JEE Main 2020 Paper 2B (B.Planning) 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 2B (B.Planning.) 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 100 questions: Mathematics (25), Aptitude Test (50), Planning (25), 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) Calculators, log tables, slide rules and electronic gadgets are not allowed.

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

1. 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) $S_{13} = \frac{13}{2}$

(B) $a_6 + a_8 = 1$

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

(D) $a_{13} = 0$

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

Solution:

Concept:

- For an arithmetic progression with first term a and common difference d, the kth term is $a_k = a + (k-1)d$.
- The sum of its first n terms is $S_n = \frac{n}{2}[2a + (n-1)d]$. The question asks for the statement that is not true, so all four statements must be tested.

Step 1: Translate the two conditions The terms numbered 5 and 9 are $a + 4d$ and $a + 8d$, respectively. Their sum and the given ninth partial sum yield

$$2a + 12d = 1, \qquad \frac{9}{2}(2a + 8d) = 6.$$

Dividing gives $a + 6d = \frac{1}{2}$ and $a + 4d = \frac{2}{3}$. Subtracting these equations eliminates the first term and gives $2d = -\frac{1}{6}$.

Step 2: Find the progression Thus the common difference is negative, as required by the two equations:

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

Check directly: $a_5 = \frac{2}{3}$, $a_9 = \frac{1}{3}$, and $S_9 = \frac{9}{2}\left(2 - \frac{8}{12}\right) = 6$. Both original conditions hold.

Step 3: Test each proposed statement Use the same first term and common difference throughout:

$$S_{13} = \frac{13}{2}\left(2 - \frac{12}{12}\right) = \frac{13}{2},$$

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

$$S_6 = 3\left(2 - \frac{5}{12}\right) = \frac{19}{4}, \qquad a_{13} = 1 - \frac{12}{12} = 0.$$

Therefore (A), (B) and (D) are true. The value in (C) is twice the actual sixth partial sum.

Step 4: Conclusion The statement $S_6 = \frac{19}{2}$ is not true; actually $S_6 = \frac{19}{4}$. Hence, the correct option is (C).

Quick Tip to Solve: In a question asking which statement is not true, calculate each expression from the same a, d, and mark the false statement rather than a true one.

2. 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) 10

(B) 26

(C) 25

(D) 8

Correct Answer: (B) 26

Solution:

Concept:

- Put $t=\sqrt{x}$, with $t \geq 0$. This removes the radical without squaring an equation and introducing extraneous roots.
- Completing a square makes the absolute value manageable: if $u=|t-2|$, then $(t-2)^2=u^2$ and $u \geq 0$.

Step 1: Reduce the equation to a quadratic The given equation becomes

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

Since $t^2-4t=(t-2)^2-4$, it is equivalent to

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

Writing $u=|t-2|$ now gives

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

Hence the only possible absolute values are $u=1$ and $u=2$.

Step 2: Recover every allowed square root For $|t-2|=1$, the values are $t=1,3$. For $|t-2|=2$, the values are $t=0,4$. All four satisfy the condition $t \geq 0$; none must be discarded. Converting back to the variable asked for,

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

These are distinct solutions. The value zero is allowed because the original question explicitly permits $x=0$.

Step 3: Check and add the original variable values At $t=0,1,3,4$, the pairs $(t^2-4t+6, 3|t-2|)$ are $(6,6),(3,3),(3,3),(6,6)$. Thus each reconstructed root satisfies the original equation. Their sum is

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

The sum of the square roots is only $0+1+3+4=8$, so option (D) confuses the substituted variable with x. Neither 10 nor 25 is the sum of the complete set of original solutions.

Step 4: Conclusion The sum of all values of x is 26. Hence, the correct option is (B).

Quick Tip to Solve: After substituting $t=\sqrt{x}$, enforce $t \geq 0$ and square each accepted t before adding the values of x.

3. 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 $(|z_0|, m)$ is equal to : [4 marks]

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

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

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

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

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

Solution:

Concept:

- For $z=x+iy$, the square of a modulus is $|z-(a+ib)|^2=(x-a)^2+(y-b)^2$.
- A sum of squared distances from two fixed points is minimized at their midpoint. Completing squares also proves the minimum and identifies the unique minimizer.

Step 1: Express both moduli in coordinates Write $z=x+iy$, where x, y are real. The signs of the imaginary shifts must be preserved:

$$|z-3+4i|^2=(x-3)^2+(y+4)^2,$$

$$|z-5-2i|^2=(x-5)^2+(y-2)^2.$$

Thus the fixed points are $3-4i$ and $5+2i$, rather than $3+4i$ and $5-2i$. The quantity to minimize is the sum of these four real squares.

Step 2: Complete squares and locate the minimum The real-coordinate terms and the imaginary-coordinate terms simplify separately:

$$(x-3)^2+(x-5)^2=2(x-4)^2+2,$$

$$(y+4)^2+(y-2)^2=2(y+1)^2+18.$$

Consequently the complete expression is

$$2(x-4)^2+2(y+1)^2+20.$$

Both square terms are nonnegative and vanish together exactly at $x=4, y=-1$. It follows that the least value is $m=20$, attained at $z_0=4-i$.

Step 3: Calculate the requested ordered pair The question requests the modulus of the minimizing complex number, not the complex number itself:

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

As a check, each original squared distance at $4-i$ is $1^2+3^2=10$, and their sum is 20. Options (A) and (C) have the wrong modulus, while (D) gives the value of only one squared distance instead of their sum.

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

Quick Tip to Solve: For two equally weighted squared distances, take the midpoint to find z_0, then evaluate both the total minimum and the modulus separately.

4. 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) 16.5

(B) 17

(C) 16

(D) 15.5

Correct Answer: (A) 16.5

Solution:

Concept:

- For five observations already arranged in increasing order, the third observation is the median. Hence here $x = 18$.
- If μ is the arithmetic mean, the mean deviation about the mean is $\frac{1}{5}\sum|x_i - \mu|$. Locate μ before opening the absolute values.

Step 1: Use the median and bound the mean The data become $4, 10, 18, y, 27$, with $18 \le y \le 27$ by the given ordering. Therefore

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

The bound on y implies $15.4 \le \mu \le 17.2$. In particular, $10 < \mu < 18$, so exactly the first two observations lie below the mean and the last three lie above it. This justifies all signs in the next calculation.

Step 2: Apply the mean-deviation condition The sum of the five absolute deviations equals $5(7.6) = 38$. Using the established location of the mean,

$$(\mu - 4) + (\mu - 10) + (18 - \mu) + (y - \mu) + (27 - \mu) = 38.$$

Combining the terms gives

$$31 + y - \mu = 38, \qquad y = \mu + 7.$$

Substitute this relation in the formula for the mean:

$$5\mu = 59 + (\mu + 7), \qquad 4\mu = 66, \qquad \mu = 16.5.$$

Step 3: Check the complete data Then $y = 23.5$, which lies between 18 and 27 and preserves the required order. The deviations from 16.5 are $12.5, 6.5, 1.5, 7, 10.5$, whose sum is 38. Their average is exactly 7.6, as required. The other proposed means, 17, 16 and 15.5, cannot satisfy both equations $5\mu = 59 + y$ and $y - \mu = 7$ simultaneously; the linear system has a unique solution.

Step 4: Conclusion The mean of the data is 16.5. Hence, the correct option is (A).

Quick Tip to Solve: Bound the unknown observation using the sorted order; this often locates the mean and removes ambiguity when expanding absolute deviations.

5. 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) 280

(B) 240

(C) 250

(D) 270

Correct Answer: (C) 250

Solution:

Concept:

- Use $\sin^2\alpha + \cos^2\alpha = 1$ to convert the condition into a quadratic in $t = \sin^2\alpha$.
- Even powers of cosecant and secant depend only on these squared values: $\mathrm{cosec}^6\alpha = 1/t^3$ and $\sec^6\alpha = 1/(1-t)^3$.

Step 1: Convert the condition into a perfect square With $t = \sin^2\alpha$, we have $\cos^2\alpha = 1 - t$. The equation becomes

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

Expand and collect like terms:

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

The quadratic has a repeated root, so the original condition determines the squares uniquely:

$$\sin^2\alpha = \frac{3}{5}, \qquad \cos^2\alpha = \frac{2}{5}.$$

Step 2: Evaluate the sixth powers using reciprocals Both squared values are positive, so neither sine nor cosine vanishes and both reciprocals in the question are defined. Cubing them and taking reciprocals gives

$$\mathrm{cosec}^6\alpha = \left(\frac{5}{3}\right)^3 = \frac{125}{27},$$

$$\sec^6\alpha = \left(\frac{5}{2}\right)^3 = \frac{125}{8}.$$

Although α can have either sign within the given interval, the even powers are unchanged, so there is no need to solve for the angle itself.

Step 3: Combine the two weighted terms Substitute directly into the requested expression:

$$27\,\mathrm{cosec}^6\alpha + 8\sec^6\alpha = 27\left(\frac{125}{27}\right) + 8\left(\frac{125}{8}\right) = 125 + 125 = 250.$$

The weights cancel the denominators exactly. The distinct values 280, 240 and 270 in the other options do not equal this sum. As a check on the condition, $10(9/25) + 15(4/25) = 150/25 = 6$.

Step 4: Conclusion The required value is 250. Hence, the correct option is (C).

Quick Tip to Solve: When a weighted sum of fourth powers equals its minimum, substitution of $\sin^2\alpha$ often produces a perfect square; use its root before evaluating reciprocal powers.

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

(A) 6

(B) 2

(C) 3

(D) 9

Correct Answer: (C) 3

Solution:

Concept:

- The binomial theorem gives $\sum_{r=0}^{9}\binom{9}{r}t^r = (1+t)^9$. Differentiating and multiplying by t yields $\sum_{r=1}^{9} r\binom{9}{r}t^r = 9t(1+t)^8$.
- Split the factor $r+3$ into a weighted binomial sum and three times an ordinary binomial sum. The ordinary sum starting at $r=1$ omits its constant term.

Step 1: Separate the two sums Let the sum in the question be T. Since $2^{-r} = (1/2)^r$, write

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

The weighted sum has no contribution at $r=0$, whereas the ordinary sum would have the contribution $\binom{9}{0}=1$. They therefore require different treatment at the lower limit.

Step 2: Evaluate using the binomial identities Substitute $t=\frac{1}{2}$ in the differentiated identity:

$$\sum_{r=1}^{9} r\binom{9}{r}\left(\frac{1}{2}\right)^r = \frac{9}{2}\left(\frac{3}{2}\right)^8 = 3\left(\frac{3}{2}\right)^9.$$

The ordinary sum equals

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

The subtracted 1 accounts exactly for the excluded $r=0$ term.

Step 3: Collect the coefficient and constant Combining the evaluations,

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

Thus the coefficient and constant in the stated form are $\alpha=6$ and $\beta=-3$, so $\alpha+\beta=3$. Option (A) reports only the coefficient, while (D) adds the magnitude of the negative constant instead of the signed constant; option (B) also disagrees with the derived sum.

Step 4: Conclusion With $\alpha=6$ and $\beta=-3$, the requested sum is $\alpha+\beta=3$. Hence, the correct option is (C).

Quick Tip to Solve: For sums involving $r\binom{n}{r}$, differentiate the binomial expansion; remember to subtract the constant term only from a sum that actually excludes it.

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

(A) $-\log_e 2$

(B) $1-\log_e 2$

(C) 1

(D) $-2\log_e 2$

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

Solution:

Concept:

- On the common real domain, $\log a-\log b=\log(a/b)$ for positive a,b. Determine that domain before combining the two logarithms.
- The standard exponential limits give $\lim_{t\to 0}(e^t-1)/t=1$ and $\lim_{t\to 0}(e^{-t}-1)/t=-1$. Hence $(e^t-e^{-t})/t\to 2$.

Step 1: Identify the substitution and real domain Put $t=x(x-1)$. Then $x(1-x)=-t$, so the first logarithm has argument e^t-e^{-t}, and the second has argument $4t$. Both are positive exactly when $t>0$. In a sufficiently small neighbourhood of $x=1$, this requires $x>1$; the expression is evaluated on this common real domain. As x approaches 1 through that domain, $t\to 0^+$.

Step 2: Combine the logarithms and evaluate the ratio The difference in the question equals

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

To evaluate the inner limit, write the numerator as $(e^t-1)-(e^{-t}-1)$. Thus

$$\lim_{t\to 0^+}\frac{e^t-e^{-t}}{4t}=\frac{1}{4}\left[\lim_{t\to 0^+}\frac{e^t-1}{t}-\lim_{t\to 0^+}\frac{e^{-t}-1}{t}\right]=\frac{1}{4}[1-(-1)]=\frac{1}{2}.$$

Step 3: Use continuity of the logarithm The limiting ratio is positive, so the logarithm is continuous at that value:

$$\lim_{x\to 1}\left\{\log_e(e^{x(x-1)}-e^{x(1-x)})-\log_e(4x(x-1))\right\}=\log_e\left(\frac{1}{2}\right)=-\log_e 2.$$

There is no remaining factor e, so neither $1-\log_e 2$ nor 1 can result. The denominator 4 and the numerator leading term $2t$ give a ratio of $1/2$, rather than $1/4$, excluding $-2\log_e 2$.

Step 4: Conclusion The limit on the real domain of the expression is $-\log_e 2$. Hence, the correct option is (A).

Quick Tip to Solve: When two logarithms diverge separately, combine them first. Here the numerator is asymptotic to $2x(x-1)$, which immediately fixes the limiting ratio.

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

(A) 240

(B) 232

(C) 256

(D) 248

Correct Answer: (B) 232

Solution:

Concept:

- A function on A means a function $f : A \to A$. With four domain elements and four choices of image for each, there are 4^4 functions in total.
- A one-one (injective) function assigns distinct images to distinct domain elements. On two finite sets of the same size, an injective function is a bijection and corresponds to a permutation.

Step 1: Count all functions on the set The set is $A = \{1, 2, 3, 4\}$. For each of its four inputs, its image may be any of the four elements of A, independently of the images of the other inputs. Repeated images are permitted in this unrestricted count. By the multiplication principle,

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

This count includes constant functions, functions with some repeated images, and one-one functions.

Step 2: Count the one-one functions For an injective function, choose the image of 1 in four ways. Having used that image, the image of 2 has three choices, the image of 3 has two, and the image of 4 has only one. Therefore

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

Every such assignment uses each codomain element exactly once. No extra arrangement factor is needed because the four domain elements have already been treated as distinct inputs.

Step 3: Take the complement Every function is either one-one or not one-one, and these two categories are disjoint. Consequently

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

Option (C), 256, counts all functions and does not remove the injective ones. The numbers 240 and 248 would remove 16 and 8 functions, respectively, whereas the correct injective count is the permutation count 24. The complement therefore selects a unique offered value.

Step 4: Conclusion The number of functions on A that are not one-one is 232. Hence, the correct option is (B).

Quick Tip to Solve: Count noninjective functions by subtracting injective maps from all maps; for a set of n elements, the result is $n^n - n!$.

9. 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) $\sqrt{3} - \frac{\pi}{3}$

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

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

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

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

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 the interval where $u(x) \geq l(x)$.
- The inequalities require points above $y = 1/2$ and below $y = \sin x$. The horizontal extent is therefore determined by their intersections, rather than automatically being the entire interval $[0, \pi]$.

Step 1: Find the interval containing the region On $[0, \pi]$, the intersections satisfy $\sin x = 1/2$, giving $x = \pi/6$ and $x = 5\pi/6$. The sine curve lies above the horizontal line only between these two values. Outside this interval there is no point satisfying both vertical inequalities, so those portions contribute no area.

Step 2: Integrate the vertical difference The top boundary is $\sin x$ and the bottom boundary is $1/2$. Hence the required area is

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

The integral subtracts the rectangle under the horizontal line from the area under the sine curve on precisely the valid interval.

Step 3: Evaluate and compare the options The cosine contribution is $-\cos(5\pi/6) + \cos(\pi/6) = \sqrt{3}$. The constant contribution is $-\frac{1}{2}(5\pi/6 - \pi/6) = -\pi/3$. Thus $A = \sqrt{3} - \pi/3$. Options (B) and (C) incorrectly replace the trigonometric contribution by 3, while (D) subtracts only half the required rectangular area.

Step 4: Conclusion The area is $\boxed{\sqrt{3} - \frac{\pi}{3}}$ square units. Hence, the correct option is (A).

Quick Tip to Solve: Before integrating between two curves, solve their intersection equation and check which curve is above the other; the given outer interval may be larger than the actual region.

10. 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 intercept form $x/a + y/b + z/c = 1$. Its coefficients are the reciprocals of the corresponding intercepts.
- A fixed point common to a family of planes is obtained by rewriting the constraint on the coefficients in the same normalized form as the plane equation. The signs in that constraint determine the coordinates of the point.

Step 1: Translate the intercept condition Let the intercepts on the x, y, z axes be a, b, c, respectively. The sum of the first two reciprocals exceeds the third reciprocal by 2, so

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

The word exceeds fixes the minus sign on the z-intercept term.

Step 2: Put the condition into the plane equation Divide this relation by 2 to obtain

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

Every permitted plane has equation $x/a + y/b + z/c = 1$. Comparing the two equations shows that substituting $x = 1/2$, $y = 1/2$, $z = -1/2$ satisfies every member of the family, regardless of how the intercepts vary.

Step 3: Check the coordinate signs The positive reciprocal terms correspond to positive x and y coordinates; the negative reciprocal term corresponds to a negative z coordinate. Options (A) and (B) reverse the sign of the y coordinate and do not reproduce the given constraint. Option (C) gives a positive z term, which also differs. Only option (D) has the required three signs and common factor $1/2$.

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: Normalize a linear relation among reciprocal intercepts to have right side 1; its three coefficients can then be read directly as the coordinates of a common point.

11. 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 $Ax^2+Bx+C=0$, the sum of its roots is $-B/A$ and their product is C/A. Apply these identities to the roots $1/a$ and $1/b$, rather than to a, b themselves.
- The determinant with diagonal entries $1+a, 1+b, 1+c$ and all off-diagonal entries 1 expands to $abc+ab+bc+ca$. Express its symmetric terms using the root relations.

Step 1: Obtain the reciprocal-root relations Since $c<0$, division by c is allowed. The given quadratic yields

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

Its constant term is nonzero, so neither root is zero. Therefore a, b are well-defined and

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

Step 2: Expand the determinant Expanding along the first row gives

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

This form avoids solving the quadratic explicitly; only its sum and product of roots are required.

Step 3: Substitute and simplify Now

$$\begin{aligned} D &= ab+c(a+b)+abc \\ &= \frac{2}{3c}+\frac{2(2c-1)}{3c}+\frac{2}{3} \\ &= \frac{4c}{3c}+\frac{2}{3}=2. \end{aligned}$$

The terms involving $1/c$ cancel exactly, so the answer is independent of the permitted value of c. Values 0 and 1 do not equal this result; $4/3$ accounts for the first two symmetric terms but omits $abc=2/3$.

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

Quick Tip to Solve: When reciprocal roots occur in a determinant problem, find ab and a+b from Vieta first, and expand the determinant into symmetric terms before substituting.

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

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

(B) $\sim p \wedge (\sim p \to q)$

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

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

Correct Answer: (C) $\sim p \to \sim q$

Solution:

Concept:

- An implication satisfies $r \to s \equiv \sim r \vee s$. De Morgan's laws give $\sim (r \vee s) \equiv \sim r \wedge \sim s$ and $\sim (r \wedge s) \equiv \sim r \vee \sim s$.
- Two propositions are equivalent only if they have identical truth values for every assignment of truth values to their variables. Simplify each option to compare it with $\sim p \wedge q$.

Step 1: Simplify the first two options For option (A),

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

This is the required proposition by commutativity of conjunction. For option (B), first use $\sim p \to q \equiv p \vee q$, then distribute:

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

Thus neither (A) nor (B) is the requested exception.

Step 2: Simplify the remaining options Option (C) becomes

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

It is the negation of the target proposition, rather than an equivalent expression. Option (D) gives

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

so (D) is equivalent to the target.

Step 3: Verify the non-equivalence directly Take p false and q true. The target $\sim p \wedge q$ is true, whereas option (C) is the implication true $\to$ false, which is false. A single such assignment disproves equivalence. Together with the algebraic simplifications, this establishes that exactly option (C) fails to match the target.

Step 4: Conclusion The proposition $\boxed{\sim p \to \sim q}$ is not equivalent to $\sim p \wedge q$. Hence, the correct option is (C).

Quick Tip to Solve: Replace every implication by a disjunction before comparing logical options; then use De Morgan's laws and distribution to avoid guessing from their appearance.

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 3rd drawn ball is red, then the probability that the first two drawn balls are green is : [4 marks]

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

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

(C) $\frac{9}{56}$

(D) $\frac{9}{49}$

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

Solution:

Concept:

- Conditional probability is $P(E \mid F) = P(E \cap F)/P(F)$, where F is the information already supplied. Here E means that the first two balls are green and F means that the third ball is red.
- Without replacement, the number of balls available decreases at every draw. Every position in a random ordering of the bag has the original red proportion, so the marginal probability that the third ball is red is $6/16$.

Step 1: Compute the probability of the complete colour sequence The event $E \cap F$ is the ordered sequence green, green, red. Its probability is

$$P(E \cap F) = \frac{10}{16} \cdot \frac{9}{15} \cdot \frac{6}{14} = \frac{9}{56}.$$

After the first green is drawn there are 9 greens among 15 balls; after the second green there are still 6 reds, now among 14 balls. These changing counts account for the lack of replacement.

Step 2: Condition on the red third ball By symmetry of the random draw order,

$$P(F) = \frac{6}{16} = \frac{3}{8}.$$

Therefore

$$P(E \mid F) = \frac{9/56}{3/8} = \frac{9}{56} \cdot \frac{8}{3} = \frac{3}{7}.$$

The probability $9/56$ is only the joint probability and must be divided by the probability of the stated condition.

Step 3: Check by treating the conditioned ball as removed Once a red ball is known to occupy the third position, the remaining 15 balls contain 10 greens and 5 reds. The first two positions are a sample without replacement from these remaining balls, so their probability of both being green is $(10/15)(9/14) = 3/7$, confirming the result. Option (B) is the red marginal probability, (C) is the unconditioned joint probability, and (D) does not account correctly for the changing counts.

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

Quick Tip to Solve: If a specified draw position is known to contain a red ball, remove that red ball first and sample the other positions from the remaining composition; this gives the conditional probability directly.

14. Let $A = \begin{bmatrix} x & 2y \\ -1 & y \end{bmatrix}; x, y \in \mathbf{R}$.

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

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

(B) 2

(C) $\sqrt{2}$

(D) 1

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

Solution:

Concept:

- The (i, j) entry of AA^T is the dot product of rows i and j of A. Thus its diagonal entries are squared row lengths, and its off-diagonal entries measure row orthogonality.
- Because y is real, $t = y^2$ must be nonnegative. This restriction selects the valid root when the matrix equations produce a quadratic in t.

Step 1: Multiply the matrix by its transpose Using the two rows $(x, 2y)$ and $(-1, y)$, we obtain

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

Comparison with the specified diagonal matrix gives

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

The zero off-diagonal entries are essential; using only one diagonal entry would leave the parameters undetermined.

Step 2: Solve for the square of y Set $t = y^2 \geq 0$, so $x = 2t$. Substituting into the first equation yields

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

The quadratic formula gives

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

The minus choice is negative, so it cannot equal a real square. Consequently $y^2 = (\sqrt{2} - 1)/2$.

Step 3: Evaluate the requested combination It is not necessary to find the sign of y, since the expression uses only its square. From $\alpha = 1 + t$,

$$\alpha + y^2 = 1 + 2t = 1 + (\sqrt{2} - 1) = \sqrt{2}.$$

Option (A) gives $2y^2$, omitting the constant 1. Options (B) and (D) do not follow from the quadratic constraint; in particular $y^2 \neq 0$, so the requested sum cannot be 1.

Step 4: Conclusion The value of $\alpha + y^2$ is $\boxed{\sqrt{2}}$. Hence, the correct option is (C).

Quick Tip to Solve: For a matrix equation involving AA transpose, compare both the off-diagonal and diagonal entries; then replace y squared by a nonnegative variable to avoid unnecessary sign cases.

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

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

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

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

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

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

Solution:

Concept:

- The greatest integer $[x]$ is constant on each interval $[n, n + 1)$. Possible changes of formula inside $(-1, 3)$ occur at the integers 0, 1 and 2; endpoints outside the domain are not counted.
- Continuity requires the left limit, right limit and function value to agree. Differentiability additionally requires equal one-sided derivatives, so a continuous joining point can still fail to be differentiable.

Step 1: Simplify the minimum Put $u = x[x]$. If $u \leq 2$, then $|u - 2| + 2 = 4 - u \geq u$, so the minimum is u. If $u \geq 2$, then $|u - 2| + 2 = u$, so the minimum again equals u. Thus, for every real u, the minimum equals u, and consequently $f(x) = x[x]$. The absolute value introduces no additional joining point.

Step 2: Write the interval formulas and test continuity The simplified function is

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

At 0, both one-sided limits and $f(0)$ equal 0. At 1 the left limit is 0 while $f(1) = 1$, and at 2 the left limit is 2 while $f(2) = 4$. Hence there are exactly two discontinuities, at 1 and 2.

Step 3: Count the points of non-differentiability At 0, the left derivative is -1, while the right derivative is 0, so f is not differentiable there despite being continuous. At 1 and 2, discontinuity already rules out differentiability. Within each remaining open subinterval the formula is linear, so it is differentiable. Thus the non-differentiability set is exactly $\{0, 1, 2\}$. Options (A) and (B) have the wrong continuity count; option (C) misses the corner at 0.

Step 4: Conclusion The function is discontinuous at two points and non-differentiable at three points. Hence, the correct option is (D).

Quick Tip to Solve: Simplify the outer minimum before splitting the greatest-integer function into intervals; then check continuity and one-sided slopes separately at each integer in the domain.

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

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

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

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

(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 is increasing on intervals where its derivative is positive and decreasing where its derivative is negative. Critical points divide the real line into intervals for a sign test.
- The exponential factor e^{x+1} is strictly positive for every real x. After differentiation, it affects the size of the derivative but never its sign; only the remaining polynomial needs a sign chart.

Step 1: Differentiate with the product rule Let $P(x) = 4x^2 - 16x + 11$, so $P'(x) = 8x - 16$. The product rule gives

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

The derivative of the exponential is itself because the derivative of $x + 1$ equals 1.

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

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

Thus the critical points are $-1/2$ and $5/2$. For $x < -1/2$, both linear factors are negative and their product is positive. For $-1/2 < x < 5/2$, their signs are opposite and the product is negative. For $x > 5/2$, both factors are positive.

Step 3: Translate the signs into monotonicity Therefore f is increasing separately on $(-\infty, -1/2)$ and $(5/2, \infty)$, and decreasing on $(-1/2, 5/2)$. This matches option (D). Options (A) and (C) give decreasing intervals containing points where the derivative is positive. Option (B) includes points such as $x = 9/4$ in its asserted increasing interval, even though the derivative is negative there, so it is also false.

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

Quick Tip to Solve: For an exponential multiplied by a polynomial, factor out the positive exponential after using the product rule; the remaining polynomial alone determines all increasing and decreasing intervals.

17. 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) 22

(D) -10

Correct Answer: (C) 22

Solution:

Concept:

- The volume of a parallelepiped is the absolute scalar triple product of its three coterminous edge vectors: $V = |\vec{a} \cdot (\vec{b} \times \vec{c})|$.
- The determinant may be positive or negative; the volume condition must therefore be checked with both signs. Dot products are obtained by multiplying corresponding Cartesian components and adding.

Step 1: Calculate the scalar triple product Using the three edge vectors as the rows of a determinant gives

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

Thus $D = \lambda^2 - 6\lambda + 8 = (\lambda - 3)^2 - 1$. This is the signed volume; taking its absolute value is essential before imposing the given volume.

Step 2: Find the real parameter values The condition $|D| = 35$ gives two cases. If $D = 35$, then

$$\lambda^2 - 6\lambda - 27 = 0, \qquad (\lambda - 9)(\lambda + 3) = 0.$$

Hence $\lambda = 9$ or -3. The other case, $D = -35$, would give $(\lambda - 3)^2 = -34$, which has no real solution. Both retained values produce a volume of 35 cubic metres.

Step 3: Evaluate the required dot-product expression Calculate each term before combining:

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

Consequently the requested expression is $4 + 2\lambda$, which takes the values 22 and -2. Among the listed options only 22 occurs; neither -14, 2 nor -10 is produced by an allowed value of the parameter.

Step 4: Conclusion One possible value is 22, obtained for $\lambda = 9$. Hence, the correct option is (C).

Quick Tip to Solve: Keep the absolute value in a volume condition until both determinant signs have been checked; then test the resulting parameter values in the requested expression.

18. 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) $\sqrt{3} - 1$

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

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

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

Solution:

Concept:

- A line through the origin inclined at 60° has slope $\tan 60^\circ = \sqrt{3}$. Its intersection with the mirror fixes the point of reflection.
- Reflection in a horizontal mirror reverses the vertical component of the ray direction and preserves the horizontal component. The perpendicular distance from (x_0, y_0) to $Ax + By + C = 0$ is $|Ax_0 + By_0 + C|/\sqrt{A^2 + B^2}$.

Step 1: Locate the point where the ray meets the mirror The incident ray has equation $y = \sqrt{3}x$, with $x \geq 0$. At the horizontal mirror $y = 2$, this gives

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

Thus the point of reflection is $P = (2/\sqrt{3}, 2)$. The reflected ray travels to the right and down, because reflection changes the sign of the vertical component of its direction.

Step 2: Write the reflected ray and calculate the distance The reflected slope is $-\sqrt{3}$. Its supporting line through P is

$$y - 2 = -\sqrt{3}\left(x - \frac{2}{\sqrt{3}}\right), \qquad \sqrt{3}x + y - 4 = 0.$$

The perpendicular distance of $Q = (2, 2)$ from this line is therefore

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

The positive sign in the numerator follows from $\sqrt{3} > 1$.

Step 3: Check that the perpendicular meets the ray A reflected direction vector is $\mathbf{v} = (1, -\sqrt{3})$. The displacement $Q - P = (2 - 2/\sqrt{3}, 0)$ has positive dot product with $\mathbf{v}$. Hence its perpendicular projection is forward from P, on the reflected ray itself; the line-distance formula gives the ray distance as required. The other options differ: $3 - \sqrt{3} = \sqrt{3}(\sqrt{3} - 1)$, $1 - 1/\sqrt{3} = (\sqrt{3} - 1)/\sqrt{3}$, and option (D) is twice the latter. None equals the calculated distance.

Step 4: Conclusion The distance is $\sqrt{3} - 1$ units. Hence, the correct option is (B).

Quick Tip to Solve: For a horizontal mirror, negate the incident slope, keep the reflection point, and then apply the point-to-line distance formula.

19. 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) $-y^2 - 2\pi y$

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

(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. The equation is linear in $x(y)$, and $\frac{d}{dy}(x/y) = (yx\prime - x)/y^2$.
- Integrate on an interval avoiding $y = 0$, then determine the single integration constant from $x(-\pi) = \pi^2$. The initial value lies on the negative-y interval.

Step 1: Put the differential equation into derivative form Divide the given equation by dy and rearrange:

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

For $y \neq 0$, divide by y^2. The quotient rule now gives

$$\frac{y(dx/dy) - x}{y^2} = 2, \qquad \frac{d}{dy}\left(\frac{x}{y}\right) = 2.$$

This transformation avoids confusing dx/dy with dy/dx; the roles of the two variables matter.

Step 2: Integrate and impose the initial value Integrating with respect to y gives

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

At $y = -\pi$, the initial condition becomes

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

Therefore the particular solution is $x = 2y^2 + \pi y$. The polynomial also extends through zero, though the quotient derivation was performed away from zero.

Step 3: Verify the differential equation and compare the choices For the obtained expression, $dx/dy = 4y + \pi$, so

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

It also gives $x(-\pi) = \pi^2$, checking both requirements. Options (B) and (C) do not have the necessary coefficient 2 of y^2, so cannot satisfy the differential equation. Option (D) happens to satisfy the initial value but its residual is $2y^2 + \pi^2$, rather than $2y^2$; an initial-value check alone would wrongly retain it.

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

Quick Tip to Solve: When the equation contains $yx\prime - x$, divide by y^2 and recognize the derivative of x/y; verify both the equation and the initial condition.

20. 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) $3x-y=3$

(B) $2y-x=4$

(C) $2x-y=1$

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

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

Solution:

Concept:

- For an ellipse with major axis along the x-axis, $e^2=1-b^2/a^2$. Thus eccentricity determines the ratio of the squared semi-axes.
- Implicit differentiation gives tangent slope $-b^2x/(a^2y)$. At a point with nonzero coordinates, the normal slope is its negative reciprocal, $a^2y/(b^2x)$.

Step 1: Use the eccentricity to determine the axis ratio Here $e=1/2$, so

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

Only this ratio is needed for the normal. As a consistency check, substituting $(2,3)$ into the ellipse and using $b^2=3a^2/4$ gives

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

Hence $a^2=16$, $b^2=12$, which satisfies $a>b>0$ as specified.

Step 2: Find the normal slope at the given point Differentiate the ellipse implicitly:

$$\frac{2x}{a^2}+\frac{2y}{b^2}\frac{dy}{dx}=0, \qquad m_{\mathrm{t}}=-\frac{b^2x}{a^2y}.$$

At $(2,3)$,

$$m_{\mathrm{t}}=-\frac{12\cdot 2}{16\cdot 3}=-\frac{1}{2}, \qquad m_{\mathrm{n}}=2.$$

The product of tangent and normal slopes is -1, confirming perpendicularity.

Step 3: Form the equation through the point Use point-slope form for the normal:

$$y-3=2(x-2), \qquad y=2x-1, \qquad 2x-y=1.$$

The line passes through $(2,3)$ and has the required normal slope. Options (A), (B) and (D) also pass through the point, but their slopes are 3, $1/2$ and $3/2$, respectively. Passing through the point is necessary but insufficient; those slopes are not perpendicular to the ellipse's tangent.

Step 4: Conclusion The normal is $2x-y=1$. Hence, the correct option is (C).

Quick Tip to Solve: Use the eccentricity to find a^2/b^2 directly; the normal slope can usually be obtained without calculating either semi-axis separately.

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

21. 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:

- The odd digits are $1, 3, 5, 7, 9$, and the even digits are $0, 2, 4$. Arrange the five distinct odd digits first and place at most one even digit in each gap to prevent even digits from being adjacent.
- An arrangement starting with zero is not an eight-digit number. Count such arrangements separately and subtract them; this leading-digit restriction is independent of the nonadjacency restriction.

Step 1: Count all arrangements with separated even digits The five odd digits can be arranged in $5!$ ways. Each ordered row of five odd digits has six gaps: one before it, four between consecutive odd digits, and one after it. To separate the three even digits, choose three distinct gaps and permute the even digits in them. This gives

$$N_{\text{all}} = 5!\binom{6}{3}\,3! = 5! \cdot 20 \cdot 6 = 5! \cdot 120.$$

This count allows zero to occupy the first gap, so some of its arrangements are not valid eight-digit numbers.

Step 2: Subtract the arrangements with a leading zero For an invalid leading-zero arrangement, fix zero in the gap before the first odd digit. The odd digits still have $5!$ orders. Of the remaining five gaps, choose two for the even digits 2 and 4, and order these two digits:

$$N_{\text{zero}} = 5!\binom{5}{2}\,2! = 5! \cdot 10 \cdot 2 = 5! \cdot 20.$$

There is no additional forbidden adjacency: each selected gap contains only one even digit, and distinct gaps are separated by an odd digit.

Step 3: Compare the valid count with the given form Subtracting gives

$$N = N_{\text{all}} - N_{\text{zero}} = 5!(120 - 20) = 5! \cdot 100.$$

Every valid number has exactly one odd-digit order, one choice of occupied gaps and one even-digit order, so this method neither omits nor duplicates any number. Since all eight supplied digits are used once, there is no further choice of digits. Comparing the result with $(5!)k$ yields the requested multiplier.

Step 4: Conclusion The number of valid eight-digit numbers is $5! \times 100 = 12000$. Therefore $k = 100$, a dimensionless count multiplier.

Quick Tip to Solve: Use the odd digits to create gaps, then subtract leading-zero arrangements with zero fixed in the first gap; forgetting this subtraction overcounts the numbers.

22. 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 (x_1, y_1) is $xx_1 + yy_1 = r^2$. The given point $(2, 2)$ belongs to the circle since $2^2 + 2^2 = 8$.
- A line tangent to a parabola has a repeated intersection with it. After substitution, set the quadratic discriminant to zero; use the condition $a > 0$ when dividing by a.

Step 1: Find the tangent to the circle Using the circle's tangent formula gives

$$2x + 2y = 8, \qquad x + y = 4.$$

Hence the common tangent can be written as $x = 4 - y$. It is already fixed by the circle and the point; the parabola's parameters must be chosen so that this same line touches the parabola. Its slope is -1, so there is no vertical-tangent special case.

Step 2: Substitute the line into the parabola Substitute $x = 4 - y$ into $y^2 = 4a(x - b)$:

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

The roots of this quadratic are the y-coordinates where the line intersects the parabola. Since the line is tangent, these roots coincide. Its discriminant therefore satisfies

$$(4a)^2 - 4 \cdot 1 \cdot 4a(b - 4) = 0.$$

Keeping the sign of the constant term is important here; moving the terms incorrectly would reverse the requested difference.

Step 3: Apply tangency and verify the contact Simplify the discriminant equation:

$$16a^2 - 16a(b - 4) = 0, \qquad 16a(a - b + 4) = 0.$$

Since $a > 0$, it follows that $a - b + 4 = 0$, or $b - a = 4$. With $b = a + 4$, the intersection equation becomes $(y + 2a)^2 = 0$, displaying the repeated root explicitly. The contact point has $y = -2a$, $x = 4 + 2a$. The parabola's derivative there is $2a/y = -1$, exactly the common line's slope, providing a further tangency check.

Step 4: Conclusion $b - a = 4$. This parameter difference is dimensionless in the stated coordinate system.

Quick Tip to Solve: Find the circle tangent first, substitute its equation into the parabola, and enforce a zero discriminant rather than solving separately for the contact point.

23. 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 at every real input. Thus the one-sided limits of $g(f(x))$ are found by applying g to the respective one-sided limits of f.
- The inner function need not be continuous for the composite to be continuous: distinct limiting inputs can have the same image under g. At the joining point, also check the actual composite value.

Step 1: Find the two limiting inputs of the outer function For $x < -1$, one has $x - 3 < 0$, so $|x-3| = 3 - x$. Therefore

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

For $x \geq -1$, the formula is $f(x) = 3x + 4$, which gives

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

These limiting inputs are different. Requiring f itself to be continuous would be inappropriate because the question imposes continuity on $g \circ f$.

Step 2: Equate the two composite limits Since $g(t) = t^2 - bt - 2$ is a polynomial,

$$\lim_{x \to -1^-} g(f(x)) = g(4) = 14 - 4b,$$

while

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

The actual value $g(f(-1))$ is also $g(1) = -1 - b$. Consequently continuity is equivalent to

$$14 - 4b = -1 - b, \qquad 15 = 3b, \qquad b = 5.$$

Step 3: Check the common value at the joining point For $b = 5$, $g(4) = 16 - 20 - 2 = -6$, and $g(1) = 1 - 5 - 2 = -6$. Both one-sided limits and the actual value of the composite are therefore -6. Within each side of the joining point, the composite is a composition of continuous functions, so the only issue was equality at this join. The resulting linear equation gives one real value of b, and the explicit check confirms it satisfies the required condition.

Step 4: Conclusion The required constant is $b = 5$, a dimensionless real number.

Quick Tip to Solve: For a composite at a jump of the inner function, first find the two limiting inputs, then equate their outer-function values; do not equate the inputs themselves.

24. 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:

- When integrating e^{2x} times a linear combination of sine and cosine, look for a primitive $e^{2x}(A\cos x + B\sin x)$. Differentiation preserves this form.
- The product rule gives the required condition $g'(x) + 2g(x) = \cos x + 7\sin x$. Match the sine and cosine coefficients, then evaluate the resulting g at the two specified arguments.

Step 1: Differentiate a suitable form of the primitive Set $g(x) = A\cos x + B\sin x$ for the trigonometric factor of the primitive, leaving the additive integration constant outside. By the product rule,

$$\frac{d}{dx}\{e^{2x}g(x)\} = e^{2x}\{2g(x) + g'(x)\}.$$

Since $g'(x) = -A\sin x + B\cos x$, collecting terms gives

$$2g + g' = (2A + B)\cos x + (2B - A)\sin x.$$

This converts integration into solving two simultaneous linear equations.

Step 2: Match coefficients and obtain the primitive Compare with the given integrand's trigonometric factor:

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

The first equation gives $B = 1 - 2A$. Substitute into the second:

$$-A + 2(1 - 2A) = 7, \qquad -5A = 5, \qquad A = -1, \quad B = 3.$$

Thus the primitive is

$$\int e^{2x}(\cos x + 7\sin x)\,dx = e^{2x}(-\cos x + 3\sin x) + c.$$

Differentiating this expression returns $e^{2x}(\cos x + 7\sin x)$, confirming both coefficients and signs.

Step 3: Evaluate the requested sum Using the trigonometric factor $g(x) = -\cos x + 3\sin x$, evaluate at the two arguments:

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

Therefore

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

The exterior constant of integration disappears on differentiation and does not enter this sine-cosine coefficient calculation. In particular, the exponential multiplying g in the primitive is not part of the function values being added.

Step 4: Conclusion The requested value is $g(0) + g(\pi/2) = 2$, a dimensionless number.

Quick Tip to Solve: For $e^{ax}(p\cos x + q\sin x)$, differentiate $e^{ax}(A\cos x + B\sin x)$ and match coefficients; it is faster than two integrations by parts.

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 line through two distinct points A and B can be parameterised as $\mathbf{r} = \mathbf{a} + t(\mathbf{b} - \mathbf{a})$, where t is a real parameter. The same parameter must be used in all three coordinates.
- The xy-plane consists of points whose third coordinate is zero. Set $z = 0$ to find where the given line meets that plane, then evaluate the requested coordinate ratio.

Step 1: Form a direction vector Let $A = (-1, 2, 5)$ and $B = (3, 4, -10)$. Subtract the coordinates of A from the corresponding coordinates of B:

$$\overrightarrow{AB} = (3 - (-1),\ 4 - 2,\ -10 - 5) = (4, 2, -15).$$

Hence a point on the joining line is

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

At $t = 0$ this gives A, and at $t = 1$ it gives B, which checks the direction and signs.

Step 2: Impose the plane condition At the intersection with the xy-plane, the height coordinate vanishes. Therefore

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

This value lies between zero and one, so the intersection is on the segment joining the two given points. It is consistent with their third coordinates having opposite signs.

Step 3: Find the coordinates and their ratio Substitute the same value $t = 1/3$ in both remaining coordinates:

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

Since $x \neq 0$, the requested ratio is defined and equals

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

As a further check, the displacement from A is $(4/3, 2/3, -5)$, exactly one third of $\overrightarrow{AB}$.

Step 4: Conclusion The intersection is $\left(\frac{1}{3}, \frac{8}{3}, 0\right)$, and the required dimensionless numerical value is $\boxed{8}$.

Quick Tip to Solve: For a line meeting a coordinate plane, set the missing coordinate equal to zero first; do not impose zero on either of the two coordinates naming the plane.

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

(A) Geoffery Bawa

(B) Louis Armstrong

(C) Donald Trump

(D) Sharmila Tagore

Correct Answer: (A) Geoffery Bawa

Solution:

Concept:

- An architect designs buildings and the spaces associated with them. In a professional-identification question, the task is to connect each name with the field for which that person is known.
- Geoffrey Bawa was a Sri Lankan architect associated with tropical modernism. His approach connects modern buildings with their landscape, climate and local architectural traditions.

Step 1: Identify the architectural professional Option (A), printed as Geoffery Bawa, refers to Geoffrey Bawa. He is the architect in this group. His work is particularly associated with Sri Lanka and with designing for a tropical setting. This gives a direct professional match to the word architect in the question; the spelling of the first name in the option does not indicate a different person.

Step 2: Eliminate the other professions Louis Armstrong, option (B), was a jazz musician, especially celebrated as a trumpeter and singer. That association is with music rather than architectural design. Donald Trump, option (C), is known as a businessman, real-estate developer and politician. Commissioning, developing or owning buildings is a different role from being their architect. Sharmila Tagore, option (D), is an Indian film actor. Her professional identification is with cinema, so this option also fails the question.

Step 3: Select by the role requested The question asks for the architect, rather than someone connected with a famous building as its owner or developer. Only Bawa matches the architectural profession among these four names. The comparison therefore eliminates the musician, the developer-politician and the actor without requiring any change to the printed options.

Step 4: Conclusion Geoffrey Bawa is the architect among the listed people. Hence, the correct option is (A).

Quick Tip to Solve: Separate the designer of a building from its developer or owner; a connection with real estate alone does not make a person an architect.

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

(A) I.M. Pei

(B) Charles Correa

(C) Walter Gropius

(D) Frank Lloyd Wright

Correct Answer: (A) I.M. Pei

Solution:

Concept:

- Architectural attribution connects a particular building or intervention with its designer. The object named here is the glass pyramid at the Louvre in Paris, rather than the entire historic Louvre palace.
- The Louvre Pyramid was designed by I. M. Pei. It is a modern glass-and-metal entrance structure set in the courtyard of the historic museum complex.

Step 1: Identify the exact work named The words glass pyramid specify the modern intervention at the Louvre, not the architects responsible for the older palace. Its transparent triangular faces and geometric form distinguish it from the surrounding historic architecture. The relevant attribution is therefore the architect of the pyramid project itself. That architect is I. M. Pei, who is listed in option (A).

Step 2: Compare the other architects Charles Correa, option (B), was an important Indian architect and urban planner, but he did not design the Louvre Pyramid. Walter Gropius, option (C), is associated with the Bauhaus and modern architecture; that association does not identify him as this project's designer. Frank Lloyd Wright, option (D), is associated with American organic architecture and works such as Fallingwater. He likewise did not design the pyramid. All four names belong to architecture, so profession alone cannot eliminate these distractors; the project-to-designer match decides the answer.

Step 3: Match the project to its designer The required pair is Louvre glass pyramid – I. M. Pei. Neither a shared modernist vocabulary nor an architect's international reputation is enough to substitute another name. Retain the precise association between the particular Paris landmark and Pei, which uniquely selects the first option.

Step 4: Conclusion The glass pyramid at the Louvre, Paris, was designed by I. M. Pei. Hence, the correct option is (A).

Quick Tip to Solve: Learn landmark questions as exact pairs: Louvre Pyramid – I. M. Pei. Distinguish a modern addition from the older building or complex around it.

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

(A) Lucknow

(B) Mysore

(C) Bangalore

(D) New Delhi

Correct Answer: The key selects (D), New Delhi, but the unqualified wording also admits (C), Bangalore, which has an NGMA branch.

Solution:

Concept:

- The National Gallery of Modern Art has its principal institution at Jaipur House near India Gate in New Delhi and a regional gallery in Bengaluru (Bangalore).
- A location question must distinguish the principal institution from its branches if it is to demand a unique city. The printed question does not make that distinction.

Step 1: Identify the location used by the answer key The answer key selects New Delhi, option (D). The principal National Gallery of Modern Art is at Jaipur House near India Gate in that city. Thus New Delhi is a factually valid response, and it is the standard institution-city association likely being tested. However, a valid keyed response is not by itself proof that all other listed responses are false.

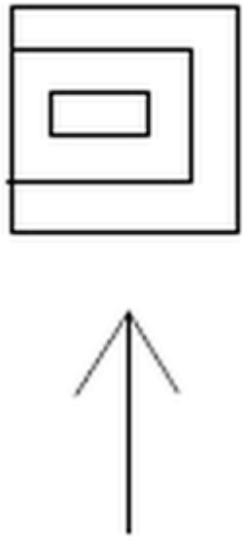
Step 2: Check the Bangalore alternative Bangalore, option (C), also has a National Gallery of Modern Art. This regional gallery is at Manikyavelu Mansion and opened in 2009, before this examination. The printed question asks where the National Gallery of Modern Art is located without specifying the principal institution, headquarters, or Jaipur House. Its literal wording therefore does not exclude the Bangalore branch. It would be incorrect to dismiss this option by claiming that no NGMA is located there.

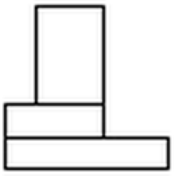
Step 3: Separate the keyed response from the literal ambiguity Lucknow and Mysore, options (A) and (B), do not identify either of these NGMA locations. Both New Delhi and Bangalore are defensible locations under the unqualified wording. Selecting only New Delhi would require an extra principal-only condition that the question does not print. The proper response is consequently to state the keyed selection while recording the ambiguity, rather than pretending that Bangalore is factually wrong.

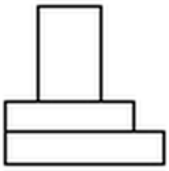
Step 4: Conclusion The keyed answer is (D), New Delhi. As printed, however, the question is ambiguous: (C), Bangalore, also has an NGMA gallery, so the wording does not support a unique city.

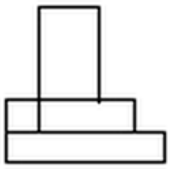
Quick Tip to Solve: Distinguish the principal museum from regional branches when answering institutional-location questions; check whether the wording actually specifies one of them.

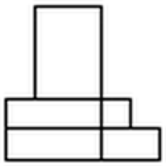
29. The problem figure shows the top view of an object. Identify the correct elevation from amongst the answer figures looking in the direction of the arrow. [4 marks]

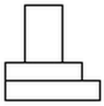


(A) 

(B) 

(C) 

(D) 

Correct Answer: (B) 

Solution:

Concept:

- An elevation is the orthographic projection seen horizontally along the indicated arrow. Widths perpendicular to that arrow remain visible; distances along the arrow collapse.
- For a stepped solid, compare the horizontal spans and alignments of its successive levels. A plan fixes the positions of the edges; an elevation must preserve those positions without adding unexplained visible seams.

Step 1: Read the viewing direction The arrow points upward on the page, so look from the lower edge of the plan towards its upper edge. The outer square represents the widest, lowest platform. Its left and right limits therefore give the full width of the bottom strip in the elevation. The next raised outline begins at the same left boundary but ends short of the outer right boundary. Consequently the middle platform must share the left edge of the bottom platform and leave a projecting ledge on the

right.

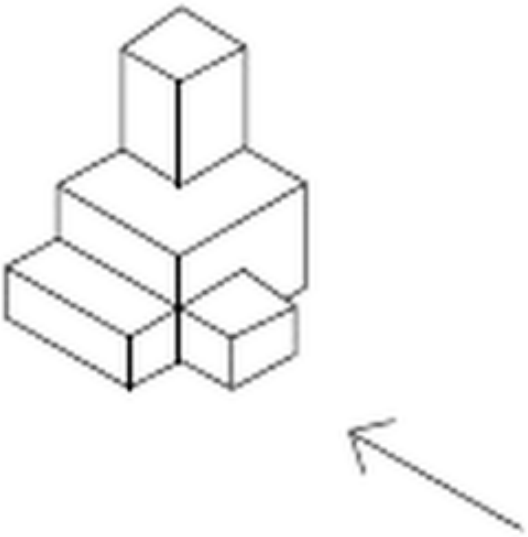
Step 2: Project the central raised portion The small inner rectangle lies strictly inside the middle outline. Project its left and right edges down to the elevation: the tall central portion must be inset from both sides of the middle platform. Its right edge cannot coincide with the right edge of that platform. The lower front edge of each platform is visible, but a concealed rear edge must not be continued as an extra vertical line through the front face.

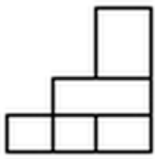
Step 3: Compare all four elevations Option (B) has the full-width base, the shorter left-aligned middle level and an upper rectangular portion inset on both sides of that middle level. Option (A) incorrectly makes the upper portion flush with the right side of the middle platform. Options (C) and (D) carry an additional vertical division down through a lower front face, respectively on the left or right of the upper portion. Those divisions do not represent visible changes of level in this viewing direction. Thus only (B) preserves both the positions and the visible boundaries.

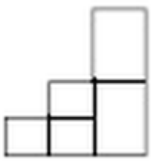
Step 4: Conclusion The elevation with the middle platform aligned to the left of the base and the upper portion inset within it is figure (B). Hence, the correct option is (B).

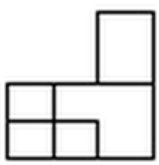
Quick Tip to Solve: Project the left and right limits of each plan outline along the arrow first. Reject an elevation as soon as one raised edge becomes flush when the plan shows an inset.

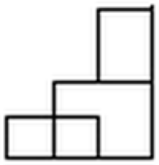
30. The 3 - D figure shows the view of an object. Identify the correct view in the direction of the arrow, from amongst the answer figures. [4 marks]

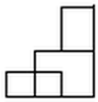


(A) 

(B) 

(C) 

(D) 

Correct Answer: (D) 

Solution:

Concept:

- An orthographic view removes depth along the line of sight and preserves vertical heights. Parts lying one behind another overlap in the projected view.
- Visible internal lines indicate actual exposed edges, not arbitrary divisions into unit squares. A continuous face remains continuous even if its outline resembles a stack of cubes.

Step 1: Look along the indicated arrow The arrow comes from the lower right towards the object. Looking in that direction makes the horizontal extent of the object appear as three adjacent width units. The tallest column is on the right of the resulting view, the middle-height part lies immediately to its left, and the lowest projecting part is at the left. The outer outline therefore rises in three steps from left to right. This observation fixes the silhouette before any internal edges are considered.

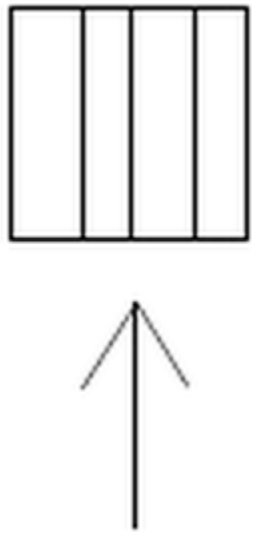
Step 2: Determine which edges remain visible The small high block supplies the uppermost right-hand rectangle. Below it, the main raised body presents a continuous face; there is no separate horizontal joint through that face at the intermediate height. The low front projection, however, produces a visible vertical boundary in the bottom strip. Depth edges behind the solid disappear in the projection and must not be added merely to create a regular square grid.

Step 3: Eliminate the incorrect line patterns Option (A) subdivides the projected face with extra horizontal and vertical seams, effectively treating every apparent unit as an independently outlined cube. Option (B) carries a long internal vertical line through the right-hand face and uses the wrong exposed-edge pattern. Option (C) introduces an additional horizontal line across the lower left projection. Option (D) retains the three-step silhouette and the exposed low-level boundary without those extra lines. Its simple connected face agrees with what is visible from the arrow direction.

Step 4: Conclusion The correct projection is the ascending stepped outline with the continuous central face shown in figure (D). Hence, the correct option is (D).

Quick Tip to Solve: For a solid with broad continuous faces, match the outside staircase first, then check internal lines separately. Do not draw a grid simply because several widths look equal.

31. 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:

- A top view records where edges lie across the width of an object. In an elevation along the arrow, those transverse positions remain unchanged, while the depth coordinate is suppressed.
- For a folded or ridged upper profile, each vertical line in the plan locates a change in slope in the elevation. The order and spacing of those changes are the useful invariants.

Step 1: List the edge positions from left to right The arrow points upward, so the required elevation is seen from the bottom of the plan. The rectangular plan contains three interior vertical edges as well as its two outside edges. Reading them across the width gives five successive profile positions. The first interior interval is comparatively broad, the next is narrower, and the remaining intervals continue in the displayed order. The corresponding elevation must therefore have three interior corners rather than one broad peak and one broad valley.

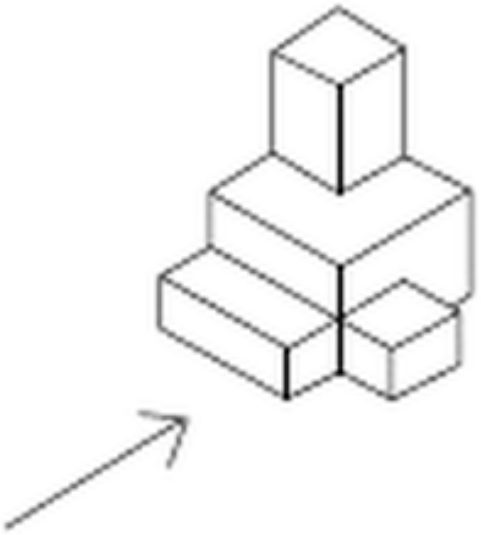
Step 2: Match the sequence of slope changes Trace the top profile while keeping each corner above the corresponding plan line. In option (B), the profile starts high at the left, descends to the first internal valley, rises to the central ridge, descends to the second valley and rises again to the right edge. The three internal slope changes occur in the same left-to-right positions as the three internal lines in the plan. The base stays horizontal and the outer width remains that of the plan.

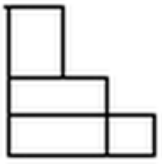
Step 3: Check the other answer figures Option (A) has only two internal changes in the upper profile and therefore cannot account for all three plan edges. Option (C) introduces more changes of slope and their positions do not match the three divisions shown. Option (D) has a strongly displaced and much narrower deep notch on the right; its corner spacing is inconsistent with the plan divisions. Option (B) alone gives the required number, order and relative spacing of the profile corners. The decision rests on correspondence of edges, rather than on the visual complexity of the outline.

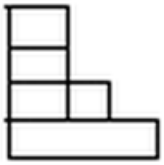
Step 4: Conclusion The profile whose three interior corners correspond to the three internal plan lines is figure (B). Hence, the correct option is (B).

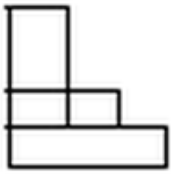
Quick Tip to Solve: Count the internal plan edges, then compare their horizontal positions with the peaks and valleys of each elevation. Equal overall width alone is insufficient.

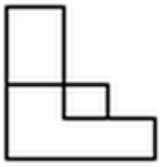
32. The 3 - D figure shows the view of an object. Identify the correct view in the direction of the arrow, from amongst the answer figures. [4 marks]

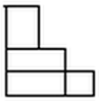


(A) 

(B) 

(C) 

(D) 

Correct Answer: (A) 

Solution:

Concept:

- In orthographic projection, the arrow fixes the observer side. Vertical heights and widths across the line of sight are preserved, while edges behind a nearer face are hidden.
- Opposite views of the same solid can share a stepped silhouette but show different internal boundaries. Correct spatial reasoning checks both the outline and which front edges are exposed.

Step 1: Establish the side from which the object is viewed The arrow points from the lower left towards the solid. View the near left face directly, suppressing the depth running away from the observer. The tall upper block now projects on the left of the elevation. The broad middle body extends farther to the right, and the low block extends farther still. Thus the overall outline descends in three levels from left to right. This is the reverse-side view relative to looking from the lower right.

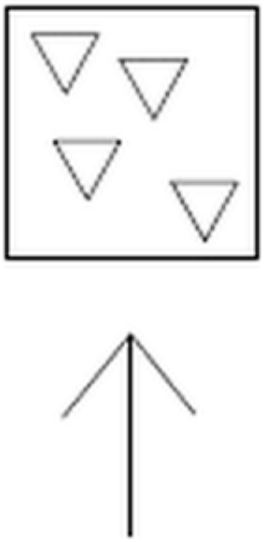
Step 2: Track the exposed horizontal and vertical boundaries The upper block has a visible bottom edge where it meets the broad supporting body. The lower projecting platform supplies another horizontal edge across the width it occupies. The separate small block at the right remains at the low level and contributes a vertical end boundary. These are real edges of distinct visible surfaces, so they remain in the drawing even though depth has collapsed. The projection must therefore retain both the support junction and the low platform edge, with the small right-hand division in its proper place.

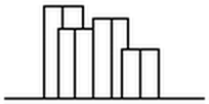
Step 3: Compare the four internal line arrangements Option (A) places the upper portion at the left, the broad supporting level below it and the small low extension at the right, retaining the required lower horizontal boundaries. Option (B) adds a horizontal division partway through the upper column which the solid does not possess. Option (C) continues the upper block's right edge through the supporting layer, dividing a face which should be continuous in this view. It also treats the lowest front strip as uninterrupted across the width. Option (D) similarly extends that upper vertical edge downward and omits the exposed lower horizontal boundary on the left. These line differences distinguish the correct answer even though the outer stepped shapes look similar.

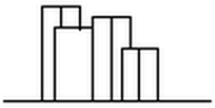
Step 4: Conclusion From the lower-left arrow direction, the visible stepped elevation and its exposed edge pattern match figure (A). Hence, the correct option is (A).

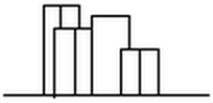
Quick Tip to Solve: When the answer outlines look alike, trace one exposed edge at a time from the solid. A missing platform seam or an extra line through a continuous face decides the choice.

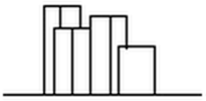
33. The problem figure shows the top view of objects. Looking in the direction of the arrow, identify the correct elevation, from amongst the answer figures. [4 marks]

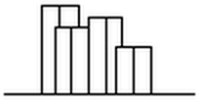


(A) 

(B) 

(C) 

(D) 

Correct Answer: (A) 

Solution:

Concept:

- To obtain an elevation, project parallel to the viewing arrow onto a vertical plane. Depth is suppressed, while left-to-right order and visible vertical edges are retained.
- A nearer solid hides the portion of a farther solid behind it. A triangular plan has a vertical ridge at its forward vertex when extruded vertically; that ridge is visible only where it is not obstructed.

Step 1: Read the arrow and lateral positions The arrow points upward from below the plan. Therefore look from the lower side of the square, without rotating the arrangement. There are four triangular footprints: a rear triangle on the left, a nearer triangle slightly to its right, a rear triangle farther right and a front triangle on the extreme right. Project their horizontal positions onto a common baseline. The overlap of the two left footprints must also appear as overlap in elevation.

Step 2: Trace the visible ridges The forward vertices of the triangles face the observer. Their vertical edges therefore appear inside the corresponding elevations. The foreground left prism hides the lower portion of the rear-left ridge; only the upper exposed portion of that ridge remains. The rear prism to the right retains its own ridge. The rightmost foreground prism also has a visible internal vertical edge. These visibility tests identify the arrangement of lines, rather than simply the similar stepped

outer silhouettes.

Step 3: Eliminate the altered line patterns Option (A) preserves the projected positions, the overlap on the left and the visible internal edges of all the exposed triangular faces. Option (B) changes the connection at the overlapping left pair. Option (C) omits the internal edge of the intermediate prism, and option (D) omits the internal edge of the rightmost prism. Those omissions would correspond to different face orientations from the triangular footprints shown.

Step 4: Conclusion The elevation with the correct overlap and visible triangular-prism ridges is figure (A). Hence, the correct option is (A).

Quick Tip to Solve: When elevations share almost the same outline, compare visible internal ridges and which nearer object hides each rear edge.

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

(A) Granite

(B) Steel

(C) Tiles

(D) Wood

Correct Answer: (B) Steel

Solution:

Concept:

- Flooring material must be selected for the use of the building. A steel factory subjects the floor to heavy concentrated loads, impact, abrasion and movement of industrial equipment.
- Steel industrial flooring has high strength and toughness. Toughness is especially important when a floor must resist repeated blows and heavy traffic rather than merely provide a decorative walking surface.

Step 1: Identify the main service requirements A steel factory is a heavy industrial workplace. Its floor must withstand the movement of heavy material and equipment, local impact and wear. The decisive properties are therefore load resistance, resistance to impact and durability under industrial traffic. Appearance and the warmth of a floor finish are secondary to these requirements. A tough metallic wearing surface is appropriate for the severe working conditions described.

Step 2: Compare the four materials Steel is strong and tough and is used for hard-wearing industrial floor surfaces where heavy loads and impact have to be resisted. Granite is a hard stone, but its brittle behaviour makes it less suitable for repeated severe blows than steel. Ordinary tiles can crack or chip under heavy concentrated loads and impact. Wood is softer, combustible and subject to wear or indentation, making it unsuitable for the demanding conditions of a steel factory. Thus the material that best matches this particular industrial use is steel rather than the finishes commonly chosen for domestic or decorative flooring.

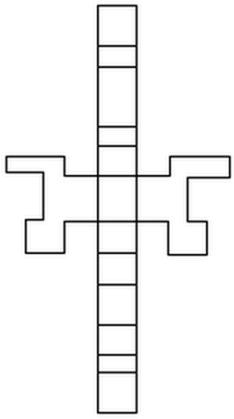
Step 3: Conclusion Steel is the most suitable of the listed materials for the heavy-duty flooring of a steel factory. Hence, the correct option is (B).

Quick Tip to Solve: For an industrial flooring question, first identify the load and impact conditions; compare toughness and wear resistance before appearance.

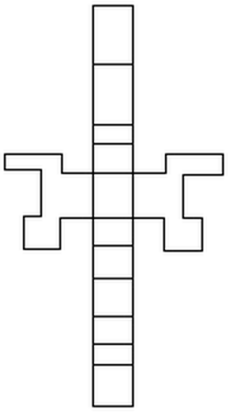
35. The 3 - D figure shows the view of an object. Identify the correct view when the figure is opened up, from amongst the answer figures. [4 marks]



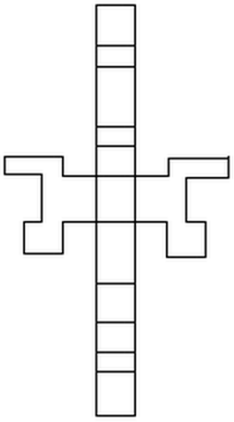
(A)



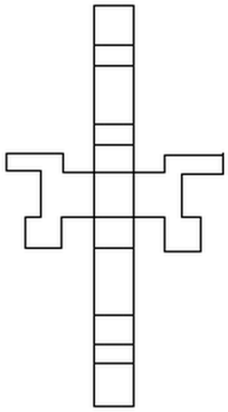
(B)



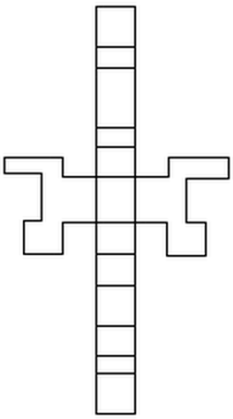
(C)



(D)



Correct Answer: (A)



Solution:

Concept:

- A prism unfolds into two congruent end profiles and a strip of lateral rectangles. Every straight boundary segment of the end profile contributes one rectangle to the lateral strip.
- The rectangles must follow the cyclic order of the profile edges. A re-entrant corner still needs its own fold; consecutive sides cannot be merged merely because they have similar lengths.

Step 1: Identify the repeated end profile The object has a constant depth and a stepped end face with inward notches. Its two end faces therefore unfold as matching stepped profiles on opposite sides of the rectangular strip. The two irregular pieces in the answer figures are these end faces. Their

similar appearance is insufficient to decide the answer: the subdivisions of the long strip must match the entire perimeter.

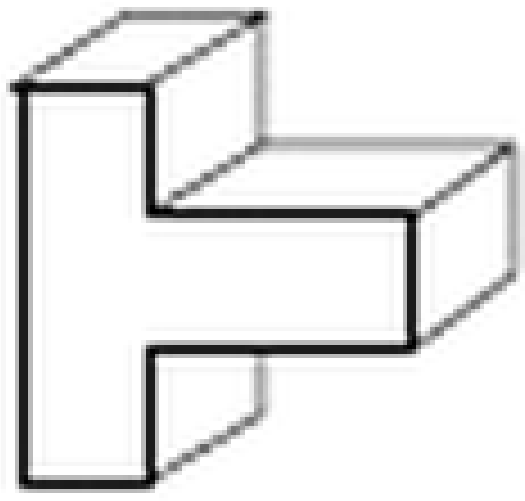
Step 2: Count and follow the perimeter edges Start at the side where an end profile joins the middle of the strip. Follow its outline completely, including each short return inside a notch. The profile has twelve straight boundary segments, so its lateral development needs twelve separate panels. The long side and short return at each step must occupy successive panels in the same order. Option (A) provides the full sequence, including both separate panels immediately below the central attaching panel and the remaining returns farther along the strip.

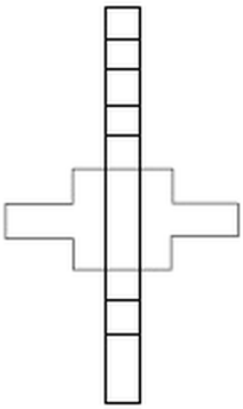
Step 3: Reject the incomplete developments Folding option (A) along successive transverse lines wraps each rectangle onto one side of the stepped solid and closes the surface without skipping an edge. Option (B) loses a required subdivision on the upper side of the attaching panel. Option (C) loses required subdivisions along the lower run. Option (D) also merges a pair of lower panels. These alternatives cannot reproduce all the corners of the end profile, even though their two irregular end pieces look similar.

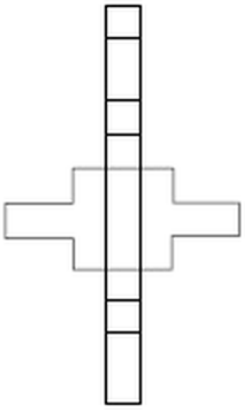
Step 4: Conclusion Only the twelve-panel lateral strip in figure (A) matches the complete stepped perimeter. Hence, the correct option is (A).

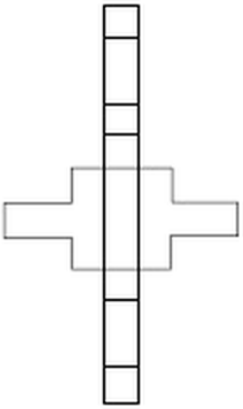
Quick Tip to Solve: For a prism net, count every straight edge of its end profile, including notch returns, and match that count to the lateral panels.

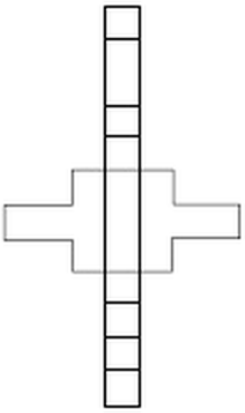
36. The 3 - D figure shows the view of an object. Identify the correct view when the figure is opened up, from amongst the answer figures. [4 marks]



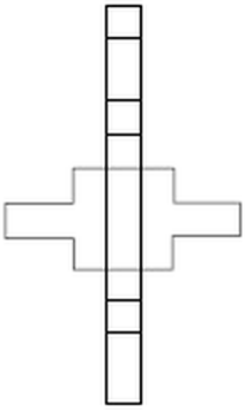
(A) 

(B) 

(C) 

(D) 

Correct Answer: (B)



Solution:

Concept:

- A uniform prism develops into two matching end faces and a strip whose panel widths equal the successive edge lengths of an end face.
- The T-shaped end profile has eight boundary edges. Short thickness edges and the longer arm edges must remain distinct in the strip, in the correct cyclic order.

Step 1: Recognise the end face and extrusion The solid is a T-shaped profile extended through a uniform depth. The two large T-shaped pieces in each answer are the end caps. The central rectangular strip joins their corresponding edges and wraps around the boundary. Perspective shortens some edges in the solid drawing, so decide the net from adjacency and the order of long and short edges rather than by directly measuring sloping lengths.

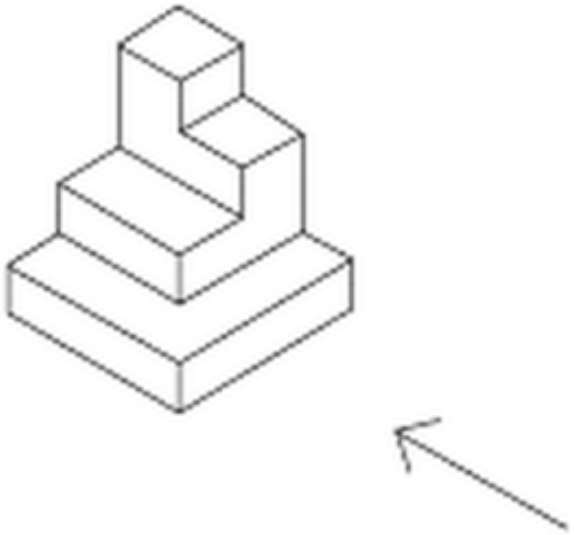
Step 2: Match the eight-edge boundary Trace the T perimeter from the edge attached to the central panel. The route includes the top thickness, the long side of the stem, a shoulder, the end of the arm, the other shoulder, the remaining stem side and the closing short edges. Each change of direction needs a fold. Option (B) has eight lateral panels and places the long panels at the required sides of the T. Its end caps attach along corresponding edges and lie on opposite sides of the strip.

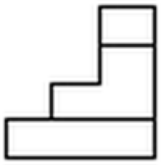
Step 3: Check the competing panel divisions Option (A) inserts extra divisions in the upper run and changes the sequence of short and long sides. Option (C) merges two required panels below the attaching region, losing a necessary corner. Option (D) adds a lower subdivision and shortens the final long face into separate panels. Option (B) alone preserves both the eight-edge count and the cyclic length sequence, allowing the strip to close around the original solid.

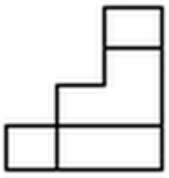
Step 4: Conclusion The correct development of the T-shaped prism is figure (B). Hence, the correct option is (B).

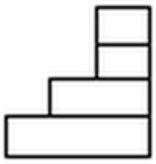
Quick Tip to Solve: For a T-shaped prism, first verify eight boundary edges; then compare where the long side panels occur in the net.

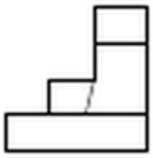
37. The 3 - D figure shows the view of an object. Identify the correct view in the direction of the arrow, from amongst the answer figures. [4 marks]

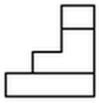


(A) 

(B) 

(C) 

(D) 

Correct Answer: (A) 

Solution:

Concept:

- An orthographic view looks parallel to the indicated arrow. Edges parallel to the sight line collapse, and depth does not appear as extra width.
- Draw only visible boundaries between faces. A line on the perspective drawing need not appear in elevation if it is parallel to the viewing direction or is hidden by a nearer face.

Step 1: Set the viewing direction The arrow approaches the object from the lower right. Look along that direction toward the stepped assembly. The wide low block forms the base of the elevation. Above it, the middle block occupies a narrower width, and the tallest part stands at the right-hand end. Thus the outline must rise in steps from left to right, with a continuous rectangular base.

Step 2: Determine which horizontal edges survive The upper assembly has an offset in depth. From the indicated side, the topmost portion projects above the nearer part, so a horizontal line remains

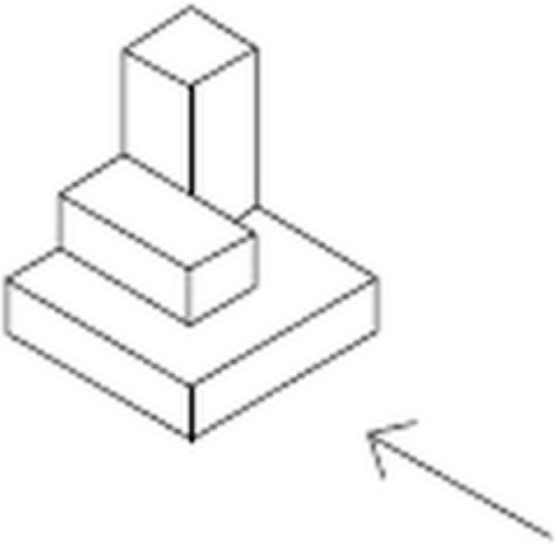
within the tallest upright. The lower visible face adjoining the middle step is continuous across the upright: an apparent perspective edge along the sight line must not be extended as an extra horizontal division through that face. The base also remains undivided vertically in this direction.

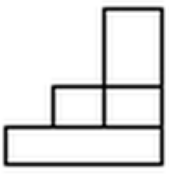
Step 3: Compare internal lines as well as silhouette Option (A) gives the stepped outline, the short upper horizontal division and the continuous lower face. Option (B) introduces vertical subdivisions through the base and middle region. Option (C) adds a horizontal line through the lower part of the upright that is not visible from this direction. Option (D) inserts an oblique internal line although the object has rectilinear horizontal and vertical edges. Therefore similar outer outlines do not make the alternatives equivalent.

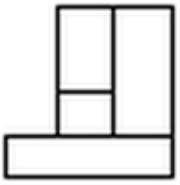
Step 4: Conclusion The view from the arrow is figure (A). Hence, the correct option is (A).

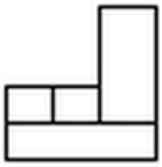
Quick Tip to Solve: After matching a stepped outline, test every internal line: remove edges along the sight line and avoid inventing seams in a continuous face.

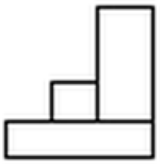
38. The 3 - D figure shows the view of an object. Identify the correct view in the direction of the arrow, from amongst the answer figures. [4 marks]

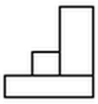


(A) 

(B) 

(C) 

(D) 

Correct Answer: (D) 

Solution:

Concept:

- In a directional elevation, the component parallel to the sight line disappears. Retain the projected outline and edges that genuinely separate visible faces.
- Adjoining coplanar faces form a continuous visible surface. Their apparent meeting position in perspective does not automatically create a line across the elevation.

Step 1: Project from the arrow The arrow points toward the solid from its lower-right side. Seen from this direction, the wide low slab becomes the continuous base. The shorter raised portion occupies the middle region, while the high upright appears on the right. These relative positions establish a low-wide base, a middle ledge and the tall right-hand column.

Step 2: Inspect the lower part of the upright The important distinction is whether a horizontal line should cross the tall column at the top level of the middle ledge. In the shown assembly, the visible vertical surface continues through this region; the ledge meets the side without producing a transverse exposed edge across the upright. The upper part of that upright is also a single face. Accordingly, the elevation must not divide the column into artificial horizontal blocks.

Step 3: Eliminate the false divisions Option (D) has the required middle ledge, continuous base and undivided tall upright. Option (A) extends the middle horizontal line through the upright, incorrectly creating a seam. Option (B) changes the high portion into two adjacent tall rectangles and adds a division at the left. Option (C) introduces additional horizontal and vertical subdivisions in the lower regions. None of those extra lines corresponds to a visible edge from the indicated viewing direction.

Step 4: Conclusion The correctly projected view with a continuous upright is figure (D). Hence, the correct option is (D).

Quick Tip to Solve: Do not extend a ledge line across an upright unless it represents an exposed edge; coplanar visible surfaces may remain one continuous face.

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

(A) Charles Correa

(B) Louis Kahn

(C) Zaha Hadid

(D) Raj Rewal

Correct Answer: (A) Charles Correa

Solution:

Concept:

- Architectural awareness questions test the association between a named building, its location and the architect responsible for its design.
- The LIC Building at Connaught Place in New Delhi is the Jeevan Bharati building. It is a work of the Indian architect Charles Correa.

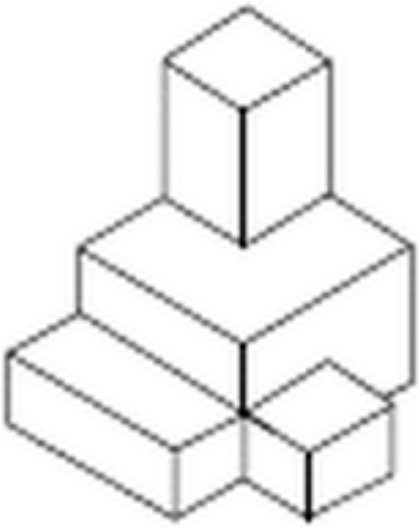
Step 1: Identify the building precisely Read both the organisation and the location in the question. The reference is to the Life Insurance Corporation building at Connaught Place, New Delhi, commonly known as Jeevan Bharati. Identifying this particular building avoids confusing it with other LIC offices in other Indian cities. The architect associated with this New Delhi project is Charles Correa, whose work forms an important part of modern Indian architecture.

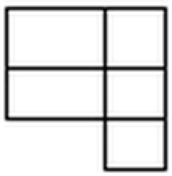
Step 2: Check the architect against the alternatives Charles Correa is the correct architect–building association for Jeevan Bharati, so option (A) matches the question. Louis Kahn is associated with the Indian Institute of Management at Ahmedabad rather than this LIC building. Zaha Hadid is known for a different body of international architectural work and is not the designer of Jeevan Bharati. Raj Rewal is associated with projects such as the former Hall of Nations at Pragati Maidan in New Delhi, not the LIC building asked about here. The fact that an architect has designed another notable building in New Delhi does not establish authorship of this particular project; the building name and location must be matched together.

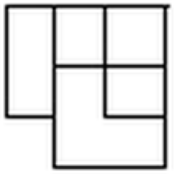
Step 3: Conclusion The architect of the LIC Building, Jeevan Bharati, in Connaught Place, New Delhi was Charles Correa. Hence, the correct option is (A).

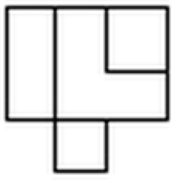
Quick Tip to Solve: Remember the specific pair "Jeevan Bharati, New Delhi–Charles Correa" rather than matching an architect only to the city.

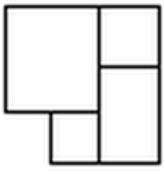
40. The 3 - D figure shows the view of an object. Identify the correct top view from amongst the answer figures. [4 marks]

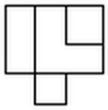


(A) 

(B) 

(C) 

(D) 

Correct Answer: (C) 

Solution:

Concept:

- A top view is a vertical projection onto a horizontal plane. Heights disappear from the outline, but boundaries between exposed horizontal surfaces at different levels remain visible.
- The footprint is the union of all component footprints. A projecting lower block remains visible beyond an upper platform; a covered lower edge is hidden.

Step 1: Look vertically down on the assembly The upright at the top contributes a small square within the footprint of the larger raised platform. The surrounding horizontal platform contributes the rest of its rectangular plan. The low blocks project beyond the platform, so the plan cannot be found by drawing only the outline of the upper platform or only the tallest block.

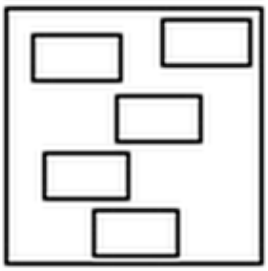
Step 2: Combine the visible footprints Trace the outermost exposed boundary while looking straight down. The broad portion produces a rectangular group of regions, while the lower projection extends from the middle of one side. This gives the characteristic outline in option (C): a broad rectangle with a smaller central rectangular projection. Within it, the square footprint of the upright occupies the corner shown in the answer, and the platform boundaries separate the remaining visible horizontal areas.

Step 3: Use the outline to reject the alternatives Option (A) places the extra projection at a corner rather than at the middle position required by the assembly. Option (B) produces an offset, corner-notched overall footprint and different internal divisions. Option (D) compresses the main region and places the lower extension along one side. Option (C) alone keeps both the middle projection and the correct corner position of the highest square. Vertical faces and the apparent diagonal perspective edges are not copied into the top view.

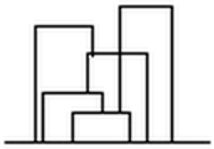
Step 4: Conclusion The correct top view is figure (C). Hence, the correct option is (C).

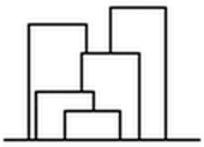
Quick Tip to Solve: Build a top view by combining every component footprint; check projecting low blocks before deciding the outer outline.

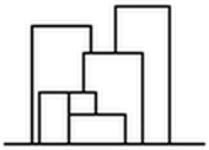
41. The problem figure shows the top view of objects. Looking in the direction of the arrow, identify the correct elevation, from amongst the answer figures. [4 marks]

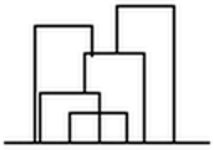


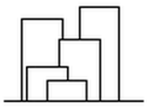


(A) 

(B) 

(C) 

(D) 

Correct Answer: (B) 

Solution:

Concept:

- An elevation viewed in the arrow direction retains horizontal positions and widths from the plan; depth is collapsed along the line of sight.
- In a visible-edge drawing, a nearer opaque object hides the portion of a rear object directly behind it. Hidden vertical edges must not continue through the front face.

Step 1: Read the arrangement from the arrow The arrow points upward from below the plan, so the bottom rectangle is nearest the observer. Behind it is the rectangle displaced left; farther back are the middle-right rectangle, the upper-left rectangle and the upper-right rectangle. Project their left and right boundaries vertically onto one elevation line, keeping the same left-to-right positions. In particular, the front rectangle overlaps the lower part of the rectangle behind and to its left. The middle-right rectangle overlaps part of the far-right rectangle.

Step 2: Apply the visibility test At each horizontal overlap, retain the front outline and stop the

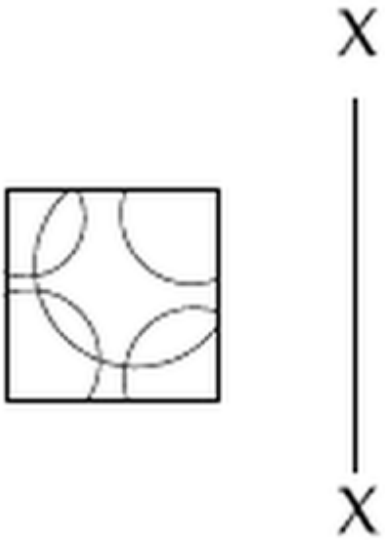
rear outline where it disappears behind a front face. A rear edge cannot be drawn as a solid line across the face of the nearest rectangle. Option (B) respects this: the low central front block has an uninterrupted face, the lower left block hides the corresponding lower part of the tall left block, and the middle-right block masks the lower left portion of the far-right block.

Step 3: Eliminate the inconsistent outlines Option (A) continues rear boundaries through nearer visible faces. Option (C) similarly retains an internal vertical boundary in the left overlap that the nearer block would hide. Option (D) carries vertical rear edges through the low central foreground block. These are visibility errors rather than changes in viewing direction. No numerical heights need to be inferred from the top view: the decisive comparison among the supplied elevations is the order of overlap and the stopping of visible edges.

Step 4: Conclusion The elevation consistent with the arrow direction, horizontal alignment and front-to-back concealment is (B). Hence, the correct option is (B).

Quick Tip to Solve: Project the rectangle nearest the arrow first. Reject any elevation that lets a rear vertical edge run visibly through its front face.

42. 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:

- Reflection in a vertical mirror reverses left and right but preserves every point's height and distance from the mirror.
- The complete pattern must be reflected together: all circular arcs, intersections and boundary contact points move to matching positions on the opposite side.

Step 1: Reflect the large features The mirror X–X is vertical and lies to the right of the square. Imagine turning the printed square over horizontally. Its large upper-right curved arc therefore becomes the large upper-left arc. The smaller curved feature near the upper-left corner moves to the upper-right corner. Neither of these features moves down or changes its curvature relative to the square. This immediately provides two separate checks rather than relying on a general resemblance.

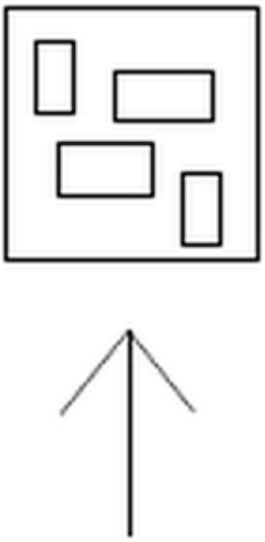
Step 2: Track the lower intersections Now follow the lower portion of the original. The narrow lens-like intersection on the lower-left side must appear on the lower-right side of the reflected square. The broader arc from the lower-right region moves to the lower-left region. The short curve segments meeting the bottom edge must exchange their horizontal positions while retaining their original levels and the same connectivity. Option (B) preserves all of these relationships together.

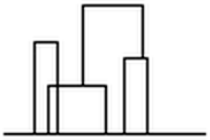
Step 3: Check the other answer figures Option (A) does not preserve the lower intersection and bottom-contact arrangement: one arc falls differently through the bottom part of the square. Option (C) alters the lower-left arc relative to the horizontal boundary contact, so it is not the horizontal reversal of the original. Option (D) changes the upper-left broad arc and its contact with the top edge. A correct mirror image cannot independently adjust one arc to make a pattern look similar; every segment must follow the same left-right reversal. The full match is therefore obtained only in (B).

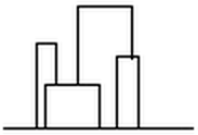
Step 4: Conclusion Option (B) reverses the complete pattern left to right while preserving vertical positions and arc connections. Hence, the correct option is (B).

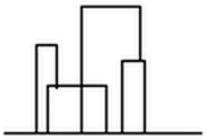
Quick Tip to Solve: For a mirror-pattern question, check one top corner, one lower intersection and the bottom contact points; all three must reverse consistently.

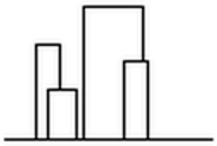
43. The problem figure shows the top view of objects. Looking in the direction of the arrow, identify the correct elevation, from amongst the answer figures. [4 marks]

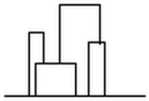


(A) 

(B) 

(C) 

(D) 

Correct Answer: (B) 

Solution:

Concept:

- An orthographic elevation collapses depth along the arrow but retains each object's horizontal position and projected width.
- When projected widths overlap, the nearer opaque object hides the lower visible outline of the farther object wherever their faces coincide.

Step 1: Project the widths in the indicated direction The arrow is below the plan and points towards its top. The narrow rectangle at the lower right is therefore on the observer's side, and the wide rectangle at the lower left is in front of the narrow upper-left rectangle. The wide upper-right rectangle lies behind these objects. Looking along the arrow collapses vertical distances in the plan, not the left-to-right positions. The front-left wide block must keep its full horizontal span; it cannot be replaced by a narrow strip.

Step 2: Resolve the overlapping edges The wide front-left block overlaps the right-hand portion of

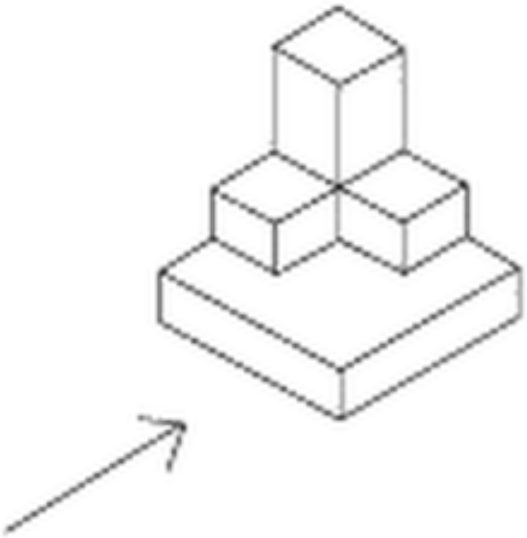
the narrow rear-left block. Its face consequently hides that portion of the rear block below its top edge. It also lies in front of part of the wide rear block, so the rear block's left edge cannot continue as a visible line across the front face. The front-right narrow block hides the lower right portion of the rear wide block. Option (B) shows these three relationships with the visible rear edges stopping at the front outlines.

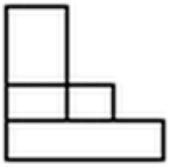
Step 3: Compare all four options Option (A) shows a rear vertical edge inside the wide foreground block, violating the concealment required by the plan. Option (C) also carries the tall rear block's left boundary down through the foreground rectangle. Option (D) replaces the broad front-left rectangle by a narrow one, losing its projected width and overlap. Option (B) retains both the widths and the correct edge terminations. The comparison is based on the supplied plan and visibility; no unprinted numerical height is required.

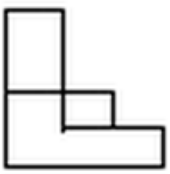
Step 4: Conclusion The consistent elevation is the one in option (B). Hence, the correct option is (B).

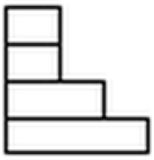
Quick Tip to Solve: Mark the left and right limits of every rectangle before considering height; then stop each rear edge at the face of the nearer block.

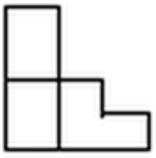
44. The 3 – D figure shows the view of an object. Identify the correct view in the direction of the arrow, from amongst the answer figures. [4 marks]

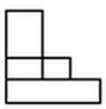


(A) 

(B) 

(C) 

(D) 

Correct Answer: (A) 

Solution:

Concept:

- An orthographic view in a specified direction removes depth and displays the heights and horizontal extents perpendicular to the line of sight.
- Visible horizontal edges separating stacked stages remain in the elevation. An outline alone is insufficient if it deletes a visible front-face boundary.

Step 1: Identify the stages seen from the arrow The arrow points diagonally towards the solid from the lower-left side of the picture. The lowest stage is the broad square base slab. Above that base are raised blocks, with the higher vertical column rising over the left part of the projected view. The neighbouring raised block extends one stage farther to the right, and the base extends still farther. Thus the outside silhouette descends in steps from a high left tower to a middle right-hand block and finally to the broad base.

Step 2: Keep the visible internal boundaries The front face of the broad base has a top boundary running horizontally across its width. The next stage has its own horizontal top edge. The tall column rises above that stage and has a vertical boundary where its face meets the lower adjacent block. Looking straight in the arrow direction does not remove these visible interfaces. Option (A) preserves the broad base as a complete bottom band, the middle stage above it and the high left column, with the appropriate vertical separation at the middle block.

Step 3: Reject views with missing or extra divisions Option (B) merges portions of the base and upper structure by omitting the full horizontal base boundary and retaining a different interior corner. Option (C) adds a horizontal division across the high column while changing the division of the lower stages; that extra line does not represent the given column face. Option (D) leaves the left face unbroken down to the bottom and deletes the base-stage boundary. Although several choices have a roughly similar stair outline, only (A) matches both the silhouette and the visible edges of the supplied solid.

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

Quick Tip to Solve: Compare internal visible edges after matching the stair silhouette; missing stage boundaries often distinguish otherwise similar elevations.

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

(A) To hold the building up

(B) To make the building water proof

(C) To give strength to a building

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

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

Solution:

Concept:

- A chimney is a vertical flue that conveys smoke and combustion gases from a fireplace or other combustion appliance to the outside above the roof.
- Hot combustion gases are less dense than the cooler surrounding air. Their upward movement produces a draught that helps carry smoke out of the occupied space.

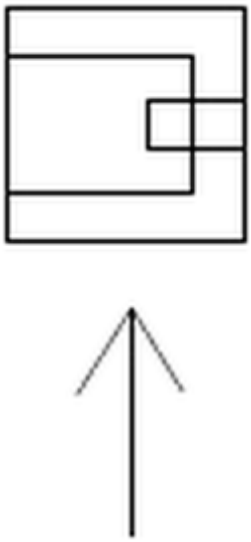
Step 1: Identify the service performed by the chimney A fireplace produces heat together with smoke and gaseous products of combustion. The building needs a passage that takes these products away from the room. A chimney provides this passage: its flue connects the fireplace to an outlet at a higher level. The warm gases rise through the flue and discharge outside, helping prevent smoke from accumulating indoors. Thus the defining purpose of the component is the removal of smoke from the fireplace.

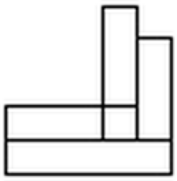
Step 2: Distinguish the other building functions Option (A), holding the building up, describes the work of the load-bearing structural system, including walls, columns and foundations. A chimney itself needs structural support; its principal function is not to support the building. Option (B), making the building waterproof, describes the role of roof coverings, membranes, damp-proofing and related weatherproofing details. Although a chimney junction needs flashing to prevent leaks, waterproofing is not the chimney's purpose. Option (C), giving strength to a building, likewise belongs to structural elements and their connections. Only option (D) describes the flue's role in exhausting the smoke produced at a fireplace.

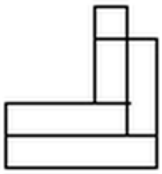
Step 3: Conclusion A chimney is provided to take out the smoke from a fireplace. Hence, the correct option is (D).

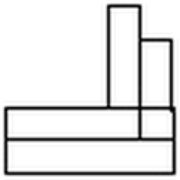
Quick Tip to Solve: Match a building component to its primary function: a chimney carries combustion gases out, while columns provide support and roof membranes keep rain out.

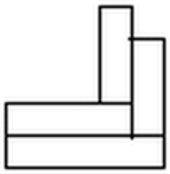
46. The problem figure shows the top view of an object. Identify the correct elevation from amongst the answer figures looking in the direction of the arrow. [4 marks]

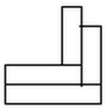


(A) 

(B) 

(C) 

(D) 

Correct Answer: (D) 

Solution:

Concept:

- In the elevation along the arrow, plan depths collapse while horizontal widths and the order of concealment are retained.
- Visible rear edges end where a nearer face hides them. A line belonging to the back of an object is not drawn through an opaque foreground surface.

Step 1: Read the nested plan from front to back The arrow below the plan points upward. The outer rectangle supplies the full width of the view. Inside it is a broad rectangle reaching from the left boundary to a vertical boundary near the right. A smaller horizontal rectangle crosses that inner right boundary, extending into the narrow right-hand strip. The nearer horizontal edge of the large inner rectangle is in front of the small rectangle. Use these horizontal spans and their overlap to compare the proposed elevations.

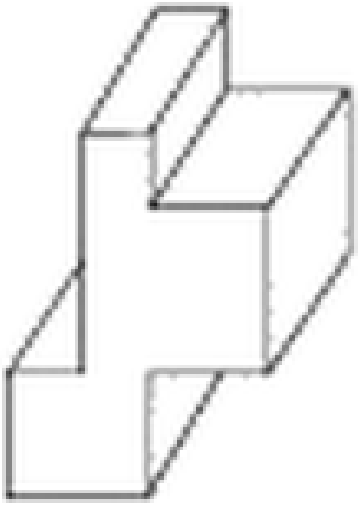
Step 2: Follow the correct stopping points The broad lower foreground portion hides rear detail over most of the width. At the right, the narrow projecting portion remains visible up to its own vertical boundary. The taller central part and the neighbouring right part overlap in projection, so their vertical lines must terminate at the faces that conceal them, rather than continuing indiscriminately into the bottom band. Option (D) has the broad base, the wide lower foreground face, and the upright portions with the required visible junctions.

Step 3: Eliminate the alternative line patterns Option (A) continues the central vertical division into the lower foreground band even though that rear edge is hidden by the nearer face. Option (B) introduces a horizontal division across the tall central portion and terminates the lower right boundary differently from the supplied arrangement. Option (C) similarly carries a rear vertical edge into the lower band, producing a small extra rectangular panel at the lower right. These extra lines are inconsistent with the front-to-back relation of the plan. Option (D) avoids those hidden-edge continuations while preserving the correct horizontal spans.

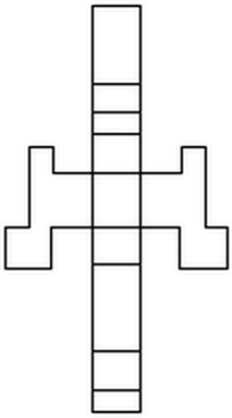
Step 4: Conclusion The elevation with the correct visible edges and horizontal alignment is (D). Hence, the correct option is (D).

Quick Tip to Solve: Do not choose by the outer silhouette alone. Check whether every short interior line is genuinely visible from the arrow or hidden behind the front face.

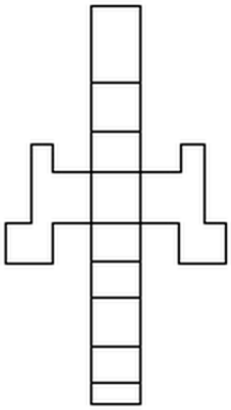
47. **The 3 - D figure shows the view of an object. Identify the correct view when the figure is opened up, from amongst the answer figures.** [4 marks]



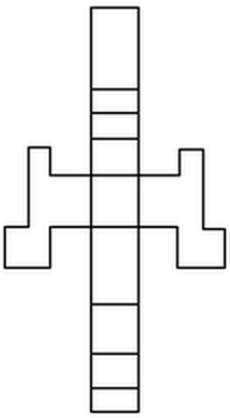
(A)



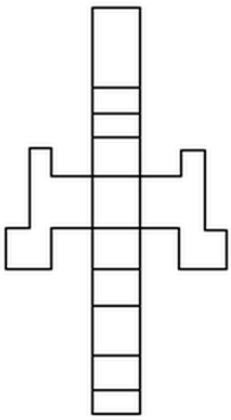
(B)



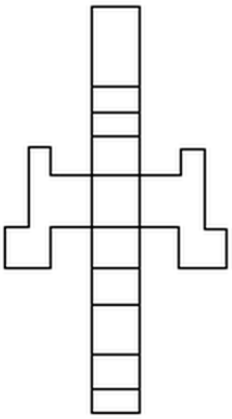
(C)



(D)



Correct Answer: (D)



Solution:

Concept:

- A prism unfolds into two congruent end faces and a connected strip of rectangular lateral faces.
- Each straight edge of the end-face perimeter contributes one rectangle to the lateral strip. Their widths follow the perimeter in cyclic order, including every inward step.

Step 1: Trace the stepped end face The solid has a constant depth and a stepped, non-rectangular end profile. Trace that profile completely rather than considering only its outer bounding rectangle. It has a high narrow portion, a wider projection on one side and a lower projection on the other. Following the outline around all outward corners and inward notches gives ten straight boundary segments. Both end faces in a valid net must reproduce this same stepped outline, with one reversed appropriately on the opposite side of the lateral strip.

Step 2: Match perimeter edges to folding panels When the lateral surface is laid flat, every one of those ten boundary segments needs a separate rectangular panel. Adjacent panels meet along fold lines, and the sequence of their lengths must follow the stepped perimeter without skipping a notch. The two stepped end pieces attach along corresponding lateral edges. Folding the strip successively around their outline must close the solid with neither an uncovered face nor an extra overlapping panel. This is a surface-development test, not merely a comparison of the two side shapes.

Step 3: Count the strip panels in the options The strip in option (D) contains ten successive rectangular panels, including the separate short panels needed for the two offsets of the stepped profile. Its two attached end pieces have the required congruent outline and can be enclosed by that strip. Options (A), (B) and (C) each have only nine strip panels: a needed division in the perimeter sequence is absent or merged. They therefore cannot cover all ten lateral faces of the shown prism. Even though their stepped side pieces look similar, that missing lateral panel prevents closure without changing the given solid.

Step 4: Conclusion The complete development is option (D), whose lateral strip supplies a panel for each of the ten perimeter edges. Hence, the correct option is (D).

Quick Tip to Solve: Trace and count every edge around one end face, including inward notches; the unfolded lateral strip must have exactly the same number of panels.

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

(A) Denmark

(B) Norway

(C) Rome

(D) Venice

Correct Answer: (C) Rome

Solution:

Concept:

- St. Peter's Basilica is the celebrated church in Vatican City, the independent enclave surrounded by Rome. Architectural-location questions commonly associate this monument with Rome.
- The answer must identify the particular landmark named in the question, rather than any city that also has well-known historic churches.

Step 1: Identify the landmark intended by the name In an architectural-awareness question, the famous St. Peter's refers to St. Peter's Basilica, whose great dome and monumental church complex are among the best-known landmarks of the Roman area. Its precise political location is Vatican City. Vatican City is an enclave within Rome, so Rome is the appropriate location among the four choices. The distinction between the independent Vatican territory and the surrounding city does not make Venice or a Scandinavian country a valid answer.

Step 2: Compare all four listed locations Denmark in option (A) and Norway in option (B) are Scandinavian countries. Neither is the location of the celebrated St. Peter's Basilica meant here. Option (C), Rome, gives the city surrounding Vatican City and therefore matches the landmark. Venice in option (D) is another Italian city with important religious architecture, but it is associated especially with St. Mark's Basilica. St. Mark's in Venice and St. Peter's in Vatican City are different monuments. Eliminating Venice prevents the common mistake of remembering only that the monument is Italian without identifying its city correctly. The known geographical association therefore singles out Rome from the alternatives.

Step 3: Conclusion The famous St. Peter's Basilica is in Vatican City, within Rome. Hence, the correct option is (C).

Quick Tip to Solve: Keep the landmark pairs distinct: St. Peter's belongs to Vatican City within Rome, whereas St. Mark's is the celebrated basilica in Venice.

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

[4 marks]

(A) North East

(B) North West

(C) South West

(D) South East

Correct Answer: (D) South East

Solution:

Concept:

- In the Northern Hemisphere, winter occurs when the northern half of Earth tilts away from the Sun. The Sun then has a southerly declination relative to the celestial equator.
- For an observer who experiences sunrise, a negative solar declination shifts the rising point south of due east. The corresponding setting point lies south of due west.

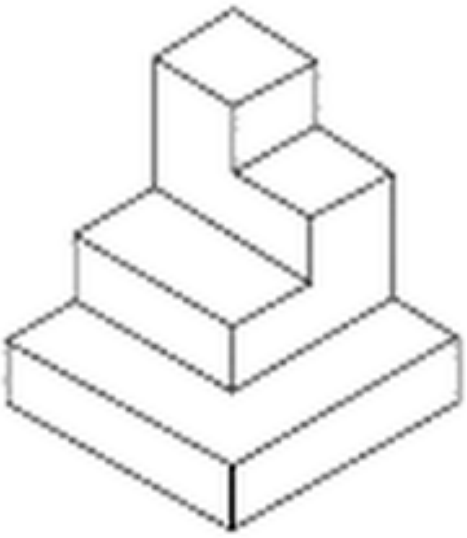
Step 1: Locate the rising side of the horizon The apparent daily motion of the Sun is from the eastern horizon toward the western horizon because Earth rotates from west to east. Sunrise therefore belongs to the eastern half of the horizon. Options North West and South West refer to the western half and describe possible setting directions, so neither can be the required rising direction.

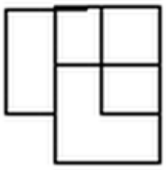
Step 2: Apply the winter shift At an equinox, the Sun rises approximately due east. During northern winter the Sun lies south of the celestial equator, so its path across the sky is lower and displaced southward. Its intersection with the eastern horizon is therefore on the southern side of east. That is the south-east direction. North East is associated with the northward rising-point shift in northern summer, rather than the winter shift asked for here. The exact bearing changes with latitude and date; the question asks for the directional quadrant, not a numerical azimuth.

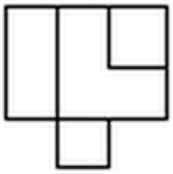
Step 3: Conclusion In the Northern Hemisphere in winter, the Sun rises in the South East. Hence, the correct option is (D).

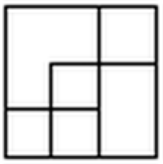
Quick Tip to Solve: First choose east for sunrise and west for sunset; then shift the point toward south in northern winter and toward north in northern summer.

50. 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 is an orthographic projection obtained by looking vertically down. Heights disappear, while the horizontal footprints of the visible levels remain.
- A solid base contributes its complete outer boundary. Edges of raised portions appear inside that boundary; no supporting portion is removed merely because a taller part stands over it.

Step 1: Trace the complete footprint The lowest slab is a complete square platform. Its plan must therefore have a closed square outer boundary. The upper stepped body is set back from the front and from one side, so a broad L-shaped strip of the base remains visible around the raised portion. Looking down does not produce an isolated tab projecting outside the base.

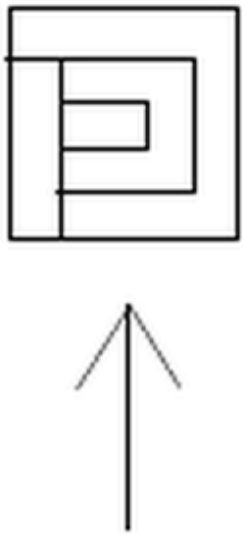
Step 2: Place the upper level boundaries Within the outer square, the raised portion has a long edge parallel to the side of the base. The two higher steps are arranged one behind the other on its

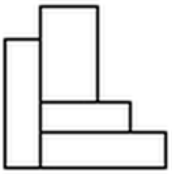
right-hand side in the plan orientation shown by the answer figures. Their transverse edges subdivide that right-hand strip. Option (D) preserves the outer square, the inset L-shaped boundary and the pair of transverse divisions. Options (A) and (B) introduce projecting or missing pieces in the outer footprint, although the slab is complete. Option (C) puts the level divisions on the wrong side and gives a different arrangement of the inset outlines. Compare the boundaries of surfaces, rather than retaining the sloping appearance of the isometric drawing.

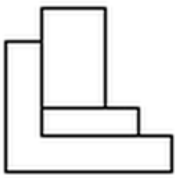
Step 3: Conclusion The top view is the square plan with the inset L-shaped outline and the right-side stepped divisions. Hence, the correct option is (D).

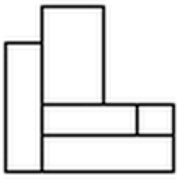
Quick Tip to Solve: For a top view, draw the lowest slab outline first, then add each raised surface as an internal footprint; discard all vertical height information.

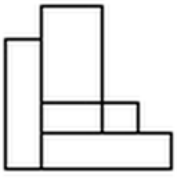
51. The problem figure shows the top view of an object. Identify the correct elevation from amongst the answer figures looking in the direction of the arrow. [4 marks]

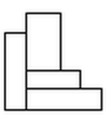


(A) 

(B) 

(C) 

(D) 

Correct Answer: (A) 

Solution:

Concept:

- An elevation is viewed horizontally in the indicated direction. Horizontal positions across the plan are preserved; distances along the viewing direction are compressed.
- For matching orthographic views, project each change in the plan boundary parallel to the viewing arrow and compare the visible vertical divisions in the candidate elevations.

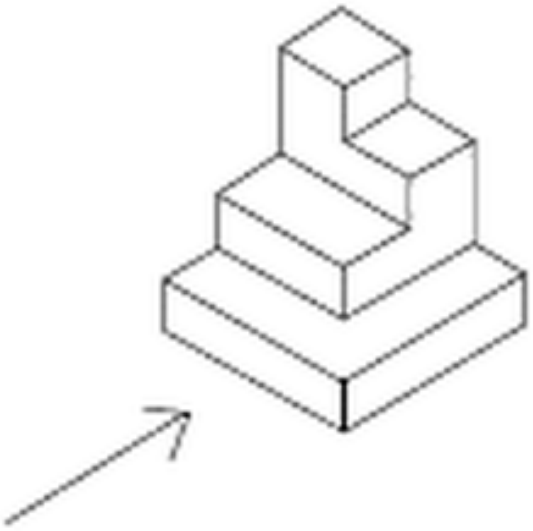
Step 1: Project along the given arrow The arrow points upward on the page, so view the object from the lower edge of the plan. The narrow strip at the left of the plan remains at the left of the elevation; it cannot be exchanged with the broad region to its right. The inner stepped outlines create changes at successive horizontal positions. Trace those positions upward from the lower edge rather than rotating the plan or treating the arrow as a direction of movement of the object.

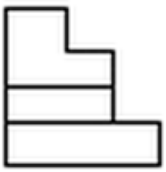
Step 2: Compare the candidate divisions Option (A) retains a separate left upright, the taller block immediately to its right, and two successively lower horizontal portions extending to the right. Its lower horizontal separation reaches the tall block edge and is consistent with the separate projected tiers of the plan. Option (B) merges the lower portion into a single bent outline and loses the full lower-tier separation. Option (C) inserts an additional division near the right end of the middle level, which has no corresponding boundary in the plan. Option (D) introduces a vertical division through the lower step beneath the tall block, also inconsistent with the given outline. The task is to match the supplied view convention and boundary relationships, not to assign numerical heights that the plan does not state.

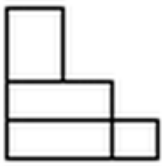
Step 3: Conclusion The elevation that matches the plan when viewed in the arrow direction is figure (A). Hence, the correct option is (A).

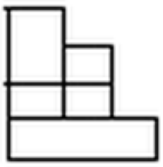
Quick Tip to Solve: Keep the viewing arrow fixed and project the plan boundaries parallel to it; check every internal line as well as the staircase silhouette.

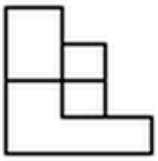
52. The 3 – D figure shows the view of an object. Identify the correct view in the direction of the arrow, from amongst the answer figures. [4 marks]

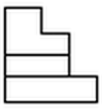


(A) 

(B) 

(C) 

(D) 

Correct Answer: (A) 

Solution:

Concept:

- Looking along an arrow produces an orthographic elevation: dimensions parallel to the line of sight collapse, while horizontal position and height remain.
- Visible boundaries between successive steps must be distinguished from hidden edges behind an opaque front face. A candidate can have the correct silhouette yet incorrect internal lines.

Step 1: Identify the side seen along the arrow The arrow approaches the object from the lower left of the isometric drawing. From this side, the highest upright lies at the left of the projected outline, then the height falls in two steps toward the right. The broad lowest platform provides the complete bottom rectangle. Thus the elevation has a descending staircase silhouette over a full-width base, rather than an outline with a separately projecting foot.

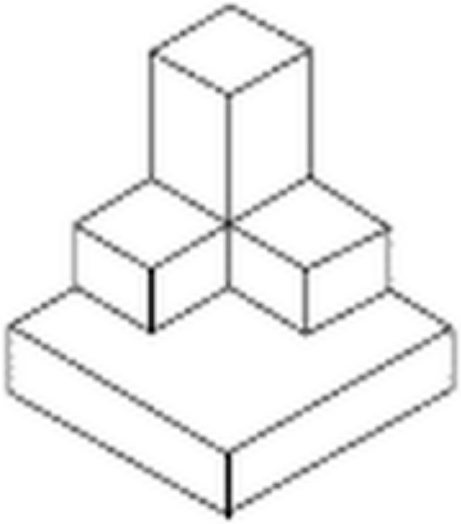
Step 2: Check the visible step boundaries In this direction the near face hides the lower part of the

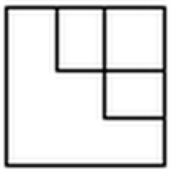
tallest rear portion. The horizontal boundary immediately above the base therefore continues across the two left portions, and another horizontal division occurs across the intermediate stepped portion. This arrangement is shown in option (A). Option (B) adds a vertical subdivision at the right-hand end of the lowest slab. Option (C) carries the tall-block vertical edge down through the exposed lower band where the front surface hides it. Option (D) uses the opposite arrangement of internal horizontal and vertical boundaries and does not show the same visible tiers. These differences matter because the question asks for a particular directed view, not merely any plausible side elevation of a staircase.

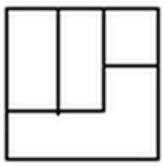
Step 3: Conclusion The directed elevation has the stepped outline and visible horizontal tier boundaries shown in figure (A). Hence, the correct option is (A).

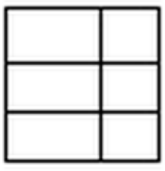
Quick Tip to Solve: After matching the outer staircase shape, check which rear vertical edges disappear behind the nearer tier; those lines distinguish similar elevations.

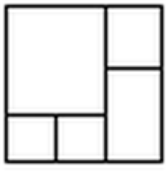
53. The 3 – D figure shows the view of an object. Identify the correct top view from amongst the answer figures. [4 marks]

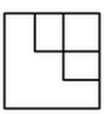


(A) 

(B) 

(C) 

(D) 

Correct Answer: (A) 

Solution:

Concept:

- A plan shows the horizontal footprints of the visible surfaces, as seen vertically from above. Vertical faces do not retain their isometric sloping edges.
- The complete square base fixes the outer boundary. Each higher block contributes an inset footprint; adjacent blocks and height changes determine the internal line pattern.

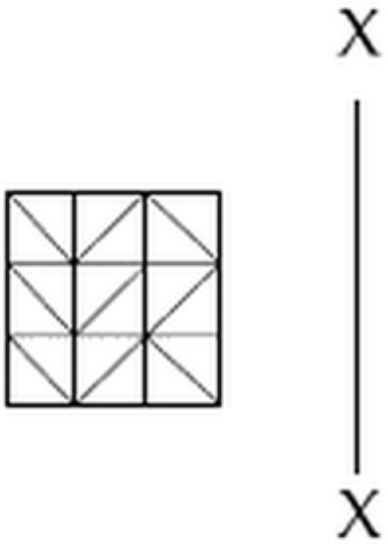
Step 1: Separate the platform from the raised blocks The lowest part is a square platform, so the plan must be enclosed by a square with no projecting extensions. Above it are the rear tall square block and two lower blocks extending toward the front and the side. Their arrangement leaves a large unoccupied part of the base visible. The tall block remains a square footprint even though its vertical faces are much taller in the isometric drawing.

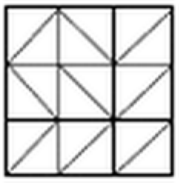
Step 2: Match the three footprints Project the upper surfaces straight down. The tall rear block occupies a corner region; one low block lies immediately to one side and another lies immediately in front of it. Their edges form the three-square stepped arrangement at the top and right of option (A), leaving the remaining broad L-shaped base surface visible. Option (B) changes the placement of the interior boundaries and extends a raised region along the wrong side. Option (C) divides the whole square into repeated full-width strips, which would require a different arrangement of raised surfaces. Option (D) puts the small stepped divisions at the lower left instead of at the locations obtained from the solid. No perspective shortening or apparent vertical length is carried into this comparison.

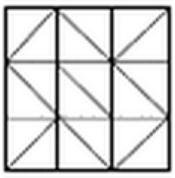
Step 3: Conclusion The correct top view is the square plan containing the three raised footprints arranged as in figure (A). Hence, the correct option is (A).

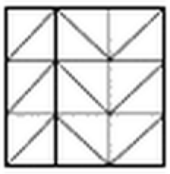
Quick Tip to Solve: For a block arrangement, mark the footprint of the tallest block and then locate its neighbours; do not mistake vertical faces for extra plan regions.

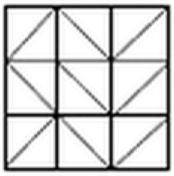
54. Which one of the answer figures is the correct mirror image of the problem figure with respect to X – X ? [4 marks]

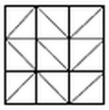


(A) 

(B) 

(C) 

(D) 

Correct Answer: (D) 

Solution:

Concept:

- Reflection in a vertical mirror reverses left and right while leaving every point at the same height. Top and bottom rows are not exchanged.
- A diagonal reverses its slope in a left-right reflection. For a three-column grid, column 1 moves to column 3, column 2 stays central, and column 3 moves to column 1.

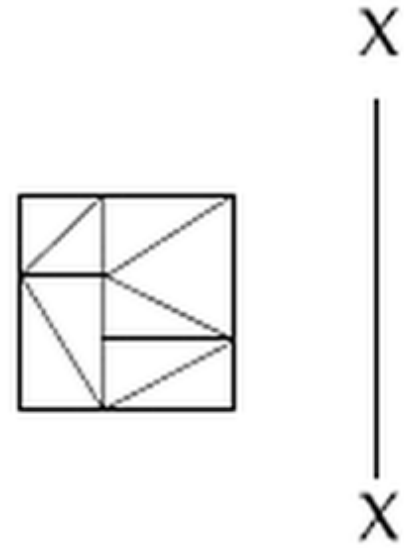
Step 1: Reflect the diagonal pattern row by row The mirror X–X is vertical and stands to the right of the problem figure. Read the three diagonal cells in each row and reflect their column positions. In the original, the top-row diagonal pattern is backslash, forward slash, backslash. Reversing the order and also reversing each diagonal gives forward slash, backslash, forward slash in the reflected top row. Preserve the horizontal grid levels throughout this operation.

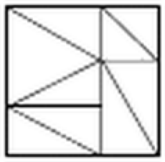
Step 2: Check the middle and bottom rows The original middle row has backslash, forward slash, forward slash; its reflection must therefore have backslash, backslash, forward slash. The original bottom row has backslash, forward slash, backslash, so its reflection again has forward slash, backslash, forward slash. Option (D) reproduces all three rows exactly. Option (A) has an incorrect lower-middle diagonal. Option (B) has incorrect cells on the right and in the lower middle. Option (C) changes the required pattern, including the middle-left diagonal and the appearance of the central grid line. Checking only the outer square cannot decide the answer because reflection preserves that square in every candidate; the internal diagonals provide the distinguishing evidence.

Step 3: Conclusion Only figure (D) preserves all row heights and reverses every diagonal with the required left-right exchange. Hence, the correct option is (D).

Quick Tip to Solve: For a grid mirror image, reverse the column order and then reverse every slash direction; a single unmatched cell eliminates an option.

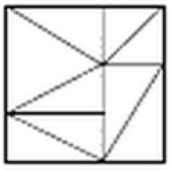
55. Which one of the answer figures is the correct mirror image of the problem figure with respect to X – X ? [4 marks]



(A) 

(B) 

(C) 

(D) 

Correct Answer: (C) 

Solution:

Concept:

- A vertical mirror performs a left-right reversal, so corresponding points keep their heights and exchange their horizontal distances from the mirror.
- Horizontal segments stay horizontal, vertical segments stay vertical, and oblique segments reverse their horizontal direction. Their endpoints and junctions must all be preserved.

Step 1: Locate the major reflected junctions The narrow vertical strip at the left of the problem figure must appear at the right in the mirror image. The long diagonal running across the lower part of the left strip must therefore connect the right outer edge at the upper strip divider to the bottom of the inner vertical divider, descending leftwards as it runs down the reflected strip. The triangular fan occupying the right part of the original moves to the left. Its main meeting point remains at the same vertical level, while its rays reverse their horizontal directions.

Step 2: Test every segment against the alternatives After reflection, the upper-left large triangular region points toward a junction near the upper end of the right strip. The lower-left part retains a horizontal divider, and its diagonal runs toward the bottom end of the right strip. The short diagonal in the upper part of the narrow strip must slope downward to the right. Figure (C) has this complete combination of junctions and slopes. Figure (A) sends the long right-strip diagonal to the wrong endpoint. Figure (B) gives the wrong direction to the lower-left diagonal and the long strip division. Figure (D) reverses the short upper diagonal incorrectly. These are endpoint tests, so they also rule out a rotation: a rotation could move a top feature to the bottom, whereas the specified mirror leaves its height unchanged.

Step 3: Conclusion The reflected strip, triangular fan and all diagonal junctions match figure (C). Hence, the correct option is (C).

Quick Tip to Solve: Check the narrow strip first and compare its short upper diagonal and long lower diagonal; their endpoints usually eliminate nearly identical mirror options.

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

(A) Green

(B) Blue

(C) Orange

(D) Red

Correct Answer: Both Green (A) and Blue (B) are commonly considered calming; the supplied key selects Green (A), but the wording does not uniquely exclude Blue.

Solution:

Concept:

- Cool colours are commonly associated with calm, rest and reduced visual excitement. Both green and blue belong to the cool side of the usual design colour scheme.
- Colour associations are qualitative: hue, saturation, brightness, context and personal response all affect the impression. A colour name alone does not make the categories mutually exclusive.

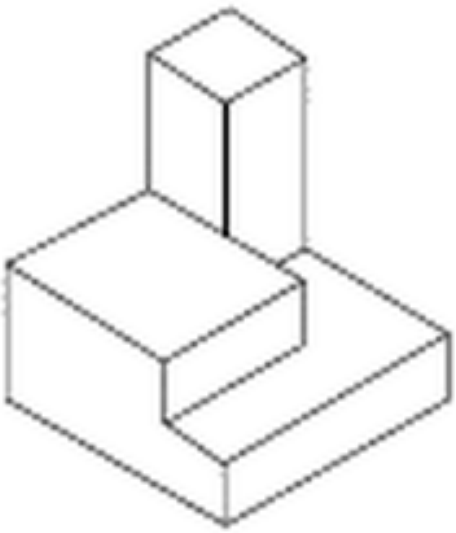
Step 1: Identify the intended keyed colour Green is conventionally associated with nature, balance and restfulness. In an architectural or environmental colour scheme, it can create a quiet, reassuring impression. This is the calming colour selected by the supplied answer key, namely option (A). Its association with foliage and natural surroundings explains why it is frequently used where a restful visual atmosphere is wanted.

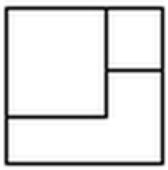
Step 2: Check whether the other choices are excluded Blue, option (B), is also conventionally considered a calming cool colour: it is associated with the sky and water and is widely used to suggest tranquillity. Thus blue cannot be ruled out solely by the printed wording. Orange and red are warm colours and are more commonly associated with activity, stimulation and visual emphasis, so they are weaker choices for the stated description. The wording supplies no further condition that distinguishes green from blue. Consequently, although green is the intended keyed answer, the general phrase "a calming color" admits both (A) and (B), rather than establishing one uniquely defensible option.

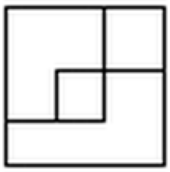
Step 3: Conclusion The supplied key selects Green, option (A). However, Blue, option (B), is also conventionally regarded as calming, so the printed wording does not uniquely distinguish these two choices.

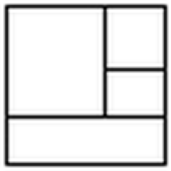
Quick Tip to Solve: For colour-association questions, compare warm versus cool first, then check whether more than one remaining cool colour has the stated psychological association.

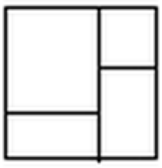
57. The 3 – D figure shows the view of an object. Identify the correct top view from amongst the answer figures. [4 marks]

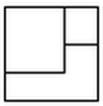


(A) 

(B) 

(C) 

(D) 

Correct Answer: (A) 

Solution:

Concept:

- A top view projects the object vertically onto a horizontal plane. Heights disappear, but the footprints and the boundaries between exposed horizontal surfaces remain.
- The base, the raised platform and the tall square pillar must retain their relative positions. A

vertical edge cannot become an extra line crossing an otherwise continuous top surface.

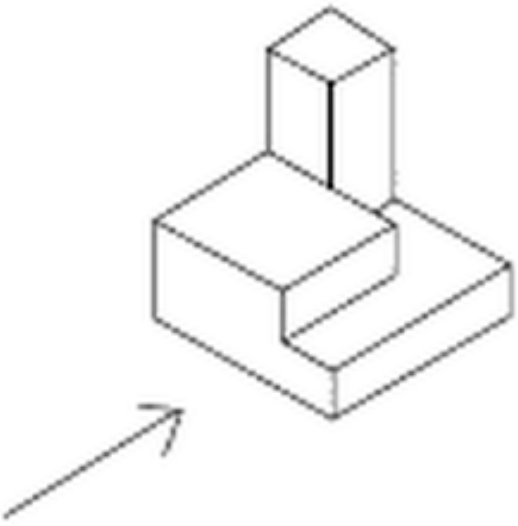
Step 1: Trace the footprints from above Start with the full square footprint of the lowest block. The broad raised platform occupies the larger region on the left of the plan. The tall narrow pillar occupies the small square at the back right. Its square footprint meets the upper part of the platform boundary; it does not extend down to the front edge. The remaining exposed base is an L-shaped strip around the lower and right sides of the broad platform.

Step 2: Compare the internal boundaries In option (A), the large left region reaches farther forward than the small upper-right square, leaving exactly the required L-shaped exposed area. Option (B) inserts an extra inward step and a small internal square not produced by the solid. Option (C) makes a full-width transverse line beneath both upper regions, incorrectly extending a surface boundary across the open base. Option (D) continues the vertical division to the front edge and divides the lower-left part, introducing a boundary that the top surfaces do not possess. Only (A) preserves both the square pillar footprint and the unequal forward extent of the raised regions.

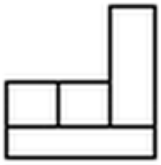
Step 3: Conclusion The plan with the large raised region on the left, the small pillar footprint at the back right and the remaining L-shaped exposed base is option (A). Hence, the correct option is (A).

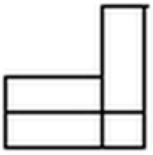
Quick Tip to Solve: Ignore vertical height first; trace the outer footprint, then add only the edges separating visible horizontal surfaces.

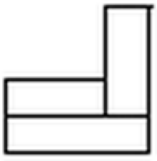
58. The 3 – D figure shows the view of an object. Identify the correct view in the direction of the arrow, from amongst the answer figures. [4 marks]



(A) 

(B) 

(C) 

(D) 

Correct Answer: (A) 

Solution:

Concept:

- An elevation is obtained by looking parallel to the indicated arrow. Features lying along the viewing direction overlap, so a drawing of a different side can have the right levels but still be wrong.
- The outline must preserve the successive heights of the base, raised platform and narrow tall pillar. Visible edges are retained only when they separate faces in that particular projection.

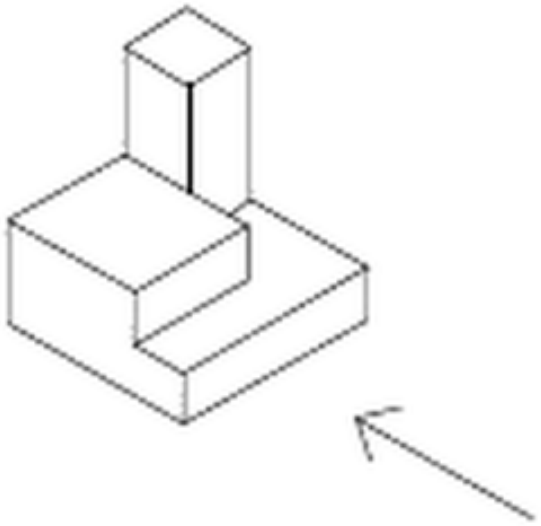
Step 1: Follow the indicated direction Follow the arrow from the lower left towards the object. Along that line of sight, the tall pillar and the nearer platform overlap in depth. Across the resulting elevation the pillar occupies the leftmost narrow interval, the intermediate platform extends farther to the right, and the base extends farthest. Their front faces on this side are flush, so a line separating the base from the platform is not visible through the combined face. This gives the descending stepped profile in option (A): tall at the left, intermediate in the middle and lowest at the right. The line visible below the exposed pillar records its junction with the platform.

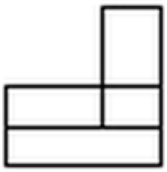
Step 2: Eliminate views from the other side Option (A) presents the single stepped profile without adding the divisions characteristic of the other viewing side. Options (B), (C) and (D) put the tall upright at the opposite end of the displayed projection and show additional subdivisions through the lower levels. They resemble alternative face views, but the question fixes the direction by its arrow. In particular, copying a familiar front elevation simply because it contains three heights ignores the change of viewing direction. Match the direction and overlap of the solid first, then its outer contour and visible edges.

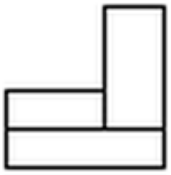
Step 3: Conclusion The stepped elevation in the direction specified by the arrow is the first answer figure. Hence, the correct option is (A).

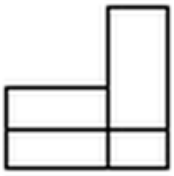
Quick Tip to Solve: Fix the viewing direction before comparing heights; a correct profile from the opposite side is still the wrong elevation.

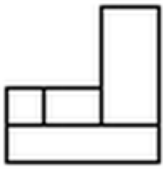
59. The 3 – D figure shows the view of an object. Identify the correct view in the direction of the arrow, from amongst the answer figures. [4 marks]

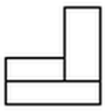


(A) 

(B) 

(C) 

(D) 

Correct Answer: (B) 

Solution:

Concept:

- An orthographic elevation removes depth along the arrow while preserving horizontal position and vertical height. Rear portions hidden by a nearer block do not create visible lines through that block.
- The base produces the lowest full-width band. The intermediate platform and tall pillar then determine where the higher outline and its visible internal boundaries occur.

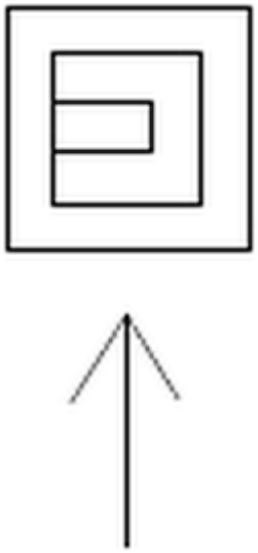
Step 1: Project the three levels Looking from the direction of the lower-right arrow, trace the base as one full-width rectangular band. Above it, the broad raised platform forms the lower portion on the left, while the tall square pillar rises on the right. The platform hides the lower portion of the pillar wherever their projections overlap. Consequently the horizontal top edge of the intermediate level stops at the pillar side rather than continuing across its visible upper face.

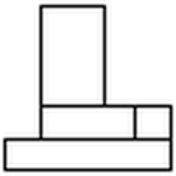
Step 2: Check every proposed dividing line Option (B) has the required lowest band, intermediate left-hand rectangle and taller right-hand portion, with the intermediate top edge ending at the upright. In option (A), a horizontal line continues through the right-hand upright at the intermediate height, introducing an edge absent from this view. Option (C) extends a vertical dividing line down through the base and therefore subdivides a continuous lower face. Option (D) adds another vertical division in the left intermediate region, as though a further block edge were visible there. Neither the base nor the platform has that additional visible subdivision. The clean junction in (B) is the one compatible with the occlusion in the supplied solid.

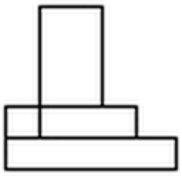
Step 3: Conclusion The correct arrow-direction elevation is the second answer figure. Hence, the correct option is (B).

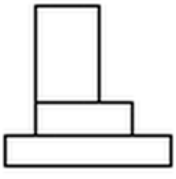
Quick Tip to Solve: After matching an elevation outline, inspect the interior lines: reject any line continuing through a face that should be continuous or hidden.

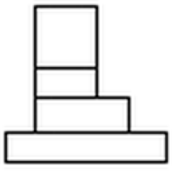
60. The problem figure shows the top view of an object. Identify the correct elevation from amongst the answer figures looking in the direction of the arrow. [4 marks]

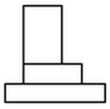


(A) 

(B) 

(C) 

(D) 

Correct Answer: (C) 

Solution:

Concept:

- A top view gives the horizontal footprint and the positions of the surface boundaries. To choose an elevation, project perpendicular to the arrow and keep the resulting left-to-right alignment.
- Boundaries parallel to the direction of sight can overlap in elevation. A plan edge must not be copied as an extra vertical division unless it produces an actual visible edge in the requested view.

Step 1: Project the plan towards the arrow The outer square is the broadest footprint. The inset outline gives the narrower intermediate portion, and the smallest rectangular feature is displaced to the left within that outline. Looking upwards along the arrow, project their left and right limits onto a horizontal line. The lowest part must extend on both sides of the intermediate part, and the narrow upper part must stand towards the left of that intermediate portion. This relative alignment is more decisive than guessing absolute heights from a plan.

Step 2: Match the junctions and rule out the alternatives Option (C) preserves the projected alignment with a wide base, an inset middle level and the narrow upper rectangle on the left. It also keeps the visible faces free of unsupported internal divisions. Option (A) extends the intermediate piece towards the right and inserts a vertical division there, unlike the single inset footprint. Option (B) adds a vertical line through the left portions of the lower two levels. Option (D) splits the upper rectangle horizontally even though the corresponding smallest footprint is one continuous element. These added edges do not follow from the supplied plan. The third figure is the consistent elevation among the choices.

Step 3: Conclusion The third answer figure gives the consistent elevation looking along the arrow. Hence, the correct option is (C).

Quick Tip to Solve: Project the left and right limits of each footprint along the viewing arrow before comparing the stepped elevation choices.

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

(A) 20″

(B) 16″

(C) 22″

(D) 18″

Correct Answer: (D) 18″

Solution:

Concept:

- A brick wall is named by its thickness in units of the length of a brick. Thus a one-brick wall is approximately one brick length thick, whereas a two-brick wall is approximately two brick lengths thick.
- In the conventional inch-based building terminology used by these options, a brick length is taken as $9\,\text{in}$. Wall thickness means the distance through the wall, perpendicular to its faces; it does not

mean the height of two brick courses.

Step 1: Identify the brick-length convention The options are expressed in inches, so use the familiar nominal inch-based sizes: a half-brick wall is about $4.5\,\text{in}$ thick and a one-brick wall is about $9\,\text{in}$ thick. The expression "two brick wall" therefore calls for twice the one-brick thickness. It is not a request to add two brick heights or to measure the length of a stretcher course.

Step 2: Calculate and compare the thickness Multiply the one-brick nominal thickness by two:

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

Consequently, $20\,\text{in}$, $16\,\text{in}$ and $22\,\text{in}$, in options (A), (B) and (C), do not represent two conventional $9\,\text{in}$ brick lengths. In an actual construction detail, brick dimensions, mortar joints and finishes must be specified separately; the question tests the customary nominal wall-size designation rather than a finished plaster-to-plaster measurement.

Step 3: Conclusion The conventional thickness of a two-brick wall is $18\,\text{in}$, matching the listed $18''$. Hence, the correct option is (D).

Quick Tip to Solve: Recall the nominal sequence: half brick is 4.5 inches, one brick is 9 inches, and two bricks are 18 inches. Use brick length, not brick height.

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

(A) King of Nepal

(B) King of Netherlands

(C) King of Prussia

(D) Queen of England

Correct Answer: (D) Queen of England

Solution:

Concept:

- Buckingham Palace is in London and is associated with the British monarchy. Its identity as a royal residence is the clue that links the building to its occupant rather than to a monarch from another country.
- Historical general-knowledge questions must be read in their examination context. In January 2020, the British sovereign was Queen Elizabeth II, so the option describing a queen is the relevant one.

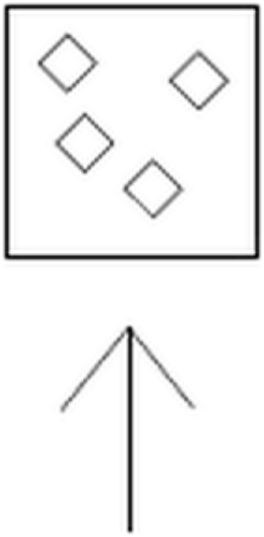
Step 1: Identify the palace and its royal association Locate Buckingham Palace in London, the capital of the United Kingdom. The palace is a residence of the British sovereign and a setting for royal ceremonial and official functions. At the date of this examination, Queen Elizabeth II occupied the British throne. Therefore, among the four given descriptions, the one intended to identify its royal resident is "Queen of England." The precise constitutional description is Queen of the United Kingdom; the wording in the option uses the familiar informal description.

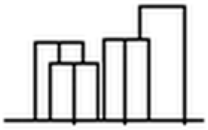
Step 2: Eliminate the other royal houses The King of Nepal belongs to Nepal's former royal house and is not the British sovereign, so option (A) does not match the palace. The King of the Netherlands belongs to the Dutch monarchy, which is a different royal house; this rules out option (B). Prussia was a historical European kingdom, and its king is not associated with Buckingham Palace as the British royal residence, so option (C) is also incorrect. These alternatives name different monarchies rather than alternative descriptions of the British sovereign in 2020.

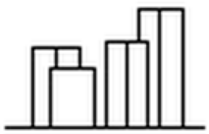
Step 3: Conclusion In the examination's 2020 context, Buckingham Palace is associated with Queen Elizabeth II, described in the choices as the Queen of England. Hence, the correct option is (D).

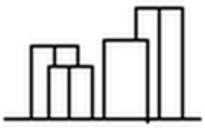
Quick Tip to Solve: Link Buckingham Palace with London and the British royal family. For a dated paper, identify the sovereign at the time of that examination.

63. 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:

- A square prism whose plan is a diamond presents two adjacent vertical faces in elevation. Its projected horizontal width is the horizontal span of that diamond, and the shared face edge lies below its left-right midpoint.
- Objects farther along the viewing arrow can be partly hidden by nearer objects. Match the projected positions and overlaps, rather than changing the left-to-right order to make a chosen silhouette fit.

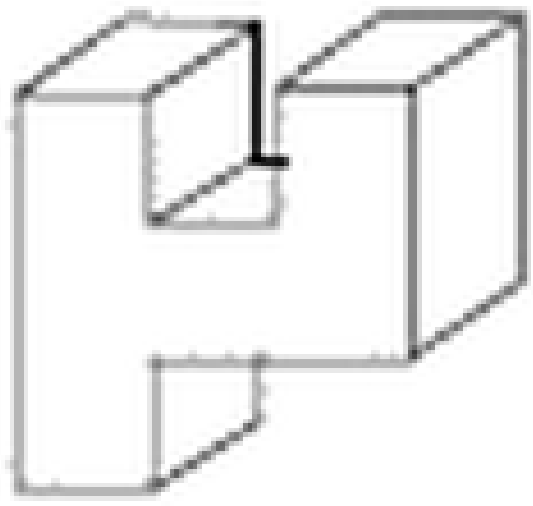
Step 1: Locate the nearer and farther objects The arrow points upwards. Thus the lowest diamond in the plan is the nearest object; the two diamonds near the top are farther away. There are two horizontal clusters: an overlapping pair towards the left and a pair towards the middle-right. In the left cluster the front diamond shifts to the right of the rear one; in the right cluster the front diamond shifts to the left of the rear one. Project the extreme left and right vertices of each diamond vertically into the elevation. The nearer member must cover the appropriate lower part of the member behind it without changing its horizontal position.

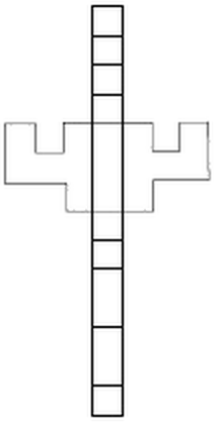
Step 2: Compare the visible face edges Option (D) retains the two clusters, their relative spacing and the face divisions consistent with the diamond-shaped plans. The left rear object remains visible to the left of the nearer left object. In the right cluster the front object occupies the central position and the taller rear object remains visible at its right, with the corresponding vertical face edges. Option (A) omits the required face division on the upper right object. Option (B) loses a face division in the left cluster and changes the right cluster grouping. Option (C) treats the central object as an undivided broad face, contrary to the oblique square plan. Checking the internal edges as well as the outer silhouettes selects (D).

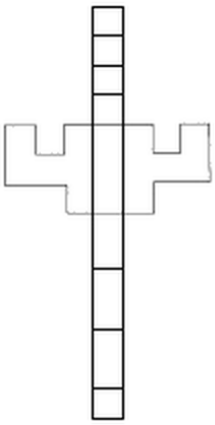
Step 3: Conclusion The elevation whose positions, overlaps and visible vertical face edges match the plan is option (D). Hence, the correct option is (D).

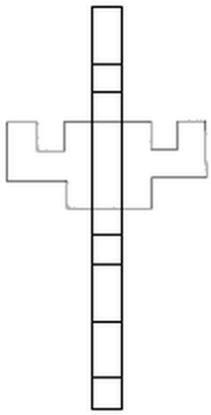
Quick Tip to Solve: Mark each diamond centre and its extreme horizontal vertices; then apply nearer-object occlusion before judging the elevation.

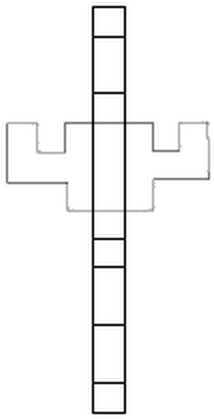
64. The 3 - D figure shows the view of an object. Identify the correct view when the figure is opened up, from amongst the answer figures. [4 marks]



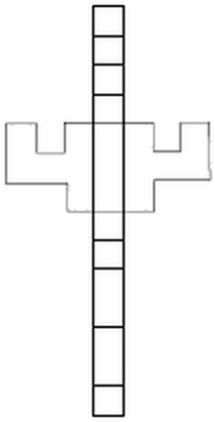
(A) 

(B) 

(C) 

(D) 

Correct Answer: (A)



Solution:

Concept:

- The solid is a prism with a notched polygonal end face. Its net contains two congruent copies of that end face and a continuous strip of rectangles forming the lateral surface.
- Each rectangle in the lateral strip corresponds to one boundary edge of the polygonal end. The rectangle widths follow those edge lengths in cyclic order; matching only the overall outline of the net is insufficient.

Step 1: Trace the perimeter of an end face Use the notched end face as the reference. It contains short unit-length segments around the top recess and bottom step, two longer segments on the outer right and lower side, and one longest uninterrupted outer side. Starting with that longest side and following the boundary gives a three-unit segment, five successive unit segments, two successive two-unit segments and two more unit segments before returning to the start. Reversing the traversal gives the same sequence in reverse order. The lateral strip must contain one rectangle for every one of these segments.

Step 2: Compare the strips beside the matching end faces All four choices resemble nets with two notched end faces, so inspect the folds in the central strip. Option (A) has the required three-unit attachment region and, on continuing around the strip, the unit and double-unit panels in the correct cyclic order. Option (B) replaces the two short panels immediately beyond the attachment by a longer panel and consequently gives the wrong boundary sequence. Option (C) also changes the lengths of panels near the attachment and at the upper end. Option (D) combines upper short panels into a longer one. These changes would place a fold at the wrong end-face vertex or omit one of the required face boundaries when wrapped around the prism.

Step 3: Conclusion The first net has the lateral-panel sequence required to close around both notched end faces. Hence, the correct option is (A).

Quick Tip to Solve: Trace the polygon perimeter and list its edge lengths in order; compare that cyclic list with the lateral strip of each proposed net.

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

(A) Kerala

(B) Punjab

(C) Uttar Pradesh

(D) Odisha

Correct Answer: (A) Kerala

Solution:

Concept:

- Tea plantations need a moist climate with abundant rainfall and well-drained soils. Hill slopes provide drainage and can support extensive cultivated tea estates.
- Kerala's Western Ghats, especially the Munnar region, are associated with large tea gardens. The answer must be selected from the four states actually listed.

Step 1: Connect tea cultivation with the landscape Tea gardens form an important plantation landscape in the highlands of Kerala. Munnar, in the Western Ghats, is particularly well known for hills covered with extensive tea estates. Its moist climate, rainfall and hill slopes provide the conditions associated with this crop. Thus Kerala has the required direct connection with large tea gardens.

Step 2: Compare the listed states Kerala, option (A), matches the plantation landscape described. Punjab is principally associated with irrigated plains and crops such as wheat and rice, rather than extensive tea estates. Uttar Pradesh is associated with the Gangetic agricultural plains and major crops such as wheat and sugarcane. Odisha is not the major tea-garden state intended by this set of alternatives. The question does not require Kerala to be India's only tea-producing state: other famous tea regions, including Assam, are not among the choices. Within the supplied alternatives, Kerala is the appropriate identification.

Step 3: Conclusion Large tea gardens, including the well-known estates around Munnar, are found in Kerala. Hence, the correct option is (A).

Quick Tip to Solve: Associate Munnar and the Western Ghats tea-estate landscape with Kerala; choose from the states actually offered.

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

(A) Red

(B) Blue

(C) Green

(D) Yellow

Correct Answer: (C) Green

Solution:

Concept:

- In the traditional artist's pigment colour wheel used for basic design, red, yellow and blue are the primary colours.
- A secondary colour is obtained by mixing two primary colours. The standard secondary colours in this system are orange, green and violet.

Step 1: Apply the pigment colour-wheel convention The aptitude question concerns colour in art and design, so use the traditional red–yellow–blue pigment system. The three primaries are the starting colours of this wheel, whereas a secondary lies between a pair of primaries and is formed by mixing that pair. This convention is distinct from the additive red–green–blue system used for light and electronic displays; switching systems would give a different classification.

Step 2: Identify the mixture and eliminate the primaries Mixing yellow and blue pigments gives green in the elementary colour wheel. Therefore green belongs to the secondary group. The other three listed colours are precisely the primaries of this convention: red in option (A), blue in option (B), and yellow in option (D). Each is a starting colour, rather than the secondary produced by a pair of the primaries. For comparison, mixing red with yellow gives orange, while mixing red with blue gives violet. These additional mixtures confirm that green is the only member of the secondary group among the four alternatives.

Step 3: Conclusion Green is a secondary colour in the traditional pigment colour wheel, obtained by mixing yellow and blue. Hence, the correct option is (C).

Quick Tip to Solve: For the artist's colour wheel, remember RYB as the primary trio; their pairwise mixtures are orange, green and violet.

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

(A) Shiny

(B) Smooth

(C) Glossy

(D) Coarse

Correct Answer: (D) Coarse

Solution:

Concept:

- Texture describes the character of a surface, particularly how fine, rough, smooth or uneven it appears or feels. A coarse texture contains readily noticeable grains or projections.
- Sandpaper consists of abrasive particles bonded to a backing. The exposed abrasive grains rub against another material to remove small amounts of its surface.

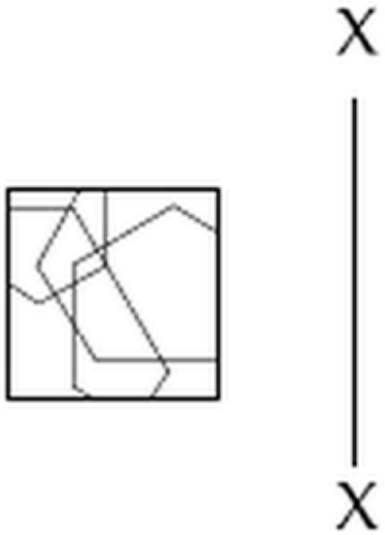
Step 1: Relate sandpaper's surface to its function Sandpaper is used to abrade, shape or prepare surfaces. Its working face carries hard particles that project above the backing. These grains make many small contacts with the material being sanded and scratch away irregularities. Consequently, the characteristic feel of the abrasive face is rough or gritty. The descriptive term among the alternatives that captures this granular roughness is coarse.

Step 2: Distinguish texture from shine Shiny in option (A) and glossy in option (C) describe a surface's reflective appearance or finish, not the defining abrasive texture of sandpaper. Smooth in option (B) suggests an even surface without the noticeable roughness needed for sanding. Although sandpapers are manufactured in different grades, even fine grades rely on abrasive grains rather than a glossy working face. The question asks for the ordinary identifying texture of the material, so the coarse description in option (D) is appropriate. Do not confuse the smoother finish that sandpaper can produce on another object with the texture of the sandpaper itself.

Step 3: Conclusion The abrasive, gritty working surface of sandpaper has a coarse texture. Hence, the correct option is (D).

Quick Tip to Solve: Link a material's texture with its use: sandpaper removes material through projecting abrasive grains, so choose coarse rather than smooth or glossy.

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:

- In a plane mirror whose axis X–X is vertical, every point moves the same horizontal distance to the opposite side. Heights and vertical order stay unchanged; left and right are interchanged.
- A correct reflection must preserve every polygon edge, crossing and contact with the square boundary. A rotated figure or one with an altered intersection is not a mirror image.

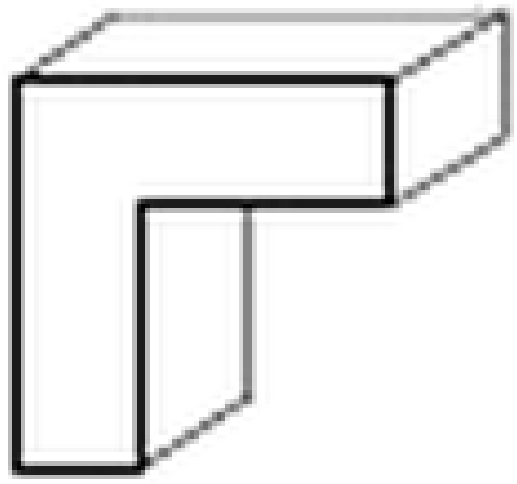
Step 1: Reverse the outline horizontally The mirror lies to the right of the square. Imagine transferring the right edge of the given square to the left edge of its reflected copy, with the top edge still at the top. The original long horizontal segment near the bottom remains horizontal at the same height. Its endpoint on the original right boundary must consequently occur on the left boundary of the answer figure. The upper sloping outline also changes the direction of each slope without moving its vertices up or down.

Step 2: Check the internal intersections Trace the irregular line near the upper left of the original. Its sharp upper vertex is very close to the top edge, and its reflected vertex must be equally close to that edge near the upper right. Continue down through the crossings and around the lower angled portion: option (A) preserves these positions and connections after the left-right reversal. Option (B) shifts the upper vertex and changes that local outline. Option (C) changes the descending internal segment into a different path near the centre. Option (D) changes the junction of the slanting lines on the right. These are changes of geometry, not consequences of reflection.

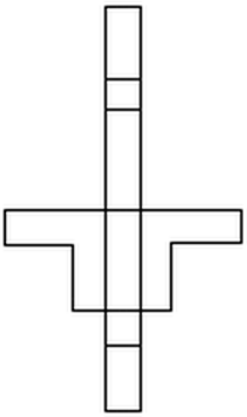
Step 3: Conclusion Option (A) preserves all heights and reverses the complete figure from left to right about X–X. Hence, the correct option is (A).

Quick Tip to Solve: Trace one distinctive vertex close to the top border, then follow its connected edges; a mirror reverses horizontal position but never height.

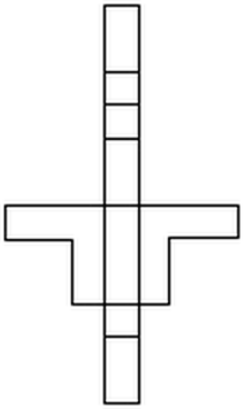
69. The 3 - D figure shows the view of an object. Identify the correct view when the figure is opened up, from amongst the answer figures. [4 marks]



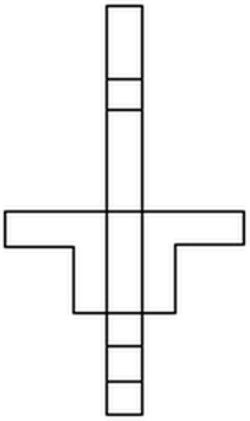
(A)



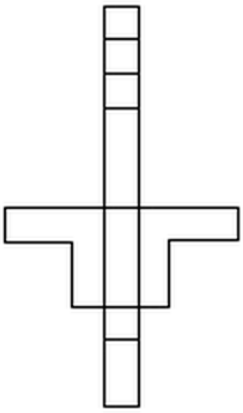
(B)



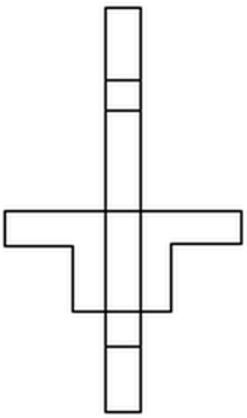
(C)



(D)



Correct Answer: (A)



Solution:

Concept:

- An unfolded prism consists of two congruent end faces and a connected strip of rectangular lateral faces. The widths of the strip panels follow the successive edge lengths around the end face.
- For an L-shaped end face with equal arm thickness, the perimeter includes two long outer edges, two shorter re-entrant edges and two edges equal to the arm thickness.

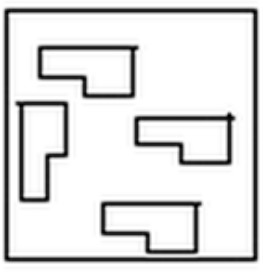
Step 1: Trace the boundary of the L-shaped end Read the given solid as a prism with an L-shaped end. In units of its arm thickness, the outer vertical and outer horizontal edges each have length three. Each return along the inner corner has length two, while the two free tips have length one. Thus a walk around the end face gives the cyclic edge sequence three, three, one, two, two, one. The rectangular side faces must reproduce this same order, allowing a different starting point or the reverse traversal.

Step 2: Match the strip and the two end faces Option (A) has the required pair of matching L-shaped ends attached to the lateral strip. Reading the strip from one free end to the other gives lengths proportional to two, one, three, three, one, two. This is the same perimeter sequence started at another edge. Folding at these lines therefore closes the side surface with the two L ends in corresponding positions. In (B), one of the long panels is subdivided by an extra fold line; (C) splits the lower end into too many short panels; and (D) splits the upper run into short panels. Those divisions do not match the six boundary edges of the given prism. A plausible L outline alone is insufficient: the order of the side rectangles must also agree.

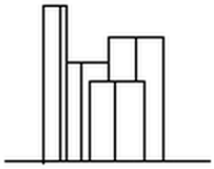
Step 3: Conclusion The net in option (A) has the correct end faces and lateral panel sequence for the given L-shaped prism. Hence, the correct option is (A).

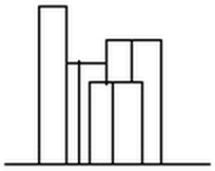
Quick Tip to Solve: Walk around the perimeter of one end face and compare that cyclic sequence with the strip widths before mentally folding a prism net.

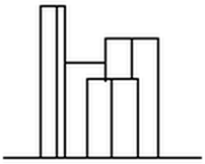
70. The problem figure shows the top view of objects. Looking in the direction of the arrow, identify the correct elevation, from amongst the answer figures. [4 marks]

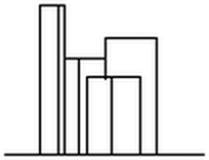


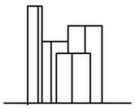


(A) 

(B) 

(C) 

(D) 

Correct Answer: (A) 

Solution:

Concept:

- An elevation is an orthographic view in the specified horizontal viewing direction. Horizontal positions across the plan are retained while depth is projected away.
- For overlapping objects, the nearer object hides edges of a farther object. A step or re-entrant corner in a footprint determines where visible vertical divisions can occur in the elevation.

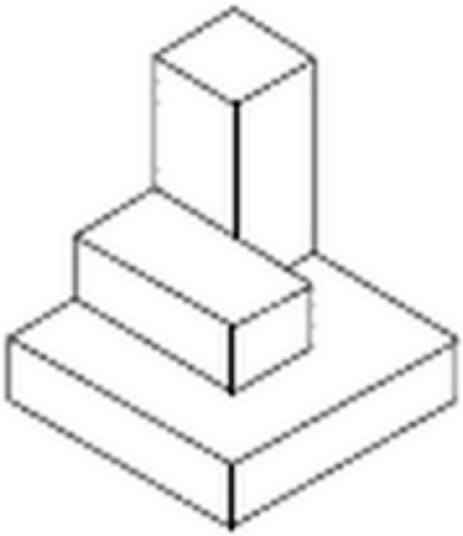
Step 1: Read the viewing direction and front objects The arrow points upward from below the plan, so the lower shapes are nearer to the observer. Keep the horizontal order of the footprints unchanged. The narrow L-shaped object on the left lies in front of the left part of the upper object. Its two offsets produce separate visible vertical edges near the left of the elevation. The lower central object similarly hides part of the objects farther back. Therefore the answer must preserve both the locations of the footprint edges and their front-to-back ordering.

Step 2: Compare the visible edge pattern In option (A), the tall left-hand form has the close pair of internal vertical boundaries corresponding to the offset of the left footprint. The central low foreground form retains its division, while the higher form behind it remains visible above it and toward the right. Its right-hand division also agrees with the step in the right footprint. Option (B) simplifies the left-hand tall form and loses the required narrow visible division. Option (C) preserves the tall left form but omits the internal vertical division in the lower rear form immediately to its right. Option (D) retains the left and central divisions but omits the internal vertical division in the upper right form. The important discriminator is the combination of visible footprint edges, not a choice based only on the approximate heights of the blocks.

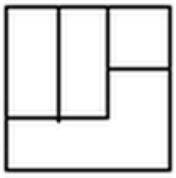
Step 3: Conclusion The visible edges and overlaps in option (A) agree with the plan when viewed along the arrow. Hence, the correct option is (A).

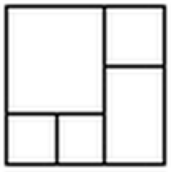
Quick Tip to Solve: Mark the left-to-right positions of every plan corner, then eliminate elevations that omit a visible offset or expose an edge hidden by a nearer object.

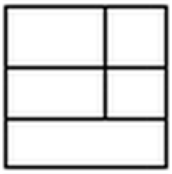
71. The 3 – D figure shows the view of an object. Identify the correct top view from amongst the answer figures. [4 marks]



(A) 

(B) 

(C) 

(D) 

Correct Answer: (A) 

Solution:

Concept:

- A top view projects the object vertically onto a horizontal plane. Heights disappear, but the horizontal footprints of the base, intermediate block and tower remain.
- Only edges visible from above are included. A higher block hides any lower edge lying directly beneath its footprint; no extra line is added across an uninterrupted horizontal surface.

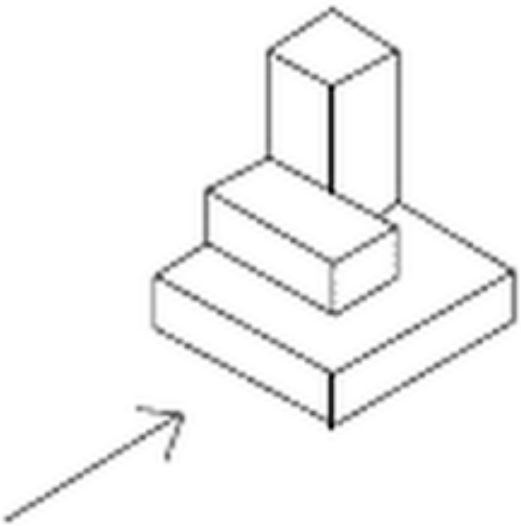
Step 1: Separate the three footprints The object has a broad square base, an intermediate rectangular step and a narrow taller block behind that step. Viewed vertically, the base forms the outer square boundary. The footprint of the intermediate step lies within this square, and the tall block occupies the rear part adjoining it. To compare with the options, turn the isometric square mentally into a flat square while retaining the relationships between its corners. Changing viewpoint removes height; it does not move a block to a different side of the base.

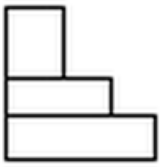
Step 2: Trace the exposed outlines from above Option (A) places the intermediate rectangle in the central-left strip and the tower footprint in the adjoining upper-right region, with the remaining base exposed around them. Its short horizontal edge on the right and the inner vertical boundaries correspond to the block contacts seen in the given object. Option (B) adds a horizontal division across the exposed lower-level region on the left; the solid has no boundary there. Option (C) moves the step arrangement toward the lower side and changes its footprint pattern. Option (D) exchanges the orientation of the principal divisions, giving a different arrangement of blocks. Compare the complete connected outlines rather than merely counting rectangles: several choices have similar numbers of regions, but only one locates them correctly.

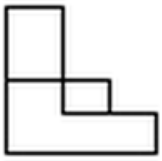
Step 3: Conclusion Option (A) gives the correct footprints and visible boundaries when the object is viewed from above. Hence, the correct option is (A).

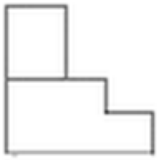
Quick Tip to Solve: Ignore vertical height in a top view, but preserve each footprint and delete any lower edge concealed beneath a higher block.

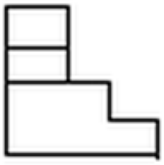
72. The 3 – D figure shows the view of an object. Identify the correct view in the direction of the arrow, from amongst the answer figures. [4 marks]

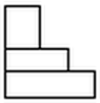


(A) 

(B) 

(C) 

(D) 

Correct Answer: (A) 

Solution:

Concept:

- An orthographic elevation shows width and height in the chosen viewing direction, with distance along the line of sight projected away.
- Visible edges between successive levels remain in the view. A silhouette alone is insufficient when the object has exposed front faces and their junction lines.

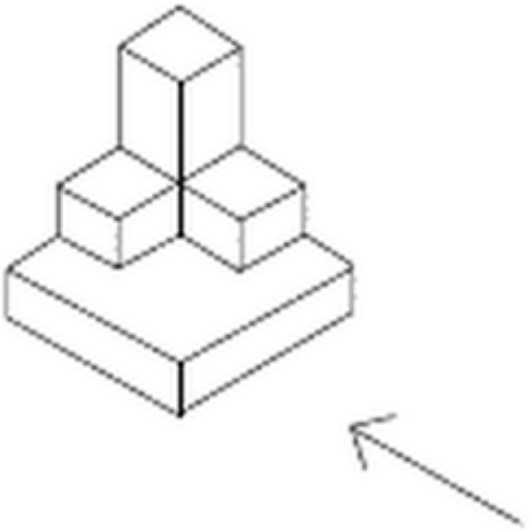
Step 1: Follow the arrow toward the front faces The arrow directs the observer toward the stepped front side of the solid. From this direction, the broad base appears as the widest low rectangle, the intermediate block forms a narrower rectangle above it, and the upright block forms the narrow highest rectangle. Their projections produce a staircase outline descending from left to right. The far isometric sloping edges do not remain sloping in this elevation; each projected horizontal edge is drawn horizontally.

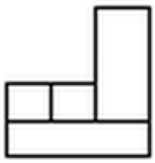
Step 2: Retain the visible junctions between levels The base and intermediate block have exposed vertical faces, so the horizontal boundaries at the two step levels must remain. The tower also has a visible vertical boundary extending down to the intermediate level. Option (A) shows these relationships with the correct alignment: the three levels are aligned at the left and reduce in width toward the top. Option (B) extends the tower's vertical edge through the intermediate tier and omits the full horizontal division at the top of the base. Option (C) retains the line at the bottom of the pillar but also omits the full horizontal base-top division. Option (D) adds an unnecessary horizontal division across the upright tower. None of those changes is present in the supplied object. Matching the outline and the interior visible edges together identifies the correct view.

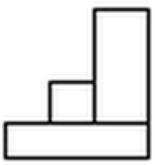
Step 3: Conclusion Option (A) shows the proper stepped outline and the visible face junctions in the direction of the arrow. Hence, the correct option is (A).

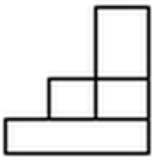
Quick Tip to Solve: For a stepped elevation, check the common side alignment first, then verify every horizontal level and every visible vertical junction.

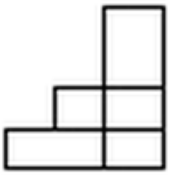
73. The 3 – D figure shows the view of an object. Identify the correct view in the direction of the arrow, from amongst the answer figures. [4 marks]

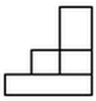


(A) 

(B) 

(C) 

(D) 

Correct Answer: (C) 

Solution:

Concept:

- An orthographic view projects the solid along parallel sight lines in the direction of the arrow. Depth disappears, but horizontal position and vertical height remain.
- A visible edge records a change of face or a joint in front of another surface. An edge hidden behind a taller block must not be carried through the projected silhouette.

Step 1: Project the stepped outline along the arrow Look from the lower-right side of the pictorial view towards the object, following the arrow. The broad lower slab forms one continuous rectangular base. Above it, the smaller block on the nearer side occupies the middle part of the projected width, while the tall upright occupies the right-hand part. Thus the outline rises in two steps: the base at the left, the short block in the middle and the tallest block at the right. The block lying farther back overlaps in this projection rather than creating another exposed small square at the left.

Step 2: Check the visible internal edges The nearer short block has its top edge at the same level as the horizontal line across the lower part of the upright in the projected view. The lower slab remains a single unbroken rectangular face: the upright does not divide the slab beneath it into separate blocks. Option (C) preserves both the stepped outline and these visible lines. Option (A) adds an extra small square on the left. Option (B) omits the horizontal edge visible across the lower part of the upright. Option (D) incorrectly continues a vertical line through the base slab. These edge checks distinguish the answer even where several options have similar outer profiles.

Step 3: Conclusion The orthographic view along the given arrow has a continuous base, a middle low step and a tall right-hand block with the indicated horizontal edge. Hence, the correct option is (C).

Quick Tip to Solve: First compare the projected silhouette; then use one visible edge or an unjustified line through the base to separate similar answer figures.

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

(A) Making the building water proof

(B) Making the space acoustically effective

(C) Making the building fire proof

(D) Supporting the walls

Correct Answer: (B) Making the space acoustically effective

Solution:

Concept:

- A false ceiling is a secondary ceiling suspended below the main structural slab. It can conceal services and improve the acoustic and visual quality of an interior.
- Acoustic treatment controls unwanted sound reflections and reverberation. Suitable ceiling panels absorb sound so that speech and music remain clear.

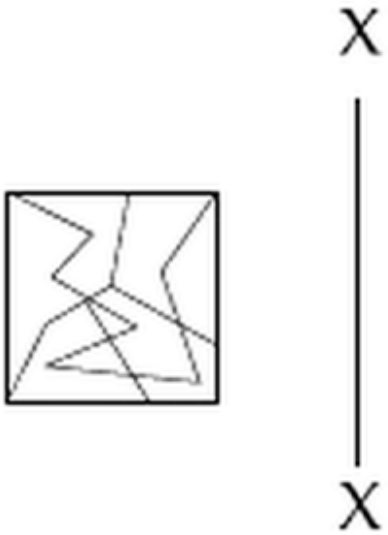
Step 1: Identify the relevant interior function In an enclosed room, sound reflects repeatedly from hard surfaces. These reflections can create excessive reverberation and reduce speech intelligibility. A false ceiling incorporating acoustically absorbent panels reduces the reflected sound energy. Its purpose can therefore be to make the occupied space acoustically effective, as stated in option (B). This is especially useful in classrooms, auditoriums, offices and meeting rooms.

Step 2: Distinguish the other building functions Waterproofing in option (A) is provided by appropriate roof, wall or wet-area construction and waterproofing layers; an ordinary suspended ceiling does not stop water entering the building. Fire resistance in option (C) requires specifically rated materials and assemblies, so installing a false ceiling does not by itself make an entire building fire proof. The ceiling is normally hung from the structural system and does not support the walls, ruling out (D). These are different functions from the acoustic treatment asked about.

Step 3: Conclusion False ceilings can improve sound absorption and control reverberation, thereby making the space acoustically effective. Hence, the correct option is (B).

Quick Tip to Solve: For a false-ceiling question, distinguish an interior performance function such as acoustics from the load-bearing and weatherproofing functions of the main building envelope.

75. 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:

- Reflection in a vertical mirror line reverses left and right while preserving height. Every point and its image are equally far from the mirror on opposite sides.
- A mirror image preserves the connections and crossing points of the line pattern. It is not a rotation: the top stays at the top and the bottom stays at the bottom.

Step 1: Reverse the main features from left to right The mirror X–X is vertical and lies to the right of the problem figure, so the reflected square retains its orientation but its internal pattern reverses horizontally. The line descending from the upper-left corner towards the lower-right region must become a line descending from the upper-right corner towards the lower-left region. Similarly, the bent line near the right side of the original must appear near the left side of the answer. The small inward zigzag near the upper-left area moves to the upper-right area. These features establish the

direction of reflection and rule out treating the figure as a half-turn.

Step 2: Follow the lower connections and compare the options Trace each remaining stroke from its endpoint rather than comparing only the general appearance. The short bent strokes in the lower half must reverse their left-right order, and their meeting points with the central oblique strokes must occur at the corresponding reflected positions. Option (B) gives this complete reversal of the upper zigzag, the side bend and the lower angular connections. Option (A) changes the lower internal arrangement. Option (C) introduces a different upper-left diagonal connection. Option (D) changes the bent connections in the middle and lower part. Since reflection cannot add, remove or reconnect strokes, these three patterns do not match the reflected original.

Step 3: Conclusion Reflecting all strokes horizontally across the vertical line X–X gives answer figure (B). Hence, the correct option is (B).

Quick Tip to Solve: Choose an asymmetric corner and trace its connected stroke through the figure; a correct mirror image must preserve the entire connection after reversing left and right.

Planning (100 marks)

76. Which one of the following is not a fundamental right as per Constitution of India ? [4 marks]

(A) Right to Freedom of Speech

(B) Right to Equality

(C) Right to Education

(D) Right to Property

Correct Answer: (D) Right to Property

Solution:

Concept:

- Fundamental rights are constitutional guarantees contained in Part III of the Constitution of India. A right can remain constitutionally protected without being a fundamental right.
- The Forty-fourth Amendment removed the right to property from the list of fundamental rights. Article 300A protects property as a constitutional right.

Step 1: Check the rights that remain fundamental Freedom of speech and expression is protected by Article 19(1)(a), subject to the constitutional restrictions, so option (A) describes a fundamental right. The right to equality is protected by Articles 14 to 18, ruling out option (B). Article 21A provides the right to free and compulsory education for children aged six to fourteen years, so the right to education in option (C) also belongs among the fundamental rights. The question asks for the exception, rather than for a right that is absent from the Constitution altogether.

Step 2: Identify the changed status of property The right to property originally had fundamental-right protection, but the Forty-fourth Constitutional Amendment removed that status. Its protection now appears under Article 300A, which states that no person shall be deprived of property save by authority of law. Thus property rights remain constitutionally significant, but their current classification differs from freedom of speech, equality and education. This distinction selects the right to property in option

(D).

Step 3: Conclusion The right to property is a constitutional right under Article 300A, but it is not a fundamental right. Hence, the correct option is (D).

Quick Tip to Solve: Remember the pair: property – Article 300A – constitutional right; education – Article 21A – fundamental right. The question tests classification, not whether a right exists at all.

77. **Read the given passage and answer the questions.**

'Jatra' is a musical folk theatre art form, popular in Bengali speaking areas of the Indian sub-continent including Bangladesh, West Bengal, Orissa, Assam and Bihar. The word 'jatra' means journey. While the original themes of 'jatra' were largely religious, by the end of the 19^{th} century, it began to include moral and later, even secular themes. The survival of this folk art form has been credited to its adaptability to changing social contexts.

The passage attributes the continued popularity of 'jatra' to. [4 marks]

(A) its beautiful folk music

(B) the different social castes in Bengal

(C) its flexibility in evolving its contents

(D) its moral preachings

Correct Answer: (C) its flexibility in evolving its contents

Solution:

Concept:

- In a passage-based question, the stated causal link decides the answer. An attractive fact mentioned in the opening sentence need not be the reason the author gives.
- Adaptability means the ability to change in response to new circumstances. Here the development from religious to moral and secular themes illustrates that ability.

Step 1: Locate the stated cause The final sentence says that the survival of this folk art form has been credited to its adaptability to changing social contexts. The earlier description explains this adaptability: the themes were originally largely religious, but later came to include moral and secular material. Thus the content evolved as society changed. Option (C), flexibility in evolving its contents, expresses the same causal idea without repeating the sentence word for word.

Step 2: Eliminate unsupported explanations The description of jatra as musical folk theatre does not state that beautiful folk music caused its continued popularity, so (A) goes beyond the passage. The passage lists Bengali-speaking areas but gives no causal argument involving different social castes, eliminating (B). Moral themes are only one stage in its development; selecting moral preachings in (D) would ignore both the original religious themes and the later secular themes. The author credits the capacity to change, rather than one fixed kind of subject matter.

Step 3: Conclusion The continued popularity of jatra is attributed to its flexibility in evolving its contents as social contexts change. Hence, the correct option is (C).

Quick Tip to Solve: For questions asking what a passage attributes something to, locate expressions such as credited to, because or due to, then match their meaning to the options.

78. Read the given passage and answer the questions.

'Jatra' is a musical folk theatre art form, popular in Bengali speaking areas of the Indian sub-continent including Bangladesh, West Bengal, Orissa, Assam and Bihar. The word 'jatra' means journey. While the original themes of 'jatra' were largely religious, by the end of the 19^{th} century, it began to include moral and later, even secular themes. The survival of this folk art form has been credited to its adaptability to changing social contexts.

Which of the following is indicated in the given paragraph ? [4 marks]

(A) 'Jatra' refers to the journey of all folk-theatre forms in Bengal

(B) 'Jatra' came into existence in the 19^{th} century

(C) 'Jatra' is popular in parts of India and Bangladesh

(D) 'Jatra' was performed originally in religious buildings only

Correct Answer: (C) 'Jatra' is popular in parts of India and Bangladesh

Solution:

Concept:

- A statement indicated by a passage must follow from the information actually given. Do not convert a statement about themes into a claim about dates or performance venues.
- The opening sentence locates jatra in Bengali-speaking areas of the Indian subcontinent, explicitly including Bangladesh and several Indian states.

Step 1: Match the geographical information The passage names Bangladesh, West Bengal, Orissa, Assam and Bihar as areas where jatra is popular. Bangladesh is a separate country, while the named states are parts of India. Therefore the statement that jatra is popular in parts of India and Bangladesh follows directly from the first sentence. This is exactly the claim made in option (C), and no additional historical assumption is required.

Step 2: Check the limits of the other statements Option (A) overextends the meaning of journey: the passage says the word jatra means journey, not that it describes the journey of all folk-theatre forms in Bengal. Option (B) confuses a change in subject matter by the end of the nineteenth century with the date when the art form began; no origin date is supplied. Option (D) replaces religious themes with religious buildings. Subject matter does not establish the place of performance, and the passage never says performances occurred only in such buildings. Each of these options adds a claim the text does not support.

Step 3: Conclusion The paragraph explicitly indicates that jatra is popular in parts of India and Bangladesh. Hence, the correct option is (C).

Quick Tip to Solve: Check every option against an exact passage statement. Be alert when an option changes a theme into a venue, a development date into an origin date, or a word meaning into a historical claim.

79. Secondary sector economic activity is related to : [4 marks]

(A) Trade and commerce

(B) Industrial

(C) Tourism

(D) Agriculture

Correct Answer: (B) Industrial

Solution:

Concept:

- Economic activity is commonly grouped into primary, secondary and tertiary sectors according to what the activity does.
- The primary sector obtains products directly from nature; the secondary sector transforms raw materials into other products; the tertiary sector supplies services.

Step 1: Identify transformation and production Industrial activity processes raw materials or intermediate goods into manufactured products. For example, cotton is turned into cloth and iron ore is used to produce steel. This transformation is the defining feature of the secondary sector. Construction is also normally included in the secondary sector because it creates buildings and infrastructure. Consequently, industrial activity in option (B) matches the sector named in the question.

Step 2: Classify the remaining activities Trade and commerce in option (A) help distribute and exchange goods rather than manufacture them, so they belong mainly to the tertiary or service sector. Tourism in option (C) provides services such as travel, accommodation and guiding, placing it in the tertiary sector as well. Agriculture in option (D) produces crops and other natural products directly from land and biological resources, so it belongs to the primary sector. These distinctions leave industry as the only secondary-sector activity among the four choices.

Step 3: Conclusion Secondary-sector economic activity is related to industrial production and the transformation of materials. Hence, the correct option is (B).

Quick Tip to Solve: Ask what the activity does: obtains from nature means primary, transforms materials means secondary, and provides support or other services means tertiary.

80. Which of the following has the maximum slope ? [4 marks]

(A) 1 : 20

(B) 1 : 15

(C) 1 : 30

(D) 1 : 10

Correct Answer: (D) 1 : 10

Solution:

Concept:

- A gradient written as $1 : n$ means one unit of vertical rise for n units of horizontal run, so its slope is $m = 1/n$.
- For positive fractions with the same numerator, the smaller denominator gives the larger value. A greater rise per unit horizontal run corresponds to a steeper slope.

Step 1: Convert the ratios to slopes Use the same units for vertical rise and horizontal run. The four dimensionless slopes are

$$\begin{aligned}(A): \quad & m = \frac{1}{20} = 0.05,\\ (B): \quad & m = \frac{1}{15} \approx 0.0667,\\ (C): \quad & m = \frac{1}{30} \approx 0.0333,\\ (D): \quad & m = \frac{1}{10} = 0.10.\end{aligned}$$

Comparing numerical slopes avoids confusing the horizontal-distance denominator with the amount of steepness. A larger denominator means that the same rise is spread over a longer distance.

Step 2: Compare steepness and reject the other ratios The order is

$$\frac{1}{10} > \frac{1}{15} > \frac{1}{20} > \frac{1}{30}.$$

Thus option (D) rises most over a fixed horizontal distance. For a direct check, over a horizontal run of 60 units the respective rises for (A), (B), (C) and (D) are 3, 4, 2 and 6 units. Options (A), (B) and (C) all have a smaller rise for that same run and hence a smaller slope. In particular, choosing $1 : 30$ merely because 30 is the largest printed number reverses the meaning of the gradient ratio.

Step 3: Conclusion The maximum slope is $1 : 10$, equal to 0.10 or a 10 percent gradient. Hence, the correct option is (D).

Quick Tip to Solve: For positive gradients written 1:n, compare denominators in reverse order: the smallest n gives the steepest slope, provided all ratios use the same rise-to-run convention.

81. Which of these does not hold true for the following observation ?

Evidences of town planning principles in Indus Valley Civilisation is demonstrated through the discovery of the following : [4 marks]

(A) Houses were connected directly to a drainage system

(B) Public transport wagons moved in the cities

(C) Great Bath that served the purpose of community bathing

(D) Some of the towns were laid out in a grid pattern

Correct Answer: (B) Public transport wagons moved in the cities

Solution:

Concept:

- Town planning is evidenced by the coordinated arrangement of streets, buildings, water facilities and drainage, rather than by an unsupported claim about a transport service.
- The negative wording asks for the statement that is not established evidence of Indus Valley urban planning.

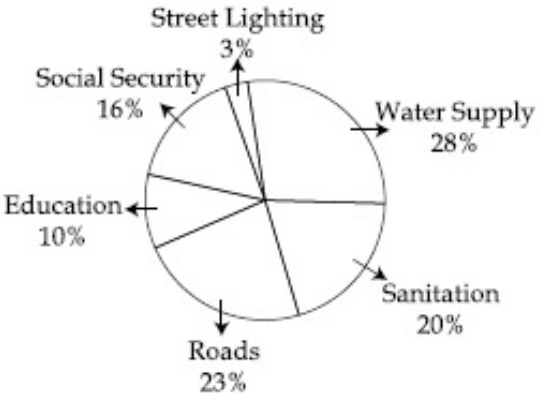
Step 1: Recognise the established urban features House drains connected to street drainage show coordinated sanitation at the settlement scale, so (A) is a genuine planning feature. The Great Bath at Mohenjo-daro demonstrates a substantial communal water structure, matching (C). The bathing interpretation describes the structure's function; the precise ritual or social use does not change its importance as an urban facility. Some Indus settlements also had streets arranged in a grid, so (D) is consistent with archaeological evidence.

Step 2: Identify the unsupported transport claim Carts and wheeled transport were known, but that does not establish an organised public transport wagon service within the cities. Option (B) adds this specific public-service claim without the sort of established evidence supporting drains, the Great Bath and grid layouts. It is therefore the exception required by the question.

Step 3: Conclusion Public transport wagons moving in the cities is the statement that does not hold as the stated evidence. Hence, the correct option is (B).

Quick Tip to Solve: In a negative history MCQ, separate an excavated urban feature from a claim about an organised service that the evidence does not establish.

82. The above graph shows a municipality's expenditure on different services for the financial year 2018-19. If the municipality spent a total of Rs. 50 crore during this period, the expenditure on 'Education' was : [4 marks]



(A) Rs. 7 crores more than that spent on 'street lighting'

(B) Rs. 0.5 crore

(C) Rs. 1 crore

(D) Rs. 3 crores less than that spent on 'social security'.

Correct Answer: (D) Rs. 3 crores less than that spent on 'social security'.

Solution:

Concept:

- A pie chart expresses each expenditure as a percentage of the total budget. If a service has share p per cent of a total T, its expenditure is $pT/100$.
- A comparison such as "less than" concerns the difference of two expenditures, whereas an individual amount concerns one sector. Keep percentages and monetary amounts distinct.

Step 1: Read the relevant shares The chart assigns Education 10%, Social Security 16% and Street Lighting 3% of the municipality's total expenditure. Water Supply, Sanitation and Roads account for the other shares. The total expenditure for 2018-19 is Rs. 50 crore; it is the base to which each percentage must be applied.

Step 2: Calculate the three expenditures Convert each percentage into its monetary amount using the same total:

$$E = \frac{10}{100} \times 50 = 5 \text{ crore},$$
$$S = \frac{16}{100} \times 50 = 8 \text{ crore},$$
$$L = \frac{3}{100} \times 50 = 1.5 \text{ crore}.$$

Here E, S, L denote education, social security and street lighting respectively. Since all three use the same total, their comparisons can also be checked directly from the percentage-point differences.

Step 3: Test every statement Education is Rs. $8 - 5 = 3$ crore less than social security, exactly as option (D) states. Its excess over street lighting is only Rs. $5 - 1.5 = 3.5$ crore, rather than Rs. 7 crore, so (A) is false. The education expenditure itself is Rs. 5 crore, which rules out both Rs. 0.5 crore in

(B) and Rs. 1 crore in (C). Notice that 10% is one tenth, so taking one hundredth of the budget would introduce a factor-of-ten error.

Step 4: Conclusion The expenditure on Education was Rs. 5 crore, which is Rs. 3 crore less than the Rs. 8 crore spent on Social Security. Hence, the correct option is (D).

Quick Tip to Solve: For a budget comparison, subtract the percentages first: $16\% - 10\% = 6\%$, and 6% of Rs. 50 crore is Rs. 3 crore.

83. Following table gives the number of households and their corresponding monthly incomes. What will be the average monthly income of the household ?

Sl. No.	No. of Households	Monthly Household income (Rs)
1	300	20000
2	200	50000
3	150	100000
4	50	500000

[4 marks]

(A) 67000

(B) 56000

(C) 70000

(D) 80000

Correct Answer: (D) 80000

Solution:

Concept:

- The average income per household is the total income of all households divided by the number of households.
- If an income x_i occurs in f_i households, the weighted mean is $\bar{x} = \dfrac{\sum f_i x_i}{\sum f_i}$. The household counts, rather than the number of income categories, supply the weights.

Step 1: Find the household count and total income The total number of households is

$$N = 300 + 200 + 150 + 50 = 700.$$

Multiply each monthly income by the number of households earning it:

$$\begin{aligned} 300(20{,}000) &= 60{,}00{,}000, \\ 200(50{,}000) &= 1{,}00{,}00{,}000, \\ 150(1{,}00{,}000) &= 1{,}50{,}00{,}000, \\ 50(5{,}00{,}000) &= 2{,}50{,}00{,}000. \end{aligned}$$

Their sum is Rs 5,60,00,000 per month.

Step 2: Divide by the number of households Hence,

$$\bar{x} = \frac{5{,}60{,}00{,}000}{700} = 80{,}000.$$

The result is a monthly amount per household. Options (A), (B) and (C), namely Rs 67,000, Rs 56,000 and Rs 70,000, do not equal this weighted mean. Taking an unweighted mean of the four income categories would give each category equal importance despite their different household counts.

Step 3: Conclusion The average monthly household income is Rs 80,000. Hence, the correct option is (D).

Quick Tip to Solve: For a frequency table, multiply income by household count before adding; divide by the total households, not by the four categories.

84. Which was the most polluted city in India in 2018 as per Central Pollution Control Board ?

[4 marks]

(A) Lucknow

(B) Patna

(C) Gurugram

(D) Ahmedabad

Correct Answer: (C) Gurugram

Solution:

Concept:

- A pollution-ranking question refers to a specified reporting period. The year in the statement must be retained when identifying the city.
- Air pollution comparisons commonly use concentrations of particulate matter. A city being polluted does not by itself make it the highest-ranked city in a particular annual comparison.

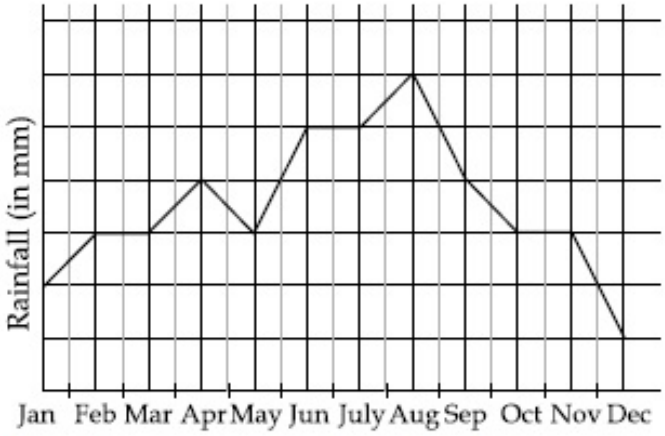
Step 1: Identify the city associated with the 2018 ranking Gurugram is the city associated with the highest pollution ranking for 2018 among the four choices. It is an urban centre in Haryana in the National Capital Region. The required selection is the city name, rather than a general statement that pollution is severe throughout northern India.

Step 2: Compare all four alternatives Lucknow and Patna also experienced serious particulate pollution, but neither is the highest-ranked city in the 2018 comparison intended here. Ahmedabad is another large urban centre with air-quality concerns, but it is not the required city in this list. Thus options (A), (B) and (D) are rejected, and Gurugram in option (C) is selected. This is a dated factual identification; no calculation from the populations or locations of the four cities is involved.

Step 3: Conclusion The city is Gurugram. Hence, the correct option is (C).

Quick Tip to Solve: Attach the year to the city when learning pollution rankings; a ranking for a different year or a single day need not give the same answer.

85. The above graph depicts the average monthly rainfall for a particular year in the country XYZ. Select the incorrect option : [4 marks]



(A) The wettest spell experienced by the country is in the month of August.

(B) The driest months in the country are December and January.

(C) February-March have the same average rainfall as October-November.

(D) The country experiences the same average monthly rainfall in the months of May - June.

Correct Answer: (D) The country experiences the same average monthly rainfall in the months of May - June.

Solution:

Concept:

- The ordinate of a point on a line graph gives its rainfall. Points on the same horizontal grid line represent equal rainfall; a higher point represents more rainfall.
- To select an incorrect statement, check every comparison against the graph. Equality of two seasonal averages means equality of their two-month totals because both totals are divided by two.

Step 1: Locate the highest and lowest points The rainfall curve reaches its unique highest point in August. Thus, August is the wettest month and statement (A) is correct. December and January are the two driest months. December is the lowest point, and January is one grid interval above December but below all remaining months, so statement (B) is also correct. These observations use the heights of the plotted points, rather than the slopes of the segments connecting them.

Step 2: Compare the paired months February and March lie on the same horizontal line as October and November. Consequently, the February-March average equals the October-November average: each pair has two months at that same height. This verifies statement (C) without needing an absolute numerical scale for the rainfall axis. In contrast, May is at the lower level shared with February and March, whereas June is two grid intervals higher. Therefore the rainfall in May and June is unequal.

Step 3: Apply the instruction to select the incorrect option Options (A), (B) and (C) agree with the plotted positions and therefore cannot be selected when the question asks for the incorrect statement. Option (D) asserts equality for May and June, but their plotted heights differ. June has greater rainfall than May, so this assertion contradicts the graph. The rise from May to June is precisely the visual evidence needed; it is unnecessary to invent numerical millimetre labels that the vertical axis does not

supply.

Step 4: Conclusion The country does not experience the same average monthly rainfall in May and June: June is wetter than May. Hence, the correct option is (D).

Quick Tip to Solve: For an equality claim on a line graph, compare horizontal levels directly. May and June occupy different grid levels, immediately disproving option (D).

86. What is the full form of GPS ? [4 marks]

(A) Global Peace and Security

(B) Green Peace Society

(C) Global Position on Security

(D) Global Positioning System

Correct Answer: (D) Global Positioning System

Solution:

Concept:

- GPS is the standard abbreviation for Global Positioning System, a satellite-based navigation system.
- A receiver uses signals from several satellites to determine its position and time. This navigation purpose helps identify the correct expansion of the abbreviation.

Step 1: Expand the three letters The first word is Global, indicating the worldwide scope of the system. The second word is Positioning, referring to determining a location. The last word is System, referring to the coordinated satellites, ground infrastructure and receivers that make the service possible. Together these words give Global Positioning System.

Step 2: Eliminate the other expansions Option (A), Global Peace and Security, describes a different kind of international concern and is not a navigation system. Option (B), Green Peace Society, refers to an environmental-sounding organisation rather than satellite positioning. Option (C), Global Position on Security, is also not the accepted technical name and does not correctly expand the positioning function. Option (D) is the complete recognised name and matches both the initials and the purpose.

Step 3: Conclusion GPS stands for Global Positioning System. Hence, the correct option is (D).

Quick Tip to Solve: Remember the function: GPS determines a position, so the middle word is Positioning and the final word is System.

87. When was the first United Nations Conference on 'Human Settlements Habitat I' held ? [4 marks]

(A) 1971

(B) 1970

(C) 1981

(D) 1976

Correct Answer: (D) 1976

Solution:

Concept:

- Habitat I was the first United Nations Conference on Human Settlements, addressing housing, settlements and urbanisation.
- The date of a conference is distinct from the later establishment or development of the organisation that follows from its recommendations.

Step 1: Recall the first Habitat conference Habitat I took place in Vancouver, Canada, from 31 May to 11 June 1976. It brought human settlements and the consequences of urbanisation onto the international policy agenda. Therefore the calendar year directly requested by the question is 1976.

Step 2: Check the proposed years The alternatives 1970 and 1971 both precede the Vancouver conference and are not its year. The alternative 1981 follows it and is also incorrect. The correct year is already available as option (D), so there is no need to substitute a later Habitat conference or the date of a subsequent institutional development. Associating the event with its host city provides a useful independent memory check: Habitat I, Vancouver, 1976.

Step 3: Conclusion The first United Nations Conference on Human Settlements, Habitat I, was held in 1976. Hence, the correct option is (D).

Quick Tip to Solve: Use the linked pair Vancouver–1976 for Habitat I; keep the first conference distinct from later Habitat meetings.

88. A system of economic enterprise based on market exchange is termed as : [4 marks]

(A) Communism

(B) Capitalism

(C) Socialism

(D) Feudalism

Correct Answer: (B) Capitalism

Solution:

Concept:

- Capitalism organises economic enterprise largely through private ownership, market exchange and production for sale.
- In a market, buyers and sellers exchange goods and services, with prices helping coordinate demand, supply and business decisions.

Step 1: Match the defining feature The expression economic enterprise based on market exchange points to capitalism. Enterprises produce goods or services for exchange, and market transactions connect producers with consumers. Private economic initiative and the pursuit of returns are characteristic features of this system, so option (B) matches the description.

Step 2: Distinguish the remaining systems Communism in option (A) is associated with common ownership rather than the private market organisation described here. Socialism in option (C) emphasises social or public ownership and collective objectives; although some socialist arrangements use markets, it is not the standard term sought by this definition. Feudalism in option (D) is organised around landholding, obligations and relations between lords and dependants. It does not describe an enterprise system defined primarily by market exchange.

Step 3: Conclusion The system described is capitalism. Hence, the correct option is (B).

Quick Tip to Solve: Match market exchange and private enterprise with capitalism; distinguish that definition from feudal land obligations or collective ownership.

89. In a survey of tourists in a city, 120 tourists were women of which 35% stayed in the city for more than one day. Which of the following is the correct conclusion for this data ? [4 marks]

(A) Approximately 35% of women tourists stay for more than one day.

(B) The majority of all tourists stay for less than a day.

(C) Average stay of women tourists is approximately one day.

(D) Approximately 35% of all tourists stay for more than one day.

Correct Answer: (A) Approximately 35% of women tourists stay for more than one day.

Solution:

Concept:

- A percentage is meaningful only with its stated reference group. Here the group is the 120 women tourists in the survey, rather than all tourists visiting the city.
- A proportion staying longer than one day does not determine the average duration of stay: computing a mean requires the actual durations or sufficient grouped duration data.

Step 1: Identify the relevant population The statement first identifies 120 tourists who were women. The stated 35% refers back to those women. Hence the number of surveyed women staying for more than one day is

$$\frac{35}{100} \times 120 = 42.$$

Thus 42 out of 120 women satisfy the stated condition. The remaining 78 do not stay for more than one day; their individual durations are not given.

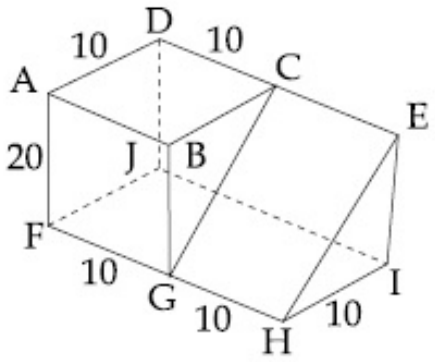
Step 2: Test each conclusion against the information Option (A) preserves both the percentage and its reference group, women tourists, and therefore directly restates the observation. Options (B) and (D) make claims about all tourists, including men, whose number and duration of stay are unspecified. These cannot be inferred from a result restricted to women. Option (C) asserts a mean duration near one day. The same 35% could have stayed two days or many days, producing different means, so the

data do not establish that average.

Step 3: Conclusion Approximately 35% of women tourists stay for more than one day. Hence, the correct option is (A).

Quick Tip to Solve: Underline the group immediately after a percentage; keep that same denominator when selecting a conclusion.

90. Calculate the surface area of the solid shown in the figure excluding the bottom surface : [4 marks]



(A) 1227.40

(B) 1223.60

(C) 1323.60

(D) 1000.36

Correct Answer: (C) 1323.60

Solution:

Concept:

- External surface area includes only faces exposed to the outside. A face shared by two joined solids is internal and must not be counted; the bottom is also omitted as requested.
- The figure combines a rectangular block of dimensions $10 \times 10 \times 20$ with a right triangular prism. The prism has triangular cross-section legs 10 and 20, and length 10.

Step 1: Find the exposed area of the rectangular block The block has a top square of area $10 \times 10 = 100$, and three completely exposed vertical rectangles, each of area $10 \times 20 = 200$. On its fourth vertical face the triangular prism covers one triangular half, leaving the other triangular half exposed. That exposed triangle has area $\frac{1}{2} \times 10 \times 20 = 100$. Excluding the base, the block therefore contributes

$$A_1 = 100 + 3(200) + 100 = 800.$$

Counting the entire fourth rectangle would wrongly include the internal contact triangle.

Step 2: Add the exposed faces of the triangular prism The triangular end away from the block has area 100. Its vertical rectangular face has area $20 \times 10 = 200$. The sloping edge of its triangular

cross-section is found by Pythagoras:

$$s = \sqrt{20^2 + 10^2} = 10\sqrt{5}.$$

Consequently, the inclined rectangular face has area $10s = 100\sqrt{5}$. The other triangular end is joined to the block, and the horizontal rectangular base is excluded. Thus the prism's contribution is

$$A_2 = 100 + 200 + 100\sqrt{5}.$$

Step 3: Total the external faces and compare the options Adding the two contributions gives

$$A = 800 + 100 + 200 + 100\sqrt{5} = 1100 + 100\sqrt{5} \approx 1323.60.$$

All areas are in square units corresponding to the dimensions in the figure. Option (C) matches this total. Options (A), (B) and (D) do not equal the sum of the exposed top, vertical, triangular and inclined faces; they therefore cannot represent the requested external area.

Step 4: Conclusion The surface area excluding the bottom is approximately 1323.60 square units. Hence, the correct option is (C).

Quick Tip to Solve: List the exposed faces before calculating: remove both the common contact triangle and all bottom faces, then find the sloping length with Pythagoras.

91. The Eastern coast of India is also known as : [4 marks]

(A) Konkan Coast

(B) Coromondal Coast

(C) Bay of Bengal

(D) Bengal Coast

Correct Answer: (B) Coromondal Coast

Solution:

Concept:

- Indian coastal names refer to geographical stretches of the mainland coast. The Coromandel Coast lies on the southeastern side of India, facing the Bay of Bengal.
- The Konkan Coast is on the western side, facing the Arabian Sea. A sea or bay and the adjoining named coast are different geographical features.

Step 1: Locate the named coasts The eastern side of peninsular India faces the Bay of Bengal. Its well-known southeastern coastal region, including the Tamil Nadu coast, is the Coromandel Coast. The name appears in option (B), printed as Coromondal Coast. In contrast, the Konkan Coast extends along the western side of the peninsula. Therefore Konkan cannot identify the eastern coast asked about here.

Step 2: Compare the remaining geographical names Option (C), Bay of Bengal, names the water body adjoining the eastern coast; it does not name the coastal land region itself. Option (D), Bengal Coast,

refers to a more limited northern coastal association and is not the intended peninsular coastal name in this set of options. Strict geographical terminology subdivides the eastern coast into regions, so Coromandel is particularly the southeastern stretch. Among the printed choices, it is the established east-coast regional name matching the question, while Konkan is on the opposite side and the Bay of Bengal is offshore.

Step 3: Conclusion The intended east-coast name is Coromandel Coast, printed as Coromondal Coast. Hence, the correct option is (B).

Quick Tip to Solve: Associate Konkan with the Arabian Sea and Coromandel with the Bay of Bengal; distinguish a coast from its adjoining sea.

92. Which is the First Airport in India ? [4 marks]

(A) Kolkata Airport

(B) Madras Airport

(C) Safdarjung Airport

(D) Juhu Aerodrome

Correct Answer: (D) Juhu Aerodrome

Solution:

Concept:

- An aerodrome is an area used for aircraft arrival, departure and ground operations. Early Indian aviation facilities were called aerodromes before modern large airport terminals developed.
- Juhu Aerodrome in Mumbai was established in 1928 and is conventionally identified as India's first civil airport in general-knowledge questions.

Step 1: Identify the early civil aviation facility Juhu Aerodrome, on the western side of Mumbai, began operating in 1928. It is the historical facility associated with the first civil airport in India. The word Aerodrome in its name does not make it a different category for this question: it performed the aircraft landing and take-off functions of an early airport, before the development of the modern airport infrastructure familiar today.

Step 2: Eliminate the alternative airport names Kolkata Airport and Madras Airport are major historic airports, but neither is the facility identified by the accepted first-civil-airport description in these choices. Safdarjung Airport is an early Delhi aviation facility, yet its establishment followed Juhu. Therefore neither the present importance of Kolkata and Madras nor the historic role of Safdarjung changes the chronological identification. The appropriate comparison is the origin of the named civil aerodrome, rather than the current size of its terminal, the volume of scheduled flights, or whether it continues to serve as a principal commercial airport.

Step 3: Conclusion Juhu Aerodrome is the first civil airport identified by the question. Hence, the correct option is (D).

Quick Tip to Solve: For airport-history questions, compare establishment dates and the exact historical facility, rather than present-day passenger traffic.

93. Statement I :

Exposure to computer based learning is common in most schools today.

Statement II :

Most jobs require at least basic computer literacy.

Pick the correct option : [4 marks]

(A) Statement I is the cause and statement II is its effect

(B) Statements I and II are causes of some common effect

(C) Statement II is the cause and statement I is its effect

(D) Statements I and II are independent effects

Correct Answer: (C) Statement II is the cause and statement I is its effect

Solution:

Concept:

- A cause is the condition that explains why another event or practice occurs; the effect is the resulting response. The direction must be consistent with the explanation.
- For this question, the practical need for computer literacy provides a reason for schools to expose pupils to computer-based learning.

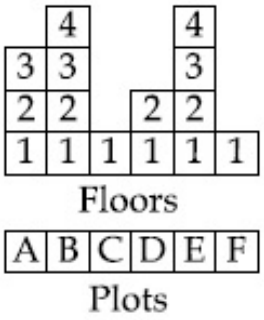
Step 1: Find the motivating requirement Statement II says that most jobs require at least basic computer literacy. This creates a need to prepare students to use computers before they enter employment. Schools can respond to that need by incorporating computer-based learning into normal education. Thus statement II supplies a plausible motivating condition for the educational practice described in statement I.

Step 2: Check the direction represented by each option Statement I describes the resulting exposure to computers in schools. Accordingly, statement II is treated as the cause and statement I as its effect, which is option (C). Option (A) reverses this intended explanatory direction: jobs do not require computer skills merely because schools provide computer-based learning. Option (B) calls both statements causes of an unspecified common effect instead of linking the job requirement to the school response. Option (D) treats them as independent effects, overlooking the clear educational response to workplace requirements. The relationship is an explanatory inference in the question, rather than proof that this is the only factor shaping school education.

Step 3: Conclusion Statement II is the cause and statement I is its effect. Hence, the correct option is (C).

Quick Tip to Solve: Ask which statement answers Why would this practice be adopted?; that statement gives the cause in the intended explanation.

94. The figure shows floors as 1, 2, 3, 4 on each plot A, B, C, D, E, F. Plot A, D and E are commercial on all floors. B, C and F are residential on all floors. Find the percentage of total floors that are commercial and residential respectively : [4 marks]



(A) 60% and 40%

(B) 10% and 90%

(C) 40% and 60%

(D) 50% and 50%

Correct Answer: (A) 60% and 40%

Solution:

Concept:

- The height of each column gives the number of floors on that plot. The entries 1, 2, 3 and 4 identify floor levels, so a column reaching 4 contains four floors; its numbers must not be added together.
- For each use, its share of total floors is percentage $= 100 \times$ floors of that use/total floors. Count floors rather than merely counting plots.

Step 1: Read the number of floors on each plot Reading the six columns from left to right gives

$$A : 3, \quad B : 4, \quad C : 1, \quad D : 2, \quad E : 4, \quad F : 1.$$

For example, plot A contains levels 1, 2 and 3 and therefore has three floors, while plot C contains only level 1. The total number of floors across all six plots is

$$3 + 4 + 1 + 2 + 4 + 1 = 15.$$

Step 2: Group the floors by their assigned use The question assigns every floor of A, D and E to commercial use. These plots contribute

$$N_{\text{commercial}} = 3 + 2 + 4 = 9.$$

Every floor of B, C and F is residential, so their contribution is

$$N_{\text{residential}} = 4 + 1 + 1 = 6.$$

The check $9 + 6 = 15$ confirms that all floors have been counted once and the two groups cover the complete chart.

Step 3: Calculate the two percentage shares Using the same denominator, 15 total floors, gives

$$P_{\text{commercial}} = \frac{9}{15} \times 100 = 60\%, \qquad P_{\text{residential}} = \frac{6}{15} \times 100 = 40\%.$$

Option (A) gives these percentages in the requested order. Option (C) reverses the categories. Option (D) counts the three plots in each group as though every plot had equal floors; their unequal heights make that approach invalid. Option (B) is inconsistent with the directly counted 9 commercial and 6 residential floors.

Step 4: Conclusion Commercial floors form 60% and residential floors form 40% of the total. Hence, the correct option is (A).

Quick Tip to Solve: When column heights differ, sum the floors in each category before finding percentages; equal numbers of plots do not imply equal floor shares.

95. With what amongst the given option is 'The White Revolution' in India associated ? [4 marks]

(A) Rise in use of white marbles in buildings

(B) Rise in rice production

(C) Cooperatives of paper mill workers

(D) Cooperatives of milk producers

Correct Answer: (D) Cooperatives of milk producers

Solution:

Concept:

- The White Revolution refers to the development and expansion of India's dairy sector, especially milk production, procurement and distribution.
- A dairy cooperative brings milk producers together so that they can collect, process and market milk through a shared organisation. Operation Flood is closely associated with this cooperative dairy development.

Step 1: Connect the revolution with its product The colour word White here points to milk. The White Revolution strengthened the dairy supply system by linking rural milk producers with consumers through organised collection, processing and marketing. Milk producers could cooperate instead of depending entirely on individual local sales. Therefore the question is about dairy development and the organisations of the farmers who supply milk.

Step 2: Check the four proposed associations Option (D), cooperatives of milk producers, matches this dairy-centred movement. Option (A) interprets the colour literally as white marble used in buildings, but construction materials have no connection to the milk production programme. Option (B) refers to rice, a food grain; the agricultural transformation associated with increased food-grain output is conventionally linked to the Green Revolution, not the White Revolution. Option (C) names paper-mill workers and is unrelated to dairy producers or milk marketing. The cooperative form alone is insufficient: the relevant members must be the milk producers who form the basis of the dairy network.

Step 3: Conclusion The White Revolution is associated with cooperatives of milk producers. Hence, the correct option is (D).

Quick Tip to Solve: Link White Revolution to milk and then identify the producer organisation; the word cooperative alone does not select the answer.

96. The headquarters of International Labour Organisation (ILO) is located in which city ? [4 marks]

(A) Vienna

(B) New York

(C) Geneva

(D) Washington DC

Correct Answer: (C) Geneva

Solution:

Concept:

- The International Labour Organization, abbreviated ILO, works on labour standards, decent work and social justice. Its headquarters are in Geneva, Switzerland.
- Headquarters questions require the specific organisation's administrative base; hosting other international bodies does not make a city the headquarters of every organisation.

Step 1: Identify the organisation and its headquarters ILO stands for International Labour Organization. It brings together governments, employers and workers in its work on labour matters. The organisation is headquartered in Geneva, Switzerland. Therefore the city needed for this question is Geneva rather than a city chosen merely because it is prominent in international diplomacy, finance or the United Nations system.

Step 2: Eliminate the other international centres Option (C) names Geneva and matches the ILO headquarters. Vienna is an important international centre with several organisations, but it is not the ILO headquarters. New York is strongly associated with the United Nations headquarters, which must not be confused with the separate headquarters of this specialised agency. Washington DC is associated with major international financial institutions, including the World Bank and the International Monetary Fund, rather than the ILO headquarters. Thus all three other options are recognisable international centres, but their prominence is not the fact being tested. Matching the complete organisation name to its own city yields a unique answer.

Step 3: Conclusion The headquarters of the International Labour Organization is in Geneva. Hence, the correct option is (C).

Quick Tip to Solve: Pair the complete abbreviation with its city: ILO–Geneva. Do not substitute the UN headquarters in New York for a specialised agency.

97. Sustainable Development takes care of the present and : [4 marks]

(A) Community

(B) Future

(C) Past

(D) Population

Correct Answer: (B) Future

Solution:

Concept:

- Sustainable development meets the needs of the present without compromising the ability of future generations to meet their own needs.
- Its essential time relationship is between present welfare and future welfare. Economic growth, social well-being and environmental protection must be considered together.

Step 1: Identify the two generations in the definition The phrase "takes care of the present" refers to meeting current needs such as food, shelter, employment, energy and basic services. Development is sustainable only if doing so also preserves the resources and environmental conditions on which later generations will depend. Thus, the missing word must express the other end of this time relationship: the future. For example, using water at a rate that allows supplies to recover can serve current residents while protecting availability for people who live there later.

Step 2: Compare the four choices Future in option (B) completes the defining idea. Community in option (A) is a group whose welfare development may improve, but it does not express the intergenerational requirement. Past in option (C) points backward in time and cannot represent the needs of generations yet to come. Population in option (D) describes the people affected by development, rather than the future time horizon that makes development sustainable. These terms may occur in planning discussions, but only one supplies the defining complement to "present".

Step 3: Conclusion Sustainable development takes care of the present and the future, so that meeting current needs does not undermine future generations' opportunities. Hence, the correct option is (B).

Quick Tip to Solve: Associate sustainability with the pair "present needs–future generations"; this distinguishes its defining time horizon from its social beneficiaries.

98. Which of the following Ministers has never held the portfolio of Urban Development ? [4 marks]

(A) Jaipal Reddy

(B) Jairam Ramesh

(C) Venkaiah Naidu

(D) Hardeep Singh Puri

Correct Answer: (B) Jairam Ramesh

Solution:

Concept:

- A minister's portfolio is the specific area of government for which that minister has been responsible. The question tests portfolio history up to the date of this examination.
- Urban Development and Rural Development are distinct portfolios. Holding responsibility for rural development does not establish that a minister has held Urban Development.

Step 1: Identify the ministers associated with urban development Jaipal Reddy held the Union Urban Development portfolio, so option (A) cannot answer a question asking who has never held it. Venkaiah Naidu also served as Union Minister for Urban Development, excluding option (C). Hardeep Singh Puri was responsible for Housing and Urban Affairs, the ministry covering the urban development functions, and is therefore also associated with this portfolio area. Option (D) is not the intended exception among the listed ministers.

Step 2: Separate Jairam Ramesh's portfolios from these Jairam Ramesh is associated with Environment and Forests and with Rural Development, among his Union ministerial responsibilities. He did not hold the Urban Development portfolio. The word "Rural" is important: rural development concerns villages and rural livelihoods, while urban development concerns towns, cities and their infrastructure and services. A general association with development policy does not make the two ministerial assignments interchangeable. Thus the three urban-related names are eliminated and Jairam Ramesh remains as the exception requested by the negative wording.

Step 3: Conclusion Among the listed ministers, Jairam Ramesh had not held the Urban Development portfolio as of this examination. Hence, the correct option is (B).

Quick Tip to Solve: Underline "never" in portfolio-history questions, and distinguish Rural Development from Urban Development before eliminating names.

99. Topographical map of an area is used to understand : [4 marks]

(A) Landform

(B) Population Density

(C) Economic Activity

(D) Climate

Correct Answer: (A) Landform

Solution:

Concept:

- A topographical map represents the physical shape or relief of the Earth's surface along with selected natural and human-made features.
- Contour lines connect points at equal elevation. Their heights, spacing and patterns help a reader identify slopes, hills, valleys, ridges and other landforms.

Step 1: Recognise what topography describes Topography concerns the arrangement and shape of surface features. On a topographical map, the elevation information lets us understand whether an area is flat, hilly, steep or gently sloping. Closely spaced contours generally indicate a steep slope, while widely spaced contours indicate a gentler one. The patterns made by contours also help identify hills and valleys. This makes landform the direct answer to what such a map is used to understand.

Step 2: Distinguish the thematic alternatives Population density in option (B) is the number of people per unit area; a map designed to show it needs population data and density categories. Economic activity in option (C) needs information on industries, occupations or production. Climate in option (D) is shown through long-term patterns of variables such as temperature and rainfall. Although a topographical map can show settlements, roads and rivers that support wider analysis, these three themes are not its defining subject. Option (A), landform, matches the relief and elevation information for which topographical maps are specifically used.

Step 3: Conclusion A topographical map is used to understand the landform or relief of an area. Hence, the correct option is (A).

Quick Tip to Solve: Link "topographical" to contours and elevation; link population, economic activity and climate to specialised thematic maps.

100. Find the correct match :

(P)	**Aligarh**	**(I)**	**Silk Sarees**
(Q)	**Firozabad**	**(II)**	**Brass product**
(R)	**Kanjeevaram**	**(III)**	**Bangles**
(S)	**Moradabad**	**(IV)**	**Locks**

[4 marks]

(A) (P)-(I), (Q)-(III), (R)-(II), (S)-(IV)

(B) (P)-(III), (Q)-(I), (R)-(IV), (S)-(II)

(C) (P)-(II), (Q)-(IV), (R)-(I), (S)-(III)

(D) (P)-(IV), (Q)-(III), (R)-(I), (S)-(II)

Correct Answer: (D) (P)-(IV), (Q)-(III), (R)-(I), (S)-(II)

Solution:

Concept:

- Industrial geography associates centres of specialised production with their characteristic products. A matching question requires every city-product pair in the selected option to be correct.
- Aligarh is known for locks, Firozabad for glass bangles, Kanjeevaram for silk sarees and Moradabad for brass products.

Step 1: Match each city to its specialised product Start with Aligarh, labelled (P). Its established lock-making industry gives (P)–(IV). Firozabad, labelled (Q), is a major glass-making centre particularly associated with bangles, giving (Q)–(III). Kanjeevaram, labelled (R), refers to the silk-weaving centre also known as Kanchipuram; its famous silk sarees give (R)–(I). Moradabad, labelled (S), is well known for its brassware and metal handicrafts, giving (S)–(II). The order of the products in the printed table is not itself the matching order; the Roman identifiers must be carried across to the corresponding city.

Step 2: Check the complete option against the four pairs Option (D) states (P)–(IV), (Q)–(III), (R)–(I), (S)–(II), which reproduces all four matches. Option (A) incorrectly connects Aligarh to silk sarees and Kanjeevaram to brass products. Option (B) incorrectly connects Aligarh to bangles and Firozabad to silk sarees. Option (C) incorrectly connects Aligarh to brass products and Firozabad to locks. Thus the alternatives can be rejected immediately from the first city, and checking the remaining three pairs confirms that (D) is fully consistent rather than merely partly correct.

Step 3: Conclusion The correct matching is Aligarh–Locks, Firozabad–Bangles, Kanjeevaram–Silk Sarees and Moradabad–Brass product: (P)–(IV), (Q)–(III), (R)–(I), (S)–(II). Hence, the correct option is (D).

Quick Tip to Solve: First use one secure city-product pair, such as Aligarh–Locks, to narrow the options; then verify every remaining pair before selecting.