

(D) 

Correct Answer: (B) 

Solution:

Concept:

- An orthographic view records the outline and visible edges perpendicular to the specified viewing direction; distances along the line of sight collapse.
- A correct outline alone is insufficient: the positions of the inclined edge and the visible vertical divisions must also agree with the object.

Step 1: Read the direction of sight Look along the arrow from the lower left towards the object. This presents the tall portion at the left of the elevation and the lower, extended part towards the right. Preserve the vertical dimensions while collapsing the receding direction. The elevation therefore has a tall narrow left portion and a long lower portion, rather than an isometric outline.

Step 2: Trace the visible internal edges The horizontal edge at the height of the lower portion continues across the left portion. A vertical division continues down from its right-hand junction to the baseline. From this junction, the inclined edge descends towards the right until it reaches the baseline at the vertical division before the last narrow right-hand portion. That final portion remains a rectangular strip.

Step 3: Compare all four answer figures Option (B) contains this complete combination: the divided tall left portion, the descending diagonal and the narrow rectangular portion at the right. Option (A) carries the diagonal to the far-right extremity and omits the required right-hand division. Option (C) omits the lower vertical division beneath the tall left portion. Option (D) omits the horizontal division

across that tall portion. These edge differences eliminate the other three figures.

Step 4: Conclusion The elevation seen along the arrow is the figure in option (B). Hence, the correct option is (B).

Quick Tip to Solve: After matching the outer profile, compare the endpoints of the diagonal and the vertical divisions; these distinguish otherwise similar elevations.

76. Complete the number sequence :

18, 27, 38, 51, ..., 83 [4 marks]

(A) 62

(B) 66

(C) 64

(D) 72

Correct Answer: (B) 66

Solution:

Concept:

- A number sequence can be identified by examining the differences between successive terms. Constant second differences indicate a quadratic pattern, so the first differences form an arithmetic progression.
- A proposed missing term must fit both its preceding and succeeding terms. Checking the final given term prevents a pattern based on only the first few numbers from being accepted without verification.

Step 1: Calculate the successive differences Subtract each known term from the next one at the beginning of the sequence:

$$27 - 18 = 9, \qquad 38 - 27 = 11, \qquad 51 - 38 = 13.$$

These differences are consecutive odd numbers, increasing by two each time. Continuing the same rule gives the next differences as 15 and 17. Equivalently, the second differences are constant and equal to two. Therefore the term following 51 must be obtained by adding 15 rather than repeating the previous increment of 13.

Step 2: Complete the sequence and verify the endpoint The required value is

$$51 + 15 = 66.$$

Check it against the final printed term:

$$66 + 17 = 83.$$

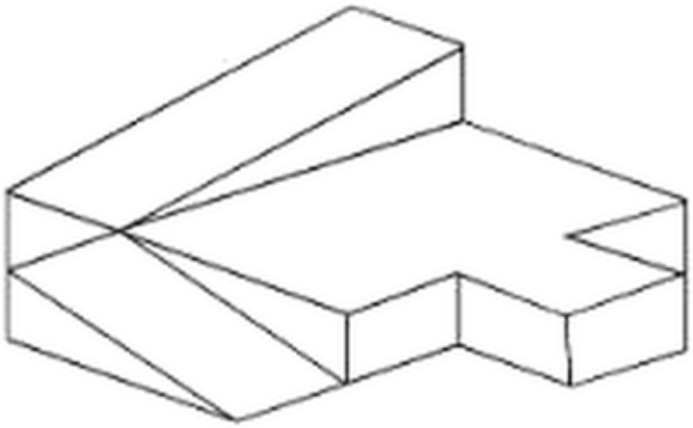
Hence the full sequence has differences $9, 11, 13, 15, 17$, exactly preserving the rule throughout. Option (B) gives 66. The other proposed terms do not preserve these increments: 62 produces adjacent

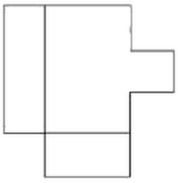
differences 11 and 21; 64 produces 13 and 19; and 72 produces 21 and 11. None continues the steadily increasing odd-number differences. Thus both sides of the missing position support the same option.

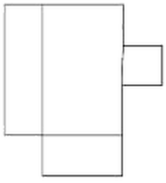
Step 3: Conclusion The missing number is 66, giving the sequence $18, 27, 38, 51, 66, 83$. Hence, the correct option is (B).

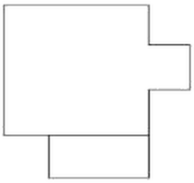
Quick Tip to Solve: When successive differences increase regularly, continue those differences and check the missing term against the next printed value.

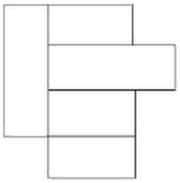
77. In the question figure a-3-D object is given, Identify the correct top view of the object amongst the answer figures. [4 marks]

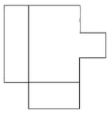


(A) 

(B) 

(C) 

(D) 

Correct Answer: (A) 

Solution:

Concept:

- A top view is obtained by looking vertically down: height disappears, while the horizontal footprint and visible top edges remain.
- A change of surface direction can remain an internal line in the plan even when both adjoining

surfaces have the same outer footprint.

Step 1: Project the footprint vertically Imagine every point of the object dropping vertically onto a horizontal plane. The central body gives the broad main region. Its right-hand projection forms a rectangular tongue, with recesses above and below that tongue. The portion extending towards the viewer projects below the main region, beginning to the right of the left-hand strip. Keep these offsets in their original order.

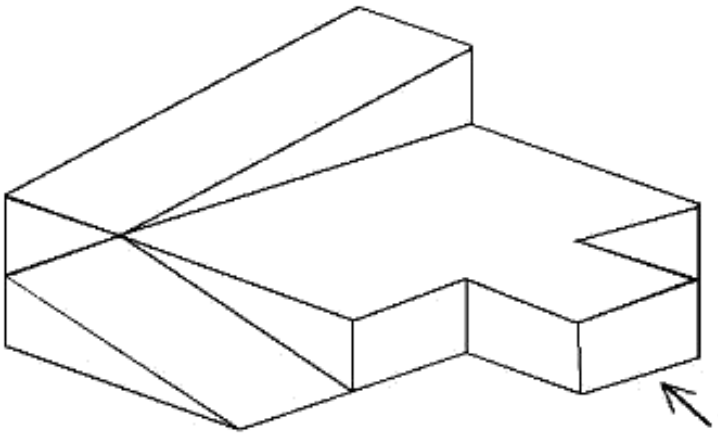
Step 2: Retain the visible surface boundaries The narrow strip along the left side has a visible boundary with the larger central surface. This becomes the vertical internal line in the plan. The junction with the front portion forms the horizontal internal line across the lower part of the main region. The side tongue does not create two long transverse lines right across the main upper face: its two sides belong to the stepped outer perimeter.

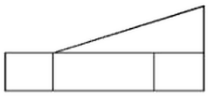
Step 3: Check each proposed plan Option (A) preserves both the stepped perimeter and these internal lines. Option (B) adds a line across the root of the right-hand tongue, treating the projecting region as a separately enclosed rectangle. Option (C) omits the visible vertical boundary of the left strip. Option (D) carries the tongue boundaries into the main region as extra horizontal divisions. The original upper surfaces do not support those extra divisions.

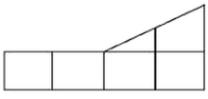
Step 4: Conclusion The correct top view is option (A). Hence, the correct option is (A).

Quick Tip to Solve: For a top view, check the footprint first, then retain actual visible surface edges without adding lines merely where a side projection begins.

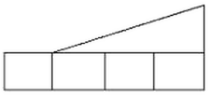
78. In question figure - 3D object is given, Identify the correct view of the object looking in the direction of the arrow, amongst the answer figures. [4 marks]

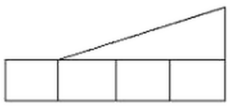


(A) 

(B) 

(C) 

(D) 

Correct Answer: (D) 

Solution:

Concept:

- For a directional orthographic elevation, project the solid along the arrow and keep height and the transverse horizontal dimension.
- A correct elevation must preserve both the endpoints of its inclined edge and the visible vertical divisions in the lower part of the object.

Step 1: Orient the elevation along the arrow The arrow approaches from the lower right. Looking along it gives a long rectangular lower profile with vertical divisions produced by the changes in the outline of the solid. The inclined upper boundary begins at the top of the first internal lower division and rises towards the tall right end. The view must retain this direction of rise; it is not the elevation obtained from the opposite side.

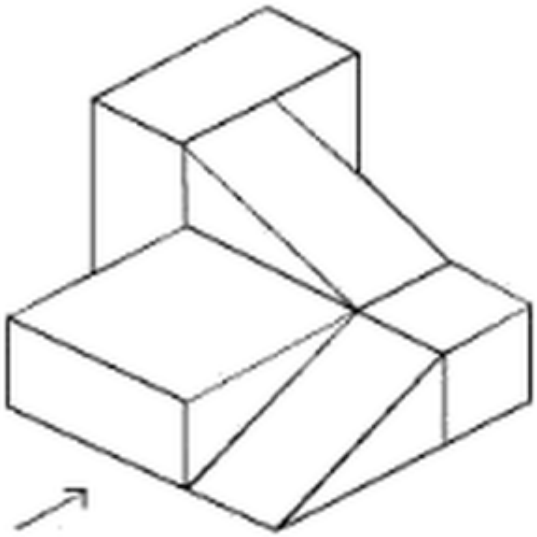
Step 2: Trace the slope and the lower divisions separately Follow the upper inclined edge across the viewing plane. Its projection begins above the first internal vertical division, at the top of the lower rectangular portion, and rises continuously to the right-hand top corner. The short portion to its left retains a horizontal top edge. Beneath it, the horizontal top edge of the lower portion remains continuous. Three internal vertical divisions distinguish four adjacent lower regions; in particular, the central change of edge remains visible. These divisions stop at the horizontal edge and do not extend upwards through the sloping triangular portion.

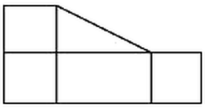
Step 3: Eliminate the shortened or subdivided slopes Option (D) preserves the rising edge from the first lower division, the horizontal edge beneath it and all three internal divisions confined to the lower strip. Option (A) has the same slope endpoints but omits the central lower vertical division. Option (C) incorrectly delays the start of the slope until the middle. Option (B) also starts the slope near the middle and additionally extends a lower division up to the sloping boundary. These differences eliminate the other three figures.

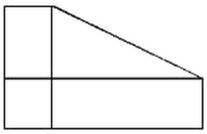
Step 4: Conclusion The requested view is option (D). Hence, the correct option is (D).

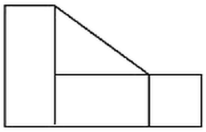
Quick Tip to Solve: Check the slope endpoints and then count the visible lower divisions: options can share the same outer profile yet differ by a necessary internal edge.

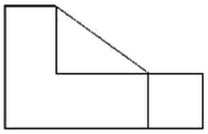
79. In question figure a 3-D object is given. Identify the correct view of the object looking in the direction of arrow, amongst the answer figures. [4 marks]

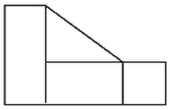


(A) 

(B) 

(C) 

(D) 

Correct Answer: (C) 

Solution:

Concept:

- A directional view is an orthographic projection: look along the arrow, retain the object's height and transverse width, and collapse distances along the viewing direction.
- The outline and visible changes of surface must both agree. A line visible in an oblique drawing need not remain visible when its direction is parallel to the line of sight or another face obscures it.

Step 1: Establish the outline from the arrow Look from the lower-left side of the drawing along the arrow. The tall upright portion appears on the left. From its upper right corner the inclined surface descends towards the lower platform. The platform continues to the right beyond the point where the incline reaches it. Thus the projection needs a high left rectangle, a descending diagonal in the middle, and a short low rectangular extension at the right.

Step 2: Check the visible internal edges Keep the upright division at the right of the tall left portion and the upright division at the start of the short right extension. The horizontal platform edge begins to the right of the tall portion; it does not run across that tall face. Option (C) preserves

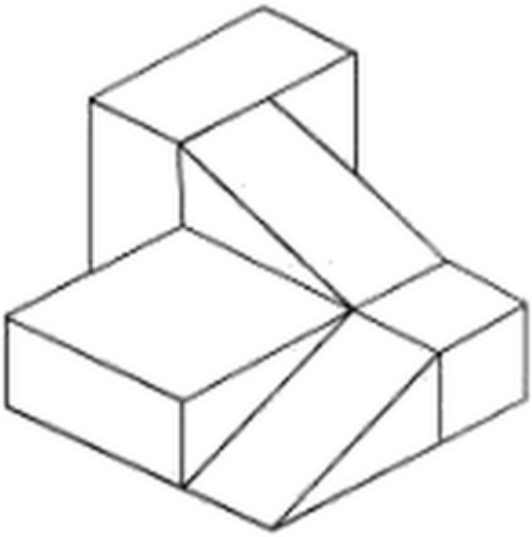
this arrangement, with the left upright division continuing down to the base and the platform line extending across the middle and right portions.

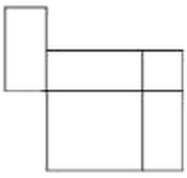
Step 3: Eliminate the other views Option (A) adds a horizontal division across the tall left face that is absent in this view. Option (B) carries the slope to the extreme right and omits the distinct low extension beyond its foot. Option (D) does not continue the left internal upright down to the base. These edge differences exclude them even though some of their outer boundaries resemble the object.

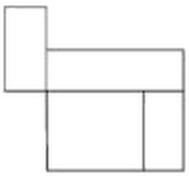
Step 4: Conclusion The tall left portion, descending middle surface, low right extension and visible internal edges match option (C). Hence, the correct option is (C).

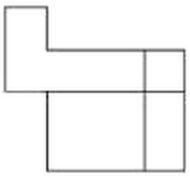
Quick Tip to Solve: After matching the outer silhouette, compare where each internal edge starts and ends; this separates the nearly identical alternatives here.

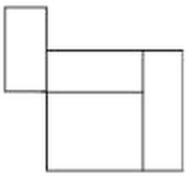
80. In the question figure a 3-D object is given. Identify the correct top view of the object amongst the answer figures. [4 marks]

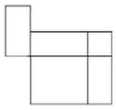


(A) 

(B) 

(C) 

(D) 

Correct Answer: (A) 

Solution:

Concept:

- A top view is obtained by looking vertically downwards. Height is suppressed, while the horizontal footprint and boundaries between visible top surfaces remain.
- An inclined surface occupies its horizontal projected area in the plan. Its sloping height profile is not drawn as a side-view triangle in a top view.

Step 1: Identify the footprint and its orientation Trace the object from above, keeping the orientation used in the answer figures. The tall upright block gives the narrow upper-left rectangular projection. The lower body extends to its right and below, giving the same stepped outer footprint shown in the choices. Since all four choices resemble this footprint, the outline alone is insufficient to select the answer.

Step 2: Follow the surface boundaries through the plan Project the edges of the tall block, the broad flat slab and the two inclined portions onto a horizontal plane. The right edge of the narrow left block remains a visible division, including through the central band. The division near the right side also continues through that band, and the transverse boundary continues into the small right-hand region. These intersections form the complete arrangement in option (A).

Step 3: Compare the missing segments in the alternatives Option (B) omits the upper segment of the internal upright near the right side: that division begins only below the central horizontal line. Option (C) omits the segment along the right side of the narrow left block across the central band. Option (D) stops the central horizontal boundary at the inner right division instead of continuing it to the outer right edge. Option (A) retains all three required segments and their intersections.

Step 4: Conclusion Option (A) gives the complete top-view footprint and the visible projected surface boundaries. Hence, the correct option is (A).

Quick Tip to Solve: For top-view choices with identical outlines, trace one surface boundary at a time and check whether its continuation through each intersection is present.

Drawing Test (100 marks)

81. Draw the sketch of the image given below in detail:

Use monochromatic colour rendering techniques, light and shadow to represent its depth and intensity. [50 marks]



Solution:

Concept:

- Observational sketching begins with the proportions, placement and silhouette of the given subject. Smaller details should be fitted into an accurate overall construction rather than drawn independently.
- Monochromatic rendering uses variations of one hue, including the white of the paper, to distinguish illuminated surfaces, middle tones and deep shadows. Overlap, perspective and tonal contrast together convey depth.

Step 1: Establish the vertical composition Use a portrait-format composition for the man riding the bicycle towards the viewer. Lightly mark the top of his turban, the level of his shoulders and handlebar, and the bottom of the near wheel. Keep sufficient margin around the whole silhouette. Locate the head above the broad torso, with the arms descending towards the handlebar and the bicycle occupying the lower central portion. Preserve the slight asymmetry of the pose instead of making both sides mechanically identical.

Step 2: Construct the rider and bicycle Block in the turban and bearded face as simple masses, then establish the shoulder slope, shirt outline, bent arms and hands. Locate the handlebar across the front of the body and align the steering assembly with the narrow front wheel below. Follow the frame members and the visible leg positions from the reference, checking which forms overlap. The near wheel appears narrow because it is viewed nearly along the bicycle's direction of travel; do not replace it with a broad side-view circle. Place the hanging containers and side load in their observed positions and retain their different sizes and outlines.

Step 3: Develop the characteristic details Refine the turban folds, eyebrows, nose, moustache and beard without allowing facial details to upset the head's proportions. Indicate the shirt collar, short sleeves, chest area and folds across the waist. Define the fingers where they grip the handlebar, the bicycle tubing, wheel rim and the attachments supporting the containers. Use selective detail: the rider's face, hands and near wheel should remain clear, while minor background marks can stay subdued.

Step 4: Organise the light and shadow Establish a light, a middle and a dark tonal group before adding fine shading. Preserve paper highlights on the illuminated facial planes, the turban and the lighter shirt. Place darker values beneath the turban, around the beard, inside the sleeve openings, beneath folds and between overlapping forms. Shade the rounded containers with a gradual transition from light to dark, retaining their rims and attachment points. Keep the deepest accents for recesses, wheel and frame intersections, and contact areas rather than outlining every form with the same heavy line.

Step 5: Render texture and depth in one hue Use a single monochromatic medium, such as graphite, throughout. Apply hatching that follows the curving cloth, facial forms and cylindrical containers, and build darker tones with closer strokes or additional layers. Differentiate the soft cloth and beard from the harder bicycle frame and containers by varying edge sharpness and mark density. Keep the background comparatively light so that the rider reads clearly. Reproduce the ground shadow near the wheel and lower figure, allowing it to anchor the bicycle to the ground without becoming a flat, uniform dark patch.

Step 6: Check the final tonal hierarchy Step back and compare the whole sketch with the reference. Check the relative sizes of the head, torso, handlebar, wheel and hanging loads, and verify the overlap of the hands, frame and containers. Strengthen only the focal edges that need clarity, soften secondary boundaries and remove unnecessary construction lines. Ensure that highlights, middle tones and deep shadows remain distinct enough to communicate volume while every coloured or shaded area belongs to the same monochromatic palette.

Step 7: Conclusion The finished composition should faithfully show the turbaned, bearded rider approaching on his bicycle with the visible hanging containers and side load. Accurate proportions, overlapping forms, a narrow frontal wheel and controlled monochromatic light-and-shadow modelling give the figure and bicycle their depth and intensity.

Quick Tip to Solve: Squint at both the reference and the sketch: matching the main light and dark masses first makes the face, cloth, bicycle and containers read convincingly before fine details are added.

82. Draw G20 Logo with one Alphabet, two numeric, a triangle, a circle, and a rectangle. Use any 3 colours of your choice [50 marks]

Solution:

Concept:

- A logo communicates a theme through a simple, balanced arrangement of shapes and lettering. The required inscription supplies one alphabet, G, and two numerals, 2 and 0, which together read G20.
- Shape hierarchy makes the main message immediately readable. A triangle, a circle and a rectangle must remain identifiable within the composition, and the applied palette must contain exactly three colours.

Step 1: Plan the main arrangement Place a broad horizontal rectangle in the central portion of the available space, leaving generous paper margins. Position G20 across it as the main inscription. Give the G and the two numerals a consistent stroke thickness and baseline, with enough separation that they remain distinct characters. This provides a clear reading order from left to right.

Step 2: Integrate the required geometry Place a clearly outlined circle above the centre of the rectangular base and a small upright triangle inside that circle. Keep a visible gap between the triangle's three straight edges and the surrounding circumference. The circle forms the upper emblem, the triangle supplies its central focal point, and the rectangle supports the lettering below. Make the emblem smaller than the lettering panel so it complements rather than obscures the G20 message.

Step 3: Refine proportion and visual balance Align the centre of the upper emblem with the midpoint of the rectangular panel. Keep the circle genuinely circular and construct the triangle with clean, straight edges. Round the lettering consistently while retaining the open curve of G, the diagonal transition in 2 and the closed oval of 0. Adjust the spaces optically: a curved character can appear farther from its neighbour than a straight-edged one even when the measured gap is equal.

Step 4: Apply the three-colour scheme Use saffron for the triangle, blue for the circle outline and G20 inscription, and green for the rectangle outline or a narrow band along its bottom edge. Leave the remaining interior areas as untouched paper to keep the characters readable. Repeat only these three applied colours, avoiding a fourth coloured outline or background. Use flat, even fills and crisp boundaries rather than elaborate shading that would weaken the logo at a small size.

Step 5: Check the finished composition View the design from a short distance and then imagine reducing it to the size of a small badge. G20 should still read immediately, all three geometric shapes should remain visible, and the emblem should feel centred over its base. Remove stray construction lines and uneven fill edges. Confirm that the design contains the single alphabet G, the two numerals 2 and 0, and the specified triangle, circle and rectangle without adding extra lettering.

Step 6: Conclusion The proposed logo has a centred circular emblem containing a saffron triangle above a green-accented rectangular panel carrying blue G20 lettering. It combines the required alphabet, two numerals and three geometric forms in a balanced composition using saffron, blue and green.

Quick Tip to Solve: Before colouring, reduce the sketch mentally to a small badge: if G20 and each required shape remain recognisable, the hierarchy and spacing are working.

OR

82. Draw sketch of a road in one point perspective. Imagine the road to be a vehicular road with both side footpath having vendors and hawkers around it. Use colours of your choice. [50 marks]

Solution:

Concept:

- In one-point perspective, lines perpendicular to the picture plane converge at one vanishing point on the horizon. Vertical edges remain vertical, while horizontal edges across the road remain horizontal.
- Depth comes from convergence, overlap and diminishing size. A convincing street composition must include the vehicular road, footpaths on both sides, vendors and hawkers, with colour and light supporting the spatial structure.

Step 1: Establish the viewpoint and road Choose an eye-level viewpoint looking along the vehicular road. Place a horizontal horizon line roughly above the middle of the sheet and mark one vanishing point near its centre. Draw two road boundaries from widely separated points near the lower edge towards that point. The large foreground opening welcomes the viewer into the scene, while the narrowing road leads the eye into the distance. Add a broken centre line whose individual segments become shorter and closer together as they approach the horizon.

Step 2: Construct both footpaths Draw an outer edge beyond each road boundary, also converging to the same vanishing point, to give a footpath on each side. Show a low kerb with a narrow vertical face where visible. Add paving joints as transverse lines, with the gaps decreasing progressively into the distance. Keep each footpath continuous behind the stalls so that the road remains clearly separated from the pedestrian areas.

Step 3: Place vendors and street activity Arrange a few stalls, handcarts or simple counters along both footpaths. Give the nearest stalls larger, clearer forms and let them overlap smaller stalls farther away. Use awnings, baskets and displayed goods as varied details while leaving a walkable strip for pedestrians. Include vendors behind their counters and hawkers beside their carts. Add a few pedestrians and vehicles on the road, keeping them separate from the selling spaces. Avoid making every person or cart the same size: their heights and widths must diminish with distance.

Step 4: Keep the perspective consistent Direct the receding edges of stall counters, roofs, kerbs and roadside building fronts towards the single vanishing point. Keep poles, people standing upright and the vertical sides of buildings vertical. For people standing on the same ground plane, place their feet according to depth and scale their bodies consistently with the horizon. Use foreground overlap to establish which objects stand in front, and reduce detail towards the vanishing point so the background does not compete with the main activity.

Step 5: Add colour, light and final emphasis Select a coherent palette, such as warm awnings and clothing against cooler road and building tones. Choose one light direction, for example from the upper left, and place darker tones on the opposite faces of carts and buildings. Cast shadows should follow that same direction across the ground. Keep the foreground more saturated and contrast-rich, with lighter, less detailed distant forms. Finish with a few clear human gestures and goods at the nearest stalls, then remove unnecessary guide lines while retaining the road's strong depth cues.

Step 6: Conclusion The composition shows a vehicular road receding to a single horizon vanishing point, with continuous footpaths on both sides occupied by vendors, hawkers and pedestrians. Converging edges, diminishing scale, overlap and consistent light create the one-point perspective, while a coordinated colour scheme gives the street a lively, readable atmosphere.

Quick Tip to Solve: Check every long edge that runs away along the street with a ruler aimed at the same vanishing point; use smaller people, paving gaps and stalls to reinforce depth.