JEE Main 2020 Paper 2A (B.Arch) Jan 6 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) 2020, Session 1 (January), conducted by the National Testing Agency (NTA) in Computer Based Test (CBT) mode on 6 January 2020, Shift 2. The total duration is 3 hours.

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

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

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

(v) Marking scheme (numerical value questions): $+4$ for a correct answer, no negative marking 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. If m be the least value of $|z-3+i4|^2+|z-5-i2|^2$, $z \in \mathbb{C}$ attained at $z=z_0$, then the ordered pair $(|z_0|, \mathrm{m})$ is equal to : [4 marks]

(A) $(\sqrt{17}, 10)$

(B) $(\sqrt{17}, 20)$

(C) $(\sqrt{13}, 10)$

(D) $(\sqrt{13}, 20)$

Correct Answer: (B) $(\sqrt{17}, 20)$

Solution:

Concept:

- Write $z = x + iy$, where x, y are real. Then $|z-(a+ib)|^2 = (x-a)^2+(y-b)^2$.
- A sum of squares is least when every variable square vanishes. Completing squares gives both the minimum and its unique point of attainment.

Step 1: Express both moduli in Cartesian form The first fixed complex number is $3-4i$, whereas the second is $5+2i$. Thus the signs inside the moduli must be retained carefully:

$$S = (x-3)^2+(y+4)^2+(x-5)^2+(y-2)^2.$$

We minimise this expression over all real x, y; there is no restriction on the complex number z.

Step 2: Complete the squares and locate the minimum Collect the real-coordinate and imaginary-coordinate contributions separately:

$$(x-3)^2+(x-5)^2 = 2(x-4)^2+2,$$
$$(y+4)^2+(y-2)^2 = 2(y+1)^2+18.$$

Consequently

$$S = 2(x-4)^2+2(y+1)^2+20 \geq 20.$$

Equality requires $x=4$ and $y=-1$, so $z_0 = 4-i$.

Step 3: Calculate the modulus and compare the ordered pairs At this point,

$$|z_0| = \sqrt{4^2+(-1)^2} = \sqrt{17}.$$

Direct substitution gives $|1+3i|^2+|-1-3i|^2 = 10+10 = 20$, confirming the minimum. Option (A) has the right modulus but halves the minimum; options (C) and (D) have the wrong modulus. Only option (B) gives both coordinates correctly.

Step 4: Conclusion The required ordered pair is $\boxed{(\sqrt{17}, 20)}$. Hence, the correct option is (B).

Quick Tip to Solve: For the sum of squared distances from two fixed points, try their midpoint; the minimum is half the squared distance between them.

2. If the volume of a parallelopiped whose coterminous edges are $\vec{a} = \hat{i} + \hat{j} + 2\hat{k}$, $\vec{b} = 2\hat{i} + \lambda\hat{j} + \hat{k}$ and $\vec{c} = 2\hat{i} + 2\hat{j} + \lambda\hat{k}$ is 35 cu.m, then a value of $\vec{a} \cdot \vec{b} + \vec{b} \cdot \vec{c} - \vec{c} \cdot \vec{a}$ is : [4 marks]

(A) -14

(B) 2

(C) -10

(D) 22

Correct Answer: (D) 22

Solution:

Concept:

- The volume of a parallelepiped with coterminous edge vectors is $V = |\vec{a} \cdot (\vec{b} \times \vec{c})|$. The absolute value allows either sign of the determinant.
- The scalar product is the sum of products of corresponding components. Solve for all real λ before comparing the proposed values.

Step 1: Form the determinant for the volume Using the given vectors as rows,

$$\begin{aligned} D &= \begin{vmatrix} 1 & 1 & 2 \\ 2 & \lambda & 1 \\ 2 & 2 & \lambda \end{vmatrix} \\ &= (\lambda^2 - 2) - (2\lambda - 2) + 2(4 - 2\lambda) \\ &= \lambda^2 - 6\lambda + 8 = (\lambda - 3)^2 - 1. \end{aligned}$$

The supplied volume is therefore $|(\lambda - 3)^2 - 1| = 35$.

Step 2: Find the admissible parameter values If the determinant is 35, then $(\lambda - 3)^2 = 36$, giving $\lambda = 9$ or $\lambda = -3$. If the determinant is -35, then $(\lambda - 3)^2 = -34$, which has no real solution. Thus the real edge vectors give precisely the two values $9, -3$; discarding one without checking the requested expression would be unjustified.

Step 3: Evaluate the requested combination The individual dot products are

$$\vec{a} \cdot \vec{b} = \lambda + 4, \qquad \vec{b} \cdot \vec{c} = 4 + 3\lambda, \qquad \vec{c} \cdot \vec{a} = 4 + 2\lambda.$$

Hence their combination is

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

Its possible values are 22 and -2. The question asks for a value: 22 occurs when $\lambda = 9$. None of $-14, 2, -10$ occurs for either admissible parameter.

Step 4: Conclusion A possible value is $\boxed{22}$. Hence, the correct option is (D).

Quick Tip to Solve: Keep the absolute value in a volume equation, then test which resulting expression values actually appear among the options.

3. If $x = x(y)$ is the solution of the differential equation, $y\mathrm{d}x - \left(x + 2y^2\right)\mathrm{d}y = 0$, with $x(-\pi) = \pi^2$, then x is equal to : [4 marks]

(A) $2y^2 + \pi y$

(B) $-2y^2 + 3\pi y$

(C) $-y^2 - 2\pi y$

(D) $2y^2 - \pi^2$

Correct Answer: (A) $2y^2 + \pi y$

Solution:

Concept:

- Treat x as the dependent variable and y as the independent variable. For $y \neq 0$, the equation is $dx/dy - x/y = 2y$.
- The quotient rule gives $d(x/y)/dy = (y\,dx/dy - x)/y^2$, which turns the differential equation into an immediately integrable form.

Step 1: Rewrite the equation using the quotient rule The original differential equation yields

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

Since the initial value is specified at $y = -\pi \neq 0$, work on an interval containing that point with $y \neq 0$. Dividing by y^2 gives

$$\frac{d}{dy}\left(\frac{x}{y}\right) = 2.$$

This is also the standard integrating-factor method for the linear equation.

Step 2: Integrate and impose the initial condition Integration gives

$$\frac{x}{y} = 2y + C, \qquad x = 2y^2 + Cy.$$

Substitute $y = -\pi$ and $x = \pi^2$:

$$\pi^2 = 2\pi^2 - C\pi, \qquad C = \pi.$$

Thus the particular expression is $x = 2y^2 + \pi y$; the constant is positive because its contribution at $y = -\pi$ is negative.

Step 3: Check the differential equation and eliminate alternatives For this expression, $dx/dy = 4y + \pi$, so

$$y(4y + \pi) - \left(2y^2 + \pi y + 2y^2\right) = 0.$$

It also gives $x(-\pi) = \pi^2$, confirming both requirements. Options (B) and (C) have the wrong coefficient of y^2 and fail the differential equation. Option (D) satisfies the stated initial value but its constant term prevents it from satisfying the differential equation for general y.

Step 4: Conclusion $\boxed{x(y) = 2y^2 + \pi y}$. Hence, the correct option is (A).

Quick Tip to Solve: When you see $y\,dx - x\,dy$, divide by y^2 and recognise $d(x/y)$; check the initial condition only after integrating.

4. If $10\sin^4\alpha + 15\cos^4\alpha = 6$, $\alpha \in \left(-\frac{\pi}{2}, \frac{\pi}{2}\right)$, **then** $27\,\mathrm{cosec}^6\alpha + 8\sec^6\alpha$ **is equal to :** [4 marks]

(A) 240

(B) 270

(C) 280

(D) 250

Correct Answer: (D) 250

Solution:

Concept:

- Use $\sin^2\alpha + \cos^2\alpha = 1$ to replace the two fourth powers with a quadratic in $t = \sin^2\alpha$.
- Once $\sin^2\alpha$ and $\cos^2\alpha$ are known, the sixth powers of cosecant and secant are their reciprocal cubes; the sign of α is irrelevant.

Step 1: Reduce the condition to one squared quantity Put $t = \sin^2\alpha$; then $\cos^2\alpha = 1 - t$. The given equality becomes

$$10t^2 + 15(1-t)^2 = 6.$$

Expanding without dropping the constant term gives

$$25t^2 - 30t + 9 = 0, \qquad (5t-3)^2 = 0.$$

Therefore $\sin^2\alpha = 3/5$ and $\cos^2\alpha = 2/5$. Both are positive, so the reciprocals required in the question exist.

Step 2: Evaluate the two reciprocal cubes Cubing the squared values gives $\sin^6\alpha = 27/125$ and $\cos^6\alpha = 8/125$. Hence

$$\begin{aligned} 27\,\mathrm{cosec}^6\alpha + 8\sec^6\alpha &= 27\left(\frac{5}{3}\right)^3 + 8\left(\frac{5}{2}\right)^3 \\ &= 27\frac{125}{27} + 8\frac{125}{8} \\ &= 125 + 125 = 250. \end{aligned}$$

Each weighted term is exactly 125; no approximation to an angle is needed.

Step 3: Check the range and compare the answers The interval $(-\pi/2, \pi/2)$ has positive cosine, and admits angles with the computed sine square. Either sign of sine gives the same even powers. Substitution into the initial condition confirms $10(9/25)+15(4/25) = 6$. Options $240, 270, 280$ disagree with the exact sum of the two equal contributions.

Step 4: Conclusion The required value is $\boxed{250}$. Hence, the correct option is (D).

Quick Tip to Solve: Convert fourth-power trigonometric constraints into a quadratic in $\sin^2\alpha$; a repeated root often makes the reciprocal-power expression simple.

5. If a variable plane in 3-dimensional space moves in such a way that the sum of the reciprocals of its intercepts on the x and y-axes exceeds the reciprocal of its intercept on the z-axis by 2, then all such planes will pass through the point : [4 marks]

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

Correct Answer: (D) $\left(\frac{1}{2}, \frac{1}{2}, -\frac{1}{2}\right)$

Solution:

Concept:

- A plane with finite nonzero intercepts a, b, c on the coordinate axes has equation $x/a+y/b+z/c = 1$. Intercepts are signed quantities.
- A point common to a family of planes is found by matching its coordinates with a relation that every set of plane coefficients satisfies.

Step 1: Translate the reciprocal-intercept condition Let the intercepts on the x, y, z axes be a, b, c, respectively. The statement that the first two reciprocals exceed the third by 2 means

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

The minus sign belongs to the z-intercept term; replacing it with a plus sign would describe a different family of planes.

Step 2: Match this relation to the intercept equation Divide the coefficient relation by 2:

$$\frac{1/2}{a} + \frac{1/2}{b} + \frac{-1/2}{c} = 1.$$

Comparing with $x/a + y/b + z/c = 1$ proves that every plane in the family contains

$$P = \left(\frac{1}{2}, \frac{1}{2}, -\frac{1}{2}\right).$$

This argument does not choose any special intercepts; it uses the condition valid for the entire family.

Step 3: Check the competing sign patterns For an additional check, choose $1/a = 1$, $1/b = 2$, $1/c = 1$, which satisfies $1 + 2 - 1 = 2$. The plane is $x + 2y + z = 1$. The left-hand side at option (D) is $1/2 + 1 - 1/2 = 1$, as required. It is -1, 2, and 0 at options (A), (B), and (C), respectively. Hence those points do not even lie on this admissible member and cannot be common to all members.

Step 4: Conclusion All the planes pass through $\boxed{(1/2, 1/2, -1/2)}$. Hence, the correct option is (D).

Quick Tip to Solve: Divide a reciprocal-intercept relation so its right side is 1; its numerators then give a fixed point of the plane family.

6. Let the data 4, 10, x, y, 27 be in the increasing order. If the median of the data is 18 and its mean deviation about mean is 7.6, then the mean of this data is : [4 marks]

(A) 16

(B) 17

(C) 15.5

(D) 16.5

Correct Answer: (D) 16.5

Solution:

Concept:

- For five observations already in increasing order, the median is the third observation, so $x = 18$. The arithmetic mean is the sum divided by five.
- Mean deviation about the mean μ is $\frac{1}{5}\sum_{i=1}^{5}|x_i - \mu|$. Establish where μ lies before removing absolute-value signs.

Step 1: Use the median and bound the mean The ordered observations become $4, 10, 18, y, 27$, with $18 \le y \le 27$. Their mean is

$$\mu = \frac{4 + 10 + 18 + y + 27}{5} = \frac{59 + y}{5}.$$

These bounds imply

$$\frac{77}{5} \le \mu \le \frac{86}{5}, \quad \text{so} \quad 10 < \mu < 18.$$

Thus exactly the first two observations are below the mean, and the last three are above it.

Step 2: Remove absolute values and use the deviation The sum of the five absolute deviations is

$$\begin{aligned} 5(7.6) &= (\mu - 4) + (\mu - 10) + (18 - \mu) \\ &\quad + (y - \mu) + (27 - \mu) \\ &= 31 + y - \mu. \end{aligned}$$

Hence $38 = 31 + y - \mu$, giving $y = \mu + 7$. Combining this with $5\mu = 59 + y$ yields

$$5\mu = 66 + \mu, \qquad 4\mu = 66, \qquad \mu = 16.5.$$

Step 3: Verify the data and eliminate the other means The corresponding value is $y = 23.5$, which preserves the stated order. The deviations about 16.5 are $12.5, 6.5, 1.5, 7, 10.5$; they total 38, giving $38/5 = 7.6$. The linear equation $4\mu = 66$ has a unique solution, so the alternative proposed means $16, 17, 15.5$ cannot satisfy both the mean relation and the deviation condition.

Step 4: Conclusion The mean of the data is $\boxed{16.5}$. Hence, the correct option is (D).

Quick Tip to Solve: Use the ordering to bound the mean before expanding absolute deviations; the correct signs turn the problem into two linear equations.

7. Which of the following is not equivalent to $\sim p \wedge q$? [4 marks]

(A) $\sim p \wedge (\sim p \rightarrow q)$

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

(C) $\sim (q \rightarrow p)$

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

Correct Answer: (D) $\sim p \rightarrow \sim q$

Solution:

Concept:

- An implication satisfies $u \rightarrow v \equiv \sim u \vee v$. Thus an implication is false only when its antecedent is true and its consequent is false.
- De Morgan's law gives $\sim (u \vee v) \equiv (\sim u) \wedge (\sim v)$. Also, $r \wedge (r \vee s) \equiv r$ is the absorption law.

Step 1: Simplify the first expression The target statement is true exactly when p is false and q is true. For option (A), remove the implication first and then distribute the conjunction:

$$\begin{aligned} \sim p \wedge (\sim p \rightarrow q) &\equiv \sim p \wedge (p \vee q) \\ &\equiv (\sim p \wedge p) \vee (\sim p \wedge q) \\ &\equiv \sim p \wedge q. \end{aligned}$$

The first conjunction is always false, so this option is equivalent to the target.

Step 2: Check the next two expressions For option (B), De Morgan's law changes the negated disjunction into a conjunction:

$$\sim (p \vee \sim q) \equiv \sim p \wedge q.$$

For option (C), first replace the implication and then negate it:

$$\sim (q \rightarrow p) \equiv \sim (\sim q \vee p) \equiv q \wedge \sim p.$$

Commutativity makes this the target as well. Hence neither (B) nor (C) answers the negative demand in the question.

Step 3: Test the remaining implication Option (D) reduces to

$$\sim p \rightarrow \sim q \equiv p \vee \sim q \equiv \sim (\sim p \wedge q).$$

It is the negation of the target rather than the target itself. For an explicit distinguishing assignment, take p false and q true: the target is true but option (D) is false.

Step 4: Conclusion The expression $\sim p \rightarrow \sim q$ is not equivalent to $\sim p \wedge q$. Hence, the correct option is (D).

Quick Tip to Solve: For a question asking which statement is not equivalent, simplify the implication first; one counterexample truth assignment is enough to reject equivalence.

8. Let the ellipse, $\frac{x^2}{a^2}+\frac{y^2}{b^2}=1$, $a>b$, pass through the point $(2,3)$ and have eccentricity equal to $\frac{1}{2}$. Then equation of the normal to this ellipse at $(2,3)$ is : [4 marks]

(A) $3x-2y=0$

(B) $3x-y=3$

(C) $2y-x=4$

(D) $2x-y=1$

Correct Answer: (D) $2x-y=1$

Solution:

Concept:

- For an ellipse with $a>b$, its eccentricity satisfies $e^2=1-b^2/a^2$. The ratio of the squared semi-axes controls the tangent and normal slopes.
- Implicit differentiation of $x^2/a^2+y^2/b^2=1$ gives tangent slope $-b^2x/(a^2y)$. At an ordinary point, the normal has the negative reciprocal slope.

Step 1: Find the semi-axes from the data As $e=1/2$, the ratio of the squared semi-axes is

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

Substitute the given point $(2,3)$ into the ellipse:

$$\frac{4}{a^2}+\frac{9}{(3/4)a^2}=1 \quad \Rightarrow \quad \frac{16}{a^2}=1.$$

Thus $a^2=16$ and $b^2=12$. Both are positive and $a>b$, so they satisfy the stipulated orientation.

Step 2: Calculate the normal slope Differentiate the equation of this ellipse with respect to x:

$$\frac{x}{8}+\frac{y}{6}\frac{dy}{dx}=0.$$

At $(2,3)$, the tangent slope is

$$m_t=-\frac{12(2)}{16(3)}=-\frac{1}{2}.$$

The normal is perpendicular to the tangent, hence $m_n=2$. The point is neither an end of the major axis nor an end of the minor axis, so the reciprocal calculation is valid.

Step 3: Form the line and compare the options The point-slope form through $(2,3)$ is

$$y-3=2(x-2) \quad \Rightarrow \quad 2x-y=1.$$

Option (A) does pass through the given point but has slope $3/2$, which is not the normal slope. Options (B) and (C) also pass the point test: at $(2,3)$, their left sides are 3 and 4, respectively; but their slopes are 3 and $1/2$, not 2. The slope test distinguishes the required normal among these lines.

Step 4: Conclusion The equation of the normal is $\boxed{2x-y=1}$. Hence, the correct option is (D).

Quick Tip to Solve: Find b^2/a^2 from the eccentricity first. The normal slope at (x_1,y_1) is $a^2y_1/(b^2x_1)$, so the actual semi-axis lengths need not be computed.

9. The sum of the values of x satisfying the equation, $\sqrt{x}(\sqrt{x}-4)-3|\sqrt{x}-2|+6=0$ $(x \geq 0)$, is :

[4 marks]

(A) 26

(B) 10

(C) 25

(D) 8

Correct Answer: (A) 26

Solution:

Concept:

- The substitution $t=\sqrt{x}$ requires $t \geq 0$ and gives $x=t^2$. Solutions for t must be squared to obtain the requested values of x.
- Complete the square about the same centre that occurs in the absolute value. Writing $u=|t-2|$ makes $(t-2)^2=u^2$, with $u \geq 0$.

Step 1: Reduce the equation to a quadratic Put $t=\sqrt{x}$. The given equation becomes

$$t^2-4t-3|t-2|+6=0.$$

Complete the square in its polynomial part:

$$(t-2)^2-3|t-2|+2=0.$$

Since the square of a real number equals the square of its absolute value, the substitution $u=|t-2|$ gives

$$u^2-3u+2=0 \quad \Rightarrow \quad (u-1)(u-2)=0.$$

Both roots $u=1,2$ satisfy the nonnegative domain of u.

Step 2: Recover every permitted square root When $|t-2|=1$, the two values are $t=1$ and $t=3$. When $|t-2|=2$, they are $t=0$ and $t=4$. All four values satisfy $t \geq 0$, including the endpoint zero. Consequently,

$$x \in \{1^2, 3^2, 0^2, 4^2\} = \{1, 9, 0, 16\}.$$

The substitutions were equivalences with the domain enforced, so no additional squaring check is needed to discard extraneous roots.

Step 3: Add the values of the original variable The required sum is

$$0+1+9+16=26.$$

For example, the endpoint $x=0$ gives $0-3(2)+6=0$, confirming that it must not be dropped. The alternatives 10, 25, and 8 are different from the sum of all four valid roots; summing t instead would incorrectly give 8.

Step 4: Conclusion The sum of all values of x is $\boxed{26}$. Hence, the correct option is (A).

Quick Tip to Solve: When a radical equation also contains $|\sqrt{x}-a|$, set $t=\sqrt{x}$, complete the square about a, and remember to sum t^2, not t.

10. If $\sum_{r=1}^{9}\left(\frac{r+3}{2^r}\right){}^{9}C_r = \alpha\left(\frac{3}{2}\right)^9 + \beta$, then $\alpha+\beta$ is equal to : [4 marks]

(A) 6

(B) 3

(C) 2

(D) 9

Correct Answer: (B) 3

Solution:

Concept:

- The binomial expansion is $\sum_{r=0}^{n}\binom{n}{r}z^r = (1+z)^n$. Its differentiated form gives $\sum_{r=0}^{n} r\binom{n}{r}z^r = nz(1+z)^{n-1}$.
- The factor $r+3$ separates into a weighted binomial sum and three times an ordinary binomial sum. The missing term at $r=0$ must be subtracted only where it is nonzero.

Step 1: Separate the two binomial sums Denote the given sum by S and write $2^{-r} = (1/2)^r$. Then

$$S = \sum_{r=1}^{9} r\binom{9}{r}\left(\frac{1}{2}\right)^r + 3\sum_{r=1}^{9}\binom{9}{r}\left(\frac{1}{2}\right)^r.$$

The first sum has zero contribution at $r=0$, whereas the ordinary binomial sum has contribution 1. Thus the lower limit cannot be changed indiscriminately in both sums.

Step 2: Evaluate using the generating identity Differentiate $(1+z)^9$ and multiply by z:

$$\sum_{r=0}^{9} r\binom{9}{r}z^r = 9z(1+z)^8.$$

At $z=1/2$, this is

$$\frac{9}{2}\left(\frac{3}{2}\right)^8 = 3\left(\frac{3}{2}\right)^9.$$

The second, unweighted sum from $r=1$ to 9 is $(3/2)^9 - 1$. This subtracts exactly its omitted constant term.

Step 3: Read the coefficients and compare Combining the two evaluated parts yields

$$S = 3\left(\frac{3}{2}\right)^9 + 3\left[\left(\frac{3}{2}\right)^9 - 1\right]$$
$$= 6\left(\frac{3}{2}\right)^9 - 3.$$

In the required form, $\alpha = 6$ and $\beta = -3$, so $\alpha+\beta = 3$. Option (A) gives only α; option (D) effectively loses the negative sign of the constant; option (C) agrees with neither coefficient comparison nor their sum.

Step 4: Conclusion Here $\alpha = 6$, $\beta = -3$, and $\boxed{\alpha+\beta = 3}$. Hence, the correct option is (B).

Quick Tip to Solve: For $(r+c)\binom{n}{r}z^r$, combine $nz(1+z)^{n-1}$ with $c(1+z)^n$, and then remove the original sum's omitted constant term.

11. A ray of light is projected from the origin at angle of 60° with the positive direction of x-axis towards the line, $y = 2$, which gets reflected from the point $(\alpha, 2)$. Then the distance of the reflected ray of light from the point $(2, 2)$ is : [4 marks]

(A) $3 - \sqrt{3}$

(B) $1 - \frac{1}{\sqrt{3}}$

(C) $\sqrt{3} - 1$

(D) $2\left(1 - \frac{1}{\sqrt{3}}\right)$

Correct Answer: (C) $\sqrt{3} - 1$

Solution:

Concept:

- A line making angle θ with the positive x-axis has slope $\tan\theta$. Reflection in a horizontal mirror reverses the vertical component of the ray while preserving its horizontal component.
- The perpendicular distance from (x_0, y_0) to $Ax + By + C = 0$ is $|Ax_0 + By_0 + C|/\sqrt{A^2 + B^2}$. For a ray, verify that the perpendicular foot belongs to the forward half-line.

Step 1: Locate the point of reflection The incident ray starts at the origin with slope $\tan 60^\circ = \sqrt{3}$, so its equation is $y = \sqrt{3}x$. At the reflecting line $y = 2$,

$$\alpha = \frac{2}{\sqrt{3}}.$$

Hence the ray meets the mirror at $R = (2/\sqrt{3}, 2)$. The mirror is horizontal, so the reflected ray travels to the right and downward, with slope $-\sqrt{3}$.

Step 2: Obtain the reflected ray and its distance The reflected line through R is

$$y - 2 = -\sqrt{3}\left(x - \frac{2}{\sqrt{3}}\right),$$

which simplifies to $\sqrt{3}x + y - 4 = 0$. The perpendicular distance of $P = (2, 2)$ from it is

$$d = \frac{|2\sqrt{3} + 2 - 4|}{\sqrt{3+1}} = \frac{2\sqrt{3} - 2}{2} = \sqrt{3} - 1.$$

The numerator is positive because $\sqrt{3} > 1$.

Step 3: Check that the foot lies on the ray A forward direction vector of the reflected ray is $(1, -\sqrt{3})$. The projection parameter of $P - R$ on this direction is

$$s = \frac{(P - R) \cdot (1, -\sqrt{3})}{4} = \frac{2 - 2/\sqrt{3}}{4} > 0.$$

Thus the closest point is on the reflected ray itself and the line-distance formula applies. The other options have values $3 - \sqrt{3}$, $1 - 1/\sqrt{3}$, and $2(1 - 1/\sqrt{3})$, each different from the perpendicular distance just derived.

Step 4: Conclusion The distance of the reflected ray from $(2, 2)$ is $\boxed{\sqrt{3} - 1}$ coordinate units. Hence,

the correct option is (C).

Quick Tip to Solve: For reflection at a horizontal line, change the sign of the slope and retain the reflection point. Check the perpendicular foot is forward on the ray before using line distance.

12. If $A = \{1, 2, 3, 4\}$, then the number of functions on the set A, which are not one - one, is : [4 marks]

(A) 232

(B) 240

(C) 248

(D) 256

Correct Answer: (A) 232

Solution:

Concept:

- A function on A means a map $A \to A$. If the domain has n elements and each has m possible images, the total number of functions is m^n.
- A one-one function assigns different images to different domain elements. On a finite set with the same size of domain and codomain, these assignments are permutations, numbering $n!$.

Step 1: Count all maps on the set The set $A = \{1, 2, 3, 4\}$ has four elements. Choose the image of each domain element independently. There are four choices for $f(1)$, four for $f(2)$, four for $f(3)$, and four for $f(4)$. The multiplication rule therefore gives

$$N_{\text{all}} = 4 \times 4 \times 4 \times 4 = 4^4 = 256.$$

This count allows repeated images, so it includes both one-one and non-one-one functions.

Step 2: Count the one-one maps For injectivity, first assign any of four images to 1. Then only three unused images remain for 2, followed by two for 3, and one for 4. Hence

$$N_{\text{one-one}} = 4 \times 3 \times 2 \times 1 = 4! = 24.$$

No image can repeat in this count. Since there are four images for four inputs, each such injective map is also onto, but onto-ness is not an additional restriction here.

Step 3: Take the complement and eliminate alternatives Every function is either one-one or not one-one, and these categories are disjoint. Subtracting the first category from the total yields

$$N_{\text{not one-one}} = 256 - 24 = 232.$$

Option (D), 256, includes all functions and forgets the exclusion. The values 240 and 248 would subtract 16 or 8, respectively, instead of the actual 24 injective assignments, so neither meets the condition.

Step 4: Conclusion The required number of functions is $\boxed{232}$. Hence, the correct option is (A).

Quick Tip to Solve: For self-maps of an n-element set, count non-injective functions by the complement $n^n - n!$; counting all possible collisions separately causes double counting.

13. A bag contains 6 red balls and 10 green balls. 3 balls are drawn from it one by one randomly without replacement. If the 3^{rd} drawn ball is red, then the probability that the first two drawn balls are green is : [4 marks]

(A) 3/7

(B) 3/8

(C) 9/49

(D) 9/56

Correct Answer: (A) 3/7

Solution:

Concept:

- For events E and F, conditional probability is $P(E \mid F) = P(E \cap F)/P(F)$, provided $P(F) > 0$. Here the information about the third draw must be incorporated.
- Without replacement, the denominator decreases after every draw. Equivalently, fixing a red ball in the third position leaves fifteen balls, of which ten are green, available for the first two positions.

Step 1: Define the given event and the required event Let E be the event that the first two balls are green, and let F be the event that the third ball is red. Every position in a random ordering is equally likely to contain any ball. Thus the marginal probability of a red third ball is $P(F) = 6/16$. This is a conditional question: the required answer is not the unconditional chance of drawing two greens from the full bag.

Step 2: Calculate the probability of the ordered colour pattern The intersection is the specific colour pattern green, green, red. After the first green is removed there are nine green balls among fifteen remaining balls; after the second green there are still six reds among fourteen balls. Therefore

$$P(E \cap F) = \frac{10}{16} \cdot \frac{9}{15} \cdot \frac{6}{14}.$$

No factor of three is needed because the locations of all three colours have already been specified.

Step 3: Divide by the probability of the condition Use the conditional-probability formula and cancel the common red-ball factor:

$$P(E \mid F) = \frac{(10/16)(9/15)(6/14)}{6/16} = \frac{90}{210} = \frac{3}{7}.$$

As a check, after reserving the red third ball, the first two positions sample from ten greens and five reds, giving $(10/15)(9/14) = 3/7$. The other proposed values $3/8$, $9/49$, and $9/56$ do not equal this conditional probability.

Step 4: Conclusion The required probability is $\boxed{3/7}$. Hence, the correct option is (A).

Quick Tip to Solve: Condition on the known third red ball first: remove that red from the population, then choose the first two balls from ten greens and five reds.

14. Let S_n denote the sum of the first n terms of an A.P., $a_1, a_2, a_3, \ldots, a_n$. If $a_5 + a_9 = 1$ and $S_9 = 6$, then which one of the following is not true ? [4 marks]

(A) $a_{13} = 0$

(B) $S_{13} = \frac{13}{2}$

(C) $a_6 + a_8 = 1$

(D) $S_6 = \frac{19}{2}$

Correct Answer: (D) $S_6 = \frac{19}{2}$

Solution:

Concept:

- In an arithmetic progression with first term a and common difference d, the nth term is $a_n = a + (n-1)d$. Terms equally spaced around a middle term have twice that middle term as their sum.
- The sum of the first n terms is $S_n = \frac{n}{2}[2a + (n-1)d]$. Both given conditions determine a and d; the question asks which proposed statement is false.

Step 1: Translate the two given conditions The fifth and ninth terms give

$$a_5 + a_9 = (a + 4d) + (a + 8d) = 2a + 12d = 1,$$

so $a + 6d = 1/2$. The given nine-term sum yields

$$S_9 = \frac{9}{2}(2a + 8d) = 9(a + 4d) = 6,$$

hence $a + 4d = 2/3$. Notice that the sum condition uses the fifth term, whereas the symmetric-term condition fixes the seventh term.

Step 2: Determine the progression Subtract the second linear equation from the first:

$$2d = \frac{1}{2} - \frac{2}{3} = -\frac{1}{6}, \qquad d = -\frac{1}{12}.$$

Then

$$a = \frac{2}{3} - 4\left(-\frac{1}{12}\right) = 1.$$

Thus every term is known explicitly: $a_n = 1 - (n-1)/12$. This also verifies the original data: $a_5 = 2/3$ and $a_9 = 1/3$, whose sum is one.

Step 3: Check each proposed statement For (A), $a_{13} = 1 - 12/12 = 0$, so it is true. For (B),

$$S_{13} = \frac{13}{2}(1 + 0) = \frac{13}{2},$$

also true. For (C),

$$a_6 + a_8 = \left(1 - \frac{5}{12}\right) + \left(1 - \frac{7}{12}\right) = 1,$$

so this is true as well. Finally,

$$S_6 = \frac{6}{2}\left(2 - \frac{5}{12}\right) = 3 \cdot \frac{19}{12} = \frac{19}{4}.$$

This is not the claimed $19/2$, so only the last statement is false.

Step 4: Conclusion The false statement is $S_6 = 19/2$; its actual value is $\boxed{19/4}$. Hence, the correct option is (D).

Quick Tip to Solve: For an odd number of AP terms, use the sum divided by the number of terms to find the middle term; then check the word "not before selecting the answer.

15. The function $f(x) = e^{x+1}\left(4x^2 - 16x + 11\right)$ is : [4 marks]

(A) decreasing in $\left(-\infty, -\frac{5}{2}\right) \cup \left(\frac{1}{2}, \infty\right)$

(B) decreasing in $\left(-\infty, \frac{1}{2}\right) \cup \left(\frac{5}{2}, \infty\right)$

(C) increasing in $(-\infty, -2) \cup (2, \infty)$

(D) increasing in $\left(-\infty, -\frac{1}{2}\right) \cup \left(\frac{5}{2}, \infty\right)$

Correct Answer: (D) increasing in $\left(-\infty, -\frac{1}{2}\right) \cup \left(\frac{5}{2}, \infty\right)$

Solution:

Concept:

- A differentiable function increases where its derivative is positive and decreases where its derivative is negative. The sign must be checked on intervals separated by the real zeros of the derivative.
- For $f(x) = e^{x+1}g(x)$, the product rule gives $f\prime(x) = e^{x+1}[g(x) + g\prime(x)]$. Since an exponential is always strictly positive, it contributes no sign changes.

Step 1: Differentiate the given product Take $g(x) = 4x^2 - 16x + 11$, so $g\prime(x) = 8x - 16$. Applying the product rule to both factors,

$$\begin{aligned} f\prime(x) &= e^{x+1}(4x^2 - 16x + 11) + e^{x+1}(8x - 16) \\ &= e^{x+1}(4x^2 - 8x - 5). \end{aligned}$$

The exponential remains e^{x+1}, because the derivative of its exponent is one. Differentiating only the quadratic would miss an entire contribution.

Step 2: Factor and determine the derivative sign The quadratic factors as

$$4x^2 - 8x - 5 = (2x + 1)(2x - 5).$$

Hence its zeros are $-1/2$ and $5/2$. For $x < -1/2$, both factors are negative, giving a positive product. For $-1/2 < x < 5/2$, the factors have opposite signs, giving a negative product. For $x > 5/2$, both are positive. Multiplication by $e^{x+1} > 0$ preserves these signs.

Step 3: Compare the sign intervals with the options Therefore the function increases on

$$(-\infty, -1/2) \cup (5/2, \infty)$$

and decreases on $(-1/2, 5/2)$. Option (A) wrongly claims decreasing behaviour on outer intervals. Option (B) also includes intervals where the derivative is positive. Option (C) starts its right-hand increasing interval at two; this is too early, since, for example, the derivative at $x = 9/4$ is negative. The outer increasing intervals in (D) have precisely the correct endpoints.

Step 4: Conclusion The function is increasing in $\boxed{(-\infty, -1/2) \cup (5/2, \infty)}$. Hence, the correct option is (D).

Quick Tip to Solve: Factor out the positive exponential before making a sign chart; the remaining quadratic alone determines the monotonicity intervals.

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16. If for some $c < 0$, the quadratic equation, $2cx^2 - 2(2c-1)x + 3c^2 = 0$ has two distinct real roots, $\frac{1}{a}$ and $\frac{1}{b}$, then the value of the determinant, $\begin{vmatrix} 1+a & 1 & 1 \\ 1 & 1+b & 1 \\ 1 & 1 & 1+c \end{vmatrix}$ is : [4 marks]

(A) 0

(B) 1

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

(D) 2

Correct Answer: (D) 2

Solution:

Concept:

- For a quadratic $Ax^2 + Bx + C = 0$, the sum and product of its roots are $-B/A$ and C/A. With reciprocal roots, first write these relations for $1/a$ and $1/b$, then recover $a + b$ and ab.
- The determinant of a three-by-three matrix whose diagonal entries are $1 + a, 1 + b, 1 + c$ and whose other entries are one simplifies to $ab + ac + bc + abc$.

Step 1: Apply the root relations carefully The coefficient of x in the given equation is $-2(2c - 1)$. Since $c < 0$, the leading coefficient is nonzero and the root product is nonzero. Vieta's relations give

$$\frac{1}{a} + \frac{1}{b} = \frac{2c-1}{c}, \qquad \frac{1}{ab} = \frac{3c}{2}.$$

Consequently

$$ab = \frac{2}{3c}, \qquad a + b = ab\frac{2c-1}{c} = \frac{2(2c-1)}{3c^2}.$$

The nonzero product justifies all reciprocals used here.

Step 2: Expand the determinant into symmetric terms Expanding along the first row,

$$\begin{aligned} D &= (1+a)[(1+b)(1+c)-1] \\ &\quad -[(1+c)-1]+[1-(1+b)] \\ &= (1+a)(b+c+bc)-c-b \\ &= ab+ac+bc+abc. \end{aligned}$$

This expression groups naturally as $D = ab(1+c)+c(a+b)$, so individual values of the roots are unnecessary. In particular, there is no need to solve the quadratic using radicals.

Step 3: Substitute and cancel the parameter Insert the two symmetric quantities:

$$\begin{aligned} D &= \frac{2(1+c)}{3c}+\frac{2(2c-1)}{3c} \\ &= \frac{2[(1+c)+(2c-1)]}{3c} \\ &= \frac{6c}{3c} = 2. \end{aligned}$$

The result holds for every permitted value of c. The restriction on distinct real roots ensures the stated roots exist, but does not introduce another value of the determinant. Thus the alternatives zero, one and $4/3$ fail the exact expansion and substitution.

Step 4: Conclusion The determinant has the constant value $\boxed{2}$. Hence, the correct option is (D).

Quick Tip to Solve: For reciprocal-root problems, obtain the product first and use it to turn the reciprocal-root sum into $a+b$; substitute symmetric quantities instead of finding the roots.

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17. Let a function, $f:(-1,3)\to$ R be defined as $f(x)=\min\{x[x],|x[x]-2|+2\}$, where $[x]$ denotes the greatest integer $\le x$. Then f is : [4 marks]

(A) neither continuous nor differentiable at exactly 3 points.

(B) not continuous at two points and not differentiable at 3 points.

(C) not continuous at only one point and not differentiable at three points.

(D) neither continuous nor differentiable at exactly two points.

Correct Answer: (B) not continuous at two points and not differentiable at 3 points.

Solution:

Concept:

- For every real number t, the inequality $|t-2|\ge t-2$ implies $|t-2|+2\ge t$. Thus the minimum of these two expressions is always t.
- The greatest-integer function is constant between consecutive integers. Continuity and differentiability of its product with x must also be checked at the integers lying strictly inside the given domain.

Step 1: Simplify the minimum before splitting the domain Set $t=x[x]$. The inequality $|t-2|+2\ge t$

is valid whether t is below or above two. It follows immediately that

$$f(x) = \min\{t, |t-2|+2\} = t = x[x].$$

In particular, the absolute-value branch never produces a smaller value. Introducing an extra corner where $x[x] = 2$ would therefore be incorrect.

Step 2: Write the function on each integer interval Inside $(-1, 3)$, the only integer transition points are zero, one and two. The formula becomes

$$f(x) = \begin{cases} -x, & -1 < x < 0, \\ 0, & 0 \le x < 1, \\ x, & 1 \le x < 2, \\ 2x, & 2 \le x < 3. \end{cases}$$

Each open interval has a linear formula and so is both continuous and differentiable there. The domain endpoints -1 and three are excluded and are not additional exceptional points.

Step 3: Check the three transition points At zero, the left limit is zero and the right limit and value are zero. Thus f is continuous there, but its left derivative is -1 and its right derivative is zero, so it is not differentiable. At one, the left limit is zero while $f(1) = 1$, giving a discontinuity. At two, the left limit is two while $f(2) = 4$, giving another discontinuity. Differentiability implies continuity, so it fails at both of these points too. Hence continuity fails at exactly two points, while differentiability fails at exactly three points. This rejects (A), (C) and (D), whose exceptional-point counts differ.

Step 4: Conclusion The function is discontinuous at $1, 2$, and is not differentiable at $0, 1, 2$. Hence, the correct option is (B).

Quick Tip to Solve: Before analysing a minimum with an absolute value, compare its two entries globally; here $|t-2|+2 \ge t$ removes the minimum entirely.

18. Let $\mathrm{A} = \begin{bmatrix} x & 2y \\ -1 & y \end{bmatrix}; x, y \in \mathbf{R}$. **If** $\mathrm{AA}^{\mathrm{T}} = \begin{bmatrix} 1 & 0 \\ 0 & \alpha \end{bmatrix}$ $(\alpha \in \mathbf{R})$, **then** $\alpha + y^2$ **is equal to :** [4 marks]

(A) 1

(B) $\sqrt{2}$

(C) 2

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

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

Solution:

Concept:

- The entries of AA^{T} are dot products of the rows of A. Its off-diagonal entries vanish exactly when the two rows are perpendicular.
- A square such as y^2 is nonnegative. This sign condition selects the admissible root after the matrix

equations have been reduced to a quadratic.

Step 1: Multiply the matrix by its transpose The rows of A are $(x, 2y)$ and $(-1, y)$. Therefore

$$AA^{\mathrm{T}} = \begin{bmatrix} x^2 + 4y^2 & -x + 2y^2 \\ -x + 2y^2 & 1 + y^2 \end{bmatrix}.$$

Comparing all entries with the stated diagonal matrix gives

$$x^2 + 4y^2 = 1, \qquad x = 2y^2, \qquad \alpha = 1 + y^2.$$

It is essential to use AA^{T}, rather than squaring A, because ordinary matrix squaring gives different cross terms.

Step 2: Solve for the nonnegative square Put $u = y^2 \geq 0$. Substitution of $x = 2u$ into the first equation yields

$$4u^2 + 4u = 1, \qquad u^2 + u - \frac{1}{4} = 0.$$

The quadratic formula gives

$$u = \frac{-1 \pm \sqrt{1+1}}{2} = \frac{-1 \pm \sqrt{2}}{2}.$$

The root with a minus sign is negative and cannot equal y^2. Hence $y^2 = (\sqrt{2} - 1)/2$. Either sign of y is possible, but the requested expression depends only on its square.

Step 3: Evaluate the requested sum and compare the options Using the lower-right entry of the matrix product,

$$\begin{aligned} \alpha + y^2 &= (1 + y^2) + y^2 \\ &= 1 + 2\left(\frac{\sqrt{2} - 1}{2}\right) \\ &= \sqrt{2}. \end{aligned}$$

Thus (B) is exactly the computed value. The alternatives one and two ignore the quadratic constraint, and $\sqrt{2} - 1$ equals $2y^2$ alone, missing the extra one in α. The nonnegative-root choice is also consistent with the positive lower-right entry $\alpha = 1 + y^2$.

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

Quick Tip to Solve: Use the off-diagonal zero to express x through y^2, then substitute $u = y^2 \geq 0$; this avoids unnecessary square roots for y.

19. $\lim_{x\to 1}\left\{\log_e\left(e^{x(x-1)}-e^{x(1-x)}\right)-\log_e(4x(x-1))\right\}$ **is equal to :** [4 marks]

(A) $1-\log_e 2$

(B) 1

(C) $-\log_e 2$

(D) $-2\log_e 2$

Correct Answer: (C) $-\log_e 2$

Solution:

Concept:

- The difference of two real logarithms is the logarithm of their quotient when both arguments are positive: $\ln A-\ln B=\ln(A/B)$.
- The standard exponential limit is $\lim_{u\to 0}(e^u-1)/u=1$. A continuous logarithm can be applied after finding a positive quotient limit.

Step 1: Introduce the vanishing exponent Put $t=x(x-1)$. Then $x(1-x)=-t$, and $t\to 0$ as $x\to 1$. The expression becomes

$$\ln\left(\frac{e^t-e^{-t}}{4t}\right).$$

For the original real logarithms to exist near $x=1$, we have $t>0$, corresponding to $x>1$. Thus the approach is through the domain of the given expression. Both logarithm arguments are positive on that approach.

Step 2: Evaluate the quotient before taking the logarithm Factor the numerator without dropping either exponential term:

$$\frac{e^t-e^{-t}}{4t}=\frac{e^{-t}}{2}\,\frac{e^{2t}-1}{2t}.$$

As $t\to 0^+$, the first factor tends to $1/2$ and the second tends to 1. Hence the quotient tends to $1/2$. Continuity of $\ln z$ for $z>0$ gives $\ln(1/2)=-\ln 2$. The value is negative, excluding options (A) and (B); option (D) would require a quotient limit of $1/4$, which the factorisation rules out.

Step 3: Conclusion The required limit, along the real domain of the given expression, is $\boxed{-\ln 2}$. Hence, the correct option is (C).

Quick Tip to Solve: Combine logarithms before evaluating a difference of divergent terms; for e^t-e^{-t}, the leading term is $2t$, not t.

20. The area (in sq. units) of the region $\left\{(x, y) : \frac{1}{2} \leq y \leq \sin x, 0 \leq x \leq \pi\right\}$ is : [4 marks]

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

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

(C) $\sqrt{3} - \frac{\pi}{3}$

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

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

Solution:

Concept:

- The area between an upper curve $y = u(x)$ and a lower curve $y = l(x)$ is $\int_a^b [u(x) - l(x)]\, dx$, over intervals where $u \geq l$.
- The horizontal line $y = 1/2$ meets $y = \sin x$ in $[0, \pi]$ at $x = \pi/6$ and $x = 5\pi/6$.

Step 1: Find the interval that actually contains the region The simultaneous inequalities require $\sin x \geq 1/2$. In the prescribed interval $0 \leq x \leq \pi$, this occurs exactly when

$$\frac{\pi}{6} \leq x \leq \frac{5\pi}{6}.$$

Outside this interval there is no y satisfying both bounds, so those outer portions contribute no area. The vertical height of the region is $\sin x - 1/2$, which is nonnegative between these two intersection points.

Step 2: Integrate the upper curve minus the lower line The area in square units is therefore

$$\begin{aligned} A &= \int_{\pi/6}^{5\pi/6} \left(\sin x - \frac{1}{2}\right) dx \\ &= \left[-\cos x - \frac{x}{2}\right]_{\pi/6}^{5\pi/6} \\ &= \left(\frac{\sqrt{3}}{2} - \frac{5\pi}{12}\right) - \left(-\frac{\sqrt{3}}{2} - \frac{\pi}{12}\right) \\ &= \sqrt{3} - \frac{\pi}{3}. \end{aligned}$$

The sine contribution is $\sqrt{3}$, while the rectangle removed has width $2\pi/3$ and height $1/2$, hence area $\pi/3$. Options (A) and (D) incorrectly replace the sine contribution by 3; option (B) subtracts too small a rectangle.

Step 3: Conclusion The area is $\boxed{\sqrt{3} - \pi/3}$ square units. Hence, the correct option is (C).

Quick Tip to Solve: Locate where the upper bound exceeds the lower bound before integrating; the stated overall x-range need not be the region's actual width.

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

21. Let a, $\mathrm{b} \in \mathbf{R}$ and $\mathrm{a} > 0$. If the tangent at the point $(2, 2)$ to the circle $x^2 + y^2 = 8$ touches the parabola $y^2 = 4\mathrm{a}(x - \mathrm{b})$, then $\mathrm{b} - \mathrm{a}$ is equal to _____. [4 marks]

Solution:

Concept:

- The tangent to $x^2 + y^2 = r^2$ at a point (x_1, y_1) on the circle is $xx_1 + yy_1 = r^2$.
- A line is tangent to a parabola when substitution of the line into its equation gives a quadratic with a repeated root, so its discriminant is zero.

Step 1: Write the tangent to the circle The point $(2, 2)$ lies on the circle since $2^2 + 2^2 = 8$. Using the tangent formula gives

$$2x + 2y = 8 \quad \Longrightarrow \quad x + y = 4.$$

The radius has slope 1, and this tangent has slope -1, confirming that they are perpendicular. Rearrange the tangent as $x = 4 - y$, which lets us substitute into the parabola without introducing a denominator.

Step 2: Impose tangency to the parabola Insert $x = 4 - y$ into $y^2 = 4a(x - b)$:

$$y^2 = 4a(4 - y - b),$$
$$y^2 + 4ay - 4a(4 - b) = 0.$$

For the line to touch rather than cut the parabola, the two intersection values of y must coincide. Thus

$$(4a)^2 - 4(1)[-4a(4 - b)] = 0,$$
$$16a(a + 4 - b) = 0.$$

The condition $a > 0$ excludes the degenerate factor $a = 0$. Consequently $a + 4 - b = 0$, or $b - a = 4$. As a check, the repeated root is $y = -2a$ and the point on the line is $(4 + 2a, -2a)$; with $b = a + 4$, it satisfies the parabola exactly.

Step 3: Conclusion The required numerical value is $\boxed{b - a = 4}$. This is a dimensionless parameter difference.

Quick Tip to Solve: For a common tangent, first obtain the fixed line from the circle and then use a zero discriminant for its intersection with the parabola.

22. If the total number of ways in which 8-digit numbers can be formed by using all the digits $0, 1, 2, 3, 4, 5, 7, 9$ such that no two even digits appear together is $(5!)\mathrm{k}$, then k is equal to _____.

[4 marks]

Solution:

Concept:

- To ensure that no two selected digits are adjacent, first arrange the other digits and place the restricted digits in distinct gaps.
- An eight-digit number cannot start with zero. Count every valid separation arrangement, then subtract arrangements with a leading zero.

Step 1: Arrange the odd digits and distribute the even digits The odd digits are $1, 3, 5, 7, 9$, and the even digits are $0, 2, 4$. Arrange the five distinct odd digits in $5!$ ways. Their arrangement creates six gaps: one before the first odd digit, four between consecutive odd digits, and one after the last. At most one even digit can occupy any gap. Choose three of the six gaps and permute the three even digits within them:

$$N_{\text{all}} = 5!\binom{6}{3}3! = 5! \cdot 120.$$

This enforces separation of even digits, but temporarily permits zero to lead.

Step 2: Remove the arrangements that begin with zero For an invalid leading-zero arrangement, zero is fixed in the very first gap. The five odd digits still have $5!$ possible orders. The remaining even digits 2 and 4 must occupy two distinct gaps among the five remaining gaps, giving

$$N_{\text{zero first}} = 5!\binom{5}{2}2! = 5! \cdot 20.$$

There is no overlap ambiguity in this subtraction: every leading-zero arrangement is counted exactly once, and all already satisfy the no-adjacent-even condition. Therefore

$$N = 5!(120 - 20) = 5! \cdot 100 = 12000.$$

Comparing this with the specified form $(5!)k$ determines k. The zero restriction is essential; counting zero as an ordinary digit without subtracting would overcount by 2400.

Step 3: Conclusion The required dimensionless value is $\boxed{k = 100}$.

Quick Tip to Solve: In digit-arrangement gap problems, apply the no-leading-zero condition after counting the separated arrangements; zero is an even digit here.

23. If $\int e^{2x}(\cos x + 7\sin x)dx = e^{2x}g(x) + c$, where c is a constant of integration, then $g(0) + g\left(\frac{\pi}{2}\right)$ is equal to _____. [4 marks]

Solution:

Concept:

- For a linear combination of sine and cosine multiplied by e^{2x}, seek a particular antiderivative in the form $e^{2x}(A\cos x + B\sin x)$.
- Differentiate the proposed antiderivative using the product rule and compare the coefficients of $\cos x$ and $\sin x$.

Step 1: Determine the coefficients in the antiderivative Write $g(x) = A\cos x + B\sin x$ for the trigonometric factor, keeping the integration constant outside as in the question. Differentiation gives

$$\frac{d}{dx}\left[e^{2x}(A\cos x + B\sin x)\right] = e^{2x}\left[(2A + B)\cos x + (2B - A)\sin x\right].$$

Matching this with $e^{2x}(\cos x + 7\sin x)$ yields

$$2A + B = 1, \qquad -A + 2B = 7.$$

Substitution of $B = 1 - 2A$ into the second equation gives $-5A = 5$, so $A = -1$ and $B = 3$.

Step 2: Evaluate the required values and verify Thus the particular trigonometric factor is $g(x) = -\cos x + 3\sin x$. Using $\cos 0 = 1$, $\sin 0 = 0$, $\cos(\pi/2) = 0$, and $\sin(\pi/2) = 1$,

$$g(0) = -1, \qquad g\left(\frac{\pi}{2}\right) = 3.$$

Their sum is $-1 + 3 = 2$. A direct check confirms the signs: $g\prime(x) = \sin x + 3\cos x$, and hence

$$2g(x) + g\prime(x) = \cos x + 7\sin x.$$

Multiplication by e^{2x} recovers exactly the given integrand; the separate constant c differentiates to zero.

Step 3: Conclusion Using the particular antiderivative with its constant written separately, $\boxed{g(0) + g(\pi/2) = 2}$. The requested value is dimensionless.

Quick Tip to Solve: For $e^{ax}(p\cos x + q\sin x)$, compare coefficients after one differentiation instead of repeating integration by parts.

24. Let $f(x) = \begin{cases} |x-3|, & \text{if } x < -1 \\ 3x+4, & \text{if } x \geq -1 \end{cases}$, $g(x) = x^2 - \mathrm{b}x - 2 (x \in \mathbf{R})$ **and** b **is a real constant. If** $g \circ f$ **is continuous at** $x = -1$**, then** b **is equal to _____.** [4 marks]

Solution:

Concept:

- A polynomial g is continuous everywhere. Thus one-sided limits of $g(f(x))$ are obtained by applying g to the corresponding one-sided limits of f.
- The composition can be continuous even when f jumps, provided g takes the same value at the two limiting inputs.

Step 1: Find the limiting inputs to the polynomial For $x < -1$, we have $x - 3 < 0$, so $|x-3| = 3 - x$. The left-hand limit is therefore

$$\lim_{x \to -1^-} f(x) = 3 - (-1) = 4.$$

For $x \geq -1$, the other branch gives $f(x) = 3x + 4$, so

$$f(-1) = 1, \qquad \lim_{x \to -1^+} f(x) = 1.$$

The inner function has a jump from limiting input 4 to limiting input 1. It would be incorrect to require f itself to be continuous; the question requires continuity of $g \circ f$.

Step 2: Equate the two images under the outer function Because $g(t) = t^2 - bt - 2$ is polynomial, continuity of the composition requires

$$g(4) = g(1).$$

Evaluate both sides carefully:

$$g(4) = 16 - 4b - 2 = 14 - 4b,$$
$$g(1) = 1 - b - 2 = -1 - b.$$

Hence $14 - 4b = -1 - b$, giving $15 = 3b$ and $b = 5$. To check the actual value at the point, $(g \circ f)(-1) = g(1) = -6$. At $b = 5$, the left limit is $g(4) = 16 - 20 - 2 = -6$, while the right limit is also $g(1) = -6$. Both limits equal the function value, which proves continuity.

Step 3: Conclusion The required dimensionless constant is $\boxed{b = 5}$.

Quick Tip to Solve: When an inner function jumps between two finite inputs, test whether the outer function maps both inputs to the same output.

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25. If the line joining the points $(-1, 2, 5)$ **and** $(3, 4, -10)$ **intersects the** xy**-plane at the point** (x, y, z)**, then** $\frac{y}{x}$ **is equal to _____.** [4 marks]

Solution:

Concept:

- A point on the line through two fixed points A and B can be written as $A + t(B - A)$, where the real parameter t describes its position along the line.

- Every point of the xy-plane has zero z-coordinate. Set the line's z-coordinate equal to zero first, then use the same parameter in its other two coordinates.

Step 1: Express the coordinates of a general point on the line Take $A = (-1, 2, 5)$ and $B = (3, 4, -10)$. Subtract the coordinates of A from those of B in the same order:

$$B - A = (3 - (-1),\ 4 - 2,\ -10 - 5) = (4, 2, -15).$$

Thus the direction vector has components $4, 2, -15$, and the point with parameter t has coordinates

$$(x, y, z) = (-1 + 4t,\ 2 + 2t,\ 5 - 15t).$$

At $t = 0$ this is A, and at $t = 1$ it is B, which checks both the direction and the signs in the equations.

Step 2: Impose the plane condition and evaluate the requested ratio At the intersection with the xy-plane, the third coordinate vanishes. Therefore

$$5 - 15t = 0 \quad \Longrightarrow \quad t = \frac{1}{3}.$$

Substituting this single value in both remaining coordinate equations gives

$$x = -1 + \frac{4}{3} = \frac{1}{3}, \qquad y = 2 + \frac{2}{3} = \frac{8}{3}.$$

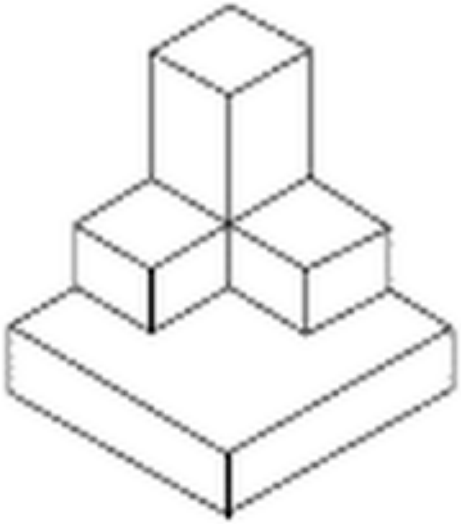
The point is $(1/3, 8/3, 0)$; its zero third coordinate confirms that it lies in the required plane. Since $x \neq 0$, the requested quotient is defined:

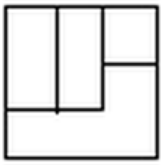
$$\frac{y}{x} = \frac{8/3}{1/3} = 8.$$

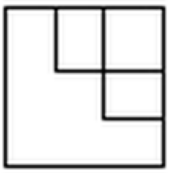
Step 3: Conclusion The line meets the xy-plane at $(1/3, 8/3, 0)$. Hence the required dimensionless numerical value is $\boxed{8}$.

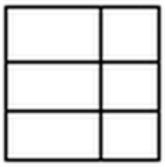
Quick Tip to Solve: For intersection with a coordinate plane, set its perpendicular coordinate to zero in the parametric line; here set $z = 0$ before finding x and y.

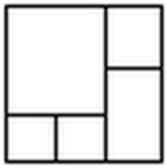
26. The 3 - D figure shows the view of an object. Identify the correct top view from amongst the answer figures. [4 marks]

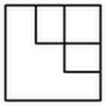


(A) 

(B) 

(C) 

(D) 

Correct Answer: (B) 

Solution:

Concept:

- A top view is an orthographic projection along the vertical direction. Height is suppressed, while the positions of exposed horizontal surfaces and their boundaries are retained.
- Use the square base as the fixed outline. Compare the positions of the high central column and its two lower neighbours within this outline, without rotating one answer independently.

Step 1: Identify the footprint of the raised portions The base is a square platform. Above it there is a tall square column at the far corner, with one lower square block on each of its two frontward sides. Looking vertically down, each raised block occupies a square position. The three raised positions therefore form an L: the rear square is common to the two arms and the diagonally frontward position

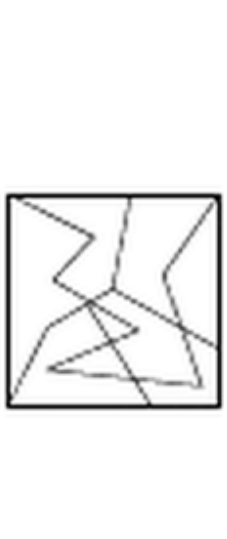
is not raised to the same level. The two lower blocks are separate neighbours of the high column; they are not two divisions of a long strip on one side.

Step 2: Match the exposed edges to the options In the plan, the square base remains the outer boundary. The L-shaped raised arrangement occupies the upper-right part of that square in the displayed orientation. One division separates the two upper squares, and another separates the two right-hand squares. Option (B) shows exactly these three square positions. Option (A) extends an internal boundary into a long strip down the left-hand side and changes the arrangement. Option (C) divides the square into an incompatible set of rows and a side strip. Option (D) places the small subdivisions along the lower-left edge rather than as the two neighbours of the far column. Thus matching both the outer base and the internal step boundaries selects only (B).

Step 3: Conclusion The correct top view is the L-shaped arrangement of three raised square positions inside the square base. Hence, the correct option is (B).

Quick Tip to Solve: For stepped solids, mark the footprint of each level first; a tall column changes height, not the size or location of its square footprint.

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



(A) 

(B) 

(C) 

(D) 

Correct Answer: (B) 

Solution:

Concept:

- A mirror in a vertical line reverses left and right. It preserves vertical positions, lengths and the order of points from top to bottom.
- Each point must appear on the opposite side at the same perpendicular distance from the mirror. Every segment must connect the reflected versions of its original endpoints.

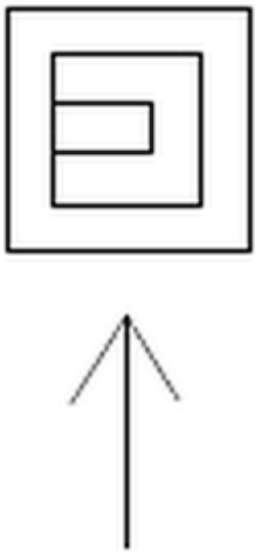
Step 1: Reflect the prominent boundary connections The mirror line X–X stands to the right of the problem square. The required image is therefore a horizontal reflection, not a rotation. The diagonal beginning at the upper-left corner of the problem must begin at the upper-right corner of its image and run down towards the left. Likewise, a feature near the left border must move near the right border at the same height. The upper zigzag and the sloping central line must both reverse their sideways bends while retaining their sequence of corners from top to bottom.

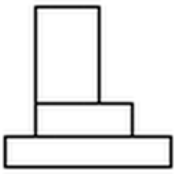
Step 2: Check the complete broken-line pattern Follow each connected stroke through the interior rather than comparing only the square outline. In the correct reflection the upper-right diagonal joins the reflected upper zigzag; the other upper stroke starts near the middle of the top edge and slopes down towards the right before joining the central intersections. The lower oblique and nearly horizontal strokes must also exchange left and right endpoints without changing which strokes meet. Option (B) preserves all these reflected connections. Option (A) changes the direction of the upper middle stroke, so that it is not the reflection of the original line. Option (C) rearranges a lower diagonal connection, and option (D) changes the lower interior broken-line arrangement. Those differences remain even though all four choices have the same surrounding square. Checking the upper and lower connections together identifies (B).

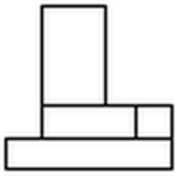
Step 3: Conclusion Option (B) reverses the figure from left to right across X–X while preserving its heights and all line connections. Hence, the correct option is (B).

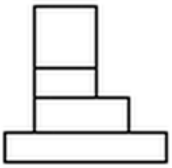
Quick Tip to Solve: For a vertical mirror, track one upper corner and one lower intersection: reverse their horizontal positions while keeping their vertical levels unchanged.

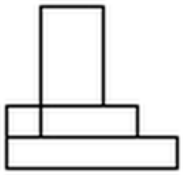
28. The problem figure shows the top view of an object. Identify the correct elevation from amongst the answer figures looking in the direction of the arrow. [4 marks]

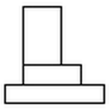


(A) 

(B) 

(C) 

(D) 

Correct Answer: (A) 

Solution:

Concept:

- An elevation is the view obtained by looking horizontally in the indicated direction. The arrow determines the viewing side, so its direction must be fixed before comparing the answers.
- Compare widths, alignments and visible step boundaries with the top view. An edge hidden behind a nearer surface is not added as a solid visible line in the elevation.

Step 1: Read the alignment indicated by the top view The arrow points upwards from below the square, so view the object from the lower side of the supplied plan. The outer square is the broad base footprint. Inside it is a smaller square footprint, and the narrow inner part lies on the left of that smaller region. Consequently the upper, narrower portion is left-aligned over the intermediate portion, and both stand over a wider base. Preserve this left-to-right alignment; reversing the viewing direction would interchange the side relationships.

Step 2: Select the elevation with the corresponding visible steps Option (A) presents the required three-part silhouette: a wide low base, an intermediate ledge, and a narrower upright portion positioned on its left. The upper portion rises from the same left boundary as the intermediate ledge, while the base extends beyond it on each side. Its visible divisions are the platform changes rather than extra divisions across the upright face. Option (B) adds a vertical division on the right of the intermediate band. Option (C) adds horizontal divisions through the upright part. Option (D) adds an extra block boundary through the left of the base and changes the intermediate alignment. These additional visible subdivisions do not match the supplied arrangement as viewed along the arrow. Matching the nested footprints and the unobstructed front silhouette therefore gives (A).

Step 3: Conclusion The elevation corresponding to the indicated viewing direction is the stepped outline in option (A). Hence, the correct option is (A).

Quick Tip to Solve: Fix the arrow direction first, then compare the left and right extents of each footprint; do not confuse a top-view boundary with an extra visible front-face line.

29. Which one of the following is a secondary color ? [4 marks]

(A) Blue

(B) Yellow

(C) Red

(D) Green

Correct Answer: (D) Green

Solution:

Concept:

- In the traditional artist's colour wheel, the primary colours are red, yellow and blue. A secondary colour is obtained by mixing two of these primary colours.
- The three secondary colours in this wheel are green, orange and violet. Classify a colour using the same colour model throughout the comparison.

Step 1: Recall how secondary colours are formed The question concerns the colour relationships used in drawing and visual composition. In the traditional pigment colour wheel, red, yellow and blue are the primary starting colours. Mixing yellow and blue produces green; mixing red and yellow produces orange; and mixing red and blue produces violet. These mixed colours form the secondary group. The term secondary describes this relationship to the primary colours, rather than whether a colour looks light, dark, warm or cool. Green therefore satisfies the required classification directly.

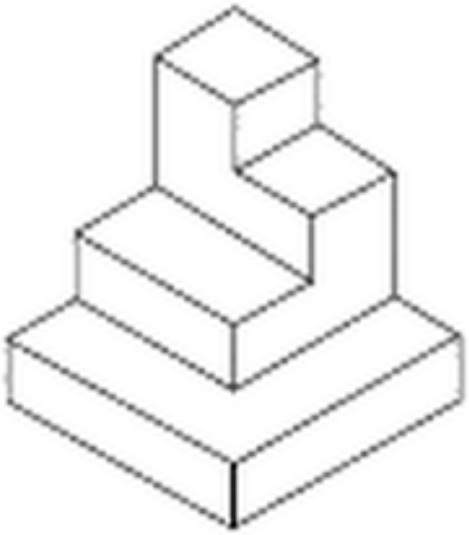
Step 2: Compare all four listed colours Option (A), blue, is one of the primary colours in this artist's wheel, so it is not the required secondary colour. Option (B), yellow, is also primary and fails for the same reason. Option (C), red, is the third primary colour, rather than a colour formed by mixing the other two. Option (D), green, is formed from the two primaries yellow and blue, so it belongs to the secondary group. There is exactly one secondary colour among the four choices. Keep this pigment-colour convention consistent: replacing it midway with the red-green-blue additive model of coloured light would change the classification and would not be the drawing colour wheel being

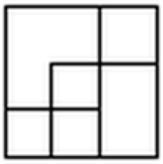
tested here.

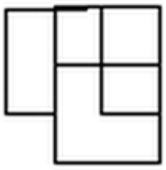
Step 3: Conclusion Green is a secondary colour in the traditional artist's colour wheel because it is obtained by mixing yellow and blue. Hence, the correct option is (D).

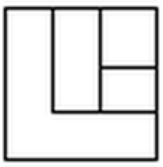
Quick Tip to Solve: Recall the artist's pairs: yellow with blue gives green, red with yellow gives orange, and red with blue gives violet; these three mixtures are secondary colours.

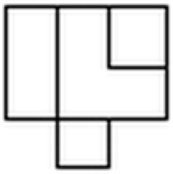
30. The 3 - D figure shows the view of an object. Identify the correct top view from amongst the answer figures. [4 marks]



(A) 

(B) 

(C) 

(D) 

Correct Answer: (C) 

Solution:

Concept:

- A top view suppresses vertical height and retains the horizontal footprint and visible boundaries between surfaces at different levels.

- Adjacent coplanar surfaces have no step edge between them. Surfaces at different heights retain their common boundary in a plan even though their vertical faces are not seen.

Step 1: Separate the base outline from the raised structure The outer platform is square, so its top view must have a complete square outer boundary. The raised structure lies within it and has a stepped profile: the tallest square column is at the back, the next higher square portion is to its right in the displayed orientation, and the lower terrace continues around the nearer side. Looking down removes the apparent vertical lengths of the columns. It does not create a notch in the footprint of the broad square base.

Step 2: Trace the internal terrace boundaries and compare In the plan, the lower exposed terrace forms an L-shaped region around the higher parts. The higher right-hand portion and the tallest rear portion have separate square footprints, so the right-hand strip has a transverse division marking the change of level. Option (C) combines this internal L-shaped boundary with that division and keeps the square base complete. Option (A) puts the small subdivided regions along the lower side and adds an incompatible lower horizontal division. Option (B) has a notch in its lower outer outline, although the solid has a full square platform there. Option (D) projects a small tab outside the main outline, which also contradicts the square base. Thus the outer footprint rejects (B) and (D), while the position of the internal step boundaries distinguishes (C) from (A).

Step 3: Conclusion The square base with the internal L-shaped terrace and the divided right-hand higher portion appears in option (C). Hence, the correct option is (C).

Quick Tip to Solve: In a top-view problem, reject options with a missing corner or projecting tab when the actual lowest platform is a complete square; then compare only the internal level boundaries.

31. Where from the following is the National Gallery of Modern Art located ? [4 marks]

(A) Lucknow

(B) New Delhi

(C) Mysore

(D) Bangalore

Correct Answer: (B) New Delhi

Solution:

Concept:

- Architectural awareness questions connect a named cultural institution with its principal location. The National Gallery of Modern Art is associated with Jaipur House in New Delhi.
- Jaipur House is a former royal residence near India Gate. Identifying the building and its city together is more reliable than guessing from a city's general artistic reputation.

Step 1: Identify the institution and its principal building The name National Gallery of Modern Art refers here to the national institution housed at Jaipur House. This gallery presents modern Indian art; it should not be confused with a local museum, an art college, or a palace collection. The location to recall is therefore the city containing Jaipur House, rather than simply a city known for arts or

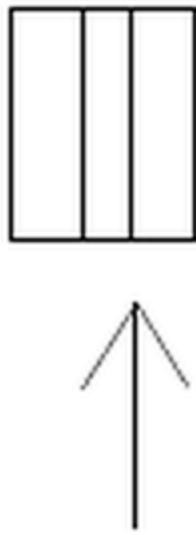
historic buildings.

Step 2: Match the building with the listed city Jaipur House is in New Delhi, making option (B) the intended match. Lucknow and Mysore are not the location of this principal gallery, so options (A) and (C) do not supply the required institution–city pair. Bangalore has a regional branch of the National Gallery of Modern Art, but this conventional general-awareness question asks for the principal institution at Jaipur House. Thus option (D) does not replace New Delhi as the intended answer to this question.

Step 3: Conclusion The principal National Gallery of Modern Art at Jaipur House is located in New Delhi. Hence, the correct option is (B).

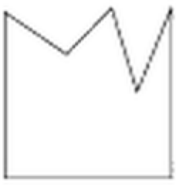
Quick Tip to Solve: Memorise the pair "NGMA – Jaipur House – New Delhi"; connecting an institution to its building prevents confusion with its regional branches.

32. The problem figure shows the top view of an object. Identify the correct elevation from amongst the answer figures looking in the direction of the arrow. [4 marks]



(A) 

(B) 

(C) 

(D) 

Correct Answer: (B) 

Solution:

Concept:

- The top view records horizontal positions and widths, while the elevation records the height profile seen along the indicated arrow. Project each visible change of roof slope onto the same horizontal baseline.
- The rectangular plan is divided by three interior parallel lines into four strips. Each strip represents one continuous inclined face, so its elevation must contain four corresponding slope segments in the same left-to-right order.

Step 1: Read the plan from the arrow The arrow points upwards towards the lower edge of the plan. Consequently the elevation uses the plan's horizontal width without turning the object sideways. Starting at the left boundary, the first strip is relatively wide, the second narrower, the third wide again, and the last narrower. The three interior lines indicate successive changes in the visible roof slope. We must preserve both the number and the relative spacing of these changes.

Step 2: Compare the four profiles Option (B) has four successive sloping segments, with the turning points aligned with the three internal divisions of the given plan. Its first broad descending face, narrower ascending face, broad descending face and final ascending face give the required sequence of projected widths. Option (A) has only three slope segments, so one required division is absent. Option (C) places its turning points at a different set of horizontal positions, including a much narrower deep notch near the right. Option (D) introduces extra turns and therefore more divisions than the plan shows. Only (B) preserves the plan's division pattern.

Step 3: Conclusion The elevation whose slope changes correspond to all four strips of the top view is option (B). Hence, the correct option is (B).

Quick Tip to Solve: Count the plan strips first, then compare the horizontal positions of the turning points; a similar zigzag silhouette alone is insufficient.

33. What amongst the following is the thickness of a two brick wall ? [4 marks]

(A) 18″

(B) 16″

(C) 20″

(D) 22″

Correct Answer: (A) 18″

Solution:

Concept:

- Brick-wall thickness is commonly named by the number of brick lengths across the wall. A one-brick wall has a nominal thickness of about 9 inches in the conventional brick-size system used in this question.
- A two-brick wall is therefore approximately twice the nominal one-brick thickness. This terminology describes the wall's thickness across its section, rather than the number of courses in its height.

Step 1: Interpret the term two-brick wall A half-brick wall has approximately the width of one brick across its thickness, while a one-brick wall has approximately the length of one brick across it. The conventional one-brick thickness is taken as 9 inches. Consequently, the phrase two-brick wall means two such nominal brick lengths across the thickness; it does not mean two thin half-brick leaves with their widths added.

Step 2: Calculate and compare the nominal thickness Using the conventional nominal value gives

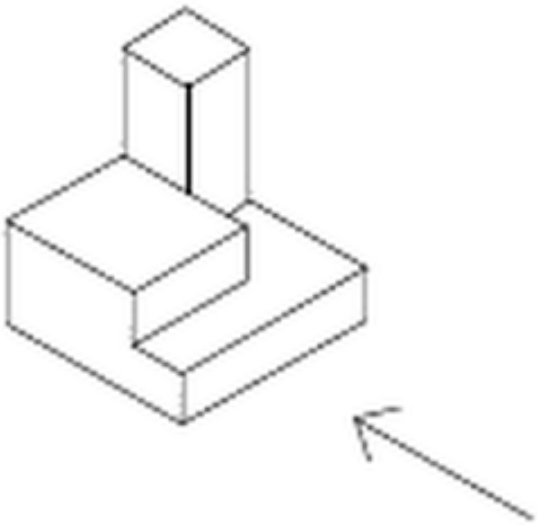
$$t = 2 \times 9 = 18 \text{ inches.}$$

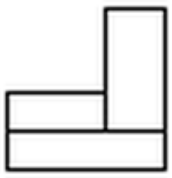
The 18-inch choice agrees directly with the two-brick designation. A thickness of 16 inches would correspond to only 8 inches per nominal brick length, whereas 20 inches and 22 inches would require 10 inches and 11 inches per nominal brick length respectively. Those are not the conventional value used by the choices. Mortar joints and finishes affect an actual measured wall, but the question asks for the standard nominal designation, so plaster is not added to the result.

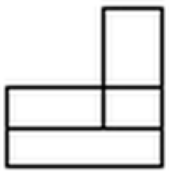
Step 3: Conclusion The conventional thickness of a two-brick wall is 18 inches. Hence, the correct option is (A).

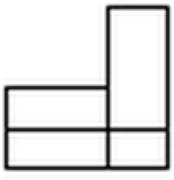
Quick Tip to Solve: Use the nominal sequence: half-brick about 4.5 inches, one-brick about 9 inches, and two-brick about 18 inches; do not count courses as wall thickness.

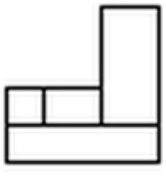
34. The 3 - D figure shows the view of an object. Identify the correct view in the direction of the arrow, from amongst the answer figures. [4 marks]

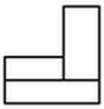


(A) 

(B) 

(C) 

(D) 

Correct Answer: (A) 

Solution:

Concept:

- An elevation is obtained by looking parallel to the given arrow. Dimensions along that line of sight collapse, while vertical heights and the transverse positions of edges remain visible.
- Hidden edges are not drawn as solid visible lines. An edge where one exposed surface changes level is retained, but a boundary concealed behind a nearer block is omitted.

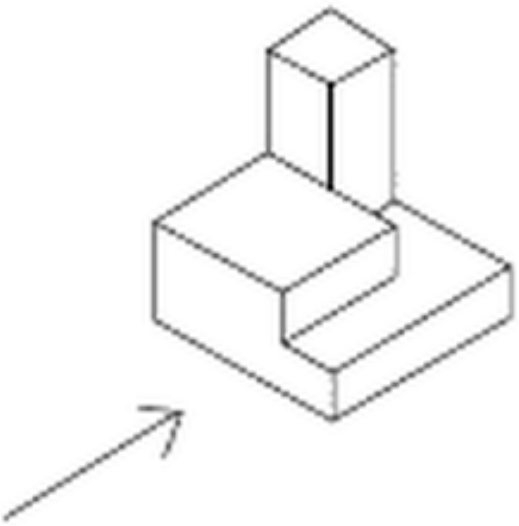
Step 1: Project the three levels from the specified side The object consists of a low rectangular base, a raised rectangular portion and a tall narrow square column. The arrow comes from the lower right of the pictorial view and points towards the object. Seen from this direction, the column lies at the right of the elevation and the raised part extends to its left. The bottom base gives a continuous horizontal strip. Above it, the shorter raised portion and the tall column retain their distinct heights.

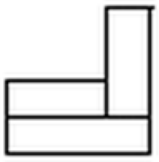
Step 2: Keep the visible junctions and eliminate hidden ones The required view has a continuous horizontal boundary at the top of the base, a shorter horizontal line at the top of the intermediate portion, and the column rising on the right. In option (A), the intermediate top line terminates against the column and the vertical boundary beside the column ends at the top of the base. Option (B) adds a horizontal continuation through the column at the intermediate level. Option (C) carries the vertical boundary beside the column down through the base, although the base has an uninterrupted front surface. Option (D) introduces an extra vertical subdivision in the shorter raised portion. Those extra lines do not represent exposed edges from the indicated direction. The visible outline and junctions agree with (A).

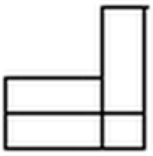
Step 3: Conclusion The directed elevation has a tall column on the right, a lower raised portion on the left and the visible junctions shown in option (A). Hence, the correct option is (A).

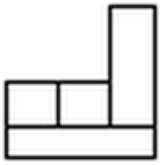
Quick Tip to Solve: Fix the viewing direction before comparing choices; then test the interior lines, because the outer stepped silhouette may be shared by several options.

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



(A) 

(B) 

(C) 

(D) 

Correct Answer: (D) 

Solution:

Concept:

- The arrow selects the observer's position; the same three-dimensional object can produce different elevations when viewed from different sides.
- In an orthographic elevation, depth is suppressed. Project the outline and include only the edges visible from the chosen side, rather than copying all lines of the pictorial drawing.

Step 1: Look along the lower-left arrow The arrow approaches the object from the lower left. This direction is perpendicular to the direction used for the other side view of this stepped object. The tall narrow column is now projected at the left, with the upper platform extending to its right and the lowest base extending farther still. Thus the highest part of the elevation must stand on the left and the top boundary must descend towards the right in steps.

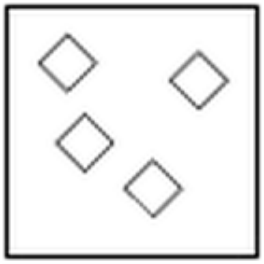
Step 2: Compare the visible stepped outline Following the exposed top boundary from left to right

gives the top of the tall column, a vertical descent to the intermediate platform, a horizontal run, and another descent to the base extension. Option (D) displays this left-high, right-low staircase outline and the appropriate visible vertical junction beside the column. Options (A), (B) and (C) place the tall column on the right, which corresponds to a different direction of sight. Their additional horizontal and vertical interior divisions also describe different exposed faces. One must not choose them merely because they show the same heights somewhere in the picture: their left-to-right arrangement contradicts the arrow. Therefore the complete visible projection is (D).

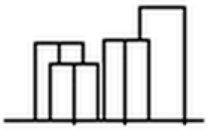
Step 3: Conclusion Viewed from the lower-left arrow, the tall column is on the left and the silhouette descends in two steps towards the right. Hence, the correct option is (D).

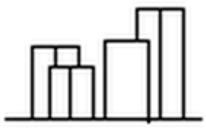
Quick Tip to Solve: Use the arrow to decide which side contains the tallest part before examining smaller internal edges; this quickly rejects reversed elevations.

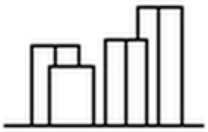
36. The problem figure shows the top view of objects. Looking in the direction of the arrow, identify the correct elevation, from amongst the answer figures. [4 marks]



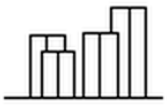


(A) 

(B) 

(C) 

(D) 

Correct Answer: (D) 

Solution:

Concept:

- The horizontal coordinate of each object is preserved when the observer looks along the upward arrow. Its distance from the observer determines which overlapping edges are hidden.
- A diamond-shaped plan represents a square column turned relative to the viewing direction. Its two exposed front faces meet at a vertical ridge; an elevation must retain that ridge wherever it is not hidden by a nearer column.

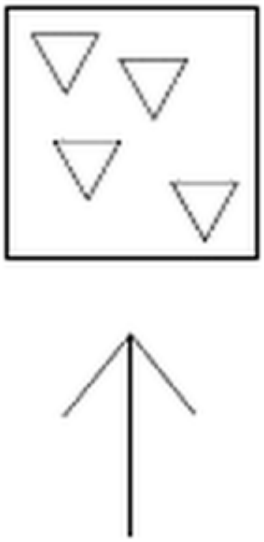
Step 1: Place the four projected columns Viewed from below the plan, the lower diamonds are nearer the observer than the upper diamonds. The two left-hand diamonds overlap in horizontal projection: the nearer lower-left object covers part of the farther upper-left object. On the right, the low diamond is nearer than the upper-right diamond and covers the lower part of its left edge. The left-to-right locations and widths must match these overlaps; the drawing is not simply four independent bars standing side by side.

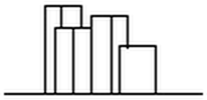
Step 2: Check the ridges and the hidden-edge interruptions Option (D) preserves the front vertical ridge on every square column wherever it is exposed, including the nearer right-hand column and the taller column behind it. It also interrupts the rear column's left boundary where the nearer column covers it. The corresponding overlap on the left is likewise maintained: the back object is visible above and to the left of the nearer one. Option (A) omits the central visible ridge of the tallest, far-right square column. Option (B) omits the central visible ridge of the nearer right-hand square column. Option (C) omits the visible ridge on the nearer left-hand column. Each such omission incorrectly merges two exposed faces into one flat face. Comparing these interior ridges, together with the projected locations and overlaps, identifies (D).

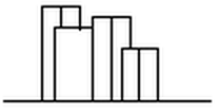
Step 3: Conclusion The projected positions, visible vertical ridges and interruptions caused by the nearer objects agree with option (D). Hence, the correct option is (D).

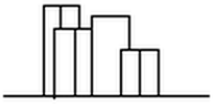
Quick Tip to Solve: For overlapping diamond plans, mark the nearest object in each overlapping pair and erase the rear edges it hides; then check each square column's visible front ridge.

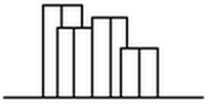
37. The problem figure shows the top view of objects. Looking in the direction of the arrow, identify the correct elevation, from amongst the answer figures. [4 marks]

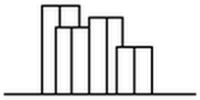


(A) 

(B) 

(C) 

(D) 

Correct Answer: (D) 

Solution:

Concept:

- An elevation is an orthographic view in the arrow direction. Horizontal positions and overlaps are retained; distances along the line of sight collapse.
- For each triangular footprint, project its left end, front vertex and right end vertically. The front vertex creates a visible upright edge; a nearer object hides only the portion of a farther object behind it.

Step 1: Project the four footprints Look upward from the arrow at the bottom of the plan. The two left triangles overlap in horizontal position: the lower triangle lies nearer and partly masks the upper-left triangle. The upper triangle farther to the right is also partly overlapped by the lowest, rightmost triangle. Thus the elevation must show four upright objects arranged as two staggered overlapping pairs, rather than merge either pair into one undivided rectangle.

Step 2: Retain the visible front vertices Each downward-pointing triangle has its apex toward the observer. Its apex therefore projects as an upright line within the visible front of the corresponding object. In particular, the nearest right-hand object must have its central upright edge visible. The broad face of the rear-right object must also retain its projected apex edge where it is not hidden.

Follow the same rule for the two left-hand objects; the rear outlines terminate where a nearer front face covers them.

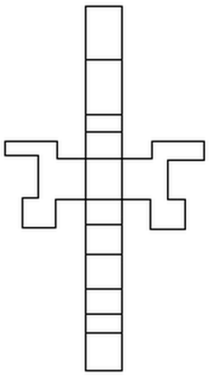
Step 3: Eliminate the incomplete elevations Option A omits the upright apex edge of the nearest right-hand object, leaving that face undivided. Option B loses the required internal edge on the nearer left-hand face. Option C omits the projected ridge on the rear-right object. Option D retains the necessary upright divisions in both overlapping pairs and has the correct left-to-right arrangement. These edge tests distinguish the options without interpreting a diagonal in the plan as a sloping line in elevation.

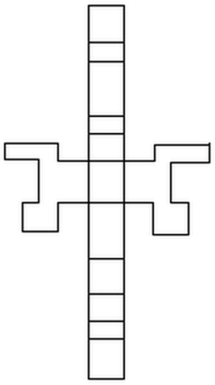
Step 4: Conclusion The visible front-vertex edges and the overlapping order agree with answer figure D. Hence, the correct option is (D).

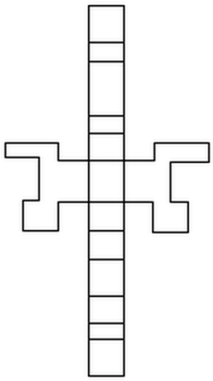
Quick Tip to Solve: Project the three horizontal positions of every triangular footprint, then erase only the parts hidden by a nearer object.

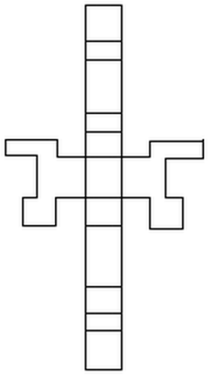
38. The 3 - D figure shows the view of an object. Identify the correct view when the figure is opened up, from amongst the answer figures. [4 marks]



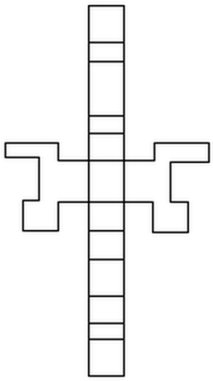
(A) 

(B) 

(C) 

(D) 

Correct Answer: (C)



Solution:

Concept:

- A solid formed by extruding a polygon has two congruent end faces and a strip of rectangular lateral faces. Every turn around the end-face boundary gives one fold in that strip.
- The widths of consecutive rectangles must follow consecutive boundary edges, including the short edges at the recess. Equal total area alone does not make a valid net.

Step 1: Identify the end profile The solid has a stepped, recessed end profile rather than a plain rectangular end. Its two matching end faces must therefore be the two stepped outlines on opposite sides of the central strip. The recess and the projecting portions must retain their orientation when these outlines fold inward. A plausible outer silhouette is insufficient: the narrow strip must connect the edges of those profiles in exactly the order around their perimeter.

Step 2: Trace the lateral strip around the boundary Start at the rectangular panel between the two

end profiles and mentally fold one end face through a right angle. Then travel along the central strip, folding at each transverse line. A broad boundary edge requires a broad panel; a short return at a step requires a narrow panel. Continue around both the outward projections and the inward recess. The last panel must meet the first without leaving an extra return edge or closing across the recess. In figure C the broad and narrow panels occur in the order needed to wrap this stepped boundary.

Step 3: Compare the competing nets Although A, B and D also contain two similar stepped end outlines, their transverse divisions place a short return or a longer face at the wrong stage of the wrap. Folding those strips against the end outline makes a fold arrive before or after the corresponding corner, so the strip cannot close along every edge of the illustrated profile. C preserves the successive broad faces, narrow step faces and recess faces, while its two end outlines attach on opposing sides. The test is edge-to-edge correspondence, not the total height of the flat drawing.

Step 4: Conclusion The unfolded surface whose strip follows the stepped end-face boundary is figure C. Hence, the correct option is (C).

Quick Tip to Solve: For a prism net, trace one end-face perimeter and match every edge, in order, to one panel of the long strip.

39. Where from among the following is the famous St. Peters located ? [4 marks]

(A) Norway

(B) Denmark

(C) Venice

(D) Rome

Correct Answer: (D) Rome

Solution:

Concept:

- St. Peter's Basilica is a major Renaissance church in Vatican City, the independent enclave within Rome. Questions about landmarks commonly associate the Vatican and its monuments with Rome.
- Identify the specific building before comparing places: St. Peter's Basilica and its large piazza are different from the Basilica of St. Mark in Venice.

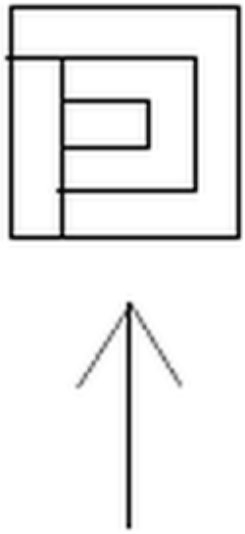
Step 1: Identify the landmark named in the question The famous St. Peter's refers to St. Peter's Basilica, the monumental church associated with the Vatican. Its architectural identity includes the great dome and the piazza in front of the basilica. Vatican City lies within the city of Rome, so Rome is the geographical association requested by these alternatives. The wording does not ask for the name of the sovereign state containing the basilica.

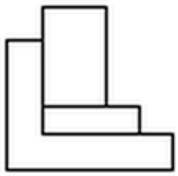
Step 2: Compare all four locations Norway and Denmark are Scandinavian countries; neither is the location of this Vatican landmark. Venice is an Italian city, but its famous basilica on the principal square is St. Mark's, not St. Peter's. Rome is the only option that identifies the city surrounding Vatican City and therefore matches St. Peter's Basilica. Keeping the distinction between the two Italian basilicas rules out the most plausible distractor, Venice.

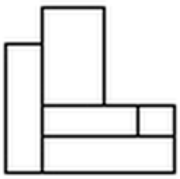
Step 3: Conclusion St. Peter's Basilica is in Vatican City, within Rome. Among the given locations, the answer is Rome. Hence, the correct option is (D).

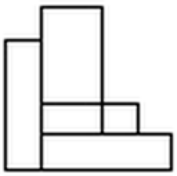
Quick Tip to Solve: Pair St. Peter's with Vatican City and Rome; pair St. Mark's with Venice to avoid confusing the two Italian landmarks.

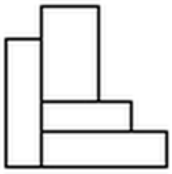
40. The problem figure shows the top view of an object. Identify the correct elevation from amongst the answer figures looking in the direction of the arrow. [4 marks]

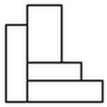


(A) 

(B) 

(C) 

(D) 

Correct Answer: (D) 

Solution:

Concept:

- In an orthographic elevation, positions across the page remain fixed while depth in the arrow direction collapses. A line behind an opaque nearer face is not shown as a visible continuation.
- A stepped object is checked by following its outer silhouette first and then the visible horizontal and vertical junctions between its levels.

Step 1: Fix the viewing direction and the stepped outline The arrow points upward into the plan, so the lower boundary is the near side. The plan has a continuous left-hand strip, an outer surrounding portion and a smaller central projection. Carry their left and right positions into elevation without reversing them. The answer must consequently have the left vertical member and the descending stepped silhouette toward the right, with the taller central portion above the lower right-hand levels.

Step 2: Apply the near-face visibility test At a junction, ask which of the connected faces is nearer the arrow. The left strip appears as a continuous upright member and its boundary continues down to the ground line. The central high part rests above the intermediate horizontal ledge; a smaller ledge then extends to the right, above the bottom platform. A rear vertical boundary must stop at the face that covers it. The plan does not justify an extra upright seam crossing the visible intermediate ledge.

Step 3: Compare each answer figure A interrupts the continuous left member at the lower ledge instead of carrying its boundary to the base. B adds a vertical subdivision through the right-hand part of the intermediate ledge. C carries an extra vertical line downward through the central lower faces. D shows the continuous left member and the successive horizontal ledges, while terminating the covered rear edges at the appropriate faces. Its visible junctions therefore fit the plan and the direction of observation.

Step 4: Conclusion The correct elevation is answer figure D. Hence, the correct option is (D).

Quick Tip to Solve: After matching the stepped silhouette, check the internal junctions: an extra visible seam can invalidate an otherwise similar elevation.

41. In which State in India are the large Tea Gardens located ? [4 marks]

(A) Odisha

(B) Punjab

(C) Kerala

(D) Uttar Pradesh

Correct Answer: (C) Kerala

Solution:

Concept:

- Large tea gardens are characteristic of humid hill regions with abundant rainfall, suitable soils and well-drained slopes. Kerala's Western Ghats include major tea-growing landscapes.
- A location question must be answered from the alternatives given. Other important Indian tea regions do not make an incorrect listed state the answer.

Step 1: Relate tea gardens to the physical landscape Tea cultivation requires a moist environment and benefits from well-drained terrain. Kerala has extensive hill plantations in the Western Ghats, including the well-known tea estates around Munnar. These estates are recognisable as large planted gardens covering hillsides. This gives a direct and specific example connecting the landscape in the question with one of the listed states.

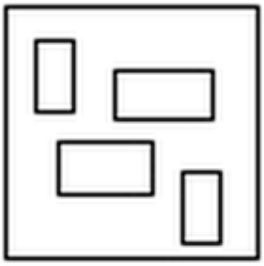
Step 2: Eliminate the remaining states Punjab is principally associated with intensive agriculture

on the northwestern plains and is not the tea-garden state intended here. Uttar Pradesh is likewise not the location of the large hill tea estates described by this choice. Odisha is not the major tea-garden landscape represented in these alternatives. Kerala, by contrast, has established extensive tea plantations in its hill districts. Assam and West Bengal are also major tea-growing states, but neither is an offered alternative; the question does not claim Kerala is India's only tea-producing state.

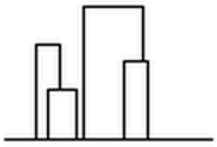
Step 3: Conclusion Among the four states listed, Kerala is known for large tea gardens, including the hill estates around Munnar. Hence, the correct option is (C).

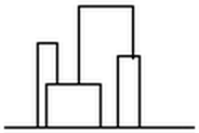
Quick Tip to Solve: For these options, recall Munnar in Kerala; distinguish identifying a tea-growing state from asking which state produces the most tea.

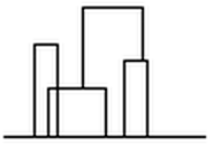
42. The problem figure shows the top view of objects. Looking in the direction of the arrow, identify the correct elevation, from amongst the answer figures. [4 marks]

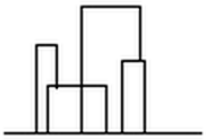


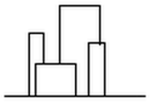


(A) 

(B) 

(C) 

(D) 

Correct Answer: (B) 

Solution:

Concept:

- For a plan-to-elevation question, the arrow defines the near-to-far order. Keep every object in its horizontal position and collapse only its depth.
- When horizontal ranges overlap, the nearer object hides part of the rear one. Visible outlines must terminate at the nearer face rather than pass through it.

Step 1: Locate the four objects in the plan Looking upward from the arrow, the broad lower-left rectangle and the narrow lower-right rectangle lie nearer the observer. The slim upper-left rectangle and broad upper-right rectangle are farther away. Across the view, the upper-left footprint partly overlaps the nearer broad left footprint. Similarly, the broad upper-right footprint overlaps the nearer narrow right footprint. Preserve this ordering instead of swapping front and rear objects.

Step 2: Project the overlaps into the elevation The nearer broad left object must cover the lower right part of the slim rear-left object and also the lower left part of the broad rear-right object. The nearer narrow right object covers the right-hand lower portion of that broad rear-right object. Consequently the broad rear object has a visible upper rectangle rising behind both foreground objects. At its left edge, the vertical outline stops against the top of the nearer broad left face, rather than continuing visibly through that face.

Step 3: Distinguish the similar alternatives Option A makes the foreground left block narrow and loses the required broad overlap. C lets a rear upright continue visibly through the foreground left block to the baseline. D likewise includes an extra upright line through that foreground block, inconsistent with its being an opaque nearer face. B alone shows the broad foreground left face uninterrupted and terminates the rear-left boundary on its upper edge, while retaining the correct narrow object on the right. The visibility at that junction is the decisive difference.

Step 4: Conclusion The overlap order and visible-edge terminations match answer figure B. Hence, the correct option is (B).

Quick Tip to Solve: Mark the near objects first; then stop each rear outline when it reaches the face of a nearer object.

43. What is the purpose of a chimney in a building ? [4 marks]

(A) To give strength to a building

(B) To take out the smoke from a fire place

(C) To hold the building up

(D) To make the building water proof

Correct Answer: (B) To take out the smoke from a fire place

Solution:

Concept:

- A chimney is a vertical flue that carries smoke and combustion gases from a fireplace or furnace to the outside atmosphere above the building.

- Hot combustion gases are less dense than cooler surrounding air. Their upward movement creates a natural draught that helps ventilate the fireplace.

Step 1: Identify the function of the flue Burning fuel in a fireplace produces smoke and hot gases. These must leave the occupied room through a suitable passage. A chimney provides that passage: it connects the fireplace to an outlet above roof level and directs the products of combustion outside. Thus its principal purpose is smoke removal, rather than supporting the floors, walls or roof.

Step 2: Relate the function to natural draught The heated gases tend to rise through the chimney because they are less dense than the surrounding cooler air. This buoyancy establishes a draught through the fireplace and flue. Replacement air enters near the fire while the smoke is carried upward. The height and continuity of the flue help the gases discharge away from the room; they do not make the chimney a waterproofing treatment.

Step 3: Eliminate the unrelated building functions Option (B) describes precisely the removal of smoke from a fireplace. Option (A) concerns structural strength, which comes from a properly designed structural system. Option (C) also describes load-bearing support, a role of foundations, columns, beams and bearing walls. Option (D) concerns protection against water penetration, provided by suitable roofing, flashings and waterproofing materials. None of these three functions is the defining purpose of a chimney.

Step 4: Conclusion A chimney takes smoke and combustion gases out of a fireplace and discharges them outside the building. Hence, the correct option is (B).

Quick Tip to Solve: Match a building service to what it carries: a chimney carries combustion gases, while structural members carry loads and waterproofing excludes water.

44. Who was the architect of the LIC Building in Connaught Place, New Delhi ? [4 marks]

(A) Louis Kahn

(B) Charles Correa

(C) Raj Rewal

(D) Zaha Hadid

Correct Answer: (B) Charles Correa

Solution:

Concept:

- Architectural-awareness questions associate a named building with the architect responsible for its design, rather than with its owner or present use.
- The LIC building at Connaught Place in New Delhi is Jeevan Bharati, designed by the Indian architect Charles Correa.

Step 1: Identify the building named in the question LIC denotes the Life Insurance Corporation of India. Its landmark office building at Connaught Place, New Delhi, is known as Jeevan Bharati. The location is an essential part of the identification: the question concerns this particular building, rather than every office used by the same organisation. Once the building is identified, the required answer

is the name associated with its architectural design.

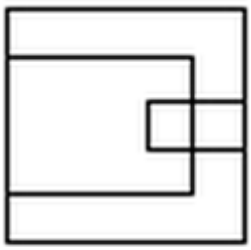
Step 2: Recall its architect Jeevan Bharati is a work of Charles Correa. Correa's practice included major public, cultural and office buildings in India, and this New Delhi office complex belongs to his body of work. Therefore the architect-building association required here is Charles Correa with the LIC building at Connaught Place. This matches the name printed in option (B).

Step 3: Distinguish the other listed architects Louis Kahn is associated with the Indian Institute of Management campus in Ahmedabad, not with the design asked for here. Raj Rewal is associated with works such as the Hall of Nations in New Delhi; his presence among the choices does not identify him as the designer of Jeevan Bharati. Zaha Hadid is also not the architect of this LIC building. Thus options (A), (C) and (D) do not give the correct attribution, even though all four choices name well-known architects. The direct building-to-architect match selects Correa.

Step 4: Conclusion Charles Correa designed the LIC building, Jeevan Bharati, at Connaught Place in New Delhi. Hence, the correct option is (B).

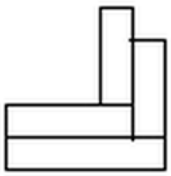
Quick Tip to Solve: Remember the three-part association: Jeevan Bharati – Connaught Place, New Delhi – Charles Correa. The building's name prevents confusion with other LIC offices.

45. The problem figure shows the top view of an object. Identify the correct elevation from amongst the answer figures looking in the direction of the arrow. [4 marks]

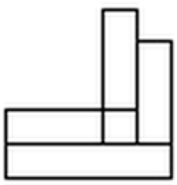




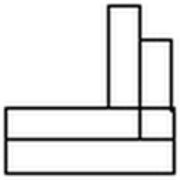
(A)



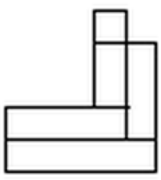
(B)

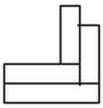


(C)



(D)



Correct Answer: (A) 

Solution:

Concept:

- An elevation looking along an arrow is obtained by projecting parallel sight lines in that direction. Positions across the arrow are preserved, while distances along it collapse.
- Visible edges depend on overlap: a nearer raised platform hides the lower portion of a pillar behind it. A top view establishes the lateral positions and overlaps that the elevation must respect.

Step 1: Establish the viewing direction The arrow points upward on the page, so the observer is below the plan and looks toward its upper edge. Read the plan from left to right without rotating or reflecting it. The outer rectangle gives the full width of the lowest base. The large inner rectangle extends from the left almost to the right edge, while the smaller rectangular feature is placed at the right, partly inside and partly beyond that larger rectangle.

Step 2: Project the overlapping features In the elevation, retain a full-width bottom slab. The broad raised platform extends from the left and ends at the inner vertical boundary near the right. The tall narrow part stands near that boundary, and the adjoining right-hand upright lies farther right. Since the broad platform is nearer the observer than the inner part of the upright, the lower portion of that upright is hidden by the platform. Its visible left edge begins above the platform rather than continuing through its front face.

Step 3: Compare the visible junctions Option (A) preserves these positions and the stepped right-hand assembly. Option (B) continues the tall inner vertical edge down across the broad platform, introducing an edge hidden from this direction. Option (C) alters the lower termination of the right-hand dividing edge at the platform junction. Option (D) adds an upper horizontal division across the tall upright that is not the corresponding visible junction in the required elevation. Thus both the outer profile and the internal edge terminations select (A).

Step 4: Conclusion The elevation with the correct stepped profile and visible-edge junctions is figure (A). Hence, the correct option is (A).

Quick Tip to Solve: For a plan-to-elevation problem, keep left and right fixed by the arrow, then check which lower pillar edges are hidden behind the nearer platform.

46. In the Northern Hemisphere the winter sun rises from which one of the following directions ?

[4 marks]

(A) North West

(B) North East

(C) South West

(D) South East

Correct Answer: (D) South East

Solution:

Concept:

- The apparent daily motion of the Sun is from the eastern part of the horizon toward the western part. Sunrise and sunset must therefore be distinguished before considering the season.
- During Northern Hemisphere winter, the Sun has a southerly declination. At ordinary northern latitudes where sunrise occurs, its rising point lies south of east and its setting point south of west.

Step 1: Use the daily direction of solar motion The Earth rotates from west to east, so the Sun appears to travel across the sky from east to west. Consequently a sunrise direction must be on the eastern side of the horizon. This immediately excludes North West in option (A) and South West in option (C): those are western directions and cannot describe the ordinary rising point.

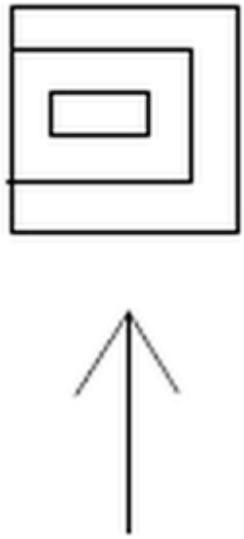
Step 2: Apply the winter seasonal shift In Northern Hemisphere winter the northern half of the Earth is tilted away from the Sun. The Sun's apparent path is displaced toward the southern part of the sky compared with its equinoctial path. Its horizon crossing at sunrise is therefore on the southern side of due east. The resulting compass direction is South East. North East, option (B), corresponds instead to a rising point north of east, characteristic of Northern Hemisphere summer.

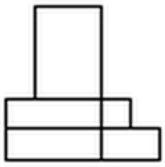
Step 3: Select the matching compass direction Combining the two tests gives east from the sunrise condition and south from the winter condition. Of the four printed directions, only South East satisfies both. The question uses the usual seasonal solar-path description for northern latitudes with a daily sunrise. In the polar-night region the Sun may not rise on a winter day; that exceptional absence of sunrise does not turn either western option into a sunrise direction.

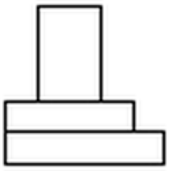
Step 4: Conclusion The winter Sun rises south of east in the Northern Hemisphere, conventionally described as South East. Hence, the correct option is (D).

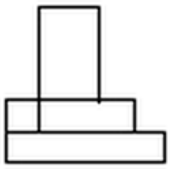
Quick Tip to Solve: First choose east for sunrise; then use south for Northern Hemisphere winter and north for summer. At the equinoxes the rising point is due east.

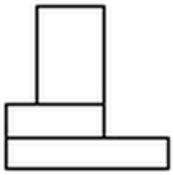
47. The problem figure shows the top view of an object. Identify the correct elevation from amongst the answer figures looking in the direction of the arrow. [4 marks]

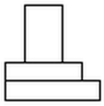


(A) 

(B) 

(C) 

(D) 

Correct Answer: (B) 

Solution:

Concept:

- An elevation is a projection along the viewing arrow. Widths perpendicular to the arrow remain visible; front-to-back separations are collapsed.
- Only exposed edges appear as continuous visible lines. A nearer platform hides the lower part of a smaller upright situated behind it.

Step 1: Read the plan in the arrow direction The observer is below the figure and looks upward along the arrow. The outer rectangle represents the widest base. Inside it is a large rectangular platform whose left side aligns with the left boundary of the base and whose right side stops short of the base right edge. The small central rectangle lies completely inside the footprint of that platform. Its left and right sides determine the width of the upright in the elevation.

Step 2: Determine the visible overlaps Project the base as a full-width low rectangle and the platform

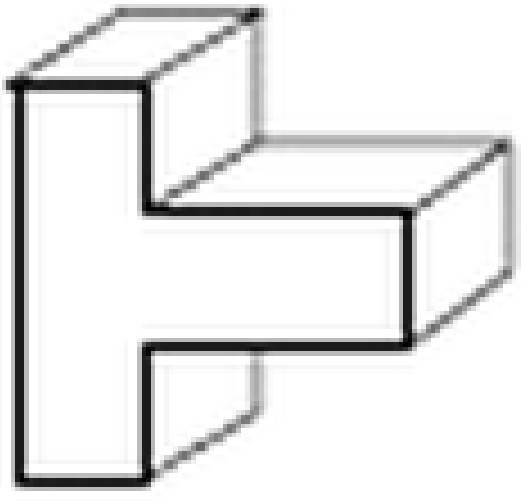
as a second level above it, stopping before the base right edge. The central upright must rise above this platform. Looking from below the plan, the front edge of the platform is nearer than the small rectangle. It therefore hides the lower portion of the upright. Consequently neither vertical side of the upright should continue down through the front face of the platform or the lowest base.

Step 3: Reject inconsistent edge continuations Figure (B) has the full-width base, the narrower second level and the central upright with its vertical sides stopping at the platform top. Figure (A) continues the right upright edge downward through lower levels. Figure (C) carries the left upright boundary into the platform front. Those lines would show obscured edges as exposed ones. Figure (D) instead changes the stepped silhouette and horizontal alignment on the right. It does not retain the separate wide platform beneath the central upright. The required visible elevation is therefore (B).

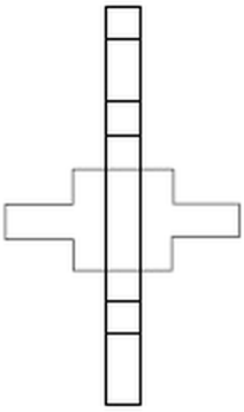
Step 4: Conclusion Figure (B) correctly shows the central upright above the nearer platform without exposing its hidden lower edges. Hence, the correct option is (B).

Quick Tip to Solve: A small rectangle fully inside a raised platform in the plan produces an upright whose lower edges are hidden by that platform in the front elevation.

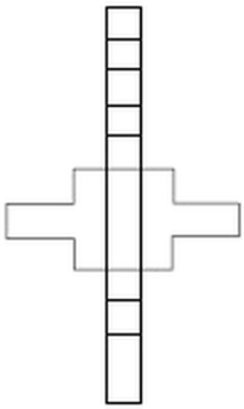
48. The 3 - D figure shows the view of an object. Identify the correct view when the figure is opened up, from amongst the answer figures. [4 marks]



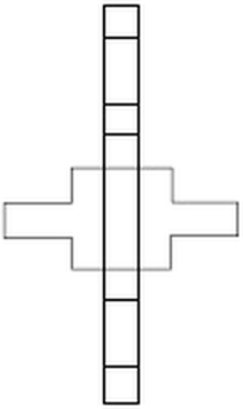
(A)



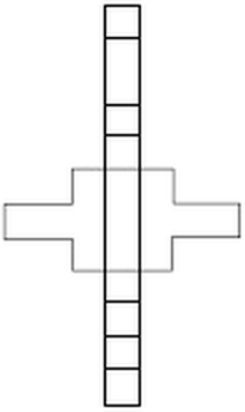
(B)



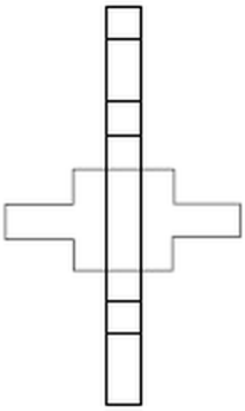
(C)



(D)



Correct Answer: (A)



Solution:

Concept:

- The net of a prism consists of two congruent end profiles and a strip of rectangular lateral faces. Each rectangle width matches one consecutive boundary edge of the end profile.
- A correct net must preserve the cyclic order of long and short boundary edges, not merely the number of rectangles or its general cross-like appearance.

Step 1: Identify the end profile The solid is a prism with a stepped T-shaped end profile: a long vertical stem has a horizontal arm projecting from its middle toward the right. When opened, the two matching end faces appear on opposite sides of the lateral-face strip. All proposed figures have a broadly similar pair of end profiles, so the decisive comparison is the sequence of fold divisions in the long strip.

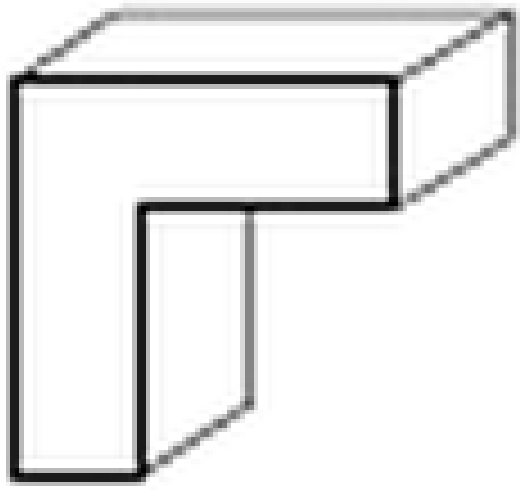
Step 2: Walk around the profile Begin with the long straight edge at the back of the vertical stem. Moving around its boundary gives a long segment, then two short segments around one end of the stem, a longer horizontal segment along one side of the projecting arm, a short outer end of that arm, the longer returning horizontal segment, and two short segments around the other end of the stem. Each change of direction needs its own fold line. The two long sides of the projecting arm must therefore occupy the corresponding positions on opposite sides of the short outer end.

Step 3: Match the strip divisions Figure (A) places the wider lateral rectangles and the short rectangles in the required cyclic order around the central long face. Folding its strip places a rectangle against every boundary segment without skipping a corner. Figure (B) replaces the required wider segment on the upper run with additional short divisions. Figure (C) shifts the long segment on the lower run next to the central face instead of after the short intervening faces. Figure (D) changes the lower-run divisions, so its edge sequence does not match the stepped profile. Matching the boundary successively, rather than counting folds alone, leaves (A).

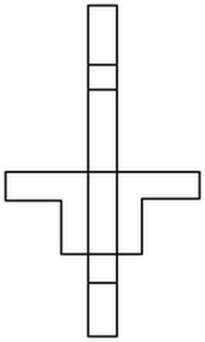
Step 4: Conclusion The development in figure (A) preserves the lateral-face sequence of the stepped prismatic object. Hence, the correct option is (A).

Quick Tip to Solve: Trace the perimeter of one end face and say short or long at every edge; compare that sequence with the divisions in each proposed lateral strip.

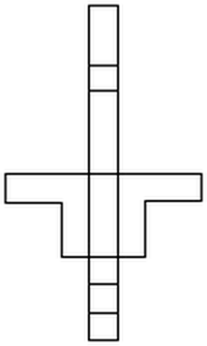
49. **The 3 - D figure shows the view of an object. Identify the correct view when the figure is opened up, from amongst the answer figures.** [4 marks]



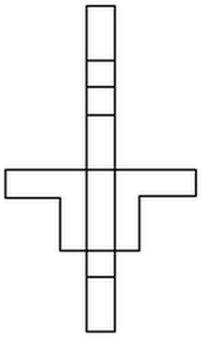
(A)



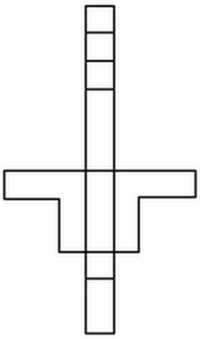
(B)



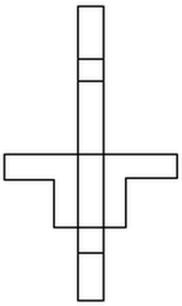
(C)



(D)



Correct Answer: (A)



Solution:

Concept:

- The development of a prism consists of two congruent end profiles and a connected belt of rectangular side faces. Each segment of the end-profile boundary generates one rectangle in the belt.
- To check a proposed net, follow the boundary cyclically. Both the number of faces and the sequence of long and short edges must match; merely having an L-shaped end is insufficient.

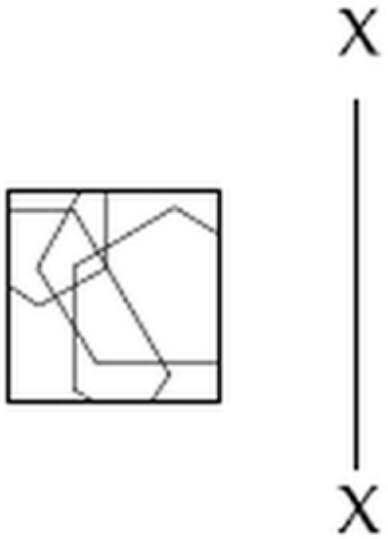
Step 1: Trace the boundary of the solid The given solid is an L-shaped prism: its front end has one re-entrant corner and six straight boundary segments. The back end is a congruent parallel L. When the lateral surface is unfolded, the six successive edges of the L must give six successive rectangles. The internal corner produces its own face; it cannot be replaced by a continuous flat face across the notch. The strip must also close with the final edge meeting the first edge without an additional crease.

Step 2: Compare the crease pattern in the options In option (A), count six rectangular panels along the vertical belt and check their lengths against the corresponding outer and inner edges of either L-shaped end. The two attached end profiles are congruent, and their attachment edges line up with the appropriate belt panel. Folding about those lines recreates the notch and the two outer arms. Options (B), (C) and (D) introduce an additional division in the belt or put a division at a different boundary position. Those extra or displaced fold lines do not correspond to the six boundary edges of this prism. They therefore fail the face-by-face development test even though their overall outlines resemble the correct net.

Step 3: Conclusion Option (A) gives the two matching L-shaped ends and the correctly divided lateral belt. Hence, the correct option is (A).

Quick Tip to Solve: Count the straight edges around one end profile first; the side-face belt must contain exactly that many panels in the same cyclic order.

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



(A) 

(B) 

(C) 

(D) 

Correct Answer: (B) 

Solution:

Concept:

- A mirror image about a vertical axis reverses left and right while preserving vertical positions, lengths and angles. Every point stays at the same perpendicular distance from the mirror axis.
- Intersecting lines must remain intersecting in the reflected figure, with the same incidence relationships. A similar outer square alone does not establish that an option is the mirror image.

Step 1: Reflect distinctive features first The mirror line X–X lies vertically to the right of the square. Consequently, the original figure's right-hand features appear on the left of the reflected square, and its left-hand features appear on the right. The upper broken sloping line, the near-vertical internal line and the lower horizontal portion provide useful landmarks. Their heights are unchanged: an upper junction cannot become a lower junction. A sloping segment rising towards the right becomes one rising towards the left.

Step 2: Follow the connected internal lines Starting at a corner or boundary junction, trace the same connected path after reflection rather than matching isolated strokes. Option (B) preserves the reflected positions of the upper polygonal path, the crossing oblique line, the near-vertical segment and the lower bent path together. In particular, the branch that lies on the left within the original square lies on the right at the corresponding height in (B). The other options contain a changed bend or a displaced internal segment: although they retain the square and many of the same strokes, their junctions do not all map back to the original under a left-right reflection. A reflection cannot independently move one of those junctions or change the connection between two segments.

Step 3: Conclusion The complete line arrangement is reflected correctly in option (B). Hence, the correct option is (B).

Quick Tip to Solve: Trace one continuous path through several junctions, reversing left and right only; this exposes small alterations hidden in otherwise similar mirror-image options.

51. What is the texture of sand-paper ? [4 marks]

(A) Shiny

(B) Glossy

(C) Smooth

(D) Coarse

Correct Answer: (D) Coarse

Solution:

Concept:

- Texture describes the surface character of a material, particularly whether it feels smooth or rough. It is distinct from gloss, which describes the way the surface reflects light.
- Sandpaper consists of abrasive grains bonded to a backing sheet. The projecting grains make its working face rough or coarse and allow it to abrade another material.

Step 1: Identify the working surface of sandpaper Sandpaper is used to rub down wood, remove small surface irregularities and prepare surfaces for finishing. Its abrasive face contains numerous hard particles rather than a continuous polished film. Those particles provide small cutting edges and a gritty feel. The relevant texture is therefore rough or coarse. Finer grades have smaller abrasive particles, but their working principle is still abrasion; they are not described as glossy polishing films merely because their grit is fine.

Step 2: Compare the descriptions offered Option (D), coarse, describes the granular, abrasive surface directly. Shiny in option (A) refers to visible lustre, while glossy in option (B) refers to a reflective finish; neither identifies the characteristic tactile texture of sandpaper. Smooth in option (C) would describe a surface without the projecting abrasive grains responsible for sanding. Sandpaper may produce a smoother finish on the object it rubs, but that result must not be confused with the texture of the sandpaper itself.

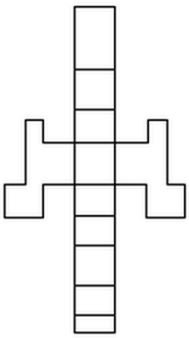
Step 3: Conclusion The texture of sandpaper is **coarse**, because its working surface is covered with abrasive grains. Hence, the correct option is (D).

Quick Tip to Solve: Distinguish the abrasive tool from the finish it produces: sandpaper feels gritty even though sanding makes another surface smoother.

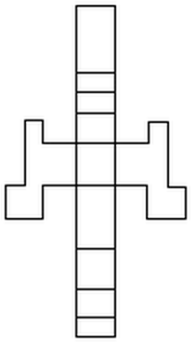
52. **The 3 - D figure shows the view of an object. Identify the correct view when the figure is opened up, from amongst the answer figures.** [4 marks]



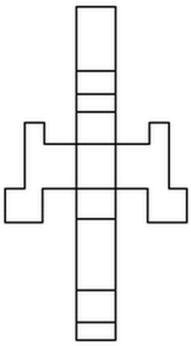
(A)



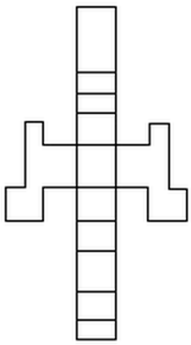
(B)



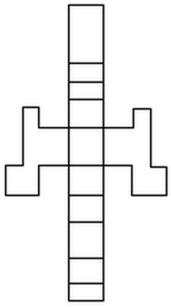
(C)



(D)



Correct Answer: (D)



Solution:

Concept:

- A prism unfolds into a strip of rectangular lateral faces together with two identical polygonal ends. The strip widths follow the successive edge lengths of the end profile.
- A valid development preserves every step and recess. Both the position of a fold and the length of the panel on either side matter when the strip is wrapped back around the end.

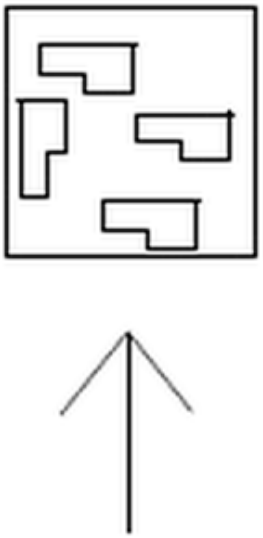
Step 1: Read the stepped end profile The solid has a stepped, offset end outline, rather than a simple rectangle. Its projecting lower portion and raised upper portion create short return edges as well as longer straight edges. Each turn of that outline must have a corresponding fold in the lateral strip. The two end profiles in a development must be congruent; they close opposite ends of the same solid and are not different views or differently proportioned pieces.

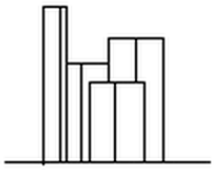
Step 2: Test the rectangular belt against the steps Follow the boundary of either stepped end in each option, starting from its attached edge, and match each edge to the next rectangle of the long belt. Option (D) places the short panels at the returns of the steps and the long panels against the long outer edges. Thus the belt can be wrapped continuously around the profile, and the second profile closes the other end without moving a fold. In options (A), (B) and (C), the divisions along the belt do not occur in the required sequence: a long run or a short return of the profile reaches a division at the wrong distance. Similar stepped side pieces do not repair that mismatch. It is the alignment of the complete belt with both profiles, rather than the central outline alone, that determines the development.

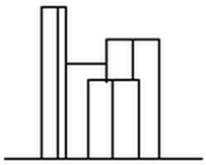
Step 3: Conclusion Option (D) is the development whose fold sequence reproduces the given stepped solid. Hence, the correct option is (D).

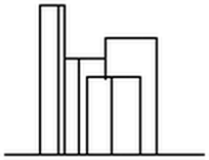
Quick Tip to Solve: Walk around the end profile in order and mark every turn; compare that ordered sequence with the fold divisions in the long strip.

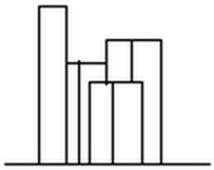
53. The problem figure shows the top view of objects. Looking in the direction of the arrow, identify the correct elevation, from amongst the answer figures. [4 marks]

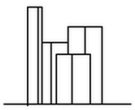


(A) 

(B) 

(C) 

(D) 

Correct Answer: (A) 

Solution:

Concept:

- An elevation viewed along an arrow retains horizontal positions across the plan and removes depth along the viewing direction. Nearer surfaces hide portions of more distant surfaces where their projected widths overlap.
- An internal vertical edge is visible only if the plan geometry leaves that edge exposed. Correct silhouettes can still have incorrect internal edges.

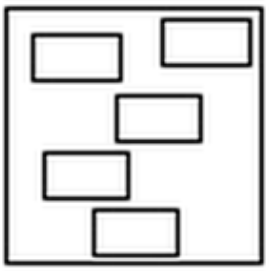
Step 1: Establish the viewing direction and lateral order The arrow points upwards from below the plan, so the observer looks from the lower edge of the square towards the upper edge. Left and right in the plan therefore remain left and right in the elevation. The narrow upright projection belongs on the left, while the overlapping broader projections lie towards the middle and right. Their order must not be reversed. The lower L-shaped object is nearer the observer than the upper objects wherever their horizontal positions overlap.

Step 2: Match the visible edges, not only the skyline Project each corner of an L-shaped footprint parallel to the arrow. The returns in those footprints explain why some objects show an internal vertical edge while another exposed face remains uninterrupted. In option (A), the left-hand upright has the appropriate narrow return, the central projections overlap in the order set by the plan, and the rear right-hand object retains its visible vertical return. The foreground object masks the lower portions behind it. Option (B) omits the visible vertical return of the upper-left horizontal L-shaped object, in the interval between the tall left object and the foreground object. The re-entrant corner of that footprint projects to a vertical edge, which (A) retains. Option (C) loses the vertical return on the rear right-hand projection. Option (D) loses the division on the tall left-hand projection. Those changes alter visible edge information that is required by the L-shaped footprints; matching the outer massing alone is insufficient.

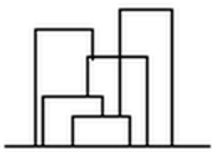
Step 3: Conclusion The elevation consistent with the arrow and the visible returns is option (A). Hence, the correct option is (A).

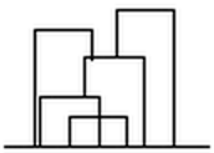
Quick Tip to Solve: For an L-shaped plan, check the re-entrant corner as well as the outside silhouette; its visibility often distinguishes nearly identical elevations.

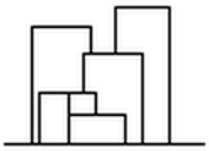
54. The problem figure shows the top view of objects. Looking in the direction of the arrow, identify the correct elevation, from amongst the answer figures. [4 marks]

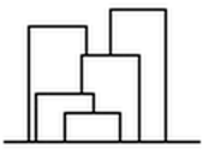


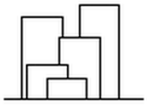


(A) 

(B) 

(C) 

(D) 

Correct Answer: (D) 

Solution:

Concept:

- In an elevation, width is measured perpendicular to the viewing arrow and depth collapses along it. A foreground object hides a background object only over their shared projected width.
- The plan determines left-right locations and front-back order. Use both together to check which vertical edges should remain visible in an answer figure.

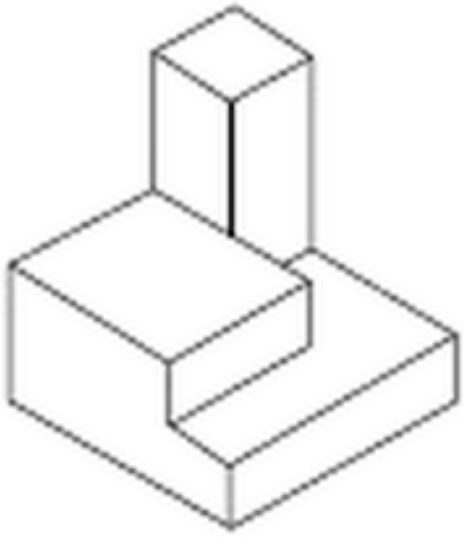
Step 1: Project the rectangles along the arrow The observer is below the square and looks upwards. The bottom rectangle is therefore in front, the next rectangle on the lower left lies behind it, the central rectangle lies farther back, and the two upper rectangles lie at the rear. Their horizontal positions are retained in the elevation. In particular, the foreground rectangle sits to the right of much of the lower-left rectangle and overlaps part of its width; it is not wholly to its left.

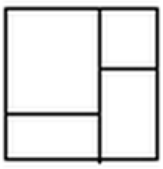
Step 2: Check each overlap in the proposed elevations Option (D) shows the foreground low rectangle in its correct horizontal interval and allows the left portion of the rectangle behind it to remain visible. The central taller rectangle rises behind these nearer objects, while the two rear objects occupy the left and right background intervals. The right rear vertical edge is concealed where the central object overlaps it, rather than being drawn through a solid foreground face. In option (A), a rear edge is carried through the overlapping central region. Options (B) and (C) arrange the low foreground overlaps differently, changing which part of the lower-left rectangle remains visible. Those configurations do not preserve the near-to-far order in the plan. The correct choice must satisfy all of the overlaps at once, rather than merely show five rectangular blocks.

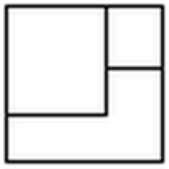
Step 3: Conclusion The consistent elevation is shown in option (D). Hence, the correct option is (D).

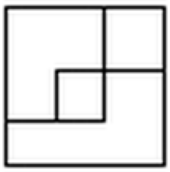
Quick Tip to Solve: Begin with the bottommost footprint, draw its projected width mentally, then hide the portions of the remaining objects that fall behind it.

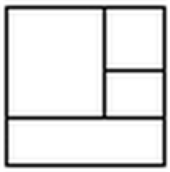
55. The 3 – D figure shows the view of an object. Identify the correct top view from amongst the answer figures. [4 marks]

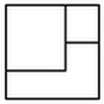


(A) 

(B) 

(C) 

(D) 

Correct Answer: (B) 

Solution:

Concept:

- A top view is an orthographic projection looking vertically down. Heights disappear, but the positions and footprints of the top surfaces remain.
- An edge is drawn in the plan when a visible change of surface level produces a boundary. A vertical edge does not keep its apparent isometric length in this projection.

Step 1: Trace the outside footprint Look directly down at the broad bottom slab. Its outline becomes a square rather than the sloping diamond seen in the pictorial view. The raised rectangular platform occupies the upper-left part of this square in the orientation used by the options. The exposed base continues along the lower side and around the right of that platform.

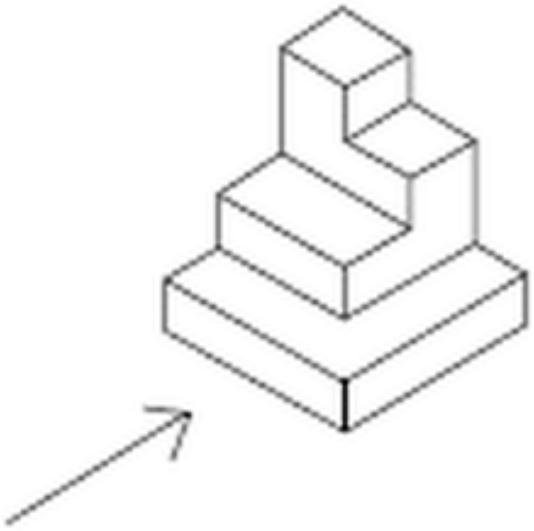
Step 2: Locate the tall column The tall narrow column stands toward the upper-right corner, beside the raised platform. Its top projects to a small rectangle in that corner. Its lower vertical faces do not add another rectangular strip across the bottom of the plan: their heights have collapsed in the vertical projection. Keep the platform boundary and the column footprint at their actual horizontal positions.

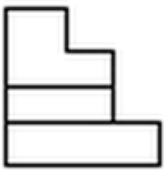
Step 3: Compare all four plans Option (B) has the large upper-left rectangular platform, the small upper-right column footprint, and the exposed base wrapping around the lower and right sides. Option (A) adds an extra transverse division of the lower-left region. Option (C) introduces a small central stepped square that the object does not contain. Option (D) carries the horizontal division across the lower strip, creating another boundary absent from the visible top surfaces.

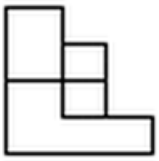
Step 4: Conclusion The footprint and all visible changes of level match the plan in option (B). Hence, the correct option is (B).

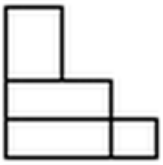
Quick Tip to Solve: Ignore how high the column rises; place its small top footprint beside the larger platform before tracing the exposed base.

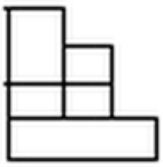
56. The 3 – D figure shows the view of an object. Identify the correct view in the direction of the arrow, from amongst the answer figures. [4 marks]

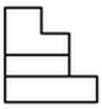


(A) 

(B) 

(C) 

(D) 

Correct Answer: (A) 

Solution:

Concept:

- For a view in the direction of an arrow, sight along the arrow toward the solid. Depth parallel to the sight line is removed; horizontal position and height remain.
- A continuous coplanar face does not acquire a seam merely because an edge from a different depth projects nearby. Only visible surface boundaries belong in the final elevation.

Step 1: Fix the viewing direction The arrow approaches from the lower-left of the isometric picture. Thus we look toward the stepped object along that family of receding edges, rather than looking down from above. The base appears as a long low rectangular strip. The tall portion is to the left in this elevation, while the successively lower portions extend to its right.

Step 2: Follow the visible staircase Starting at the highest point, the outline runs across the top of the tall upright, drops to the next ledge, then steps down toward the wider lower support and finally

the bottom slab. The broad lower support produces a horizontal line above the base. Another visible ledge produces the shorter horizontal line at the intermediate level. The external staircase is the essential first check, but it must also have the correct internal lines.

Step 3: Reject extra or missing boundaries Option (A) preserves both the descending stepped outline and the two visible horizontal ledge boundaries, without inventing a vertical seam through the connected face. Option (B) divides the interior into additional small rectangles. Option (C) shows a different stepped arrangement, extending an intermediate projection across the lower portion. Option (D) extends an internal vertical division down through the visible face; the solid does not show that seam from the arrow direction.

Step 4: Conclusion The elevation obtained by looking along the given arrow is option (A). Hence, the correct option is (A).

Quick Tip to Solve: First match the descending outside silhouette, then use the interior ledge lines to distinguish otherwise similar elevations.

57. Which one of the following is a purpose for installing false ceilings ? [4 marks]

(A) Supporting the walls

(B) Making the building fire proof

(C) Making the space acoustically effective

(D) Making the building water proof

Correct Answer: (C) Making the space acoustically effective

Solution:

Concept:

- A false ceiling is a secondary ceiling suspended below the structural slab. It forms part of the interior finish rather than the primary load-bearing structure.
- Acoustic ceiling materials can absorb incident sound, reduce repeated reflections and control reverberation, improving speech clarity and the acoustic quality of an enclosed space.

Step 1: Identify the function of the suspended ceiling Sound reflected repeatedly between hard room surfaces persists after the source stops. This persistence is reverberation. A suitable acoustic false ceiling adds an absorbing surface above the occupied space, so a smaller fraction of incident sound returns into the room. It can therefore make speech easier to understand and help a hall, office or classroom sound less echoing. Among the listed purposes, this directly matches making the space acoustically effective.

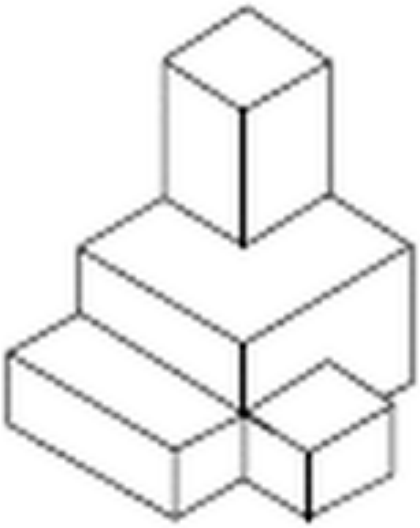
Step 2: Distinguish the other building functions Supporting walls is a structural function carried by the designed frame, slab, foundation or load-bearing construction; a suspended false ceiling is not installed to carry the walls. Fire resistance depends on the specified materials and the complete tested assembly. Some ceiling systems can contribute to fire performance, but merely installing a false ceiling does not make the whole building fire proof. Likewise, waterproofing requires suitable weatherproof layers and detailing at the roof or wet surfaces; an interior suspended ceiling does not stop water

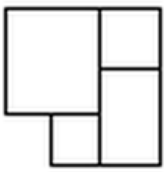
entering the building. These distinctions eliminate (A), (B) and (D).

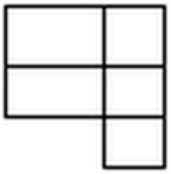
Step 3: Conclusion A purpose of installing a false ceiling is making the space acoustically effective. Hence, the correct option is (C).

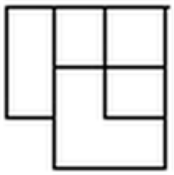
Quick Tip to Solve: Associate an acoustic false ceiling with sound absorption and reverberation control; distinguish that interior function from structural support and roof waterproofing.

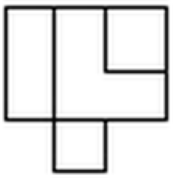
58. The 3 – D figure shows the view of an object. Identify the correct top view from amongst the answer figures. [4 marks]

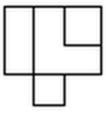


(A) 

(B) 

(C) 

(D) 

Correct Answer: (D) 

Solution:

Concept:

- A top view retains the horizontal arrangement of the visible surfaces while suppressing their heights. The outer footprint must therefore be checked separately from the inner divisions.

- Different-height surfaces can produce internal plan boundaries, but sloping edges in an isometric drawing become the horizontal or vertical edges of the orthographic plan.

Step 1: Locate the main body and its projection The main part of the solid has a broad block-like footprint. A smaller low block projects outward near the front, while the higher column stands toward the rear. Looking vertically down does not move either of these features sideways; it simply reveals their footprints. In the orientation shared by the answer figures, the small outward projection lies below the middle portion of the main outline.

Step 2: Trace the visible upper surfaces The tall column contributes a compact rectangular footprint at the upper-right of the principal plan. The broad intermediate surface surrounds its lower and left sides. The narrow lower platform contributes a strip on the left of the main plan, and the separate projecting block contributes the small lower central rectangle. These level changes must be retained as internal boundaries, rather than turning the whole top into an undivided rectangle.

Step 3: Choose the matching arrangement Option (D) places the small projection centrally below the main outline and shows the upper-right column footprint with the left strip and broad intervening surface. Option (A) puts the lower extension toward the right and rearranges the large upper surface. Option (B) also leaves the extension at the right and divides the main body into horizontal bands. Option (C) gives a recessed central arrangement and a long lower band instead of the observed outward projecting block.

Step 4: Conclusion The plan that preserves both the projecting block and the positions of the raised surfaces is option (D). Hence, the correct option is (D).

Quick Tip to Solve: Use the position of the small outward projection to eliminate plans first; then check the upper column footprint and the remaining level boundaries.

59. Buckingham Palace is the Residence of which one of the following ? [4 marks]

(A) Queen of England

(B) King of Nepal

(C) King of Prussia

(D) King of Netherlands

Correct Answer: (A) Queen of England

Solution:

Concept:

- Buckingham Palace is a royal palace in London associated with the British monarchy. Its identity and function connect the building to the British sovereign rather than to another country's royal family.
- A historical general-awareness question is interpreted in the context of its examination date. In January 2020 the British sovereign was Queen Elizabeth II, so the printed reference to a queen is consistent with that date.

Step 1: Identify the palace and the relevant monarchy Buckingham Palace is in London, in the United

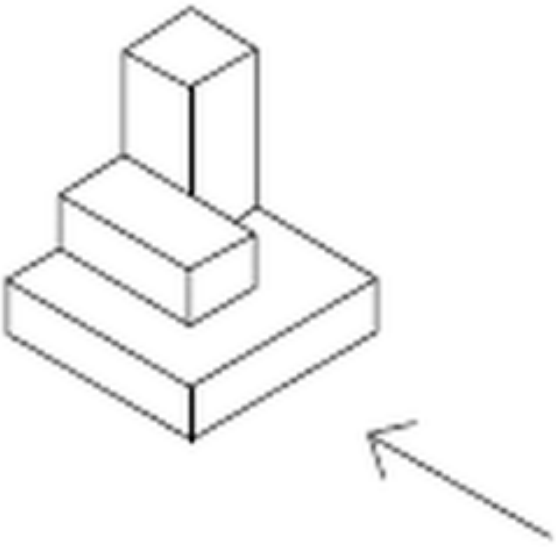
Kingdom, and is known as the official London residence and administrative headquarters of the British monarch. At the time of this 2020 examination that monarch was Queen Elizabeth II. The option labelled Queen of England uses a familiar informal description of the British queen. Although her formal constitutional title referred to the United Kingdom rather than England alone, it is clearly the intended person among these four alternatives.

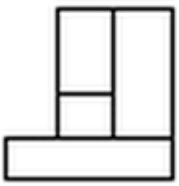
Step 2: Eliminate the unrelated royal families A king of Nepal belongs to Nepal's royal history, not to the British royal household. The Prussian monarchy is associated with Prussia and its own royal residences, not with Buckingham Palace. The Dutch monarch belongs to the Netherlands and likewise is not the sovereign whose London residence is Buckingham Palace. Consequently none of (B), (C) or (D) identifies the occupant associated with this building. The location in London and the British royal connection together distinguish (A) without relying on superficial similarity between palace names.

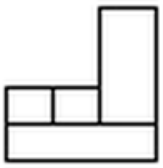
Step 3: Conclusion In the context of the 2020 paper, Buckingham Palace is associated with Queen Elizabeth II, described in the options as the Queen of England. Hence, the correct option is (A).

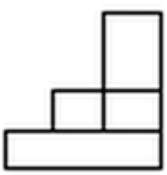
Quick Tip to Solve: Link Buckingham Palace with London and the British monarch; for a dated paper, identify the sovereign who held the position at that time.

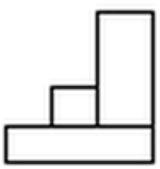
60. The 3 – D figure shows the view of an object. Identify the correct view in the direction of the arrow, from amongst the answer figures. [4 marks]

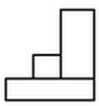


(A) 

(B) 

(C) 

(D) 

Correct Answer: (D) 

Solution:

Concept:

- An arrow view is an orthographic elevation taken along the specified line of sight. Features separated in depth can overlap in projection, while their heights remain unchanged.
- The correct elevation must preserve both its silhouette and the visible internal edges. A top-view grid is unsuitable when the arrow asks for a horizontal viewing direction.

Step 1: Look along the indicated arrow The arrow approaches the object from the lower-right. Seen from that direction, the wide bottom slab becomes a shallow rectangular base. The tallest upright appears on the right side of the elevation, with the lower raised platform extending toward the left. Therefore the answer must have a tall right-hand column and a low horizontal base, not two equally tall vertical strips.

Step 2: Track the lower platform boundaries The intermediate raised platform is lower than the tower and projects to its left. Its top edge meets the tower below the tower top. Because the platform has depth, a further short vertical boundary appears within the lower left portion of the elevation; the low exposed base remains visible at the bottom. Retain the horizontal junction at the intermediate level and this short vertical division rather than replacing the platform by a single featureless step.

Step 3: Test each offered elevation Option (D) shows the right-hand upright, the lower platform extending left, and the short lower internal vertical edge in their correct positions. Option (A) makes two strips rise to the full height, which the solid does not support. Option (B) places a separate higher little ledge at the far left and adds the wrong horizontal break. Option (C) has the broad stepped outline but carries the intermediate horizontal line through the tall right-hand column. That column presents one uninterrupted visible face above the base, so this additional seam is incorrect.

Step 4: Conclusion All the visible edges in the arrow-direction elevation agree with option (D). Hence, the correct option is (D).

Quick Tip to Solve: After locating the tall right-hand tower, check that the platform edge stops at its side instead of continuing as a false seam across its face.

61. Which one of the following is considered to be a calming color ? [4 marks]

(A) Red

(B) Orange

(C) Blue

(D) Green

Correct Answer: (D) Green

Solution:

Concept:

- Colour psychology associates colours with perceptual and emotional qualities. Warm colours such as red and orange generally feel active and stimulating, whereas cool colours often feel quieter.
- Green is conventionally associated with nature, balance, rest and visual comfort. These associations

explain its use where a calm atmosphere is desired; they are design conventions rather than universal physiological laws.

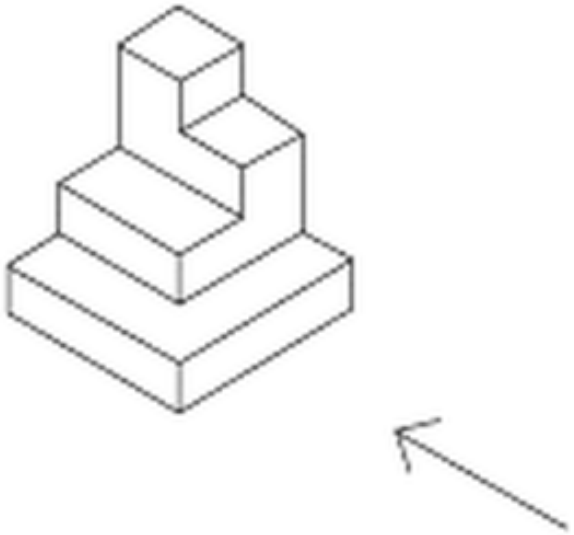
Step 1: Identify the restful association Green suggests vegetation and natural surroundings and is commonly used to communicate freshness, stability and a restful environment. Among these choices it is the intended answer for a calming colour in this question. The question does not specify a particular shade, saturation, lighting condition or cultural context, so the emotional association should be understood in the usual general design sense.

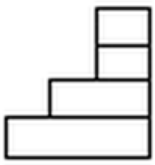
Step 2: Compare the alternatives carefully Red is generally associated with urgency, energy or excitement, so it does not fit the intended restful quality. Orange is also a warm, lively colour associated with activity and warmth. Blue is a cool colour and is also often described as peaceful or calming; therefore it cannot be excluded by a universal rule. Green gives the keyed nature-and-balance association, but the wording is broad enough for blue to be defensible as well. Colour associations are not an exclusive classification.

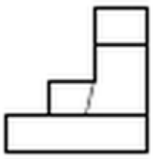
Step 3: Conclusion The intended keyed answer is green. Hence, the correct option is (D). The literal wording is not fully exclusive, since blue can also be considered calming; this qualification explains why a general colour association alone cannot prove that every other option is impossible.

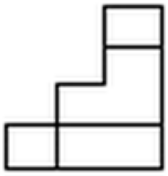
Quick Tip to Solve: Link green with nature, balance and rest; distinguish the intended colour association from a claim that only one colour can ever feel calming.

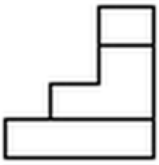
62. The 3 – D figure shows the view of an object. Identify the correct view in the direction of the arrow, from amongst the answer figures. [4 marks]

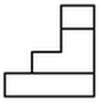


(A) 

(B) 

(C) 

(D) 

Correct Answer: (D) 

Solution:

Concept:

- An orthographic view is obtained by looking parallel to the indicated arrow. The depth along the viewing direction collapses; heights and positions perpendicular to that direction remain visible.
- The outline is not the only test: visible junctions between exposed faces must also appear at the correct levels. Edges hidden behind a nearer solid do not become extra lines in the projected face.

Step 1: Fix the viewing direction and outer profile Look towards the object from the lower-right side, following the arrow towards the upper left. The low, broad plinth forms the uninterrupted bottom strip. Above it the exposed object rises in steps towards the tall column on the right of the projected view. The topmost portion belongs to that column, so the height order must be retained rather than reflected. All distances measured away from the observer are suppressed; the sloping edges in the perspective picture therefore do not remain oblique in the required view.

Step 2: Match the visible edges with the options Trace the upper horizontal division in the tall column and then follow the stepped outline down to the broad plinth. The intermediate raised region and the lower part of the upright produce one continuous face in this projection: no extra horizontal seam should be drawn right across that region. Option (D) preserves that continuous face, the upper division and the unbroken base band. Option (A) adds an unwanted horizontal line across the intermediate region. Option (B) introduces a sloping internal edge, which is inconsistent with this face-on projection of the aligned block edges. Option (C) continues internal subdivisions down through the base band, whereas the visible plinth does not have those divisions. Thus matching only the staircase silhouette would be insufficient; both the edges present and the absence of spurious seams select the answer.

Step 3: Conclusion The view in the direction of the arrow is the stepped projection with the visible junctions shown in option (D). Hence, the correct option is (D).

Quick Tip to Solve: After matching a stepped outline, check which faces are continuous; do not insert a seam merely because the silhouette changes height.

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

(A) Sharmila Tagore

(B) Donald Trump

(C) Geoffery Bawa

(D) Louis Armstrong

Correct Answer: (C) Geoffery Bawa

Solution:

Concept:

- Architectural awareness questions test recognition of architects and their professional work. An association with property, buildings or the arts does not by itself make a person an architect.
- Geoffrey Bawa was a Sri Lankan architect known for integrating buildings with landscape, climate and local spatial traditions. His work is closely associated with tropical modernism.

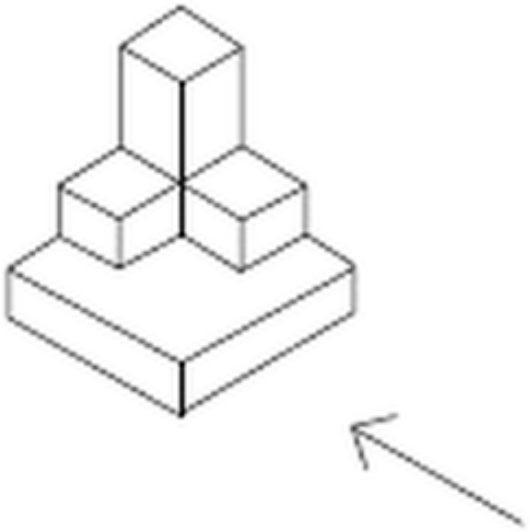
Step 1: Recognise the architect in the list The name printed as "Geoffery Bawa" refers to Geoffrey Bawa. He practised architecture in Sri Lanka and designed buildings in which indoor and outdoor spaces, courtyards, vegetation and natural ventilation are carefully related. His recognised architectural career makes this the relevant name. This identification depends on his profession, rather than on whether a listed person is famous or has been associated with a building.

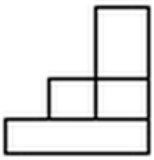
Step 2: Eliminate the other professions Sharmila Tagore is known as an actor and is not the architect asked for. Donald Trump is associated with real-estate development and business, which involves commissioning and developing buildings but is different from practising as their architect. Louis Armstrong was a jazz trumpeter and singer, not an architect. Thus the other three names belong to acting, property development and music respectively, leaving Bawa as the professional architect among the options.

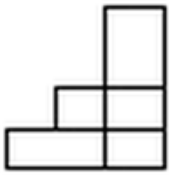
Step 3: Conclusion Geoffrey Bawa, whose name is printed as "Geoffery Bawa" in the options, is the architect. Hence, the correct option is (C).

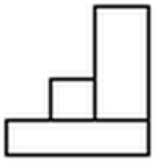
Quick Tip to Solve: Associate Bawa with Sri Lanka and tropical modernism; keep the roles of architect and real-estate developer distinct.

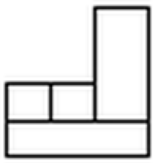
64. The 3 – D figure shows the view of an object. Identify the correct view in the direction of the arrow, from amongst the answer figures. [4 marks]

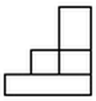


(A) 

(B) 

(C) 

(D) 

Correct Answer: (A) 

Solution:

Concept:

- For the view indicated by an arrow, project the visible faces perpendicular to the line of sight. Depth is removed, while the relative horizontal positions and vertical heights are retained.
- An assembled block object can show a junction at a change of height or where exposed parts meet. A hidden edge must not be added merely because the blocks were drawn separately in perspective.

Step 1: Read the heights from the arrow side Follow the arrow from the lower right towards the assembly. The broad bottom slab provides a low continuous rectangular base. Above that base a shorter raised block appears to the left of the taller upright portion in the required view. The tall portion reaches the greatest height on the right. The perspective diagonals describe depth and disappear when this side is viewed directly; the correct answer therefore has horizontal and vertical projected boundaries, with the same sequence of visible heights.

Step 2: Check the junction lines, not only the silhouette The raised portion contributes a short horizontal level and a vertical junction beside the taller portion. The tall portion also has its visible horizontal division at the level where the lower block arrangement meets it. Option (A) shows this combination while leaving the bottom plinth as one uninterrupted band. Option (B) carries extra vertical divisions through the plinth, which are not visible in the required projection. Option (C) omits the horizontal division in the tall portion. Option (D) adds an extra subdivision across the lower raised region and consequently does not match the exposed face pattern. These line checks distinguish (A) even though several alternatives share the same broad stair-like outline. The viewing arrow fixes the side, so one must not reverse the arrangement by looking from the opposite direction.

Step 3: Conclusion The correct orthographic view of the assembly from the arrow side is option (A). Hence, the correct option is (A).

Quick Tip to Solve: Keep the plinth unbroken unless a joint is actually visible, then compare the horizontal division on the tallest part to eliminate close alternatives.

65. Who was the architect of the glass pyramid at the Louvre Paris ? [4 marks]

(A) I.M. Pei

(B) Frank Lloyd Wright

(C) Charles Correa

(D) Walter Gropius

Correct Answer: (A) I.M. Pei

Solution:

Concept:

- A landmark-identification question is answered by matching the named structure to its designer. Here the structure is the modern glass pyramid entrance at the Louvre in Paris, rather than the historic palace surrounding it.
- I. M. Pei designed the Louvre Pyramid. Its transparent glass faces and geometric pyramid form provide a modern entrance associated with the museum's redevelopment.

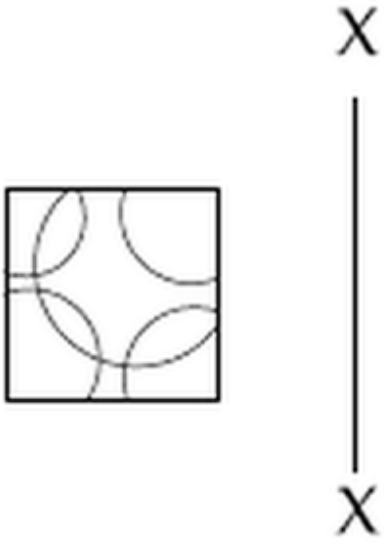
Step 1: Identify the particular Louvre structure The words "glass pyramid" distinguish the modern entrance from the older stone buildings of the Louvre complex. The pyramid stands in the museum courtyard and forms the recognisable intervention by I. M. Pei. Therefore the required association is Louvre Pyramid–I. M. Pei. It would be incorrect to attribute every part of a historic complex to the designer of this later addition; the question asks only about the pyramid.

Step 2: Check each remaining architect Frank Lloyd Wright is associated with buildings such as Fallingwater and the Solomon R. Guggenheim Museum in New York, not the Louvre Pyramid. Charles Correa is associated with modern Indian architecture, including the Gandhi Smarak Sangrahalaya in Ahmedabad, and did not design this Paris entrance. Walter Gropius is associated with the Bauhaus and modernist architecture, not the Louvre glass pyramid. These contrasting landmark associations support the direct identification of Pei and eliminate the other three choices without relying merely on the nationality of the architect.

Step 3: Conclusion I. M. Pei was the architect of the glass pyramid at the Louvre in Paris. Hence, the correct option is (A).

Quick Tip to Solve: Memorise Louvre Pyramid–I. M. Pei as a landmark pair, and distinguish this modern entrance from the historic Louvre palace.

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



(A) 

(B) 

(C) 

(D) 

Correct Answer: (D) 

Solution:

Concept:

- A mirror image in the vertical line X–X reverses left and right. Each point lies at the same perpendicular distance from the mirror as its image; vertical position and size remain unchanged.
- For a pattern of intersecting arcs, the complete arrangement must be reflected. Matching the outer square alone is insufficient: arc endpoints, crossings and the order of nearby curves must all agree.

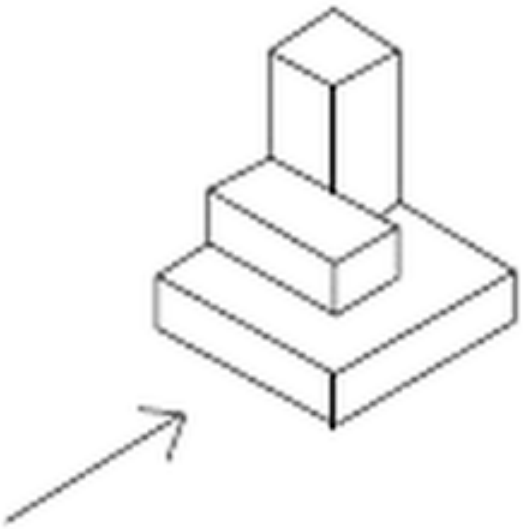
Step 1: Reflect the square and track the arc endpoints The mirror line X–X is vertical and lies to the right of the problem square. Imagine transferring the square to the other side of that line without rotating it. The top edge remains the top edge and the bottom remains the bottom; only left and right exchange. Thus the simpler arc in the upper-right part of the original moves to the upper-left part of the image, while the closely spaced curved lines near the original left edge must appear near the right edge. The lower arcs must be transferred at their original heights, preserving their crossings.

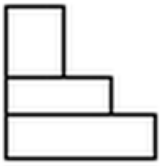
Step 2: Compare the small curved junctions in each answer Option (D) keeps the correct reflected upper arcs, the pair of nearby intersections towards the right side and the lower curved junctions in their corresponding positions. In particular, its lower crossing and the curve meeting the bottom edge reproduce the left-right reversal rather than a rotation of the original. Option (A) changes the lower-left arc arrangement and its meeting with the bottom region. Option (B) changes the upper-left arc endpoint and the detailed lower junction. Option (C) comes close in its overall outline, but the curves meeting the right-hand side do not retain the same reflected separation and junction as the original. A useful check is to follow each arc continuously from its top or side endpoint; only (D) preserves every connection under the reflection.

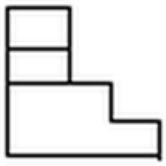
Step 3: Conclusion Option (D) is the left-right reflection of the complete problem pattern in the vertical line X–X. Hence, the correct option is (D).

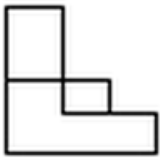
Quick Tip to Solve: Trace one arc from end to end before checking the next; a vertical mirror reverses side positions without swapping the top and bottom.

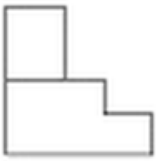
67. The 3 – D figure shows the view of an object. Identify the correct view in the direction of the arrow, from amongst the answer figures. [4 marks]

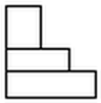


(A) 

(B) 

(C) 

(D) 

Correct Answer: (A) 

Solution:

Concept:

- An orthographic view is obtained by looking parallel to the indicated arrow; depth in that direction disappears, while vertical heights remain unchanged.
- Visible edges separating different horizontal levels must be retained. An edge hidden behind a nearer solid is not added as a visible division.

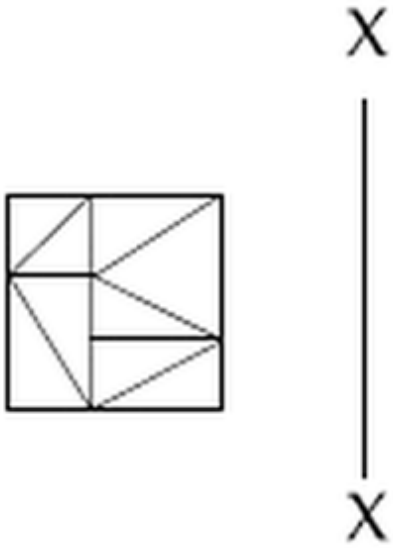
Step 1: Fix the viewing direction Look from the lower-left along the arrow towards the object. The required elevation is therefore seen from the face towards which the arrow points, rather than from above. The broad bottom slab, the narrower middle block and the upright top block project into a three-level stepped outline. The upright lies at the left of that outline, with the levels descending towards the right.

Step 2: Trace the visible level boundaries The bottom slab has its own exposed front face, so its top boundary gives a horizontal division across the bottom tier. The middle rectangular block also presents a horizontal face edge above that division, and the upright rises from its left part. Thus the two horizontal level boundaries remain visible, and the upright has no extra horizontal joint across its height. Option (A) preserves precisely these boundaries. Option (B) subdivides the upright instead; option (C) introduces a small rectangular division at the middle-right transition; option (D) removes the genuine long boundary above the bottom slab.

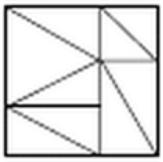
Step 3: Conclusion The stepped elevation with the continuous bottom-tier boundary and the undivided upright is shown in (A). Hence, the correct option is (A).

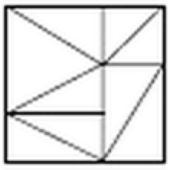
Quick Tip to Solve: For a stack of rectangular blocks, trace the exposed front edge of each level before comparing internal lines in the options.

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



(A) 

(B) 

(C) 

(D) 

Correct Answer: (A) 

Solution:

Concept:

- Reflection in a vertical mirror reverses left and right, but preserves the height of every point and the size of every segment.
- The perpendicular distance of a point from the mirror is unchanged. Diagonal slopes reverse, and all meeting points must stay connected after reflection.

Step 1: Reflect the main subdivision The mirror X–X is vertical and lies to the right of the problem figure. In the reflected square, the narrow strip that was on the left moves to the right. Its vertical dividing line must consequently be near the right side of the square. The horizontal short segment within that narrow strip remains at the same height, although its direction from the boundary reverses.

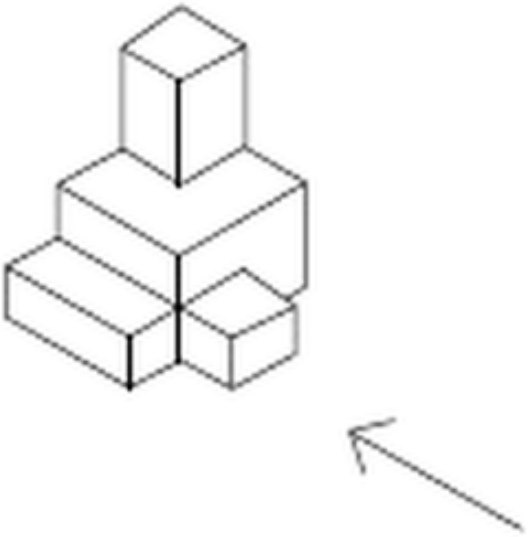
Step 2: Check the diagonals and junctions In the original wide right-hand region, the two upper diagonals run between the left dividing line and the right boundary; their reflected counterparts

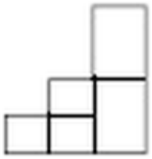
lie in the wide left-hand region. The lower horizontal segment remains horizontal and the lower diagonal changes slope. In the new narrow right strip, the upper diagonal slopes down towards the outside-right junction, and the long diagonal runs from that junction towards the bottom of the internal dividing line. These features occur together in (A). Option (B) reverses that long narrow-strip diagonal incorrectly; (C) gives the upper narrow-strip diagonal the wrong slope; (D) retains the lower horizontal segment but gives the diagonal beneath it the wrong slope in the broad lower region.

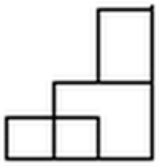
Step 3: Conclusion Only (A) preserves every junction and height while reversing the left-right arrangement. Hence, the correct option is (A).

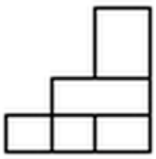
Quick Tip to Solve: In a mirror-image question, compare one asymmetric junction in the narrow strip and one diagonal in the broad region; both must reflect correctly.

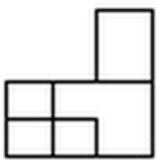
69. The 3 – D figure shows the view of an object. Identify the correct view in the direction of the arrow, from amongst the answer figures. [4 marks]

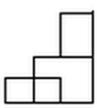


(A) 

(B) 

(C) 

(D) 

Correct Answer: (B) 

Solution:

Concept:

- A view along an arrow is a parallel projection: distances parallel to the line of sight disappear, while heights and transverse positions remain.
- An elevation contains the visible silhouette and visible edges. A foreground block can hide part of an edge belonging to a block behind it.

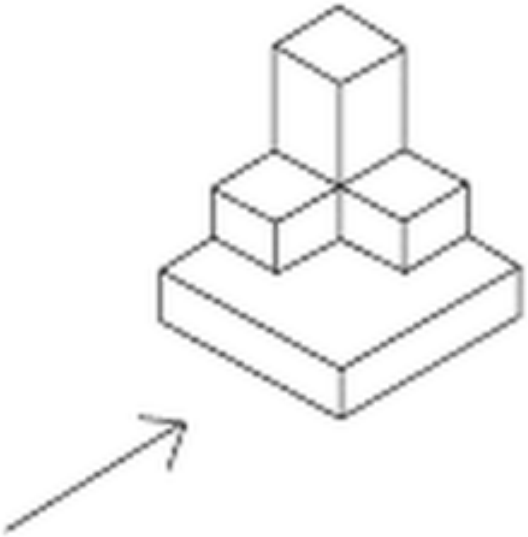
Step 1: Project from the arrow side The arrow approaches from the lower-right. Look towards the solid from that side, keeping the vertical edges vertical. The tower projects at the right-hand end, the broad intermediate block reaches towards the left, and the low projecting pieces form the bottom step. This produces the ascending three-level silhouette shown by the answer figures; the silhouette alone does not settle the answer.

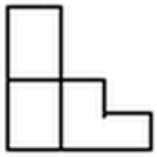
Step 2: Retain only the visible divisions Compare the internal lines with the actual block arrangement. The upright has one visible horizontal join where it meets the block below. At the lower-left there is a small square corresponding to the nearer low projection, and immediately to its right another low region is separated by a vertical edge. The middle level above that region continues to the right-hand tower. The nearer piece hides the part of the lower horizontal division that would otherwise appear across the rightmost column. This is exactly the division pattern in (B). Option (A) inserts an extra horizontal division in the central column above the low foreground square; (C) carries a horizontal division right across the lower tier; (D) inserts a square at the middle-left level. Those extra edges do not survive this viewing direction.

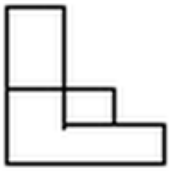
Step 3: Conclusion The visible outline and occluding lower blocks give the view in (B). Hence, the correct option is (B).

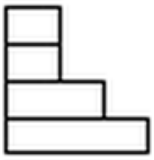
Quick Tip to Solve: When options share a silhouette, compare the lower foreground blocks first: their overlap often determines which internal edges disappear.

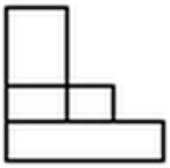
70. The 3 – D figure shows the view of an object. Identify the correct view in the direction of the arrow, from amongst the answer figures. [4 marks]

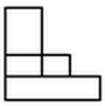


(A) 

(B) 

(C) 

(D) 

Correct Answer: (D) 

Solution:

Concept:

- An orthographic elevation removes depth along the viewing arrow and retains vertical dimensions and transverse widths.
- A line is drawn inside the elevation only when a visible edge separates faces or adjacent blocks; an apparent depth edge may disappear in projection.

Step 1: Establish the three projected heights View the solid from the lower-left in the arrow direction. The tall upright rises at the left, an intermediate block extends to its right, and the broad base extends farther right again. The outer boundary is therefore a three-step profile descending to the right. The upright is a single continuous prism; there is no horizontal line splitting its exposed height into smaller rectangles.

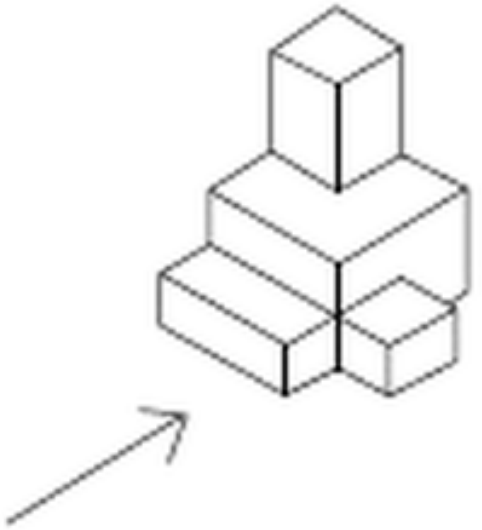
Step 2: Follow the base and intermediate edges The exposed front face of the base forms a continuous

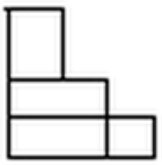
low strip. Its top edge remains visible across the full projected width. Above it, the two intermediate portions have a vertical separation aligned with the right edge of the upright. This separation stops at the top of the base rather than continuing down through its front face. Option (D) has both the long horizontal boundary above the base and that shorter vertical division above it. Option (A) wrongly extends the vertical division through the base and loses the long base boundary; (B) replaces the required base boundary by a small middle rectangle; (C) splits the upright horizontally and does not represent the two intermediate portions correctly.

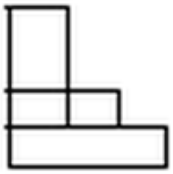
Step 3: Conclusion Option (D) gives the stepped outline with the correct continuous base strip and intermediate vertical division. Hence, the correct option is (D).

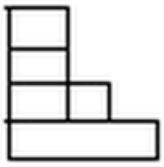
Quick Tip to Solve: Track where each vertical edge stops: a joint between upper blocks need not continue through the single solid base below them.

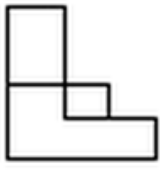
71. The 3 – D figure shows the view of an object. Identify the correct view in the direction of the arrow, from amongst the answer figures. [4 marks]

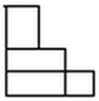


(A) 

(B) 

(C) 

(D) 

Correct Answer: (A) 

Solution:

Concept:

- Looking in the arrow direction gives a parallel elevation, with height preserved and depth collapsed.
- The correct answer must reproduce visible edges as well as the outer profile. Separate projecting blocks can add divisions within the lowest tier.

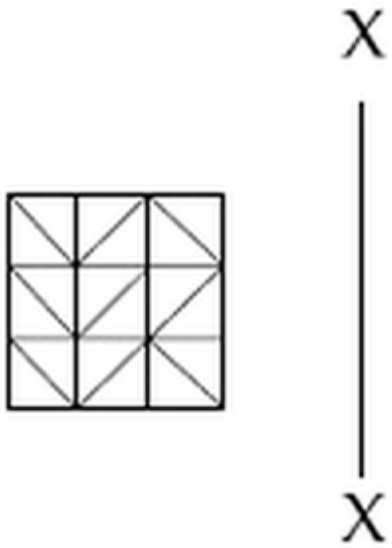
Step 1: Locate the tower and descending steps Look from the lower-left along the arrow. The tower lies on the left of the projected object, while the broad supporting block and the low foreground pieces extend towards the right. The silhouette has three heights descending from left to right. The tower remains an undivided vertical rectangle, so a horizontal subdivision inside its height would be an artificial edge.

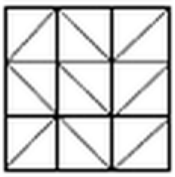
Step 2: Match the low blocks and supporting ledge The broad block below the tower presents a horizontal ledge across the middle level. Beneath it, the two low projecting pieces contribute a continuous lower horizontal boundary, with a vertical division near the right-hand end showing the separate low piece. This combination is drawn in (A): the middle ledge ends at the second step, while the lowest tier reaches the third step and contains the right-hand vertical edge. Option (B) instead divides the middle tier and treats the bottom as a single unbroken slab. Option (C) adds an extra horizontal line across the tower. Option (D) omits the genuine lower ledge and right-hand low-block division, although its outer silhouette looks similar.

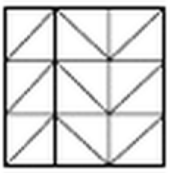
Step 3: Conclusion The arrangement of the ledges and the lower right block is reproduced by (A). Hence, the correct option is (A).

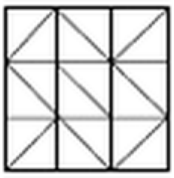
Quick Tip to Solve: After matching the outer steps, distinguish a separate foreground block from a continuous base by checking the short vertical divisions at the bottom.

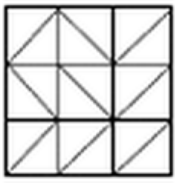
72. Which one of the answer figures is the correct mirror image of the problem figure with respect to X – X ? [4 marks]

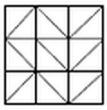


(A) 

(B) 

(C) 

(D) 

Correct Answer: (A) 

Solution:

Concept:

- Reflection in a vertical line interchanges left and right columns but leaves top, middle and bottom rows in their original order.
- Every diagonal changes its slope under this reflection. Grid lines remain horizontal or vertical, and diagonal endpoints stay at corresponding grid vertices.

Step 1: Reflect the grid cell by cell The problem figure is a three-by-three square grid. Read the diagonal slopes from left to right in each row, using a rising slash for a line from bottom-left to top-right and a falling slash for the opposite slope. The original upper row has falling, rising, falling diagonals. Reversing its column order and reversing each slope gives rising, falling, rising for the mirror image. The bottom row changes in the same way.

Step 2: Check the decisive middle row The original middle row has falling, rising, rising diagonals. Reverse their order first, giving rising, rising, falling, and then reverse each slope. The required middle row is consequently falling, falling, rising. Combined with the upper and lower rows, this is exactly (A). Option (B) has rising diagonals in the middle-middle and lower-middle cells, where falling diagonals are required; option (C) gives the middle-right cell a falling rather than rising diagonal; option (D) also gives the lower-middle cell a rising diagonal instead of the required falling diagonal. A reflected pattern cannot change the number or type of these segments, so those near matches are excluded.

Step 3: Conclusion The cell-by-cell reflection of all nine diagonals is the pattern in (A). Hence, the correct option is (A).

Quick Tip to Solve: For a gridded mirror pattern, reverse the column order and then reverse each diagonal slope; checking only the outer corners can miss an interior error.

73. What among the following would be the ideal material for flooring of a steel factory ? [4 marks]

(A) Tiles

(B) Granite

(C) Wood

(D) Steel

Correct Answer: (D) Steel

Solution:

Concept:

- A floor finish must be selected for the service conditions of the building: load, abrasion, impact and exposure matter more than its decorative appearance.
- A steel factory handles heavy metal pieces and machinery. A tough industrial surface that withstands mechanical abuse is preferable to a brittle or combustible finish.

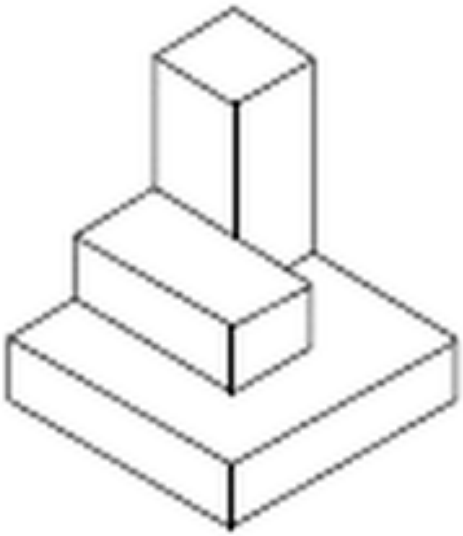
Step 1: Identify the demands on the factory floor Handling steel stock produces concentrated loads, repeated movement and the possibility of heavy objects striking the floor. The working surface therefore needs high resistance to wear and impact. In areas exposed to sparks or hot metal, a combustible finish is particularly unsuitable. The question asks for the ideal material among the four listed choices, so compare them for this industrial duty rather than for a residential or decorative floor.

Step 2: Compare the four materials Steel plate provides a tough, non-combustible wearing surface and can be supported on a suitable structural base. It is the appropriate listed choice for severe mechanical service. Tiles are relatively brittle and may crack or break under concentrated impact. Granite is hard and abrasion-resistant, but a hard stone is still brittle: its edges or surface can chip when struck by heavy metal. Wood is combustible and is vulnerable to indentation, wear and damage from hot objects. Thus neither an attractive finish nor surface hardness alone meets the full set of requirements as well as steel.

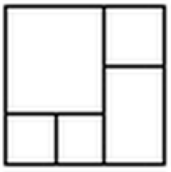
Step 3: Conclusion Steel is the suitable listed material for the flooring of a steel factory because of its toughness and resistance to heavy industrial wear. Hence, the correct option is (D).

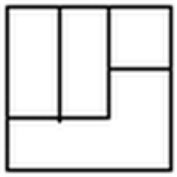
Quick Tip to Solve: Match a floor to its use: for heavy metal handling, compare impact toughness and fire behaviour before comparing appearance or polish.

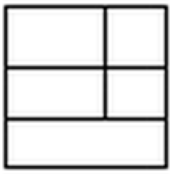
74. The 3–D figure shows the view of an object. Identify the correct top view from amongst the answer figures. [4 marks]



(A) 

(B) 

(C) 

(D) 

Correct Answer: (A) 

Solution:

Concept:

- A top view is the orthographic projection obtained by looking vertically downwards. Height is suppressed, but the horizontal footprints of the base and raised blocks remain.
- A visible change in level produces an edge in the plan. An edge on a vertical face does not automatically produce a line across an otherwise continuous horizontal surface.

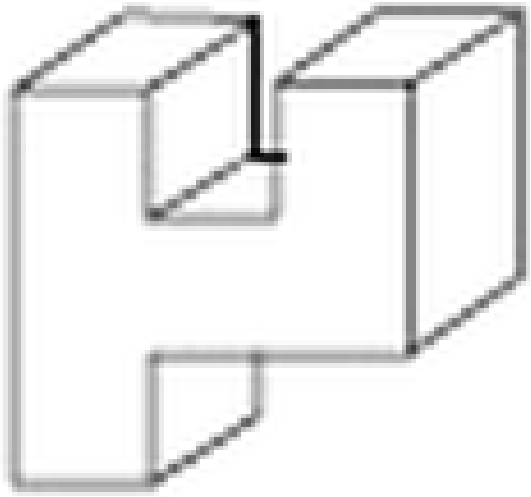
Step 1: Project the three levels onto the base Begin with the lowest square slab: its outside boundary gives the square outline of the answer. The middle raised rectangular block occupies a narrow strip extending inward from the rear of the base, so its two side boundaries and its front end form a U-shaped internal outline in plan. Looking down does not retain the vertical thickness of the front faces. The tallest square column occupies the rear portion beside that strip; its front edge therefore contributes the short horizontal line across the right-hand region near the top.

Step 2: Compare the internal edges of the alternatives Option (A) has exactly the required outer square, the inward-extending U-shaped strip and the short upper-right division for the tallest column. The remaining exposed portion of the base is continuous around the strip and must not be divided by an additional full-width horizontal edge. Option (B) adds divisions and small rectangular cells in the lower portion that the solid does not contain. Option (C) continues the front edge of the strip across the exposed left-hand base, although there is no corresponding step there. Option (D) adds horizontal divisions across the whole square and turns the plan into a grid; these lines would require extra changes of level absent from the object.

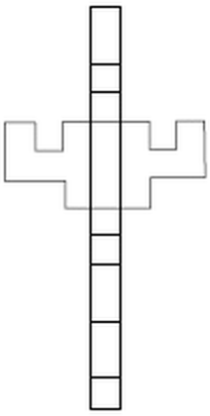
Step 3: Conclusion The top projection retains the U-shaped footprint of the intermediate block and the short rear-column boundary without introducing extra divisions of the base. Hence, the correct option is (A).

Quick Tip to Solve: Trace the base outline first, then add only the footprints and exposed level changes of the higher blocks; ignore the drawn heights of their vertical faces.

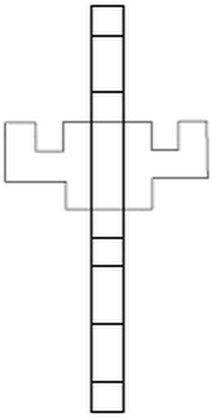
75. The 3–D figure shows the view of an object. Identify the correct view when the figure is opened up, from amongst the answer figures. [4 marks]



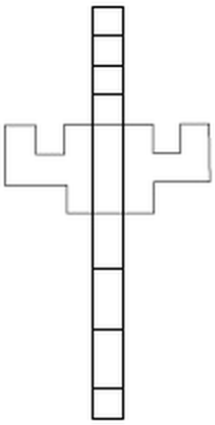
(A)



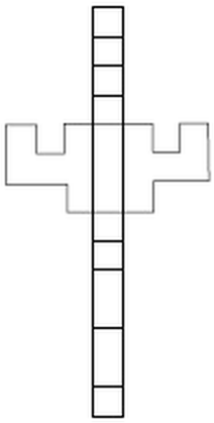
(B)



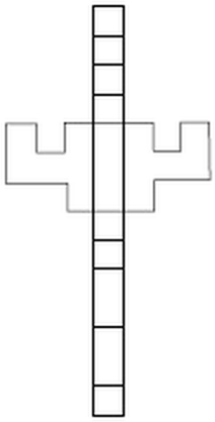
(C)



(D)



Correct Answer: (D)



Solution:

Concept:

- The net of a prism-like solid contains two matching end profiles and a strip of rectangular side faces. All the side rectangles have the same breadth, equal to the depth of the extrusion.
- The lengths of consecutive rectangles in the strip must follow the lengths of consecutive edges around the end profile. Matching the silhouette alone is insufficient: the fold positions and their order must also match.

Step 1: Trace the stepped end profile Regard the object as a stepped profile extended through a constant depth. Its end has an upper recess and an offset lower projection. Opening the solid must preserve two congruent copies of this profile, with a continuous strip of rectangular panels connecting their boundary edges. Starting at an attachment edge, mentally turn around each corner of the profile. Every change of direction requires a fold across the connecting strip. A long straight boundary edge requires one broad panel, whereas consecutive short steps require distinct narrow panels; combining or shifting those panels changes the shape when it is folded.

Step 2: Match the fold sequence rather than only the outline In (D), the narrow panels above the two side profiles follow the successive short steps, and the lower part of the strip places its narrow and broader panels in the order required to wrap around the remaining boundary. Folding each rectangular panel at its transverse line brings the two stepped end profiles into parallel planes and closes the sides of the solid. In (A), the upper strip begins with an elongated panel where separate short step faces are required. In (B), the broad upper panel is shifted to another position, so its folds again fail to follow the short upper steps. Although (C) has a similar overall cross-shaped arrangement, the division immediately below the attached profiles is missing or displaced: a required short panel is absorbed into a longer one. Its sequence therefore cannot close against the stepped end without a fold mismatch.

Step 3: Conclusion The matching end profiles and the correct ordered sequence of side panels occur together in (D). It is the development that folds back into the given stepped object. Hence, the correct option is (D).

Quick Tip to Solve: Pick one attachment edge and walk around the end profile in order, matching each short or long edge to the next panel of the net; do not choose a net by its outside shape alone.

Drawing Test (100 marks)

76. In the space provided for the answer of this question, draw an aesthetic composition appropriate to this space using only equilateral triangles. There is no restriction to numbers, sizes, placement and directions of these shapes. Color this composition so that it becomes visually exciting. [50 marks]

Solution:

Concept:

- An equilateral triangle has three equal sides and three angles of 60°. Repeating it at different scales and orientations creates unity with variety.

- An effective composition uses a clear focal area, balanced visual weight, rhythm, contrast and controlled negative space. Colour should reinforce that organisation.

Step 1: Establish a triangular framework Lightly mark the usable answer space and keep a narrow, consistent margin. Place one large equilateral triangle slightly off centre as the focal form. Around it, arrange medium triangles in a diagonal sweep, then add smaller triangles to carry the eye toward the opposite corner. Rotate some triangles and let others share edges. Keep every shape genuinely equilateral; changing size or direction does not permit stretching a triangle into a different kind. Test the arrangement in a small thumbnail before committing to the final outlines.

Step 2: Build rhythm and balance Repeat a few triangle sizes instead of scattering unrelated sizes everywhere. Group several small triangles opposite the large focal triangle to balance its visual weight. Let the spacing gradually tighten near the focal area and open out toward the margins. Interlock selected triangles into a larger triangular cluster, while retaining a few isolated small triangles as accents. Avoid accidental narrow slivers and excessive crowding at the edge. Make the triangular forms the only drawn motifs; no circles, lettering, free-form decoration or added rectangular frames are needed.

Step 3: Organise the colour and finish the work Use a limited, vivid palette: for example, warm red and orange triangles near the focal area with blue and violet triangles in the supporting groups. Repeat one accent colour in a few small triangles to connect the groups. Set light triangles beside darker ones so their edges remain clear, and reserve a few pale or uncoloured triangular spaces to provide visual rest. Fill the colours evenly and cleanly, keeping outlines sharp and avoiding muddy mixtures. Finally check the whole composition from a distance: the eye should first find the focal group, then follow the repeated triangles across the page without losing balance.

Step 4: Conclusion The finished design is a balanced, visually exciting arrangement made entirely from equilateral triangles. A dominant triangular focal group, graduated repetitions and a controlled warm–cool colour contrast give the composition unity, rhythm and variety.

Quick Tip to Solve: Make a tiny triangle-only thumbnail first. If the focal group and the balance of dark and light areas already read clearly at that size, enlarge the arrangement neatly.

77(a). Draw from imagination a mother cooking in the kitchen. [50 marks]

Solution:

Concept:

- A convincing kitchen scene combines a recognisable cooking action, believable human proportions and a consistent interior perspective. The mother's pose should communicate the activity before the smaller kitchen details are added.
- Depth comes from overlapping forms, converging receding edges and changes in scale. A single chosen light direction keeps the shading of the figure, utensils and room consistent.

Step 1: Plan the scene and viewpoint Use a landscape composition with the mother near one side of the centre, standing at a cooking counter. Leave sufficient space around her head and hands so that the action reads clearly. Choose an eye-level view into the kitchen, showing the back wall, a side wall

and some floor. Place the stove and a cooking vessel beside the mother, with a window and a few shelves as supporting elements. This is one possible imaginative arrangement; concentrate the visual emphasis on her interaction with the vessel rather than filling every empty space with objects.

Step 2: Construct the room in perspective Mark a light horizon and use a suitable vanishing point for the edges that recede towards the back wall. Establish the counter top as a plane before adding its thickness, cupboards and stove. Keep vertical cupboard and wall edges upright. Align the receding edges of the counter and floor consistently; parallel edges in the room must not converge towards unrelated points. Reduce the spacing of floor joints with distance, and use the counter's height as a practical reference for the scale of the standing figure.

Step 3: Establish the figure and cooking action Block in the head, torso, pelvis and limbs lightly. Show a slight forward lean towards the stove, with one arm bent to stir a pot and the other hand holding its handle or resting safely beside it. Maintain plausible shoulder, elbow and wrist relationships; avoid a disconnected hand or an unnaturally long forearm. Place the feet so that the body has a stable stance. Turn the face towards the cooking task and indicate clothing folds that follow the bent arm and torso. Refine the silhouette first, then add facial and finger details sparingly.

Step 4: Add supporting objects and tonal depth Draw the pot opening as an ellipse consistent with the viewpoint, and give utensils a believable size relative to the hands. Add a chopping board, vegetables and a small number of containers to explain the kitchen setting. Let nearer objects overlap farther ones, without hiding the cooking gesture. Choose light entering from the window: keep the lit surfaces lighter, shade the opposite sides and place contact shadows beneath the pot, feet and counter objects. Use stronger contrast around the figure and cooking vessel, with quieter tones on distant cupboards. If colour is used, keep a restrained warm scheme with a contrasting accent near the activity; a tonal pencil treatment can also communicate the scene clearly.

Step 5: Review and finish the composition Check that the mother is visibly cooking, the hands meet the objects naturally and the stove is supported by the counter. Review the perspective, proportions and one-direction lighting before darkening the final lines. Remove construction lines and unnecessary background detail. Preserve a clear separation between the figure and the wall by adjusting their tonal values, and keep the overall scene balanced without making every outline equally dark.

Step 6: Conclusion The composition should show a mother actively cooking at a well-proportioned kitchen counter, with a clear gesture, coherent room perspective and consistent lighting. The figure and vessel form the focal area, while restrained utensils, cupboards and a window establish the domestic setting.

Quick Tip to Solve: Sketch the mother's silhouette and hand-to-pot connection first. If the cooking action is unclear at that stage, correct the pose before spending time on tiles, shelves or utensils.

OR

77(b). Draw from imagination a beautiful building. [50 marks]

Solution:

Concept:

- An attractive building drawing depends on clear massing, harmonious proportions and a readable entrance. Repetition, balance and a controlled focal feature help the design appear coherent rather than a collection of unrelated details.
- Perspective explains the building's three-dimensional form, while light and shadow distinguish its planes. Landscaping and a small human figure can establish scale without competing with the architecture.

Step 1: Choose an architectural idea and composition Imagine a modest two-storey public library with a welcoming entrance, broad windows and a shaded terrace. This is one possible interpretation of a beautiful building. Place it in a three-quarter view so that the front and one side are visible, leaving space in front for an approach path and around the roof for a simple sky. Make the building the largest visual element. Use the entrance canopy as the focal feature, and balance it with repeated window bays and a small planted court rather than adding decorative elements without a common design purpose.

Step 2: Establish the perspective and main masses Set a horizontal eye level and choose two vanishing points well apart, outside the drawing area if necessary. Draw the nearest vertical corner, then direct each set of receding horizontal edges towards its corresponding vanishing point. Keep verticals upright for an ordinary eye-level architectural view. Construct the main rectangular volume, a slightly recessed upper floor and the entrance canopy as simple solids before adding detail. Check that the roof edges, floor lines and wall bases belong to the same perspective system; avoid a roof that appears to twist away from its walls.

Step 3: Organise openings and architectural details Divide the main facade into a small number of balanced bays, placing the entrance where the approach path naturally leads. Align the window heads and sills on their appropriate receding lines. Windows farther away become narrower in the view; they should not remain identical rectangles across an angled wall. Give the canopy thickness, show the supporting columns and recess the doors and windows enough to create shadow. Add a simple railing to the terrace and a restrained roof edge. Repeat a limited set of proportions so that the details support the overall massing instead of overwhelming it.

Step 4: Add scale and connect the building to its site Draw an approach path and a few steps or a gentle ramp leading to the entrance. Place one small standing person near the doorway to make the building's scale understandable. Include low planting beside the path and one tree positioned so that its foliage frames the building without concealing the main facade. Keep the ground plane continuous beneath the building; contact shadows and the meeting of wall and paving prevent the structure from looking as if it floats. Let distant background elements remain simple and less prominent than the architecture.

Step 5: Apply a consistent tonal and colour scheme Choose sunlight from the upper left. Keep the directly lit facade light, make the other facade a moderate tone and use deeper shadows beneath the

canopy and inside recessed openings. Project cast shadows consistently onto the ground. Suggest glass with a few controlled dark and light bands instead of filling every pane with unrelated reflections. A possible colour scheme uses pale warm walls, muted grey paving, green planting and a restrained darker accent at the entrance. If working in pencil, use the same light-to-dark hierarchy without colour. Strengthen nearby contours and keep background lines lighter to create depth.

Step 6: Check unity and finish the drawing Review the building's outline, entrance visibility, window alignment and human scale. Confirm that all receding edge families converge consistently and that the shaded planes agree with the selected light direction. Remove excessive construction lines and decorative clutter. Maintain a clear silhouette against the sky and enough open foreground to show the approach, giving the completed design a balanced and inviting appearance.

Step 7: Conclusion A successful composition presents a coherent imagined building with harmonious masses, a clear entrance and accurate three-quarter perspective. Repeated openings, restrained landscaping and consistent light and shade make the architecture appear attractive, usable and firmly placed in its surroundings.

Quick Tip to Solve: Resolve the main building volumes and their vanishing points before adding windows. Even elaborate details cannot correct a facade or roof drawn in an inconsistent perspective.

OR

77(c). Draw from memory the face of one of your parent. [50 marks]

Solution:

Concept:

- A convincing memory portrait captures the particular parent's head shape, facial proportions and familiar expression. A generic face with decorative details is less effective than a simple portrait with an accurate likeness.
- Treat the head as a three-dimensional volume. Light construction lines establish its tilt and the positions of the eyes, nose and mouth; tonal changes describe the forehead, cheekbones, nose, lips and chin.
- Use a single light direction and a limited range of pencil tones. The face remains the focal point, while hair, neck, clothing and a quiet background support the composition.

Step 1: Recall the distinguishing features Choose either parent and recall a familiar, relaxed expression before beginning. Mentally compare the width of the forehead and jaw, the shape of the chin, the hairline and hairstyle, the spacing of the eyes, and the form of the nose and mouth. Include spectacles, facial hair or other characteristic features only when they actually belong to the chosen parent. Decide on a frontal or slight three-quarter view that you can remember clearly; do not combine a frontal pair of eyes with a profile nose.

Step 2: Arrange the head and shoulders Use a portrait-oriented composition with enough margin above the hair and around the sides of the head. Place the head at a useful size so that the features can be developed clearly, and include the neck and a small portion of the shoulders to give it support. Keep

the background largely plain. Lightly block in the skull and jaw rather than starting with eyelashes or hair strands. Establish the head's tilt and, for a turned head, leave a little more space in the direction of the gaze.

Step 3: Establish proportions and the chosen view Draw a light centre line along the head and a guide through the eyes. In a level frontal view, the eyes are approximately halfway between the top of the skull and the chin, and the gap between the eyes is often about one eye-width; use these only as starting checks, then adjust them to the remembered parent. Place the nose base, mouth and chin by comparing the actual remembered distances. In a three-quarter view, curve the guides around the head's volume, allow the far side to appear narrower, and keep both eyes on the same tilted eye guide. Check the ear position against the brow and nose region, adjusting for head tilt.

Step 4: Develop the likeness before details Refine the contours of the forehead, cheeks and jaw, then indicate the eyes within their sockets, the bridge and wings of the nose, and the mouth with its natural expression. Compare feature widths and spacing repeatedly. Keep the visible whites of the eyes restrained and let the lids partly cover the irises so that the face does not look startled. Describe lips through their shape and the shadow at their meeting line rather than a heavy outline. Suggest age through observed facial planes and a few characteristic folds; avoid turning every crease into a dark stripe.

Step 5: Model the face with consistent tones Choose one light source, for example above and to one side. Preserve the paper for the brightest forehead, nose and cheek areas; build middle tones gradually over surfaces turning away from the light. Deepen the eye sockets, the shadow beneath the nose and lower lip, and the neck shadow beneath the chin where appropriate. The nose's cast shadow must fall away from the chosen light, consistently with the other shadows. Use strokes that follow the form and soften transitions across rounded cheeks. Group the hair into light and dark masses before adding a few directional strands. A monochrome pencil treatment is sufficient because the prompt does not require colour.

Step 6: Unify and finish the portrait Step back to compare the overall silhouette, gaze and expression with the remembered face. Correct misplaced features before reinforcing the darkest accents. Remove construction lines and accidental smudges, retain a few crisp edges near the eyes and important features, and soften less important clothing or background edges. Keep any background tone quiet and avoid a dark halo around the head. The final arrangement should make the parent's face immediately prominent, with believable volume and a coherent expression.

Step 7: Conclusion The composition plan is a recognisable portrait of one parent from memory, using a clearly chosen view, individual facial proportions, a familiar expression and consistent pencil shading. A simple head-and-shoulders arrangement and restrained background keep attention on the face and its likeness.

Quick Tip to Solve: Check the head outline, eye spacing and nose-to-mouth relationship before adding small details: these establish likeness more strongly than individual hairs or wrinkles.