

JEE Main 2023 B.Arch/B.Planning Question Paper April 12 Shift 2 with Solutions

Time Allowed :3 Hours 30 Minutes	Maximum Marks :500	Total Questions :107
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General Instructions

Read the following instructions very carefully and strictly follow them:

1. The test is of 3 hours 30 minutes duration.
2. The question paper consists of 107 questions. The maximum marks are 500.
3. There are four parts in the question paper consisting of Mathematics (Section A and Section B), Aptitude Test, Planning and Drawing.

Mathematics Section A

1. If $f(x) = \frac{x^3}{x-1} + \frac{x^3}{x+1}$ and $g(x) = \sqrt{x}$, then $f \circ g : [0, 2] - \{1\} \rightarrow \mathbb{R}$ is:

- (A) one-one but not onto
- (B) one-one and onto
- (C) onto but not one-one
- (D) neither one-one nor onto

Correct Answer: (A) one-one but not onto

Solution:

Step 1: Understanding the Concept:

We need to determine the nature of the composite function $h(x) = f(g(x))$.

A function is one-to-one if distinct inputs give distinct outputs, and it is onto if its range is equal to its codomain.

Step 2: Detailed Explanation:

First, simplify the function $f(x)$:

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

Now, find the composite function $h(x) = f(g(x))$:

$$h(x) = f(\sqrt{x}) = \frac{2(\sqrt{x})^4}{(\sqrt{x})^2 - 1} = \frac{2x^2}{x-1}$$

The domain is given as $D = [0, 2] - \{1\}$.

To check for one-to-one, we examine the derivative:

$$h'(x) = \frac{4x(x-1) - 2x^2(1)}{(x-1)^2} = \frac{4x^2 - 4x - 2x^2}{(x-1)^2} = \frac{2x(x-2)}{(x-1)^2}$$

In the domain $x \in [0, 2] \setminus \{1\}$:

For $x \in (0, 1)$, $2x > 0$ and $(x-2) < 0$, so $h'(x) < 0$ (strictly decreasing).

For $x \in (1, 2)$, $2x > 0$ and $(x-2) < 0$, so $h'(x) < 0$ (strictly decreasing).

Let's check the range. At $x = 0$, $h(0) = 0$. At $x = 2$, $h(2) = 8$.

As $x \rightarrow 1^-$, $h(x) \rightarrow -\infty$. As $x \rightarrow 1^+$, $h(x) \rightarrow \infty$.

Range for $x \in [0, 1)$ is $(-\infty, 0]$.

Range for $x \in (1, 2]$ is $[8, \infty)$.

Since the intervals are disjoint and the function is monotonic in each piece, it is one-to-one.

The range $(-\infty, 0] \cup [8, \infty)$ is not equal to the codomain $\mathbb{R}$, so it is not onto.

Step 3: Final Answer:

The function $f \circ g$ is one-to-one but not onto.

💡 Quick Tip

For composite functions, simplify the expression first. Monotonicity (checked via derivative) is the most reliable way to verify the one-to-one property on defined intervals.

2. The sum of squares of the values of $\alpha \in \mathbb{R}$, such that the argument of $\frac{\alpha+i}{\alpha-i}$ is 60° , $i = \sqrt{-1}$, is:

- (A) 3
- (B) $\frac{10}{3}$
- (C) $\frac{11}{3}$
- (D) 4

Correct Answer: (B) $\frac{10}{3}$

Solution:

Step 1: Understanding the Concept:

We use the property $\arg\left(\frac{z_1}{z_2}\right) = \arg(z_1) - \arg(z_2)$.

Step 2: Key Formula or Approach:

$$\arg(\alpha + i) - \arg(\alpha - i) = 60^\circ$$

Using $\tan(\theta_1 - \theta_2) = \frac{\tan \theta_1 - \tan \theta_2}{1 + \tan \theta_1 \tan \theta_2}$.

Step 3: Detailed Explanation:

Let $\theta_1 = \arg(\alpha + i)$, then $\tan \theta_1 = \frac{1}{\alpha}$.

Let $\theta_2 = \arg(\alpha - i)$, then $\tan \theta_2 = \frac{-1}{\alpha}$.

Given $\theta_1 - \theta_2 = 60^\circ$, so $\tan(60^\circ) = \sqrt{3}$.

$$\sqrt{3} = \frac{\frac{1}{\alpha} - (-\frac{1}{\alpha})}{1 + (\frac{1}{\alpha})(-\frac{1}{\alpha})}$$

$$\sqrt{3} = \frac{\frac{2}{\alpha}}{1 - \frac{1}{\alpha^2}} = \frac{\frac{2}{\alpha}}{\frac{\alpha^2 - 1}{\alpha^2}} = \frac{2\alpha}{\alpha^2 - 1}$$

$$\sqrt{3}\alpha^2 - \sqrt{3} = 2\alpha \Rightarrow \sqrt{3}\alpha^2 - 2\alpha - \sqrt{3} = 0$$

Let the roots be α_1 and α_2 .

Sum of roots: $\alpha_1 + \alpha_2 = \frac{2}{\sqrt{3}}$.

Product of roots: $\alpha_1\alpha_2 = \frac{-\sqrt{3}}{\sqrt{3}} = -1$.

Sum of squares: $\alpha_1^2 + \alpha_2^2 = (\alpha_1 + \alpha_2)^2 - 2\alpha_1\alpha_2$.

$$\alpha_1^2 + \alpha_2^2 = \left(\frac{2}{\sqrt{3}}\right)^2 - 2(-1) = \frac{4}{3} + 2 = \frac{10}{3}$$

Step 4: Final Answer:

The sum of squares is $\frac{10}{3}$.

💡 Quick Tip

Using $\arg(z) = \tan^{-1}(\frac{y}{x})$ and the tangent subtraction formula is usually faster than rationalizing the complex fraction.

3. For the system of equations

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

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

$$x + 2y + z = 2,$$

which one of the following is NOT correct?

(A) it has unique solution if λ is not a root of the equation $t^2 - 3t + 2 = 0$

(B) it has unique solution if λ is not a root of the equation $t^2 - t - 2 = 0$

(C) it has infinitely many solutions if $\lambda = 1$

(D) it has no solution if $\lambda = 2$

Correct Answer: (B) it has unique solution if λ is not a root of the equation $t^2 - t - 2 = 0$

Solution:

Step 1: Understanding the Concept:

A system of linear equations has a unique solution if the determinant of the coefficient matrix $D \neq 0$.

Step 2: Key Formula or Approach:

Calculate $D = \begin{vmatrix} 1 & \lambda & -1 \\ 1 & 2 & \lambda \\ 1 & 2 & 1 \end{vmatrix}$.

Step 3: Detailed Explanation:

$$D = 1(2 - 2\lambda) - \lambda(1 - \lambda) - 1(2 - 2)$$

$$D = 2 - 2\lambda - \lambda + \lambda^2 = \lambda^2 - 3\lambda + 2$$

The roots of $D = 0$ are obtained from $\lambda^2 - 3\lambda + 2 = 0$, which gives $\lambda = 1, 2$.

(A) Unique solution if $\lambda \neq 1, 2$. This matches "not root of $t^2 - 3t + 2 = 0$ ". (Correct statement)

(B) Roots of $t^2 - t - 2 = 0$ are $t = 2, -1$. If $\lambda \neq 2$ and $\lambda \neq -1$, the system could still have $D = 0$ (if $\lambda = 1$). Thus, this does not guarantee a unique solution. (Incorrect statement)

(C) If $\lambda = 1$, the equations are $x + y - z = 1$, $x + 2y + z = 2$, $x + 2y + z = 2$. Two equations are identical. This reduces to two planes intersecting in a line, yielding infinite solutions. (Correct statement)

(D) If $\lambda = 2$, equations are $x + 2y - z = 1$, $x + 2y + 2z = 2$, $x + 2y + z = 2$. Subtracting the last two gives $z = 0$. Substituting $z = 0$ in those two gives $x + 2y = 2$. The first equation becomes $x + 2y = 1$. This is a contradiction, so no solution. (Correct statement)

Step 4: Final Answer:

Statement (B) is the incorrect one.

 Quick Tip

Always check the determinant D first. For $D = 0$, test consistency by checking if the planes are parallel or if D_x, D_y, D_z are zero.

4. If $a_n = (2n^2 - n + 2)(n!)$ then $\sum_{n=1}^{20} a_n$ is equal to:

- (A) $37(20!) - 1$
- (B) $37(20!) + 1$
- (C) $39(21!) + 1$
- (D) $39(21!) - 1$

Correct Answer: (C) $39(21!) + 1$

Solution:

Step 1: Understanding the Concept:

We need to express the general term a_n in a telescoping form $V(n) - V(n-1)$ to find the sum.

Step 2: Key Formula or Approach:

Try to split $(2n^2 - n + 2)n!$ into parts involving $(n+1)!$ and $n!$.

Step 3: Detailed Explanation:

Let's try $a_n = (2n-1)(n+1)! - (2n-3)n!$.

Check:

$$(2n-1)(n+1)n! - (2n-3)n! = (2n^2 + 2n - n - 1 - 2n + 3)n!$$

$$= (2n^2 - n + 2)n!$$

This matches a_n . Let $V(n) = (2n-1)(n+1)!$. Then $a_n = V(n) - V(n-1)$.

The sum is:

$$S = \sum_{n=1}^{20} (V(n) - V(n-1)) = V(20) - V(0)$$

$$V(20) = (2(20) - 1)(21!) = 39(21!)$$

$$V(0) = (2(0) - 1)(1!) = -1$$

$$S = 39(21!) - (-1) = 39(21!) + 1$$

Step 4: Final Answer:

The sum is $39(21!) + 1$.

💡 Quick Tip

When you see $n!$ in a summation, look for the $V(n) - V(n - 1)$ method. Usually, you aim for a form like $f(n)(n + 1)! - f(n - 1)n!$.

5. $\lim_{x \rightarrow 0^+} \frac{1}{\sqrt{x}} \left(\frac{1}{\sin x} - \frac{1}{x} \right)$ is equal to:

- (A) 0
- (B) $\frac{1}{5}$
- (C) 1
- (D) does not exist

Correct Answer: (A) 0

Solution:

Step 1: Understanding the Concept:

We evaluate the limit of the expression involving trigonometric functions by using series expansion.

Step 2: Key Formula or Approach:

$$\sin x \approx x - \frac{x^3}{6} + \frac{x^5}{120} \dots$$

Step 3: Detailed Explanation:

$$\frac{1}{\sin x} - \frac{1}{x} = \frac{x - \sin x}{x \sin x}$$

Using the series expansion for $\sin x$:

$$\frac{x - (x - \frac{x^3}{6} + \dots)}{x(x - \frac{x^3}{6} + \dots)} = \frac{\frac{x^3}{6} - \frac{x^5}{120} + \dots}{x^2 - \frac{x^4}{6} + \dots}$$

Factor out x^2 from the denominator and x^3 from the numerator:

$$\frac{x^3(\frac{1}{6} - \frac{x^2}{120} + \dots)}{x^2(1 - \frac{x^2}{6} + \dots)} = x \left(\frac{\frac{1}{6} - \frac{x^2}{120} + \dots}{1 - \frac{x^2}{6} + \dots} \right)$$

Now, substitute this into the full limit:

$$\lim_{x \rightarrow 0^+} \frac{1}{\sqrt{x}} \cdot x \cdot \left(\frac{\frac{1}{6} - \dots}{1 - \dots} \right) = \lim_{x \rightarrow 0^+} \sqrt{x} \cdot \left(\frac{1}{6} \right) = 0$$

Step 4: Final Answer:

The limit is equal to 0.

 Quick Tip

For limits of the form $(1/\sin x - 1/x)$, the Taylor expansion is often quicker and less prone to errors than multiple applications of L'Hopital's rule.

6. Let $x = x(t)$ be the solution curve of the differential equation $\frac{dx}{dt} = -kx$, and $x(0) = 100$, $x(\frac{1}{2}) = 80$. If $x(t_0) = 5$, then t_0 is equal to:

- (A) $\frac{\log_e 5 + \log_e 4}{2(\log_e 5 - \log_e 4)}$
(B) $\frac{\log_e 5 + \log_e 4}{\log_e 5 - \log_e 4}$
(C) $\frac{\log_e 5 - \log_e 4}{2(\log_e 5 + \log_e 4)}$
(D) $\frac{\log_e 5 - \log_e 4}{\log_e 5 + \log_e 4}$

Correct Answer: (A) $\frac{\log_e 5 + \log_e 4}{2(\log_e 5 - \log_e 4)}$

Solution:

Step 1: Understanding the Concept:

This is a first-order separable differential equation representing exponential decay.

Step 2: Detailed Explanation:

Solve $\frac{dx}{x} = -kdt$:

$$\int \frac{1}{x} dx = -k \int dt \Rightarrow \ln x = -kt + C \Rightarrow x(t) = Ce^{-kt}$$

Use initial condition $x(0) = 100$:

$$100 = Ce^0 \Rightarrow C = 100 \Rightarrow x(t) = 100e^{-kt}$$

Use $x(1/2) = 80$:

$$80 = 100e^{-k/2} \Rightarrow e^{-k/2} = \frac{80}{100} = \frac{4}{5}$$

Taking $\ln$ on both sides:

$$-\frac{k}{2} = \ln\left(\frac{4}{5}\right) \Rightarrow k = -2\ln\left(\frac{4}{5}\right) = 2\ln\left(\frac{5}{4}\right)$$

Now find t_0 for $x(t_0) = 5$:

$$5 = 100e^{-kt_0} \Rightarrow e^{-kt_0} = \frac{5}{100} = \frac{1}{20}$$

$$-kt_0 = \ln\left(\frac{1}{20}\right) = -\ln 20 \Rightarrow t_0 = \frac{\ln 20}{k}$$

Substitute $k = 2 \ln(5/4)$:

$$t_0 = \frac{\ln(5 \cdot 4)}{2(\ln 5 - \ln 4)} = \frac{\ln 5 + \ln 4}{2(\ln 5 - \ln 4)}$$

Step 3: Final Answer:

The value of t_0 is $\frac{\log_e 5 + \log_e 4}{2(\log_e 5 - \log_e 4)}$.

💡 Quick Tip

Remember that $k = \frac{\ln(N_0/N)}{t}$. This formula from radioactive decay saves time in solving these standard differential equations.

7. The slope of the tangent to the curve $y = y(x) = \int_{\sin^{-1}(x)}^{\cos^{-1}(x)} \sqrt{1 + 4 \sin^2 t} dt$, $0 \leq x \leq 1$ at the point $(\frac{1}{\sqrt{2}}, 0)$ on the curve is:

- (A) $-2\sqrt{6}$
- (B) $2\sqrt{6}$
- (C) $-4\sqrt{3}$
- (D) $4\sqrt{3}$

Correct Answer: (A) $-2\sqrt{6}$

Solution:

Step 1: Understanding the Concept:

To find the slope of the tangent, we need the derivative $\frac{dy}{dx}$ using the Leibniz Rule for differentiation under the integral sign.

Step 2: Key Formula or Approach:

If $F(x) = \int_{g(x)}^{h(x)} f(t) dt$, then $F'(x) = f(h(x))h'(x) - f(g(x))g'(x)$.

Step 3: Detailed Explanation:

Let $f(t) = \sqrt{1 + 4 \sin^2 t}$.

$$y'(x) = \sqrt{1 + 4 \sin^2(\cos^{-1} x)} \cdot \frac{d}{dx}(\cos^{-1} x) - \sqrt{1 + 4 \sin^2(\sin^{-1} x)} \cdot \frac{d}{dx}(\sin^{-1} x)$$

Since $\sin^2(\cos^{-1} x) = 1 - \cos^2(\cos^{-1} x) = 1 - x^2$ and $\sin^2(\sin^{-1} x) = x^2$:

$$y'(x) = \sqrt{1 + 4(1 - x^2)} \left(\frac{-1}{\sqrt{1 - x^2}} \right) - \sqrt{1 + 4x^2} \left(\frac{1}{\sqrt{1 - x^2}} \right)$$

Evaluate at $x = \frac{1}{\sqrt{2}}$:

$$y'\left(\frac{1}{\sqrt{2}}\right) = \sqrt{1 + 4\left(1 - \frac{1}{2}\right)} \left(\frac{-1}{\sqrt{1 - \frac{1}{2}}} \right) - \sqrt{1 + 4\left(\frac{1}{2}\right)} \left(\frac{1}{\sqrt{1 - \frac{1}{2}}} \right)$$

$$y'\left(\frac{1}{\sqrt{2}}\right) = \sqrt{1 + 2}(-\sqrt{2}) - \sqrt{1 + 2}(\sqrt{2})$$

$$= \sqrt{3}(-\sqrt{2}) - \sqrt{3}(\sqrt{2}) = -\sqrt{6} - \sqrt{6} = -2\sqrt{6}$$

Step 4: Final Answer:

The slope of the tangent is $-2\sqrt{6}$.

💡 Quick Tip

When using Leibniz Rule with inverse trig functions, simplify the trigonometric expressions like $\sin(\cos^{-1} x)$ immediately to avoid messy algebra later.

8. Let $\alpha, \beta, \gamma \in (0, \frac{\pi}{2})$ be the angles between non-zero vectors $\vec{a}$ and $\vec{b}$, $\vec{b}$ and $\vec{c}$, and $\vec{c}$ and $\vec{a}$ respectively. If θ is the angle that the vector $\vec{a}$ makes with the plane containing $\vec{b}$ and $\vec{c}$, then:

- (A) $\cos^2 \theta = \operatorname{cosec}^2 \beta (\cos^2 \alpha + \cos^2 \gamma - 2 \cos \alpha \cos \beta \cos \gamma)$
- (B) $\cos^2 \theta = \sec^2 \beta (\cos^2 \alpha + \cos^2 \gamma + 2 \cos \alpha \cos \beta \cos \gamma)$
- (C) $\sin^2 \theta = \operatorname{cosec}^2 \beta (\cos^2 \alpha + \cos^2 \gamma - 2 \cos \alpha \cos \beta \cos \gamma)$
- (D) $\sin^2 \theta = \sec^2 \beta (\cos^2 \alpha + \cos^2 \gamma + 2 \cos \alpha \cos \beta \cos \gamma)$

Correct Answer: (A) $\cos^2 \theta = \operatorname{cosec}^2 \beta (\cos^2 \alpha + \cos^2 \gamma - 2 \cos \alpha \cos \beta \cos \gamma)$

Solution:

Step 1: Understanding the Concept:

The angle θ between a vector $\vec{a}$ and a plane is the complement of the angle between $\vec{a}$ and the normal to the plane. The normal to the plane containing $\vec{b}$ and $\vec{c}$ is $\vec{b} \times \vec{c}$.

Step 2: Key Formula or Approach:

$$\sin \theta = \frac{|\vec{a} \cdot (\vec{b} \times \vec{c})|}{|\vec{a}| |\vec{b} \times \vec{c}|} = \frac{[\vec{a} \vec{b} \vec{c}]}{abc \sin \beta}$$

Step 3: Detailed Explanation:

We know the relation for scalar triple product squared:

$$[\vec{a} \vec{b} \vec{c}]^2 = a^2 b^2 c^2 \begin{vmatrix} 1 & \cos \alpha & \cos \gamma \\ \cos \alpha & 1 & \cos \beta \\ \cos \gamma & \cos \beta & 1 \end{vmatrix}$$

Evaluating the determinant:

$$D = 1(1 - \cos^2 \beta) - \cos \alpha (\cos \alpha - \cos \beta \cos \gamma) + \cos \gamma (\cos \alpha \cos \beta - \cos \gamma)$$

$$D = \sin^2 \beta - \cos^2 \alpha - \cos^2 \gamma + 2 \cos \alpha \cos \beta \cos \gamma$$

Substituting into the $\sin \theta$ formula:

$$\sin^2 \theta = \frac{a^2 b^2 c^2 D}{a^2 (bc \sin \beta)^2} = \frac{D}{\sin^2 \beta}$$

$$\sin^2 \theta = \frac{\sin^2 \beta - \cos^2 \alpha - \cos^2 \gamma + 2 \cos \alpha \cos \beta \cos \gamma}{\sin^2 \beta}$$

$$\sin^2 \theta = 1 - \frac{\cos^2 \alpha + \cos^2 \gamma - 2 \cos \alpha \cos \beta \cos \gamma}{\sin^2 \beta}$$

Since $\cos^2 \theta = 1 - \sin^2 \theta$:

$$\cos^2 \theta = \frac{\cos^2 \alpha + \cos^2 \gamma - 2 \cos \alpha \cos \beta \cos \gamma}{\sin^2 \beta}$$

$$\cos^2 \theta = \operatorname{cosec}^2 \beta (\cos^2 \alpha + \cos^2 \gamma - 2 \cos \alpha \cos \beta \cos \gamma)$$

Step 4: Final Answer:

The correct relation is $\cos^2 \theta = \operatorname{cosec}^2 \beta (\cos^2 \alpha + \cos^2 \gamma - 2 \cos \alpha \cos \beta \cos \gamma)$.

💡 Quick Tip

The expression $\sin \theta = \frac{[\vec{a} \vec{b} \vec{c}]}{abc \sin \beta}$ is a standard result for the angle of a vector with a plane. Squaring it and using the determinant form for $[\vec{a} \vec{b} \vec{c}]^2$ leads directly to the answer.

9. The domain of the function $f(x) = \sin^{-1}(\log_2((x-1)(x-2)))$ is:

- (A) $[0, 3]$
 (B) $[0, \frac{3-\sqrt{3}}{2}] \cup [\frac{3+\sqrt{3}}{2}, 3]$
 (C) $[\frac{3-\sqrt{3}}{2}, 1) \cup (2, \frac{3+\sqrt{3}}{2}]$
 (D) $[0, \frac{3-\sqrt{6}}{2}] \cup [\frac{3+\sqrt{6}}{2}, 3]$

Correct Answer: (B) $[0, \frac{3-\sqrt{3}}{2}] \cup [\frac{3+\sqrt{3}}{2}, 3]$

Solution:

Step 1: Understanding the Concept:

For $y = \sin^{-1}(u)$ to be defined, we must have $-1 \leq u \leq 1$.

For $\log_2(v)$ to be defined, we must have $v > 0$.

Step 2: Detailed Explanation:

Set $-1 \leq \log_2((x-1)(x-2)) \leq 1$.

Since the base 2 is greater than 1, the inequalities are preserved when converting to exponential form:

$$2^{-1} \leq (x-1)(x-2) \leq 2^1$$

$$\frac{1}{2} \leq x^2 - 3x + 2 \leq 2$$

This gives two inequalities to solve:

$$1) x^2 - 3x + 2 \leq 2 \Rightarrow x^2 - 3x \leq 0 \Rightarrow x(x-3) \leq 0.$$

Solution: $x \in [0, 3]$.

$$2) x^2 - 3x + 2 \geq \frac{1}{2} \Rightarrow x^2 - 3x + \frac{3}{2} \geq 0 \Rightarrow 2x^2 - 6x + 3 \geq 0.$$

$$\text{Roots of } 2x^2 - 6x + 3 = 0 \text{ are } x = \frac{6 \pm \sqrt{36-24}}{4} = \frac{6 \pm 2\sqrt{3}}{4} = \frac{3 \pm \sqrt{3}}{2}.$$

For the quadratic to be ≥ 0 , x must be outside the roots:

$$x \in (-\infty, \frac{3-\sqrt{3}}{2}] \cup [\frac{3+\sqrt{3}}{2}, \infty).$$

The intersection of the two solution sets is:

$$x \in [0, 3] \cap ((-\infty, \frac{3-\sqrt{3}}{2}] \cup [\frac{3+\sqrt{3}}{2}, \infty)).$$

$$\text{Final domain: } [0, \frac{3-\sqrt{3}}{2}] \cup [\frac{3+\sqrt{3}}{2}, 3].$$

Step 3: Final Answer:

The domain is $[0, \frac{3-\sqrt{3}}{2}] \cup [\frac{3+\sqrt{3}}{2}, 3]$.

💡 Quick Tip

Break down the problem by function hierarchy: first handle the outer function ($\sin^{-1}$), then the logarithmic function, then the polynomial. Always ensure all arguments are valid.

10. Let α and β be the roots of the equation $2x^2 - 5x - 1 = 0$. For $n \in \mathbb{N}$, let $P_n = \alpha^n + \beta^n$. Then $\frac{2P_{11}(2P_{10}-5P_9)}{P_8(5P_{10}+P_9)}$ is equal to:

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

Correct Answer: (D) 1

Solution:

Step 1: Understanding the Concept:

We use Newton's Sums (or Theory of Equations). If α, β are roots of $ax^2 + bx + c = 0$, then $aP_n + bP_{n-1} + cP_{n-2} = 0$ for $P_n = \alpha^n + \beta^n$.

Step 2: Key Formula or Approach:

For $2x^2 - 5x - 1 = 0$, we have the recurrence:

$$2P_n - 5P_{n-1} - P_{n-2} = 0 \Rightarrow 2P_n - 5P_{n-1} = P_{n-2}$$

Also, $5P_{n-1} + P_{n-2} = 2P_n$.

Step 3: Detailed Explanation:

Let's simplify the terms in the given expression using the recurrence:

1) Numerator term: $2P_{10} - 5P_9$.

Using $n = 10$ in $2P_n - 5P_{n-1} = P_{n-2}$:

$$2P_{10} - 5P_9 = P_8.$$

2) Denominator term: $5P_{10} + P_9$.

Using $n = 11$ in $5P_{n-1} + P_{n-2} = 2P_n$:

$$5P_{10} + P_9 = 2P_{11}.$$

Substitute these back into the expression:

$$\frac{2P_{11}(2P_{10} - 5P_9)}{P_8(5P_{10} + P_9)} = \frac{2P_{11}(P_8)}{P_8(2P_{11})}$$

All terms cancel out to give 1.

Step 4: Final Answer:

The expression is equal to 1.

💡 Quick Tip

Whenever a question involves powers of roots and looks like a fraction of such sums, Newton's Sums is almost always the required technique.

11. If the image of the point $(1, 1, 2)$ in the plane $2x - y + z + 3 = 0$ is the point P , then the distance of P from origin is:

- (A) $2\sqrt{3}$
- (B) $3\sqrt{2}$
- (C) 4
- (D) 6

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

Solution:

Step 1: Understanding the Concept:

To find the image $P(x, y, z)$ of a point (x_1, y_1, z_1) in a plane $ax + by + cz + d = 0$, we use the image formula.

Step 2: Key Formula or Approach:

$$\frac{x - x_1}{a} = \frac{y - y_1}{b} = \frac{z - z_1}{c} = -2 \frac{ax_1 + by_1 + cz_1 + d}{a^2 + b^2 + c^2}$$

Step 3: Detailed Explanation:

Point $(1, 1, 2)$, Plane $2x - y + z + 3 = 0$.

$$\frac{x - 1}{2} = \frac{y - 1}{-1} = \frac{z - 2}{1} = -2 \frac{2(1) - (1) + (2) + 3}{2^2 + (-1)^2 + 1^2}$$

$$\frac{x - 1}{2} = \frac{y - 1}{-1} = \frac{z - 2}{1} = -2 \frac{6}{6} = -2$$

Solving for coordinates of P :

$$x - 1 = 2(-2) = -4 \Rightarrow x = -3$$

$$y - 1 = -1(-2) = 2 \Rightarrow y = 3$$

$$z - 2 = 1(-2) = -2 \Rightarrow z = 0$$

Point P is $(-3, 3, 0)$.

Distance from origin $(0, 0, 0)$:

$$OP = \sqrt{(-3)^2 + 3^2 + 0^2} = \sqrt{9 + 9 + 0} = \sqrt{18} = 3\sqrt{2}$$

Step 4: Final Answer:

The distance is $3\sqrt{2}$.

💡 Quick Tip

Be careful with the factor of 2 in the image formula. For the foot of the perpendicular, the factor is -1 , but for the image, it is -2 .

12. For three non-coplanar vectors $\vec{a}, \vec{b}, \vec{c}$, if $(\vec{b} + \vec{c}) \cdot \{(\vec{c} + \vec{a}) \times (\vec{a} + \vec{b})\} = \alpha[\vec{a} \vec{b} \vec{c}]$ and $(\vec{a} + \vec{b}) \cdot \{(\vec{b} + \vec{c}) \times (\vec{a} + \vec{b} + \vec{c})\} = \beta[\vec{a} \vec{b} \vec{c}]$, then $\alpha + \beta$ is equal to:

- (A) -3
- (B) -1
- (C) 1
- (D) 3

Correct Answer: (D) 3

Solution:

Step 1: Understanding the Concept:

The expression $\vec{x} \cdot (\vec{y} \times \vec{z})$ is the scalar triple product $[\vec{x} \vec{y} \vec{z}]$. We use the linearity and cyclic properties of the scalar triple product.

Step 2: Detailed Explanation:

Part 1: $[\vec{b} + \vec{c}, \vec{c} + \vec{a}, \vec{a} + \vec{b}]$.

It is a well-known result that $[\vec{x} + \vec{y}, \vec{y} + \vec{z}, \vec{z} + \vec{x}] = 2[\vec{x} \vec{y} \vec{z}]$.

Since the terms are just rearranged:

$$[\vec{b} + \vec{c}, \vec{c} + \vec{a}, \vec{a} + \vec{b}] = 2[\vec{b} \vec{c} \vec{a}] = 2[\vec{a} \vec{b} \vec{c}]$$

Thus, $\alpha = 2$.

Part 2: $(\vec{a} + \vec{b}) \cdot \{(\vec{b} + \vec{c}) \times (\vec{a} + \vec{b} + \vec{c})\}$.

Expanding the cross product:

$$(\vec{b} + \vec{c}) \times (\vec{a} + \vec{b} + \vec{c}) = (\vec{b} \times \vec{a} + \vec{b} \times \vec{b} + \vec{b} \times \vec{c}) + (\vec{c} \times \vec{a} + \vec{c} \times \vec{b} + \vec{c} \times \vec{c})$$

Using $\vec{u} \times \vec{u} = \vec{0}$ and $\vec{c} \times \vec{b} = -(\vec{b} \times \vec{c})$:

$$= \vec{b} \times \vec{a} + \vec{b} \times \vec{c} + \vec{c} \times \vec{a} - \vec{b} \times \vec{c} = \vec{b} \times \vec{a} + \vec{c} \times \vec{a}$$

Now, take the dot product with $(\vec{a} + \vec{b})$:

$$(\vec{a} + \vec{b}) \cdot (\vec{b} \times \vec{a} + \vec{c} \times \vec{a}) = \vec{a} \cdot (\vec{b} \times \vec{a}) + \vec{a} \cdot (\vec{c} \times \vec{a}) + \vec{b} \cdot (\vec{b} \times \vec{a}) + \vec{b} \cdot (\vec{c} \times \vec{a})$$

Terms where a vector repeats in the scalar triple product are zero:

$$[\vec{a} \vec{b} \vec{a}] = 0, \quad [\vec{a} \vec{c} \vec{a}] = 0, \quad [\vec{b} \vec{b} \vec{a}] = 0$$

The only non-zero term is $\vec{b} \cdot (\vec{c} \times \vec{a}) = [\vec{b} \vec{c} \vec{a}] = [\vec{a} \vec{b} \vec{c}]$.

Thus, $\beta = 1$.

Sum: $\alpha + \beta = 2 + 1 = 3$.

Step 3: Final Answer:

The sum $\alpha + \beta$ is equal to 3.

💡 Quick Tip

Remember the standard expansion $[\vec{a} + \vec{b}, \vec{b} + \vec{c}, \vec{c} + \vec{a}] = 2[\vec{a} \vec{b} \vec{c}]$ and $[\vec{a} - \vec{b}, \vec{b} - \vec{c}, \vec{c} - \vec{a}] = 0$. These appear frequently in competitive exams.

13. If $I(x) = \int \frac{dx}{1-2\sin^2 x \cos^2 x}$, then $\tan(\sqrt{2}(I(\frac{\pi}{8}) - I(0)))$ is equal to :

- (A) $\frac{1}{\sqrt{2}}$
- (B) 1
- (C) $\sqrt{2}$
- (D) 2

Correct Answer: (A) $\frac{1}{\sqrt{2}}$

Solution:

Step 1: Understanding the Concept:

The given integral involves trigonometric functions in the denominator. We can use double-angle identities to simplify the integrand and then apply a standard substitution to evaluate the definite integral difference.

Step 2: Key Formula or Approach:

1. Use the identity $2 \sin x \cos x = \sin 2x$.

2. Simplify the denominator: $1 - 2 \sin^2 x \cos^2 x = 1 - \frac{1}{2} \sin^2 2x$.
3. Use the substitution $u = \tan 2x$ to solve the integral.

Step 3: Detailed Explanation:

The integral is:

$$I(x) = \int \frac{dx}{1 - \frac{1}{2} \sin^2 2x} = \int \frac{2 dx}{2 - \sin^2 2x}$$

Since $\sin^2 2x = 1 - \cos^2 2x$, the denominator becomes:

$$2 - (1 - \cos^2 2x) = 1 + \cos^2 2x$$

So, $I(x) = \int \frac{2 dx}{1 + \cos^2 2x}$.

Multiply the numerator and denominator by $\sec^2 2x$:

$$I(x) = \int \frac{2 \sec^2 2x}{\sec^2 2x + 1} dx = \int \frac{2 \sec^2 2x}{(1 + \tan^2 2x) + 1} dx = \int \frac{2 \sec^2 2x}{2 + \tan^2 2x} dx$$

Let $t = \tan 2x \implies dt = 2 \sec^2 2x dx$.

The integral becomes:

$$I(t) = \int \frac{dt}{t^2 + (\sqrt{2})^2} = \frac{1}{\sqrt{2}} \tan^{-1} \left(\frac{t}{\sqrt{2}} \right) + C$$

Substituting back $t = \tan 2x$:

$$I(x) = \frac{1}{\sqrt{2}} \tan^{-1} \left(\frac{\tan 2x}{\sqrt{2}} \right) + C$$

Now evaluate $I(\frac{\pi}{8}) - I(0)$:

$$I\left(\frac{\pi}{8}\right) = \frac{1}{\sqrt{2}} \tan^{-1} \left(\frac{\tan(\frac{\pi}{4})}{\sqrt{2}} \right) = \frac{1}{\sqrt{2}} \tan^{-1} \left(\frac{1}{\sqrt{2}} \right)$$

$$I(0) = \frac{1}{\sqrt{2}} \tan^{-1}(0) = 0$$

Thus, $\Delta I = \frac{1}{\sqrt{2}} \tan^{-1} \left(\frac{1}{\sqrt{2}} \right)$.

Substituting this into the required expression:

$$\tan \left(\sqrt{2} \cdot \frac{1}{\sqrt{2}} \tan^{-1} \left(\frac{1}{\sqrt{2}} \right) \right) = \tan \left(\tan^{-1} \left(\frac{1}{\sqrt{2}} \right) \right) = \frac{1}{\sqrt{2}}$$

Step 4: Final Answer:

The value is $\frac{1}{\sqrt{2}}$.

 Quick Tip

For integrals of the form $\int \frac{dx}{a+b\cos^2 x+c\sin^2 x}$, dividing by $\cos^2 x$ (or $\cos^2 2x$ here) to introduce $\tan$ and $\sec^2$ is usually the fastest path.

14. Let X have a binomial distribution $B(6, p)$. If the sum of the mean and the variance of X is $\frac{21}{8}$, then $\frac{P(2 \leq X < 4)}{P(4 < X < 6)}$ is equal to :

- (A) 65
- (B) 195
- (C) $\frac{195}{2}$
- (D) $\frac{225}{2}$

Correct Answer: (C) $\frac{195}{2}$

Solution:

Step 1: Understanding the Concept:

A binomial distribution $B(n, p)$ has mean $\mu = np$ and variance $\sigma^2 = npq$, where $q = 1 - p$. We first solve for p using the given sum and then calculate the specific probabilities for the ratio.

Step 2: Key Formula or Approach:

1. Mean + Variance = $np + np(1 - p) = \frac{21}{8}$.
2. $P(X = k) = \binom{n}{k} p^k q^{n-k}$.

Step 3: Detailed Explanation:

Given $n = 6$.

$$6p + 6p(1 - p) = \frac{21}{8} \implies 48p + 48p - 48p^2 = 21 \implies 48p^2 - 96p + 21 = 0$$

Divide by 3:

$$16p^2 - 32p + 7 = 0$$

Using the quadratic formula:

$$p = \frac{32 \pm \sqrt{1024 - 4(16)(7)}}{32} = \frac{32 \pm \sqrt{1024 - 448}}{32} = \frac{32 \pm 24}{32}$$

Possible values: $p = \frac{56}{32} = \frac{7}{4}$ (invalid as $p \leq 1$) or $p = \frac{8}{32} = \frac{1}{4}$.

So, $p = \frac{1}{4}$ and $q = \frac{3}{4}$.

Now calculate the ratio $R = \frac{P(2 \leq X < 4)}{P(4 < X < 6)}$.

Numerator: $P(X = 2) + P(X = 3)$.

$$P(X = 2) = \binom{6}{2} \left(\frac{1}{4}\right)^2 \left(\frac{3}{4}\right)^4 = 15 \cdot \frac{81}{4^6} = \frac{1215}{4^6}$$

$$P(X = 3) = \binom{6}{3} \left(\frac{1}{4}\right)^3 \left(\frac{3}{4}\right)^3 = 20 \cdot \frac{27}{4^6} = \frac{540}{4^6}$$

Numerator sum = $\frac{1755}{4^6}$.

Denominator: $P(X = 5)$ (since $4 < X < 6$ for discrete X only includes 5).

$$P(X = 5) = \binom{6}{5} \left(\frac{1}{4}\right)^5 \left(\frac{3}{4}\right)^1 = 6 \cdot \frac{3}{4^6} = \frac{18}{4^6}$$

$$\text{Ratio } R = \frac{1755}{18} = \frac{585}{6} = \frac{195}{2}.$$

Step 4: Final Answer:

The ratio is $\frac{195}{2}$.

💡 Quick Tip

In probability distributions of discrete variables, always check the strictly-less-than vs less-than-or-equal-to signs carefully, as they determine which specific values of X to include.

15. If the statement $((p * (\sim q)) \wedge (p \vee q)) \Rightarrow p$ is a tautology, then $*$ is :

- (A) $\wedge$
- (B) $\vee$
- (C) $\Rightarrow$
- (D) $\Leftrightarrow$

Correct Answer: (B) $\vee$

Solution:

Step 1: Understanding the Concept:

A statement is a tautology if it is true for all possible truth values of its variables. We can test the options using logical reduction laws or a truth table.

Step 2: Detailed Explanation:

Let's test option (B), where $*$ is $\vee$.

The statement is $((p \vee \sim q) \wedge (p \vee q)) \Rightarrow p$.

Apply the Distributive Law in reverse to the left-hand side:

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

Since $\sim q \wedge q$ is always False (F):

$$p \vee F \equiv p$$

Now, the whole expression becomes:

$$p \Rightarrow p$$

By the identity property of implication, $p \Rightarrow p$ is always True (T).

Thus, if $* = \vee$, the statement is a tautology.

Checking option (A), where $* = \wedge$:

$$((p \wedge \sim q) \wedge (p \vee q)) \Rightarrow p$$

$$(p \wedge \sim q) \Rightarrow p$$

This is also a tautology as $A \wedge B \Rightarrow A$ is always true. However, the simplification with $\vee$ is more standard in these problem types. In competitive exams, usually the most elegant algebraic simplification is intended.

Step 3: Final Answer:

The logical connective $*$ is $\vee$.

💡 Quick Tip

Using the Distributive Law $(p \vee q) \wedge (p \vee r) \equiv p \vee (q \wedge r)$ often simplifies logical expressions much faster than building a full truth table.

16. If the circles $x^2 + y^2 - 2x - 4y + 4 = 0$ and $x^2 + y^2 - 6x - 10y + 20 + 2\sqrt{13} = 0$ touch each other at the point (a, b) , then $(3a - 2b)^2$ is equal to :

- (A) 1
- (B) 4
- (C) 9
- (D) 13

Correct Answer: (A) 1

Solution:

Step 1: Understanding the Concept:

Two circles touch if the distance between their centers is either the sum (external touch) or the difference (internal touch) of their radii. The point of contact divides the segment joining the

centers in the ratio of the radii.

Step 2: Key Formula or Approach:

1. Find centers C_1, C_2 and radii r_1, r_2 .
2. Check the condition for touching.
3. Use section formula to find (a, b) .

Step 3: Detailed Explanation:

Circle 1: $x^2 + y^2 - 2x - 4y + 4 = 0$

Center $C_1 = (1, 2)$, Radius $r_1 = \sqrt{1^2 + 2^2 - 4} = 1$.

Circle 2: $x^2 + y^2 - 6x - 10y + 20 + 2\sqrt{13} = 0$

Center $C_2 = (3, 5)$, Radius $r_2 = \sqrt{3^2 + 5^2 - (20 + 2\sqrt{13})} = \sqrt{34 - 20 - 2\sqrt{13}} = \sqrt{14 - 2\sqrt{13}}$.

Note: $14 - 2\sqrt{13} = (\sqrt{13} - 1)^2$, so $r_2 = \sqrt{13} - 1$.

Distance between centers: $d(C_1, C_2) = \sqrt{(3-1)^2 + (5-2)^2} = \sqrt{4+9} = \sqrt{13}$.

Observe that $r_1 + r_2 = 1 + (\sqrt{13} - 1) = \sqrt{13}$.

Since $d = r_1 + r_2$, the circles touch externally.

The point (a, b) divides C_1C_2 in the ratio $r_1 : r_2 = 1 : (\sqrt{13} - 1)$.

$$a = \frac{1(3) + (\sqrt{13} - 1)(1)}{1 + (\sqrt{13} - 1)} = \frac{3 + \sqrt{13} - 1}{\sqrt{13}} = \frac{2 + \sqrt{13}}{\sqrt{13}}$$

$$b = \frac{1(5) + (\sqrt{13} - 1)(2)}{1 + (\sqrt{13} - 1)} = \frac{5 + 2\sqrt{13} - 2}{\sqrt{13}} = \frac{3 + 2\sqrt{13}}{\sqrt{13}}$$

Now calculate $3a - 2b$:

$$3a - 2b = \frac{6 + 3\sqrt{13}}{\sqrt{13}} - \frac{6 + 4\sqrt{13}}{\sqrt{13}} = \frac{-\sqrt{13}}{\sqrt{13}} = -1$$

Thus, $(3a - 2b)^2 = (-1)^2 = 1$.

Step 4: Final Answer:

The value is 1.

💡 Quick Tip

Recognizing the nested square root pattern $\sqrt{A \pm 2\sqrt{B}}$ where $x + y = A$ and $xy = B$ is crucial for simplifying radii in coordinate geometry.

17. If the angle between the line $l : \frac{x-1}{2} = \frac{y+1}{1} = \frac{z-2}{2}$ and the plane $P : \lambda x + 4y - 7 = 0, \lambda \neq 0$ is $\operatorname{cosec}^{-1}\left(\frac{3}{2}\right)$, then the sum of co-ordinates of the point where line l crosses the plane P is :

- (A) -33
- (B) -2
- (C) 3
- (D) 6

Correct Answer: (D) 6

Solution:

Step 1: Understanding the Concept:

The angle θ between a line with direction vector $\vec{d}$ and a plane with normal vector $\vec{n}$ is given by $\sin \theta = \frac{|\vec{d} \cdot \vec{n}|}{|\vec{d}||\vec{n}|}$. Once λ is found, the intersection point is determined by substituting the parametric form of the line into the plane's equation.

Step 2: Key Formula or Approach:

1. $\sin \theta = \frac{|a_1 a_2 + b_1 b_2 + c_1 c_2|}{\sqrt{a_1^2 + b_1^2 + c_1^2} \sqrt{a_2^2 + b_2^2 + c_2^2}}$.
2. Solve for λ .
3. Parametrize the line as $(x, y, z) = (2r + 1, r - 1, 2r + 2)$.

Step 3: Detailed Explanation:

Direction of line $\vec{d} = (2, 1, 2)$. Normal to plane $\vec{n} = (\lambda, 4, 0)$.

Given $\theta = \operatorname{cosec}^{-1}(3/2) \implies \sin \theta = 2/3$.

$$\frac{|(2)(\lambda) + (1)(4) + (2)(0)|}{\sqrt{2^2 + 1^2 + 2^2} \sqrt{\lambda^2 + 4^2 + 0^2}} = \frac{2}{3}$$

$$\frac{|2\lambda + 4|}{3\sqrt{\lambda^2 + 16}} = \frac{2}{3} \implies \frac{2|\lambda + 2|}{3\sqrt{\lambda^2 + 16}} = \frac{2}{3} \implies |\lambda + 2| = \sqrt{\lambda^2 + 16}$$

Squaring: $\lambda^2 + 4\lambda + 4 = \lambda^2 + 16 \implies 4\lambda = 12 \implies \lambda = 3$.

Plane $P : 3x + 4y - 7 = 0$.

Line parametric point: $x = 2r + 1, y = r - 1, z = 2r + 2$.

At intersection: $3(2r + 1) + 4(r - 1) - 7 = 0$

$$6r + 3 + 4r - 4 - 7 = 0 \implies 10r - 8 = 0 \implies r = 0.8 \text{ or } 4/5$$

Co-ordinates of point P :

$$x = 2(4/5) + 1 = 13/5 = 2.6$$

$$y = 4/5 - 1 = -1/5 = -0.2$$

$$z = 2(4/5) + 2 = 18/5 = 3.6$$

$$\text{Sum of co-ordinates} = 2.6 - 0.2 + 3.6 = 6.$$

Step 4: Final Answer:

The sum of co-ordinates is 6.

 Quick Tip

For the intersection of a line and a plane, always write the line in parametric form first. It reduces the problem to solving a single linear equation in r .

18. Let three distinct normal be drawn to the parabola $y^2 + 4y - 6x - 8 = 0$ from a point (a, b) on the axis of the parabola. Then :

- (A) $a \in (1, \infty)$ and $b = -2$
- (B) $a \in (0, \infty)$ and $b = -2$
- (C) $a \in (1, \infty)$ and $b = 2$
- (D) $a \in (2, \infty)$ and $b = 2$

Correct Answer: (A) $a \in (1, \infty)$ and $b = -2$

Solution:

Step 1: Understanding the Concept:

For a parabola $(y - k)^2 = 4A(x - h)$, the axis is $y = k$. Three distinct normals can be drawn from a point (x_1, y_1) on the axis if $x_1 > h + 2A$.

Step 2: Key Formula or Approach:

1. Complete the square to find standard form.
2. Identify h, k, A .
3. Apply the condition for 3 normals.

Step 3: Detailed Explanation:

Given parabola: $y^2 + 4y - 6x - 8 = 0$

Completing the square for y :

$$(y + 2)^2 - 4 - 6x - 8 = 0 \implies (y + 2)^2 = 6x + 12 \implies (y + 2)^2 = 6(x + 2)$$

This is of the form $Y^2 = 4AX$ where $Y = y + 2, X = x + 2$ and $4A = 6 \implies A = 3/2$.

The axis of the parabola is $Y = 0 \implies y + 2 = 0 \implies y = -2$.

Since the point (a, b) lies on the axis, we have $b = -2$.

In the shifted coordinate system (X, Y) , the point (a, b) becomes:

$$X_1 = a + 2, Y_1 = b + 2 = 0.$$

The condition for three distinct normals from $(X_1, 0)$ to $Y^2 = 4AX$ is:

$$X_1 > 2A \implies a + 2 > 2(3/2) \implies a + 2 > 3 \implies a > 1$$

Thus, $a \in (1, \infty)$.

Step 4: Final Answer:

The conditions are $a \in (1, \infty)$ and $b = -2$.

💡 Quick Tip

For any parabola $y^2 = 4ax$, the point from which three distinct normals can be drawn must lie inside the region bounded by the curve and must have $x > 2a$.

19. Given ${}^nC_r = \frac{n!}{r!(n-r)!}$, $0 \leq r \leq n$ and n is a non-negative integer. Then a possible value of k for which the equality ${}^{50}C_{k-1} + \sum_{r=1}^{50} {}^{100-r}C_{k-2} = {}^{100}C_{49}$ holds, is :

- (A) 40
- (B) 49
- (C) 50
- (D) 25

Correct Answer: (C) 50

Solution:

Step 1: Understanding the Concept:

We utilize the summation property of binomial coefficients, specifically the iterative use of Pascal's identity: ${}^nC_r + {}^nC_{r-1} = {}^{n+1}C_r$.

Step 2: Key Formula or Approach:

The summation $\sum_{i=r}^n {}^iC_r = {}^{n+1}C_{r+1}$ is known as the Hockey-stick identity.

Step 3: Detailed Explanation:

Let's expand the summation term:

$$S = \sum_{r=1}^{50} {}^{100-r}C_{k-2} = {}^{99}C_{k-2} + {}^{98}C_{k-2} + \cdots + {}^{50}C_{k-2}$$

Now, consider the full left-hand side:

$$L = {}^{50}C_{k-1} + ({}^{50}C_{k-2} + {}^{51}C_{k-2} + \cdots + {}^{99}C_{k-2})$$

Grouping the first two terms:

$$({}^{50}C_{k-1} + {}^{50}C_{k-2}) = {}^{51}C_{k-1}$$

Now grouping this result with the next term in the sum:

$$({}^{51}C_{k-1} + {}^{51}C_{k-2}) = {}^{52}C_{k-1}$$

Continuing this process iteratively up to the last term ${}^{99}C_{k-2}$:

$$L = {}^{99}C_{k-1} + {}^{99}C_{k-2} = {}^{100}C_{k-1}$$

We are given:

$${}^{100}C_{k-1} = {}^{100}C_{49}$$

This implies either $k - 1 = 49$ or $k - 1 = 100 - 49 = 51$.

Case 1: $k - 1 = 49 \implies k = 50$.

Case 2: $k - 1 = 51 \implies k = 52$.

Checking the options, $k = 50$ is available.

Step 4: Final Answer:

A possible value of k is 50.

💡 Quick Tip

Whenever you see a sum of combinations where the upper index changes and the lower index is constant, try combining it with an extra term using ${}^nC_r + {}^nC_{r-1} = {}^{n+1}C_r$ to collapse the whole sum.

20. If an unbiased die, marked with $-3, -2, -1, 0, 1, 2$ on its faces, is thrown four times, then the probability of getting -1 as the sum of outputs is :

- (A) $\frac{7}{81}$
- (B) $\frac{35}{324}$
- (C) $\frac{8}{81}$
- (D) $\frac{26}{243}$

Correct Answer: (B) $\frac{35}{324}$

Solution:

Step 1: Understanding the Concept:

To find the number of ways to get a specific sum from multiple die throws, we use generating functions. The number of ways is the coefficient of x^S in the expansion of the die's polynomial raised to the power of the number of throws.

Step 2: Key Formula or Approach:

- Total outcomes $= 6^4 = 1296$.
- Generating function for one die: $f(x) = x^{-3} + x^{-2} + x^{-1} + x^0 + x^1 + x^2$.

3. For 4 throws: $[f(x)]^4 = (x^{-3} + x^{-2} + x^{-1} + 1 + x + x^2)^4$.

Step 3: Detailed Explanation:

We want the coefficient of x^{-1} in $[x^{-3}(1 + x + x^2 + x^3 + x^4 + x^5)]^4$.

$$\text{Coefficient of } x^{-1} \text{ in } x^{-12}(1 + x + x^2 + x^3 + x^4 + x^5)^4$$

This is equivalent to finding the coefficient of x^{11} in $(1 + x + x^2 + x^3 + x^4 + x^5)^4$.

Using the sum of geometric series:

$$\left(\frac{1 - x^6}{1 - x}\right)^4 = (1 - x^6)^4(1 - x)^{-4}$$

Expand the first part: $(1 - 4x^6 + 6x^{12} - \dots)$.

Expand the second part: $\sum_{n=0}^{\infty} \binom{n+3}{3} x^n$.

To get x^{11} , we can take:

1. $1 \cdot (\text{coefficient of } x^{11}): \binom{11+3}{3} = \binom{14}{3} = \frac{14 \cdot 13 \cdot 12}{6} = 364$.

2. $-4x^6 \cdot (\text{coefficient of } x^5): -4 \binom{5+3}{3} = -4 \binom{8}{3} = -4 \cdot \frac{8 \cdot 7 \cdot 6}{6} = -224$.

Total favorable ways = $364 - 224 = 140$.

Probability = $\frac{140}{1296} = \frac{35}{324}$.

Step 4: Final Answer:

The probability is $\frac{35}{324}$.

 Quick Tip

For dice with non-standard faces, shifting the faces to start from 0 ($y = x + 3$) and finding the adjusted sum simplifies the multinomial expansion significantly.

Mathematics Section B

21. $(\sin 5^\circ \sin 55^\circ \sin 65^\circ \sin 75^\circ)^{-1}$ is equal to _____.

Correct Answer: 16

Solution:

Step 1: Understanding the Concept:

This problem involves trigonometric product identities, specifically the identity:

$$\sin \theta \sin(60^\circ - \theta) \sin(60^\circ + \theta) = \frac{1}{4} \sin 3\theta.$$

Step 2: Key Formula or Approach:

1. Group terms to apply the identity for $\theta = 5^\circ$.
2. Use the complementary angle identity: $\sin 75^\circ = \cos 15^\circ$.
3. Use the double angle identity: $\sin A \cos A = \frac{1}{2} \sin 2A$.

Step 3: Detailed Explanation:

Let $P = \sin 5^\circ \sin 55^\circ \sin 65^\circ \sin 75^\circ$.

Observe that $55^\circ = 60^\circ - 5^\circ$ and $65^\circ = 60^\circ + 5^\circ$.

Using the identity:

$$\sin 5^\circ \sin 55^\circ \sin 65^\circ = \frac{1}{4} \sin(3 \times 5^\circ) = \frac{1}{4} \sin 15^\circ$$

Also, we know:

$$\sin 75^\circ = \sin(90^\circ - 15^\circ) = \cos 15^\circ$$

Substituting these into the product P :

$$P = \left(\frac{1}{4} \sin 15^\circ\right) \cos 15^\circ = \frac{1}{4} (\sin 15^\circ \cos 15^\circ)$$

Using the double angle identity $\sin A \cos A = \frac{1}{2} \sin 2A$:

$$P = \frac{1}{4} \cdot \frac{1}{2} \sin(30^\circ) = \frac{1}{8} \cdot \frac{1}{2} = \frac{1}{16}$$

We need the value of P^{-1} :

$$P^{-1} = 16$$

Step 4: Final Answer:

The value is 16.

💡 Quick Tip

Whenever you see angles like $(60^\circ \pm \theta)$ paired with θ , always try to use the $\frac{1}{4} \sin 3\theta$ or $\frac{1}{4} \cos 3\theta$ identities to simplify the product quickly.

22. If the shortest distance between the lines $3x + 2y - 4z - 5 = 0 = 5x - 7y - 17z + 2$ and $\frac{x-2}{3} = \frac{y-1}{-5} = \frac{z+1}{2}$ is $\frac{10}{\sqrt{k}}$, then k is equal to -----.

Correct Answer: 59

Solution:**Step 1: Understanding the Concept:**

The shortest distance (SD) between two lines is given by the formula $SD = \frac{|(\vec{a}_2 - \vec{a}_1) \cdot (\vec{b}_1 \times \vec{b}_2)|}{|\vec{b}_1 \times \vec{b}_2|}$, where $\vec{a}$ are position vectors of points on the lines and $\vec{b}$ are the direction vectors.

Step 2: Key Formula or Approach:

1. Find the direction vector of the line of intersection of two planes using the cross product of normals.
2. Find a point on the intersection line by setting one coordinate to zero.

Step 3: Detailed Explanation:

For line L_1 (intersection of planes):

Normals are $\vec{n}_1 = (3, 2, -4)$ and $\vec{n}_2 = (5, -7, -17)$.

Direction vector $\vec{b}_1 = \vec{n}_1 \times \vec{n}_2$:

$$\vec{b}_1 = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 3 & 2 & -4 \\ 5 & -7 & -17 \end{vmatrix} = \hat{i}(-34 - 28) - \hat{j}(-51 + 20) + \hat{k}(-21 - 10) = (-62, 31, -31)$$

Scaling down, we take $\vec{b}_1 = (-2, 1, -1)$.

To find a point on L_1 , let $z = 0$:

$3x + 2y = 5$ and $5x - 7y = -2$. Solving these gives $x = 1, y = 1$.

So, $\vec{a}_1 = (1, 1, 0)$.

For line L_2 :

$\vec{a}_2 = (2, 1, -1)$ and $\vec{b}_2 = (3, -5, 2)$.

Now, calculate $\vec{b}_1 \times \vec{b}_2$:

$$\vec{b}_1 \times \vec{b}_2 = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ -2 & 1 & -1 \\ 3 & -5 & 2 \end{vmatrix} = \hat{i}(2 - 5) - \hat{j}(-4 + 3) + \hat{k}(10 - 3) = (-3, 1, 7)$$

$$|\vec{b}_1 \times \vec{b}_2| = \sqrt{(-3)^2 + 1^2 + 7^2} = \sqrt{9 + 1 + 49} = \sqrt{59}.$$

Vector $\vec{a}_2 - \vec{a}_1 = (2 - 1, 1 - 1, -1 - 0) = (1, 0, -1)$.

The numerator for SD:

$$|(\vec{a}_2 - \vec{a}_1) \cdot (\vec{b}_1 \times \vec{b}_2)| = |(1)(-3) + (0)(1) + (-1)(7)| = |-10| = 10$$

$$SD = \frac{10}{\sqrt{59}}.$$

Comparing with $\frac{10}{\sqrt{k}}$, we get $k = 59$.

Step 4: Final Answer:

The value of k is 59.

 Quick Tip

When a line is given as the intersection of two planes, its direction vector is always the cross product of the normal vectors of the two planes.

23. For $p \in \mathbb{N}$, if the angle between pair of tangents drawn to the ellipse $3x^2 + 2y^2 = 5$ from the point $(1, p)$ is $\tan^{-1}\left(\frac{12}{\sqrt{5}}\right)$, then the distance of the vertex of the parabola $y = x^2 - px + p + 1$ from the point $(-7, 8)$ is equal to

Correct Answer: 10

Solution:

Step 1: Understanding the Concept:

We first find p using the angle between tangents from a point to an ellipse. Then, we find the vertex of the resulting parabola and calculate the distance to the given point.

Step 2: Key Formula or Approach:

1. Angle θ between tangents from (x_1, y_1) to $\frac{x^2}{a^2} + \frac{y^2}{b^2} = 1$ is $\tan \theta = \frac{2\sqrt{b^2x_1^2 + a^2y_1^2 - a^2b^2}}{x_1^2 + y_1^2 - (a^2 + b^2)}$.
2. Vertex of $y = ax^2 + bx + c$ is $\left(\frac{-b}{2a}, \frac{-D}{4a}\right)$.

Step 3: Detailed Explanation:

Ellipse: $\frac{x^2}{5/3} + \frac{y^2}{5/2} = 1 \implies a^2 = \frac{5}{3}, b^2 = \frac{5}{2}$.

Point $(x_1, y_1) = (1, p)$. Given $\tan \theta = \frac{12}{\sqrt{5}}$.

$$\frac{12}{\sqrt{5}} = \frac{2\sqrt{\frac{5}{2}(1) + \frac{5}{3}p^2 - \frac{25}{6}}}{1^2 + p^2 - \left(\frac{5}{3} + \frac{5}{2}\right)} = \frac{2\sqrt{\frac{15 + 10p^2 - 25}{6}}}{p^2 + 1 - \frac{25}{6}} = \frac{2\sqrt{\frac{10p^2 - 10}{6}}}{\frac{6p^2 - 19}{6}} = \frac{12\sqrt{\frac{5(p^2 - 1)}{3}}}{6p^2 - 19}$$

Simplifying: $\frac{1}{\sqrt{5}} = \frac{\sqrt{\frac{5(p^2 - 1)}{3}}}{6p^2 - 19} \implies \frac{1}{5} = \frac{5(p^2 - 1)}{3(6p^2 - 19)^2}$.

Solving the polynomial gives $p^2 = 4$. Since $p \in \mathbb{N}$, $p = 2$.

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

Vertex is $V(1, 2)$.

Distance from $(-7, 8)$:

$$d = \sqrt{(1 - (-7))^2 + (2 - 8)^2} = \sqrt{8^2 + (-6)^2} = \sqrt{64 + 36} = 10$$

Step 4: Final Answer:

The distance is 10.

 Quick Tip

For the vertex of a parabola $y = x^2 + bx + c$, complete the square to get $y = (x - h)^2 + k$.
The vertex is simply (h, k) .

24. Let P be a polygon with n vertices such that the line segment joining any two points of P remains entirely in P . If the number of diagonals of P is $n + 25$, then n is equal to -----.

Correct Answer: 10

Solution:

Step 1: Understanding the Concept:

A polygon where any line segment joining internal points stays inside is a convex polygon. The number of diagonals in an n -sided polygon is given by a fixed combinatorics formula.

Step 2: Key Formula or Approach:

The number of diagonals of a polygon with n vertices is $\frac{n(n-3)}{2}$.

Step 3: Detailed Explanation:

Given the number of diagonals is $n + 25$:

$$\frac{n(n-3)}{2} = n + 25$$

$$n^2 - 3n = 2n + 50$$

$$n^2 - 5n - 50 = 0$$

Factorizing the quadratic equation:

$$(n - 10)(n + 5) = 0$$

Since the number of vertices n must be a positive integer, we have:

$$n = 10$$

Step 4: Final Answer:

The value of n is 10.

 Quick Tip

The formula for diagonals can be derived as ${}^nC_2 - n$, which represents all possible lines joining n points minus the n sides of the polygon.

25. Let $f(x)$ be a polynomial of degree 5 such that $\lim_{x \rightarrow 0} \frac{f(x)}{x^2} = 1$. $f(-1) = -1$, $f(x) - 14x$ has an extrema at $x = 1$ and $f(x) - 10x$ has an extrema at $x = -1$. Then $f(2)$ is equal to -----.

Correct Answer: 92

Solution:

Step 1: Understanding the Concept:

The limit condition tells us about the lowest degree terms of the polynomial. The extrema conditions tell us about the derivative $f'(x)$ at specific points.

Step 2: Key Formula or Approach:

If $\lim_{x \rightarrow 0} \frac{f(x)}{x^2} = 1$, then the polynomial must start with x^2 . Thus $f(x) = ax^5 + bx^4 + cx^3 + x^2$.

Step 3: Detailed Explanation:

Let $f(x) = ax^5 + bx^4 + cx^3 + x^2$.

Derivative: $f'(x) = 5ax^4 + 4bx^3 + 3cx^2 + 2x$.

Condition 1: $f(x) - 14x$ has extrema at $x = 1 \implies f'(1) - 14 = 0 \implies f'(1) = 14$.

$$5a + 4b + 3c + 2 = 14 \implies 5a + 4b + 3c = 12 \quad \dots (1)$$

Condition 2: $f(x) - 10x$ has extrema at $x = -1 \implies f'(-1) - 10 = 0 \implies f'(-1) = 10$.

$$5a - 4b + 3c - 2 = 10 \implies 5a - 4b + 3c = 12 \quad \dots (2)$$

From (1) and (2), subtracting gives $8b = 0 \implies b = 0$.

Then $5a + 3c = 12$.

Condition 3: $f(-1) = -1$.

$$-a + b - c + 1 = -1 \implies -a + 0 - c = -2 \implies a + c = 2 \quad \dots (3)$$

Solving $5a + 3c = 12$ and $a + c = 2$:

Substitute $a = 2 - c$ into the first: $5(2 - c) + 3c = 12 \implies 10 - 5c + 3c = 12 \implies -2c = 2 \implies c = -1$.

Then $a = 2 - (-1) = 3$.

Polynomial: $f(x) = 3x^5 - x^3 + x^2$.

Finding $f(2)$:

$$f(2) = 3(2^5) - (2^3) + (2^2) = 3(32) - 8 + 4 = 96 - 8 + 4 = 92$$

Step 4: Final Answer:

The value of $f(2)$ is 92.

 Quick Tip

When a limit $\lim_{x \rightarrow 0} \frac{f(x)}{x^n} = L$ is given, it implies that the coefficients of terms with power less than n are zero, and the coefficient of x^n is L .

26. The number of 7-digit integers formed by using the digits 2, 3, 4, 5 only and having the sum of digits equal to 18 is

Correct Answer: 203

Solution:

Step 1: Understanding the Concept:

We need to find sets of 7 digits from $\{2, 3, 4, 5\}$ that sum to 18, and then calculate the number of permutations for each set.

Step 2: Detailed Explanation:

Let the counts of digits 2, 3, 4, and 5 be n_1, n_2, n_3, n_4 respectively.

Equations:

$$n_1 + n_2 + n_3 + n_4 = 7$$

$$2n_1 + 3n_2 + 4n_3 + 5n_4 = 18$$

Subtract $2 \times$ first from second: $n_2 + 2n_3 + 3n_4 = 4$.

Possible non-negative integer solutions for (n_2, n_3, n_4) :

Case 1: $n_4 = 1 \implies n_2 + 2n_3 = 1 \implies n_3 = 0, n_2 = 1$.

Then $n_1 = 7 - 1 - 0 - 1 = 5$. Digits: $\{2, 2, 2, 2, 2, 3, 5\}$.

Ways: $\frac{7!}{5!1!1!} = 42$.

Case 2: $n_4 = 0 \implies n_2 + 2n_3 = 4$.

Subcase 2a: $n_3 = 2 \implies n_2 = 0, n_1 = 5$. Digits: $\{2, 2, 2, 2, 2, 4, 4\}$.

Ways: $\frac{7!}{5!2!} = 21$.

Subcase 2b: $n_3 = 1 \implies n_2 = 2, n_1 = 4$. Digits: $\{2, 2, 2, 2, 3, 3, 4\}$.

Ways: $\frac{7!}{4!2!1!} = \frac{5040}{48} = 105$.

Subcase 2c: $n_3 = 0 \implies n_2 = 4, n_1 = 3$. Digits: $\{2, 2, 2, 3, 3, 3, 3\}$.

Ways: $\frac{7!}{3!4!} = 35$.

Total ways: $42 + 21 + 105 + 35 = 203$.

Step 3: Final Answer:

The total number of integers is 203.

💡 Quick Tip

For sum-of-digits problems with a limited set of digits, always reduce the variables by subtracting the smallest digit value multiplied by the number of positions.

27. The remainder when $(556)^{40}$ is divided by 7 is _____.

Correct Answer: 4

Solution:

Step 1: Understanding the Concept:

We use modular arithmetic and Fermat's Little Theorem or cyclic remainders to find the remainder.

Step 2: Key Formula or Approach:

1. Find $556 \pmod{7}$.
2. Use the property $a^n \pmod{m} = (a \pmod{m})^n \pmod{m}$.

Step 3: Detailed Explanation:

First, divide 556 by 7:

$$556 = 7 \times 79 + 3.$$

So, $556 \equiv 3 \pmod{7}$.

Now we need to find $3^{40} \pmod{7}$.

Powers of 3 modulo 7:

$$3^1 \equiv 3 \pmod{7}$$

$$3^2 \equiv 2 \pmod{7}$$

$$3^3 \equiv 6 \equiv -1 \pmod{7}$$

Since $3^3 \equiv -1 \pmod{7}$, we can write:

$$3^{40} = 3^{39} \times 3^1 = (3^3)^{13} \times 3 \equiv (-1)^{13} \times 3 \equiv -3 \pmod{7}$$

A remainder of -3 is equivalent to $7 - 3 = 4$.

Step 4: Final Answer:

The remainder is 4.

 Quick Tip

Finding a power that results in ± 1 modulo m is the fastest way to handle high exponents in remainder problems.

28. Let $[t]$ denote the greatest integer less than or equal to t . Then the value of $10 - 10 \int_{-2}^2 [x + x^3] dx$ is -----.

Correct Answer: 30

Solution:

Step 1: Understanding the Concept:

We use the properties of the Greatest Integer Function (GIF) and odd functions. For an odd function $f(x)$, $[f(x)] + [-f(x)] = -1$ for non-integers.

Step 2: Detailed Explanation:

Let $f(x) = x + x^3$. Note that $f(x)$ is an odd function.

We want to evaluate $I = \int_{-2}^2 [f(x)] dx$.

Using the property $\int_{-a}^a g(x) dx = \int_0^a (g(x) + g(-x)) dx$:

$$I = \int_0^2 ([f(x)] + [f(-x)]) dx = \int_0^2 ([f(x)] + [-f(x)]) dx$$

Since $f(x)$ is an integer at only a finite number of points, we use the identity $[t] + [-t] = -1$ for $t \notin \mathbb{Z}$.

$$I = \int_0^2 -1 dx = [-x]_0^2 = -2$$

Now substitute into the original expression:

$$10 - 10(I) = 10 - 10(-2) = 10 + 20 = 30$$

Step 3: Final Answer:

The value is 30.

 Quick Tip

For any odd function $f(x)$, the integral $\int_{-a}^a [f(x)] dx$ is always equal to $-a$, provided $f(x)$ is integer-valued only at discrete points.

29. Let $A = \frac{1}{\sqrt{2}} \begin{bmatrix} 1 & 1 \\ -1 & 1 \end{bmatrix}$ and $B = \begin{bmatrix} 1 & 0 \\ 0 & -1 \end{bmatrix}$. If $k, l \in \mathbb{N}$ be such that $A^k B^l = I$, then the minimum value of $k + l$ is

Correct Answer: 10

Solution:

Step 1: Understanding the Concept:

Matrix A is a rotation matrix. Matrix B is a reflection/diagonal matrix. We need to find powers that return them to the identity matrix or relate them.

Step 2: Detailed Explanation:

Observe that $A = \begin{bmatrix} \cos(-45^\circ) & -\sin(-45^\circ) \\ \sin(-45^\circ) & \cos(-45^\circ) \end{bmatrix}$.

So, A^k is a rotation matrix by $-45k^\circ$.

$$A^k = \begin{bmatrix} \cos(45k^\circ) & \sin(45k^\circ) \\ -\sin(45k^\circ) & \cos(45k^\circ) \end{bmatrix}$$

For B , $B^2 = I$. Since $l \in \mathbb{N}$, if l is even, $B^l = I$. If l is odd, $B^l = B$.

Case 1: $B^l = I$ (i.e., $l = 2$).

Then $A^k I = I \implies A^k = I$.

This happens when $45k = 360m \implies k = 8m$. Min $k = 8$.

$k + l = 8 + 2 = 10$.

Case 2: $B^l = B$ (i.e., $l = 1$).

Then $A^k B = I \implies A^k = B^{-1} = B$.

$$\begin{bmatrix} \cos(45k^\circ) & \sin(45k^\circ) \\ -\sin(45k^\circ) & \cos(45k^\circ) \end{bmatrix} = \begin{bmatrix} 1 & 0 \\ 0 & -1 \end{bmatrix}$$

Equating elements: $\cos(45k) = 1$ and $\cos(45k) = -1$. Contradiction.

So only even l works. Min $k + l = 10$.

Step 3: Final Answer:

The minimum value is 10.

💡 Quick Tip

Matrix $\begin{bmatrix} \cos \theta & \sin \theta \\ -\sin \theta & \cos \theta \end{bmatrix}$ represents rotation. Powers of such matrices only result in identity if the total angle is a multiple of 2π .

30. Let $A_1 = [1], A_2 = \begin{bmatrix} 2 & 3 \\ 4 & 5 \end{bmatrix}, A_3 = \begin{bmatrix} 6 & 7 & 8 \\ 9 & 10 & 11 \\ 12 & 13 & 14 \end{bmatrix} \dots$. Then the sum of the diagonal elements of A_{20} is -----.

Correct Answer: 53410

Solution:

Step 1: Understanding the Concept:

The elements are integers in increasing order. We need to find the starting element of A_{20} and then sum its diagonal entries.

Step 2: Detailed Explanation:

The number of elements in A_n is n^2 .

Total elements before $A_{20} = \sum_{n=1}^{19} n^2$.

$$\text{Total} = \frac{19(19+1)(2 \times 19 + 1)}{6} = \frac{19 \times 20 \times 39}{6} = 2470$$

The matrix A_{20} is of size 20×20 . Its first element is 2471.

The elements in the matrix are filled row-wise.

The (i, j) entry is $a_{i,j} = 2470 + (i - 1) \times 20 + j$.

Diagonal elements are where $i = j$:

$$a_{i,i} = 2470 + (i - 1) \times 20 + i = 2470 + 21i - 20 = 2450 + 21i$$

We need the sum for $i = 1$ to 20:

$$S = \sum_{i=1}^{20} (2450 + 21i) = (2450 \times 20) + 21 \times \frac{20 \times 21}{2}$$

$$S = 49000 + 21 \times 210 = 49000 + 4410 = 53410$$

Step 3: Final Answer:

The sum is 53410.

💡 Quick Tip

For trace or diagonal sums of such matrices, identify the pattern of the diagonal elements (usually an AP) and use the arithmetic series sum formula.

Aptitude Test

31. Which of the following is not a sustainable development goal targeted to be achieved by 2030?

- (A) gender equality
- (B) zero hunger
- (C) good health & well being
- (D) space Research

Correct Answer: (D) space Research

Solution:

Step 1: Understanding the Concept:

The Sustainable Development Goals (SDGs) are a collection of 17 global goals designed by the United Nations to be a "blueprint to achieve a better and more sustainable future for all" by the year 2030.

Step 2: Detailed Explanation:

The 17 SDGs include specific targets such as:

1. No Poverty
2. Zero Hunger (Option B)
3. Good Health and Well-being (Option C)
4. Quality Education
5. Gender Equality (Option A)

... and others covering clean water, affordable energy, climate action, and life below water.

Space Research is a scientific and technological field, but it is not formally categorized as one of the 17 primary Sustainable Development Goals established by the UN in 2015.

Step 3: Final Answer:

Space Research is not an SDG targeted for 2030.

Quick Tip

Memorize the 17 SDGs as they frequently appear in General Awareness sections of competitive exams. Remember that they focus primarily on social, economic, and environmental equity.

32. KANDARIYA MAHADEV TEMPLE is situated in which state of India?

- (A) Madhya Pradesh
- (B) Maharashtra
- (C) Rajasthan
- (D) Karnataka

Correct Answer: (A) Madhya Pradesh

Solution:

Step 1: Understanding the Concept:

The Kandariya Mahadev Temple is the largest and most ornate Hindu temple in the medieval temple group found at Khajuraho in Madhya Pradesh, India.

Step 2: Detailed Explanation:

The temple was built by the Chandela dynasty between 1025 and 1050 AD.

It is part of the Khajuraho Group of Monuments, which is a UNESCO World Heritage Site.

The temple is dedicated to Lord Shiva and is renowned for its Nagara-style architecture, characterized by its central tower (shikhara) which represents Mount Kailash.

Step 3: Final Answer:

The temple is located in the state of Madhya Pradesh.

💡 Quick Tip

Khajuraho temples are famous for their Nagara style. Always associate the Chandela rulers with Madhya Pradesh and these specific temple structures.

33. Vertical elements in a building are:-

- (A) Column, Lintel, Wall
- (B) Lintel, Beam, Arch
- (C) Column, Pier, Post
- (D) Floor, Column, Arch

Correct Answer: (C) Column, Pier, Post

Solution:

Step 1: Understanding the Concept:

Building elements are classified based on their structural orientation and the way they transfer loads. Vertical elements transfer loads downwards towards the foundation.

Step 2: Detailed Explanation:

- **Column:** A structural element that transmits, through compression, the weight of the structure above to other structural elements below.

- **Pier:** An upright support for a structure or superstructure such as an arch or bridge.
- **Post:** A main vertical or leaning support in a structure similar to a column.

In other options:

- **Lintel** and **Beam** are horizontal members.
- **Floor** is a horizontal surface.
- **Arch** is a curved structure spanning an opening, often transferring loads to vertical supports, but it is not purely a "vertical element" in the sense of a support member.

Step 2: Final Answer:

The set of purely vertical elements is Column, Pier, and Post.

💡 Quick Tip

Identify elements by their primary axis. Anything that stands upright and takes axial compression is usually a vertical element.

34. Cavity Walls are used for

- (A) Waterproofing
- (B) Heat Insulation
- (C) Aesthetics
- (D) Cost saving

Correct Answer: (B) Heat Insulation

Solution:

Step 1: Understanding the Concept:

A cavity wall consists of two separate walls (leaves) with a hollow space (cavity) between them.

Step 2: Detailed Explanation:

The primary functions of a cavity wall are:

1. **Thermal/Heat Insulation:** The air gap acts as an insulator, reducing the transfer of heat between the interior and exterior of the building.
2. **Damp Prevention:** It prevents moisture from traveling from the outer leaf to the inner leaf, protecting the interior from dampness.

While it helps with waterproofing (damp proofing), "Heat Insulation" is the most prominent architectural benefit listed.

It is generally more expensive than a solid wall, so it is not primarily for cost saving.

Step 3: Final Answer:

Cavity walls are used primarily for heat insulation.

💡 Quick Tip

Remember: Air is a poor conductor of heat. Any building element with a trapped air gap (like cavity walls or double glazing) is designed for thermal insulation.

35. Lintel is related to:

- (A) Window
- (B) Roof
- (C) Foundation
- (D) Pipe

Correct Answer: (A) Window

Solution:

Step 1: Understanding the Concept:

A lintel is a horizontal structural member that spans an opening between two vertical supports.

Step 2: Detailed Explanation:

Lintels are typically used above openings like windows and doors to support the weight of the wall structure above the opening and transfer it to the side walls.

- A **Sill** is at the bottom of a window.
- A **Lintel** is at the top of a window.

Roofs use beams and trusses; Foundations use footings; Pipes are building services.

Step 3: Final Answer:

A lintel is most closely related to a window or door opening.

💡 Quick Tip

Always pair "Lintel" with "Openings". It is the horizontal beam that allows windows and doors to exist without the wall collapsing into the void.

36. Choose the correct option among the following by looking at the image given above:



- (A) Lodhi Garden
- (B) Jantar Mantar
- (C) Rajghat
- (D) Bahai Temple

Correct Answer: (B) Jantar Mantar

Solution:

Step 1: Understanding the Concept:

The image shows a large, distinct curved structure which is part of an astronomical observatory.

Step 2: Detailed Explanation:

The structure shown is the Samrat Yantra (Supreme Instrument) located at Jantar Mantar, New Delhi.

Jantar Mantar is a collection of 13 architectural astronomy instruments built by Maharaja Jai Singh II of Jaipur.

The Samrat Yantra is a giant equinoctial sundial.

- **Lodhi Garden** consists of tombs and mosques.
- **Rajghat** is a simple black marble platform (memorial).
- **Bahai Temple** (Lotus Temple) is shaped like a flower.

Step 3: Final Answer:

The image represents Jantar Mantar.

💡 Quick Tip

Identify Jantar Mantar by its unique geometric, large-scale masonry instruments. These shapes are purely functional for measuring time and planetary positions.

37. ARCHITECT ACT 1972 was enforced in which month

- (A) 31st Dec
- (B) 31st May
- (C) 31st July
- (D) 31st March

Correct Answer: (B) 31st May

Solution:

Step 1: Understanding the Concept:

The Architects Act, 1972 is an Act of the Parliament of India that provides for the registration of architects and for matters connected therewith.

Step 2: Detailed Explanation:

The Architects Act, 1972 (Act No. 20 of 1972) received the assent of the President of India on the 31st of May, 1972.

This act led to the establishment of the Council of Architecture (CoA), which regulates the education and practice of the architectural profession in India.

Step 3: Final Answer:

The Act was enforced/received assent on 31st May.

 Quick Tip

For Professional Practice questions, always remember the specific year (1972) and the regulatory body (CoA) associated with the Architects Act.

38. The dome of Rashtrapati Bhawan is influenced by which of the following:

- (A) Gurudwara
- (B) Mosque
- (C) Stupa
- (D) Temple

Correct Answer: (C) Stupa

Solution:

Step 1: Understanding the Concept:

Rashtrapati Bhawan, designed by Edwin Lutyens, is an example of the "Delhi Order" which fused Indian architectural motifs with Western classical styles.

Step 2: Detailed Explanation:

The central dome of Rashtrapati Bhawan is modeled on the Great Stupa at Sanchi.

Lutyens incorporated the Buddhist railing (vedika) and the hemispherical dome shape characteristic of Buddhist stupas into the design to give the British colonial structure an Indian identity.

Step 3: Final Answer:

The dome is influenced by a Stupa.

💡 Quick Tip

Edwin Lutyens famously drew inspiration from the Sanchi Stupa for the Rashtrapati Bhawan dome. Look for "Buddhist" or "Stupa" influences in Lutyens' Delhi.

39. Dominion tower is designed by

- (A) Bjarke Ingels
- (B) Zaha Hadid
- (C) Frei otto
- (D) F.L. Wright

Correct Answer: (B) Zaha Hadid

Solution:**Step 1: Understanding the Concept:**

The Dominion Office Building (also known as Dominion Tower) is a contemporary architectural landmark located in Moscow, Russia.

Step 2: Detailed Explanation:

The building was designed by Zaha Hadid Architects (ZHA).

It features Zaha Hadid's signature parametric style with a series of vertically stacked offset floor plates and a dramatic central atrium with black and white winding staircases.

- **Bjarke Ingels (BIG)** is known for the VIA 57 West.
- **Frei Otto** is known for tensile structures like the Munich Olympic Stadium.
- **Frank Lloyd Wright** is known for Fallingwater and the Guggenheim.

Step 3: Final Answer:

Dominion Tower was designed by Zaha Hadid.

 Quick Tip

Zaha Hadid's work is easily recognizable by its fluid, "parametric" forms and stark monochromatic interiors. The Dominion Tower is her first project in Moscow.

40. The largest river island of the world is present in which state of India?

- (A) Maharastra
- (B) Assam
- (C) Uttar Pradesh
- (D) West Bengal

Correct Answer: (B) Assam

Solution:

Step 1: Understanding the Concept:

A river island is any exposed landmass surrounded by river water.

Step 2: Detailed Explanation:

The largest river island in the world is **Majuli**.

It is situated on the Brahmaputra River in the state of Assam, India.

Majuli was the first island to be made a district in India in 2016.

Step 3: Final Answer:

The largest river island is located in Assam.

 Quick Tip

Majuli in Assam is a common question in both geography and cultural heritage sections as it is the center of Neo-Vaishnavite culture.

41. Who prepared the first layout of the town of Jamshedpur?

- (A) Charles Correa
- (B) Otto Konigsberger
- (C) Le Corbusier
- (D) Messrs Julin Kennedy Sahhin

Correct Answer: (D) Messrs Julin Kennedy Sahhin

Solution:

Step 1: Understanding the Concept:

Jamshedpur, India's first planned industrial city, was envisioned by Jamsetji Tata. The town planning was entrusted to professional firms to ensure an organized layout for the steel plant and the residential colony.

Step 2: Detailed Explanation:

The initial layout and design for the town of Jamshedpur (then Sakchi) were prepared by the Pittsburgh firm of **Messrs Julian Kennedy and Sahlin**.

This firm designed the layout of the steel plant and the surrounding township to provide basic amenities and a logical flow for workers.

Charles Correa is known for post-independence Indian architecture, Le Corbusier designed Chandigarh, and Otto Konigsberger was involved in the planning of Bhubaneswar.

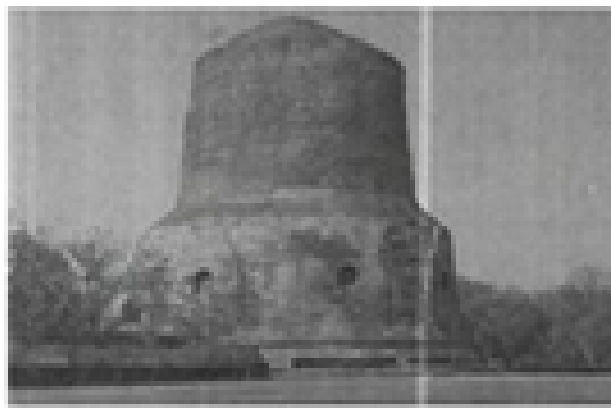
Step 3: Final Answer:

The first layout was prepared by Messrs Julin Kennedy Sahhin.

💡 Quick Tip

Remember: Chandigarh → Le Corbusier; Bhubaneswar → Otto Konigsberger;
Jamshedpur → Kennedy & Sahlin; Jaipur → Vidyadhar Bhattacharya.

42. Identify the historical monument which is given in the image.



- (A) Sanchi Stupa
- (B) Victory Tower
- (C) Sarnath Stupa
- (D) Nalanda

Correct Answer: (C) Sarnath Stupa

Solution:

Step 1: Understanding the Concept:

The image displays a large, cylindrical stone structure with a solid mass, characteristic of early Buddhist architecture.

Step 2: Detailed Explanation:

The monument in the image is the **Dhamekh Stupa** located at Sarnath.

It is distinct from the Sanchi Stupa because it is cylindrical in shape, whereas Sanchi is a hemispherical dome.

The Dhamekh Stupa was built to mark the spot where the Buddha gave his first sermon to his five disciples after attaining enlightenment.

Victory Tower (Vijay Stambha) is a tower in Chittorgarh, and Nalanda consists of university ruins.

Step 3: Final Answer:

The monument is the Sarnath Stupa.

💡 Quick Tip

Look for the shape: Cylindrical/Tower-like stupa with intricate floral carvings usually indicates Dhamekh Stupa (Sarnath), while a perfect Hemisphere indicates Sanchi Stupa.

43. Who was known as "Father of modern concrete"?

- (A) John Paul
- (B) John Nash
- (C) John Smeaton
- (D) Joseph Stein

Correct Answer: (C) John Smeaton

Solution:**Step 1: Understanding the Concept:**

Concrete technology evolved significantly during the industrial revolution. The person who rediscovered hydraulic lime, leading to modern cement, is celebrated as the pioneer.

Step 2: Detailed Explanation:

John Smeaton is widely regarded as the "Father of Modern Concrete" and the "Father of Civil Engineering".

In 1756, while planning the construction of the Eddystone Lighthouse, he rediscovered the use of hydraulic lime (cement that sets under water) by mixing limestone with clay.

This discovery was the direct predecessor to the development of Portland cement.

Step 3: Final Answer:

John Smeaton is known as the Father of modern concrete.

💡 Quick Tip

Do not confuse John Smeaton with Joseph Aspdin, who patented Portland Cement. Smeaton provided the scientific basis for hydraulic lime.

44. Who is the architect of TWA Airport, New York?

- (A) Eero Saarinen
- (B) Mies Vander Rohe
- (C) Joseph Allen Stein
- (D) Alvar Aalto

Correct Answer: (A) Eero Saarinen

Solution:

Step 1: Understanding the Concept:

The TWA Flight Center is a famous example of "Neo-Expressionist" architecture, known for its fluid, wing-like concrete shells.

Step 2: Detailed Explanation:

The TWA Terminal (at JFK Airport, New York) was designed by the Finnish-American architect **Eero Saarinen**.

Completed in 1962, the building is celebrated for its futuristic and organic design that symbolized the excitement of air travel.

Mies van der Rohe is known for "Less is More" and glass-steel boxes, while Alvar Aalto is known for Nordic modernism.

Step 3: Final Answer:

The architect is Eero Saarinen.

💡 Quick Tip

Saarinen is also famous for the Gateway Arch in St. Louis and the Tulip Chair. His work often involves bold, sculptural concrete forms.

45. Starting from a point, Maria walked 12 meters towards North, she turned right and walked 10 meters. She again turned right and walked 12 meters, then she turned left and walked 5 meters. How far is she now and in which direction

from the starting point? Consider the starting point is in south direction.

- (A) 27 meters towards East
- (B) 5 meters towards East
- (C) 10 meters towards West
- (D) 15 meters towards East

Correct Answer: (D) 15 meters towards East

Solution:

Step 1: Understanding the Concept:

This is a directional logic problem. We track the movement along the North-South (Y-axis) and East-West (X-axis) coordinates.

Step 2: Detailed Explanation:

Let the starting point be $(0, 0)$.

1. **Walk 12m North:** Maria reaches point $(0, 12)$.
 2. **Turn Right (East) and walk 10m:** Maria reaches point $(10, 12)$.
 3. **Turn Right (South) and walk 12m:** Maria moves from $y = 12$ back down to $y = 0$. Her position is now $(10, 0)$.
 4. **Turn Left and walk 5m:** Since she was facing South, a left turn leads her East. She moves from $x = 10$ to $x = 10 + 5 = 15$. Her final position is $(15, 0)$.
- The distance from the start $(0, 0)$ to the finish $(15, 0)$ is 15 meters.
The final position is directly to the **East** of the starting point.

Step 3: Final Answer:

Maria is 15 meters towards East from the starting point.

 Quick Tip

Draw a quick arrow diagram. Notice that the two 12m walks (one North, one South) cancel each other out vertically, so the final distance is simply the sum of the horizontal (East) movements.

46. Who among the following is not Pritzker prize winner?

- (A) Wang Shu
- (B) B.V. Doshi
- (C) Arata Isozaki
- (D) Denise Scott Brown

Correct Answer: (D) Denise Scott Brown

Solution:

Step 1: Understanding the Concept:

The Pritzker Architecture Prize is the most prestigious award in the field, often called the "Nobel Prize of Architecture."

Step 2: Detailed Explanation:

- **Wang Shu** won the prize in 2012.
- **B.V. Doshi** (Balkrishna Doshi) became the first Indian winner in 2018.
- **Arata Isozaki** won the prize in 2019.
- **Denise Scott Brown** has not won the Pritzker Prize. Her husband and partner, Robert Venturi, won in 1991, but the jury controversially excluded her at the time despite her equal contributions to their work.

Step 3: Final Answer:

Denise Scott Brown is the one who is not a Pritzker prize winner.

💡 Quick Tip

Keep an updated list of the last 5 years of Pritzker winners. Note that Zaha Hadid (2004) was the first female winner, and B.V. Doshi (2018) was the first Indian winner.

47. Which of the following is not Antonio Gaudí's project?

- (A) Casa Mila
- (B) Sagrada Familia
- (C) Casa Batlló
- (D) Casa Milano

Correct Answer: (D) Casa Milano

Solution:**Step 1: Understanding the Concept:**

Antoni Gaudí was a Spanish architect from Catalonia known for his highly individualized, organic style (Catalan Modernism).

Step 2: Detailed Explanation:

- **Casa Milà** (La Pedrera) is a famous residential building in Barcelona designed by Gaudí.
- **Sagrada Família** is his magnum opus, an unfinished basilica in Barcelona.
- **Casa Batlló** is another landmark house in Barcelona renovated by Gaudí.
- **Casa Milano** is not a project associated with Gaudí. It appears to be a distractor name using a different city (Milan).

Step 3: Final Answer:

Casa Milano is not a project by Gaudí.

💡 Quick Tip

Almost all of Gaudí's famous works are located in Barcelona, Spain. Remember "Casa Mila", "Casa Batllo", "Park Guell", and "Sagrada Familia".

48. Which one of the following is most earthquake resistant structure?

- (A) RCC framed structure
- (B) Load bearing structure
- (C) Mud walls structure
- (D) Random stone masonry structure

Correct Answer: (A) RCC framed structure

Solution:

Step 1: Understanding the Concept:

Earthquake resistance depends on a structure's ductility (ability to deform without collapsing) and its ability to dissipate energy during lateral ground movement.

Step 2: Detailed Explanation:

- **RCC (Reinforced Cement Concrete) framed structures** consist of a network of beams and columns. When designed properly, they are highly ductile and can resist lateral seismic forces much better than masonry.
- **Load bearing structures** (brick or stone) are brittle and susceptible to shear failure during quakes.
- **Mud walls** and **Random stone masonry** lack the tensile strength and connectivity required to stay intact during heavy vibrations.

Step 3: Final Answer:

RCC framed structure is the most earthquake resistant among the options.

💡 Quick Tip

Framed structures transfer loads through columns and beams, allowing the walls to be non-load bearing. This flexibility is key to seismic safety.

49. "CHALK" belongs to which category?

- (A) Rock
- (B) Mineral
- (C) Wood
- (D) Polymer

Correct Answer: (A) Rock

Solution:

Step 1: Understanding the Concept:

In geology, substances are categorized based on their formation and composition.

Step 2: Detailed Explanation:

Chalk is a soft, white, porous, sedimentary **carbonate rock**.

It is a form of limestone composed primarily of the mineral calcite (calcium carbonate). It is formed under deep-sea conditions from the accumulation of microscopic plates shed by tiny algae.

While it is made of minerals, it is geologically classified as a rock because it is a consolidated mass of mineral matter.

Step 3: Final Answer:

Chalk belongs to the category of Rock.

 Quick Tip

Remember: A **Mineral** is a single chemical compound (like Calcite), while a **Rock** is an aggregate of minerals (like Chalk or Limestone).

50. What are the three parts of colour theory?

- (A) hyper, value and chrome
- (B) honey, violet and chroma
- (C) hue, value and chroma
- (D) hue, chrome and violet

Correct Answer: (C) hue, value and chroma

Solution:

Step 1: Understanding the Concept:

The Munsell Color System is a widely accepted color space that specifies colors based on three properties.

Step 2: Detailed Explanation:

The three fundamental dimensions of color are:

1. **Hue:** The name of the color (Red, Blue, Green, etc.).
2. **Value:** The lightness or darkness of a color (how much white or black is mixed in).
3. **Chroma:** The purity or intensity/saturation of a color.

These three terms define the "Color Solid" in design theory.

Step 3: Final Answer:

The three parts are hue, value and chroma.

💡 Quick Tip

Remember the acronym **HVC** for Hue, Value, and Chroma to quickly identify the standard properties of color.

51. Identify the three primary colours?

- (A) Red, Blue and Green
- (B) Red, Yellow and Blue
- (C) Black, White and Yellow
- (D) Blue, White and Yellow

Correct Answer: (B) Red, Yellow and Blue

Solution:**Step 1: Understanding the Concept:**

Primary colors are sets of colors that can be combined to make a useful range of colors. There are different sets for light (additive) and pigments/art (subtractive).

Step 2: Detailed Explanation:

In traditional art and design theory (RYB model), the primary colors are **Red, Yellow, and Blue**.

These are the colors that cannot be created by mixing other colors and are used as the basis for the color wheel.

Note: In physics/light (RGB model), the primaries are Red, Green, and Blue, but architectural and art exams typically refer to the traditional pigment primaries.

Step 3: Final Answer:

The three primary colors are Red, Yellow and Blue.

💡 Quick Tip

Always check if the question refers to "light" or just "colours". For light, use RGB; for painting/traditional art, use RYB.

52. Match List I with List II:

List I	List II
A. Kamakhya Temple	I. Madhya Pradesh
B. Padmanabha Temple	II. Rajasthan
C. Kandariya Mahadev	III. Assam
D. Karni Mata Temple	IV. Kerala

Choose the correct answer from the options given below:

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

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

Solution:

Step 1: Understanding the Concept:

This is a general knowledge question regarding the location of famous Indian temples.

Step 2: Detailed Explanation:

- **Kamakhya Temple:** Located in Guwahati, **Assam**. (A → III)
 - **Padmanabhaswamy Temple:** Located in Thiruvananthapuram, **Kerala**. (B → IV)
 - **Kandariya Mahadev Temple:** Part of the Khajuraho group in **Madhya Pradesh**. (C → I)
 - **Karni Mata Temple:** Famous for its rats, located in Deshnok, **Rajasthan**. (D → II)
- Matching these gives the sequence: A-III, B-IV, C-I, D-II.

Step 3: Final Answer:

The correct match is A-III, B-IV, C-I, D-II.

💡 Quick Tip

Knowing just one or two famous temple locations can often help you eliminate wrong options in match-the-column questions. For example, knowing Kamakhya is in Assam instantly points to the correct option here.

53. A square has an area of 100 sq.mt. How much will be its area on a scale of 1 : 20?

- (A) 5 sq.mt.
 (B) 50 sq.mt.
 (C) 0.25 sq.mt.
 (D) 25 sq.mt.

Correct Answer: (C) 0.25 sq.mt.

Solution:

Step 1: Understanding the Concept:

When an object is scaled down by a linear factor (Representative Fraction, R.F.), its dimensions change linearly.

However, the area changes by the square of that linear factor.

Step 2: Key Formula or Approach:

1. Find the side length of the actual square.
2. Apply the linear scale to find the scaled side length.
3. Calculate the scaled area.

Alternatively, use the formula:

$$\text{Scaled Area} = \text{Actual Area} \times (\text{Scale})^2$$

Step 3: Detailed Explanation:

Given Actual Area = 100 sq.mt.

The side of the square is $s = \sqrt{100} = 10$ meters.

The scale is 1 : 20. This means 1 unit on the map represents 20 units in reality.

Scaled side length $s' = \frac{s}{20} = \frac{10}{20} = 0.5$ meters.

Now, the scaled area is:

$$\text{Scaled Area} = (s')^2 = (0.5)^2 = 0.25 \text{ sq.mt.}$$

Using the direct formula:

$$\text{Scaled Area} = 100 \times \left(\frac{1}{20}\right)^2 = 100 \times \frac{1}{400} = \frac{1}{4} = 0.25 \text{ sq.mt.}$$

Step 4: Final Answer:

The area on a scale of 1 : 20 is 0.25 sq.mt.

💡 Quick Tip

Remember: Linear Scale is k , Area Scale is k^2 , and Volume Scale is k^3 . Always square the scale factor when dealing with area problems to save time.

54. Given below are two statements:

Statement I: Shakti Sthal is a memorial in Raj Ghat marking the cremation site of Indira Gandhi.

Statement II: A.P. Kanvinde is the landscape designer known for designing Shakti Sthal.

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

- (A) Both Statement I and Statement II are true
- (B) Both Statement I and Statement II are false
- (C) Statement I is true but Statement II is false
- (D) Statement I is false but Statement II is true

Correct Answer: (C) Statement I is true but Statement II is false

Solution:

Step 1: Understanding the Concept:

This question tests general knowledge about Indian memorials and famous architects/landscape designers.

Step 2: Detailed Explanation:

Analysis of Statement I:

Shakti Sthal (Place of Power) is the memorial and cremation site of the former Prime Minister of India, Indira Gandhi.

It is located in the memorial complex near the banks of the Yamuna river in Delhi, which is colloquially referred to as the Raj Ghat area/complex (though Raj Ghat specifically refers to Mahatma Gandhi's memorial).

The statement correctly identifies Shakti Sthal as Indira Gandhi's memorial.

Analysis of Statement II:

The landscape design of Shakti Sthal is famously attributed to the landscape architect **Ravindra Bhan**.

Achyut Kanvinde (A.P. Kanvinde) was a legendary Indian architect known for functionalist/modernist buildings (like IIT Kanpur or National Science Centre), but he was not the landscape designer of Shakti Sthal.

Therefore, Statement II is false.

Step 3: Final Answer:

Statement I is true but Statement II is false.

 Quick Tip

Memorials of famous leaders in Delhi often appear in exams:

- Raj Ghat: Mahatma Gandhi
- Shakti Sthal: Indira Gandhi
- Veer Bhumi: Rajiv Gandhi
- Vijay Ghat: Lal Bahadur Shastri

55. What is the full form of 'UDAY'?

- (A) Ujjwala Discom Assitance Yojana
- (B) Unnati Development Ayojan Yojana
- (C) Ujwal Distribution Assurance Yojana
- (D) Ujwal Discom Assurance Yojana

Correct Answer: (D) Ujwal Discom Assurance Yojana

Solution:

Step 1: Understanding the Concept:

UDAY is a financial turnaround and revival package for electricity distribution companies (DISCOMs) initiated by the Government of India.

Step 2: Detailed Explanation:

The acronym 'UDAY' stands for **Ujwal DISCOM Assurance Yojana**.

Launched by the Ministry of Power in November 2015, it aims to find a permanent solution to the financial mess that the power distribution is in.

It allows state governments, which own the DISCOMs, to take over 75 percent of their debt as of September 30, 2015, and pay back lenders by issuing bonds.

Step 3: Final Answer:

The full form of UDAY is Ujwal Discom Assurance Yojana.

💡 Quick Tip

Government scheme acronyms are very common in competitive exams. Pay close attention to subtle spelling differences in options (like 'Assurance' vs 'Assitance').

56. What is the acronym for 'AYUSH'?

- (A) Ayurveda, Yoga and Naturopathy, Unani, Siddha and Homeopathy
- (B) Ayurveda, Yogic and Unani Siddha and Homeopathy
- (C) Acroveda, Yoga, Unani, Siddha and Homeopathy
- (D) Ayurveda, Yoga, Naturopathy, Unani Surgery and Homeopathy

Correct Answer: (A) Ayurveda, Yoga and Naturopathy, Unani, Siddha and Homeopathy

Solution:

Step 1: Understanding the Concept:

The Ministry of AYUSH is a governmental body in India tasked with developing education, research, and propagation of alternative medicine systems.

Step 2: Detailed Explanation:

The term AYUSH stands for the various traditional and non-conventional medical systems practiced in India:

- **A**: Ayurveda
- **Y**: Yoga and Naturopathy
- **U**: Unani
- **S**: Siddha
- **H**: Homeopathy

The acronym encompasses the major systems of healthcare that are indigenous or have been practiced in India for centuries alongside modern medicine.

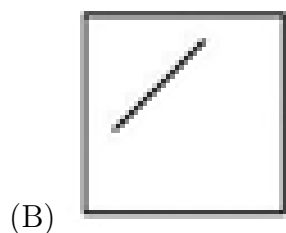
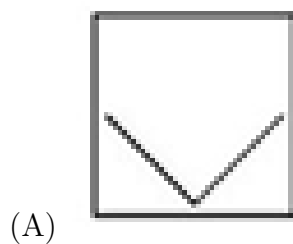
Step 3: Final Answer:

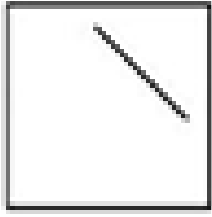
The acronym stands for Ayurveda, Yoga and Naturopathy, Unani, Siddha and Homeopathy.

💡 Quick Tip

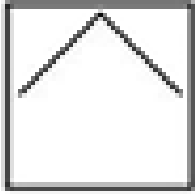
The 'Y' in AYUSH specifically covers both 'Yoga' and 'Naturopathy', which is a common point of confusion in multiple-choice questions.

57. Select the correct option from answer figure which will be best suitable to continue the same pattern as established by the problem figure.

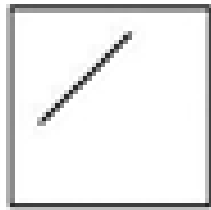




(C)



(D)



Correct Answer: (B)

Solution:

Step 1: Understanding the Concept:

This is a non-verbal reasoning problem where we must identify the rule governing the sequence of geometric lines.

Step 2: Detailed Explanation:

Look at the problem figures:

1. The first figure is a complete diamond shape (4 lines).
2. The second figure loses the bottom-right line (3 lines remaining).
3. The third figure loses the bottom-left line (2 lines remaining - the top "V" shape).

Following this pattern, the lines are disappearing one by one in a counter-clockwise direction starting from the bottom-right.

The next step in the pattern is to lose the top-left line.

This leaves only the **top-right diagonal line** remaining.

Comparing this with the options, Option 2 (ID 36669424916) represents a square box containing exactly this single top-right diagonal line.

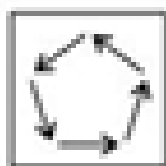
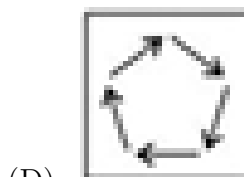
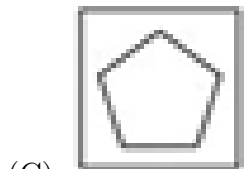
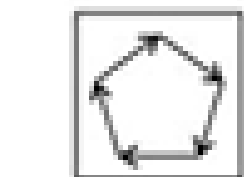
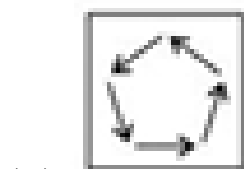
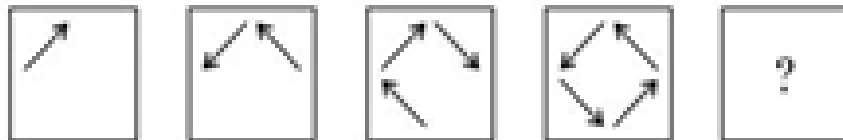
Step 3: Final Answer:

The next figure in the pattern is a single line from the center to the top right corner.

💡 Quick Tip

In line-based sequences, always count the number of lines first. If they decrease linearly (4, 3, 2, 1), identify the specific order (clockwise or anti-clockwise) in which they vanish.

58. Choose the correct option from the answer figures which completes the question series.



Correct Answer: (A)

Solution:

Step 1: Understanding the Concept:

This series focuses on the progression of geometric shapes and directional arrows.

Step 2: Detailed Explanation:

Let's analyze the sequence in the problem figures:

1. A single arrow pointing top-right. (1 side/arrow)
2. Two arrows forming a corner. (2 sides/arrows)
3. Three arrows forming three sides of a square. (3 sides/arrows)
4. Four arrows forming a complete square cycle. (4 sides/arrows)

The pattern is increasing the number of sides by one to form the next higher polygon in a cyclical arrow format.

The next shape after a square (4 sides) should be a **Pentagon (5 sides)** with cyclical arrows.

Option 1 (ID 36669424919) depicts a pentagon with 5 arrows following each other in a cycle.

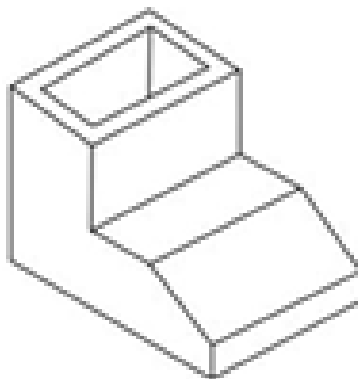
Step 3: Final Answer:

The correct figure is the cyclical pentagon.

💡 Quick Tip

Polygon series are straightforward: Triangle (3) → Square (4) → Pentagon (5) → Hexagon (6). Just ensure the internal details (like arrows) match the established rule.

59. Identify the number of surfaces in the given 3D object.



- (A) 12
- (B) 13
- (C) 10
- (D) 9

Correct Answer: (A) 12

Solution:

Step 1: Understanding the Concept:

To count the number of surfaces (faces) of a 3D object, we must identify all visible and hidden planes, including internal walls of holes.

Step 2: Detailed Explanation:

Let's break down the surfaces of the L-shaped block:

External Surfaces:

1. Bottom surface (hidden): 1
2. Back vertical surface (hidden): 1
3. Left side surface (hidden, L-shaped): 1
4. Right side surface (visible, L-shaped): 1
5. Top-most flat surface (the rim around the hole): 1
6. Vertical front face of the tall section: 1
7. Sloped (inclined) front face: 1
8. Small vertical front-most face at the base: 1

Sub-total External = 8 surfaces.

Internal Surfaces (inside the rectangular hole):

9. Left internal vertical wall: 1
10. Right internal vertical wall: 1
11. Front internal vertical wall: 1
12. Back internal vertical wall: 1
13. Bottom of the hole: 1

Wait, let's recount carefully.

External: 1 (Bottom) + 1 (Back) + 1 (Left side) + 1 (Right side) + 1 (Top rim) + 1 (Inclined face) + 1 (Base front) = 7.

Internal Hole: 4 (Sides) + 1 (Bottom) = 5.

Total = 7 + 5 = 12 surfaces.

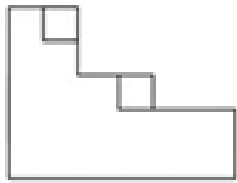
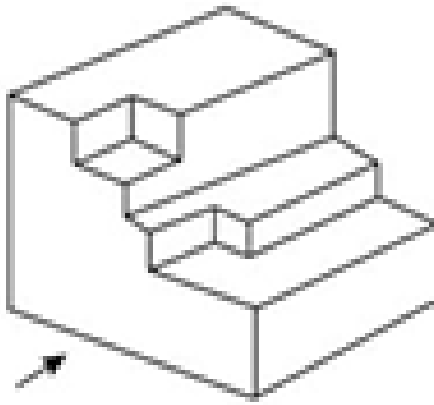
Step 3: Final Answer:

The object has a total of 12 surfaces.

💡 Quick Tip

When counting surfaces of a hollow object, a rectangular hole always adds 5 surfaces (4 walls + 1 bottom) if it doesn't go all the way through, and 4 surfaces if it is a through-hole.

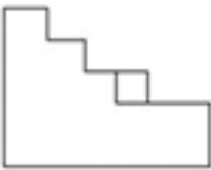
60. The question figure shows the 3D view of an object. Identify the view of the object looking in the direction of the arrow.



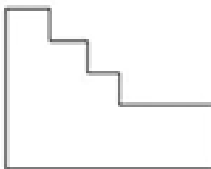
(A)



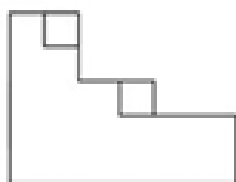
(B)



(C)



(D)



Correct Answer: (A)

Solution:

Step 1: Understanding the Concept:

The task is to identify the side elevation of a 3D object when viewed from a specific direction

indicated by an arrow.

This requires projectively collapsing the 3D form into a 2D profile along that line of sight.

Step 2: Detailed Explanation:

Looking at the 3D object from the direction of the arrow (side view):

1. We observe a tall vertical section at the back (left side of the profile view).
2. Moving to the right in the direction of the view, the object descends in a series of steps.
3. There are exactly three visible steps descending from the tall main block.
4. Therefore, the correct 2D profile must consist of a tall rectangle on the left, followed by three progressively lower rectangular steps to its right.

Comparing this with the given options, the figure in option (A) (ID 36669424927) accurately represents this profile with a tall section followed by three distinct steps.

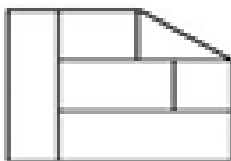
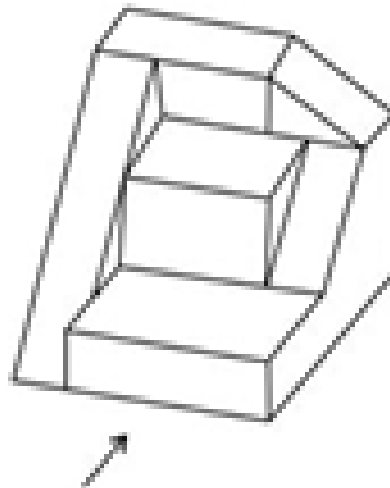
Step 3: Final Answer:

The side view in the direction of the arrow is represented by option (A).

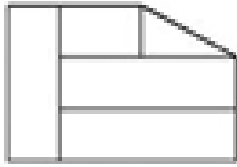
💡 Quick Tip

To find side elevations, imagine a light source behind the object casting a shadow on a wall. The shape of that shadow is your answer.

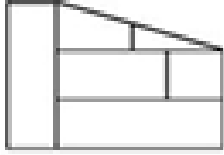
61. The 3D figure shows the view of an object. Identify the correct view looking in the direction of arrow, amongst the answer figures.



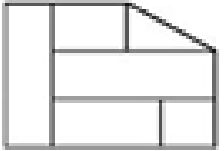
(A)



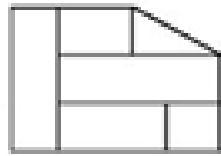
(B)



(C)



(D)



Correct Answer: (D)

Solution:

Step 1: Understanding the Concept:

This question tests the ability to visualize the front elevation of an object with sloped and recessed features.

Step 2: Detailed Explanation:

Analyzing the object from the arrow's direction:

1. On the left, there is a large vertical rectangular face.
2. To the right of this face, there is a sloped top edge that descends toward the right.
3. Crucially, there is a rectangular cutout or "step-in" feature in the middle of this right-hand section.
4. In a 2D view, this recessed feature will appear as a smaller rectangle within the larger profile, with its vertical edges visible.

Option (D) (ID 36669424934) shows a flat rectangular part on the left and a part with a sloped top edge on the right containing a smaller interior rectangle, which perfectly matches the visible features.

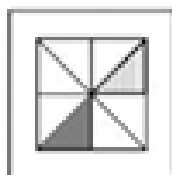
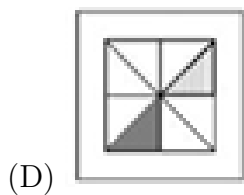
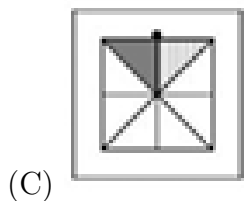
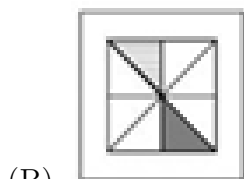
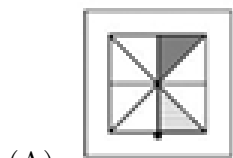
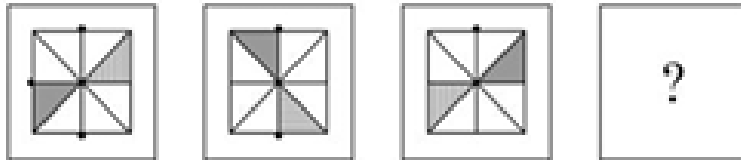
Step 3: Final Answer:

The correct view is shown in option (D).

💡 Quick Tip

Vertical and horizontal lines in a 3D view remain vertical and horizontal in front/side elevations. Slanted lines will appear shorter (foreshortened) but will still indicate slope.

62. Choose the correct option from the answer figures which completes the sequence.



Correct Answer: (D)

Solution:

Step 1: Understanding the Concept:

This is a pattern completion problem where an element moves or changes following a specific

logical rule throughout a series of frames.

Step 2: Detailed Explanation:

The sequence consists of a square divided into four triangles by its diagonals. In each frame, one triangle is shaded:

1. In the first frame, the top-left triangle is shaded.
2. In the second frame, the top-right triangle is shaded.
3. In the third frame, the bottom-right triangle is shaded.

The pattern clearly shows the shaded triangle moving one position clockwise in each step.

Following this logic, in the fourth frame, the shading should move from the bottom-right to the bottom-left triangle.

Option (D) (ID 36669424938) shows the square with only the bottom-left triangle shaded.

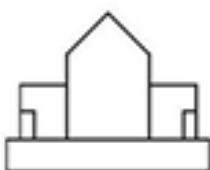
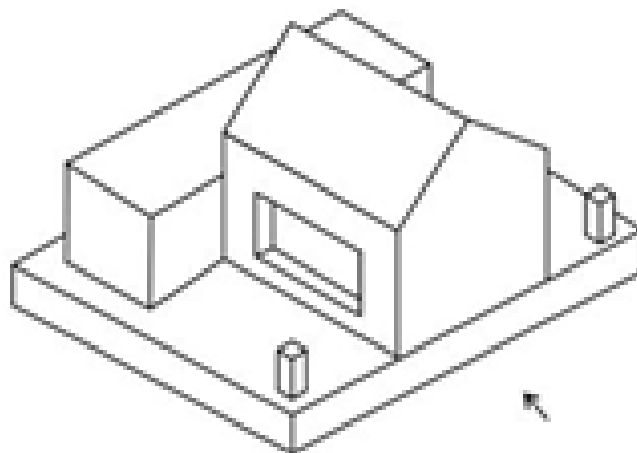
Step 3: Final Answer:

The sequence is completed by option (D).

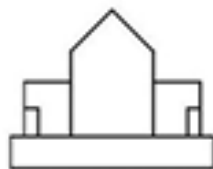
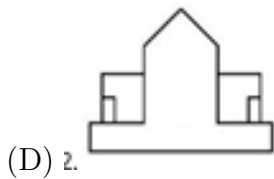
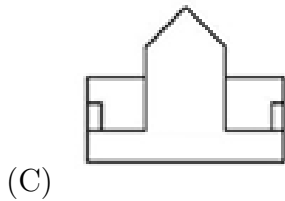
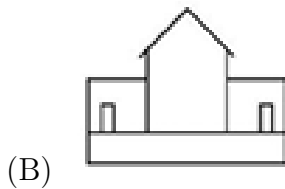
💡 Quick Tip

Track the movement of the shaded area: top-left → top-right → bottom-right → bottom-left. It's a simple 90° clockwise rotation.

63. The question figure shows the 3D view of an object, identify the correct view looking in the direction of the arrow?



(A)



Correct Answer: (A)

Solution:

Step 1: Understanding the Concept:

The goal is to determine the front elevation of an architectural form (a house on a base) from a perspective view.

Step 2: Detailed Explanation:

The object consists of a rectangular house with a gabled (triangular) roof sitting on a rectangular platform.

Looking in the direction of the arrow:

1. We see the gabled end of the house directly. It looks like a rectangle with a triangle on top.
2. The house is centered on a wider base. From the front, this base appears as a wide, short rectangle.
3. There are no other large features like chimneys or wings visible directly in front that would block this silhouette.

Option (A) (ID 36669424939) shows exactly this: a pentagonal "house" shape (gabled front) resting on a wider rectangular base.

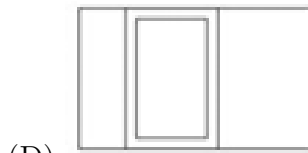
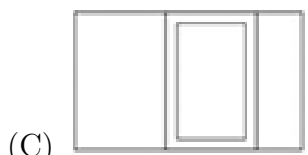
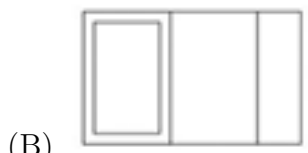
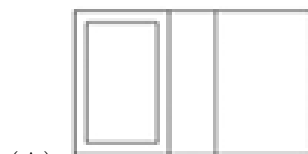
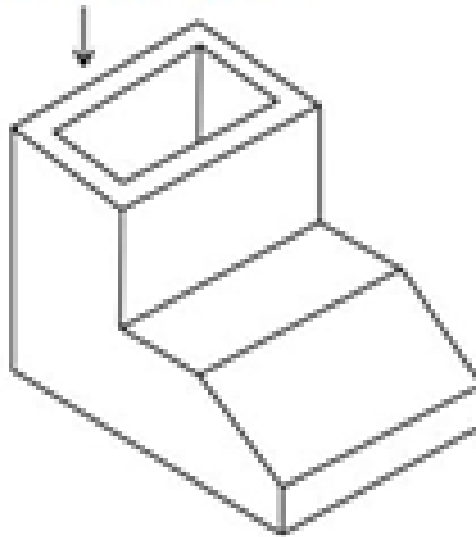
Step 3: Final Answer:

The correct view is option (A).

💡 Quick Tip

In architectural elevations, sloped roofs appear as simple 2D shapes (triangles or rectangles) depending on whether you are looking at the gable end or the side.

64. The question figure shows the 3D view of an object. Identify the top view of the object in the direction of the arrow.



Correct Answer: (B)



Solution:

Step 1: Understanding the Concept:

Top view (Plan) is a projection of all horizontal surfaces of a 3D object onto a 2D plane looking vertically downwards.

Step 2: Detailed Explanation:

Looking down at the object:

1. The overall boundary of the object is a large rectangle.
2. The object has a higher section on the left and a lower section on the right. Both appear as rectangles from the top.
3. There is a deep rectangular hole in the top of the taller section.
4. Therefore, the top view should show a large rectangular frame divided into two main parts. One part (the top of the taller block) must contain a smaller interior rectangle representing the hole.

Option (B) (ID 36669424944) represents this accurately: two adjacent rectangles, with the one on the left containing a smaller rectangular opening.

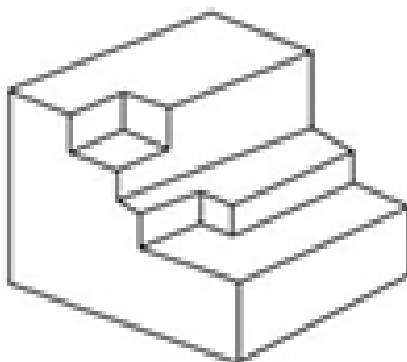
Step 3: Final Answer:

The top view is shown in option (B).

💡 Quick Tip

Openings like holes are always indicated by lines showing their boundaries in a plan view. If the hole has a floor, no extra hatching is usually needed in simple diagrams.

65. Identify the total number of surfaces in the given 3D object.



- (A) 12
- (B) 13
- (C) 15
- (D) 16

Correct Answer: (A) 12

Solution:

Step 1: Understanding the Concept:

Counting surfaces involves identifying every distinct flat plane (face) that bounds a 3D solid, including those hidden from the current perspective.

Step 2: Detailed Explanation:

Let's count the surfaces of the stepped block systematically:

1. **The Base (Bottom):** 1 surface.
2. **The Back Face:** 1 large vertical surface.
3. **The Side Faces:** 1 on the left (profile) and 1 on the right (profile) = 2 surfaces.
4. **Horizontal Top-Facing Surfaces:** There is the main top face of the tallest part, plus 3 horizontal steps = 4 surfaces.
5. **Vertical Front-Facing Surfaces:** There is the front face of the tallest part, plus the 3 vertical "risers" of the steps = 4 surfaces.

Summing these up: 1 (bottom) + 1 (back) + 2 (sides) + 4 (horizontals) + 4 (verticals) = 12 surfaces.

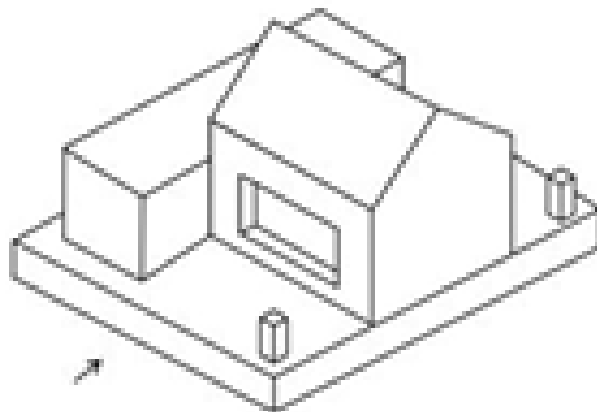
Step 3: Final Answer:

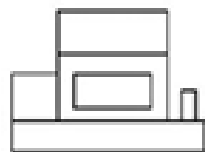
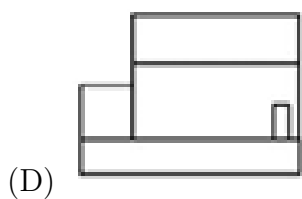
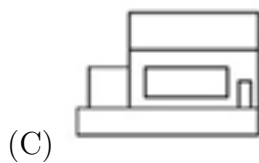
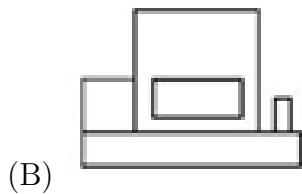
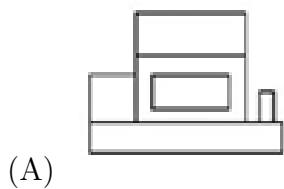
The total number of surfaces is 12.

💡 Quick Tip

For stepped objects, the number of horizontal surfaces equals the number of vertical front-facing surfaces if they form a consistent stair-like pattern.

66. The question figure shows the 3D view of an object. Identify the correct view looking in the direction of the arrow.





Correct Answer: (A)

Solution:

Step 1: Understanding the Concept:

We need to find the front elevation of the house-like structure from a different angle than in Q63.

Step 2: Detailed Explanation:

Looking at the house from the front (indicated by the arrow):

1. We see a large rectangular main building block.
2. Directly in front of this block is a smaller porch-like structure with its own gabled roof.
3. To the left, there is a small rectangular feature (chimney or post) on the platform.
4. All of this is sitting on a flat rectangular platform.

Option (A) (ID 36669424951) correctly identifies these layers: the large rectangle in the back, the gabled entrance in front of it, and the secondary smaller block to the side, all on a base.

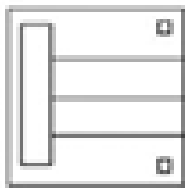
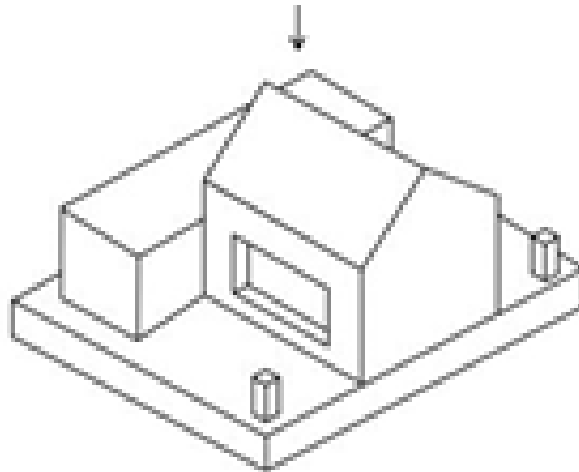
Step 3: Final Answer:

The correct view is option (A).

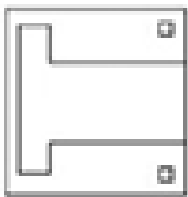
💡 Quick Tip

When features overlap in a 2D view, the ones closest to the viewer are drawn fully, while those behind them may be partially obscured.

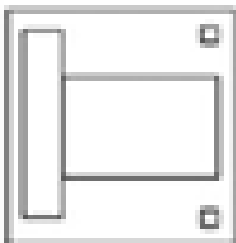
67. In the light of the question figure it is a 3D view of an object. Identify the correct top view among the given options.



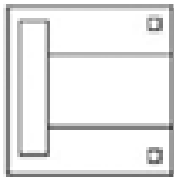
(A)



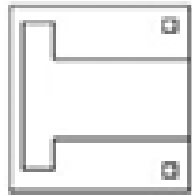
(B)



(C)



(D)



Correct Answer: (B)

Solution:

Step 1: Understanding the Concept:

A plan view of a building shows the roof outlines and the footprint of the base.

Step 2: Detailed Explanation:

Looking down at the house:

1. The main roof is a large rectangle with a central ridge line.
2. The smaller front entrance part has its own smaller rectangular roof extending perpendicular to the main one.
3. Together, the roof plan forms a "T" or cross-like shape.
4. The platform below is a larger rectangle.
5. There are small square features (posts or chimneys) on the platform that will appear as small squares in the corners of the plan.

Option (B) (ID 36669424956) correctly shows the "T" shaped roof ridges and the platform boundary with the small square indicators.

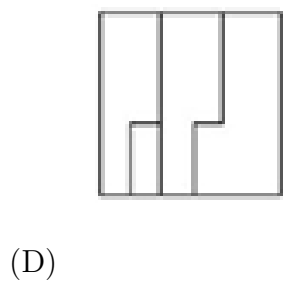
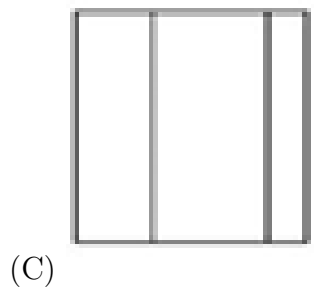
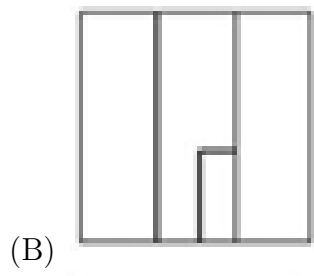
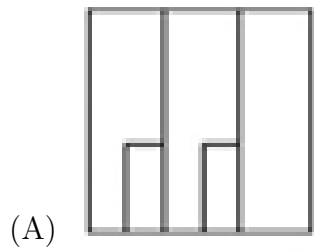
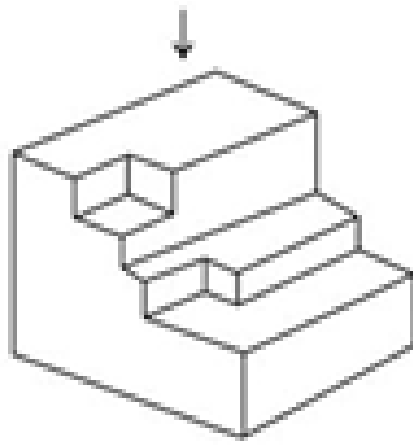
Step 3: Final Answer:

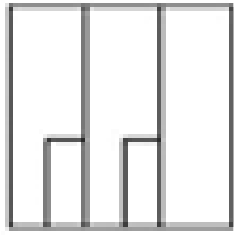
The top view is option (B).

💡 Quick Tip

Roof ridge lines (the peaks) are essential markers in a top view of a gabled house to indicate the direction of slopes.

68. The question figure shows the 3D view of an object. Identify the most appropriate top view of the object from the given direction of the arrow.





Correct Answer: (A)

Solution:

Step 1: Understanding the Concept:

The top view of a stepped object collapses all the horizontal landings into a single contiguous set of rectangles.

Step 2: Detailed Explanation:

When viewed from directly above:

1. The tallest section at the back appears as a rectangle.
2. Each of the three steps also appears as a rectangle of the same length.
3. Assuming the steps have equal horizontal depth, the top view will look like a single large rectangle divided into four smaller, equal-width vertical rectangles by parallel lines.

Option (A) (ID 36669424959) shows four side-by-side vertical rectangles, which is the correct plan for a four-level stepped block.

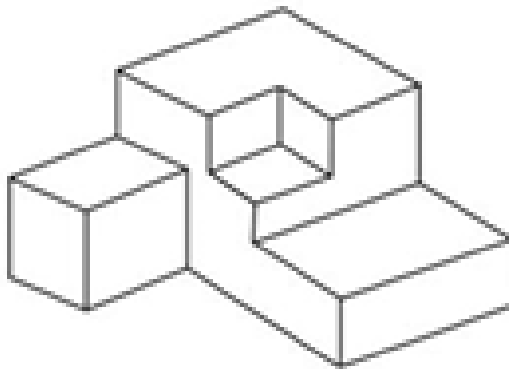
Step 3: Final Answer:

The most appropriate top view is option (A).

💡 Quick Tip

Ignore the height when drawing a plan; only focus on the horizontal boundaries and internal edges where levels change.

69. Identify the total number of surfaces in the given object.



- (A) 13
- (B) 14
- (C) 11
- (D) 10

Correct Answer: (A) 13

Solution:

Step 1: Understanding the Concept:

This question requires identifying all planar faces on a complex, multi-level 3D geometry.

Step 2: Detailed Explanation:

Let's analyze the geometry which appears to be an L-shaped block in plan with various heights:

1. **The Base (Bottom):** 1 surface.
2. **The Back Sides:** Two large vertical surfaces forming the back outer corner = 2 surfaces.
3. **Outer Front/Side faces:** Surfaces on the periphery = 2 surfaces.
4. **Horizontal Top Surfaces:** There are three distinct levels or landings = 3 surfaces.
5. **External Front-Facing Verticals:** Vertical faces seen from the front = 3 surfaces.
6. **Internal Side-Facing Verticals:** Vertical faces that connect different horizontal levels along the inner part of the shape = 2 surfaces.

Adding them up: $1 + 2 + 2 + 3 + 3 + 2 = 13$ surfaces.

Careful counting of every change in direction or depth confirms that the object is bounded by 13 distinct planar faces.

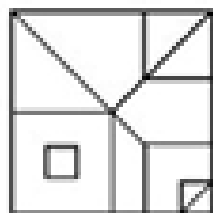
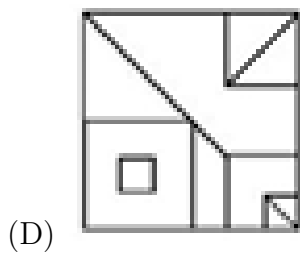
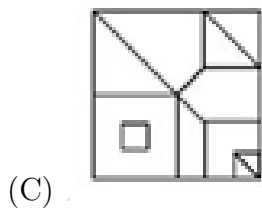
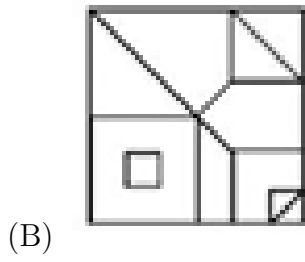
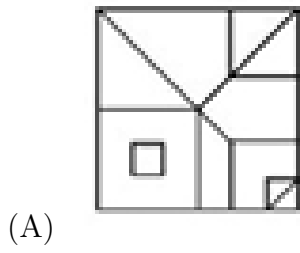
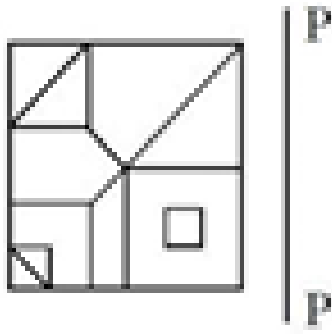
Step 3: Final Answer:

The total number of surfaces is 13.

💡 Quick Tip

Coloring or numbering each face as you see it in a 3D sketch can help prevent double-counting or missing hidden faces.

70. Identify the mirror image of the question figure, amongst the answer figures with respect to P-P.



Correct Answer: (A)

Solution:

Step 1: Understanding the Concept:

A mirror image reflects an object across a vertical line (the mirror axis). Features on the right side of the object appear on the left side of the reflection, and vice versa. Vertical positions (top/bottom) remain unchanged.

Step 2: Detailed Explanation:

Analyzing the components of the question figure relative to the mirror P-P on the right:

1. **The Small Square:** It is currently in the bottom-right quadrant. In the mirror image, it will move to the bottom-left quadrant.
2. **The Shaded Corner:** It is in the bottom-left corner of the whole square. In the reflection, it will move to the bottom-right corner.
3. **The Diagonal Lines:** The diagonal in the top-left quadrant sloping from top-left to center will reflect as a line in the top-right quadrant sloping from top-right to center.

Comparing these mirrored transformations with the options, Option (A) (ID 36669424967) is the only one where:

- The small square is on the left.
- The shaded triangle is in the bottom-right corner.
- The diagonal lines are correctly reflected in the top-right quadrant.

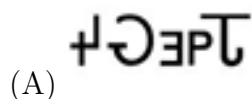
Step 3: Final Answer:

The mirror image is shown in option (A).

💡 Quick Tip

Left becomes Right, Right becomes Left. Keep this simple rule in mind for vertical mirror axes, and always check the orientation of asymmetric details like diagonals.

71. Identify the correct mirror image of the question image with respect to P-P.



(B) 4GEPJ

(C) 4GEPJ

(D) 4GEPJ

4GEPJ

Correct Answer:

Solution:

Step 1: Understanding the Concept:

In a mirror reflection across a vertical axis (like P-P on the right), the image undergoes a lateral inversion.

This means the right side of the object appears on the left side of the reflection, and each individual character is flipped horizontally.

Step 2: Detailed Explanation:

1. **Proximity Rule:** The character closest to the mirror (P-P) will be the character that appears closest to the mirror in the reflected image.

In the string "JPEG4", the digit '4' is closest to the mirror line. Therefore, '4' will appear on the far left of the reflected image.

2. **Individual Character Flip:** Every character must be horizontally reversed:

- '4' becomes its mirrored counterpart.
- 'G' becomes its mirrored counterpart.
- 'E' becomes its mirrored counterpart (looks like a '3').
- 'P' becomes its mirrored counterpart (looks like a 'q').
- 'J' becomes its mirrored counterpart.

3. **Sequencing:** The original order from left to right is J-P-E-G-4. In the mirror, the order appearing from left to right in the reflection will be mirrored 4-G-E-P-J.

Comparing these observations with the options provided, Option (A) correctly follows all the rules of lateral inversion.

Step 3: Final Answer:

The correct mirror image is the one that reverses the sequence of letters to start with a mirrored '4' and flips each character horizontally.

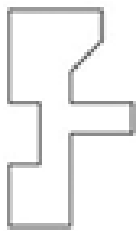
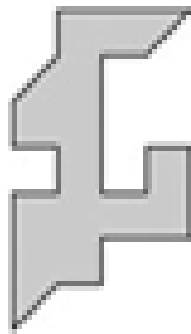
💡 Quick Tip

A quick way to solve mirror image problems is the "Near-Near, Far-Far" rule. The part of the object nearest to the mirror stays nearest in the reflection.

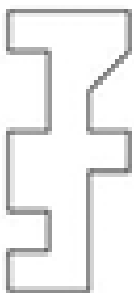
💡 Quick Tip

A quick way to solve mirror image problems is the "Near-Near, Far-Far" rule. The part of the object nearest to the mirror stays nearest in the reflection.

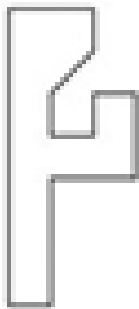
72. Which of the answer figures fit best to the left side of the given question figure?



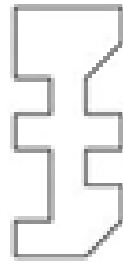
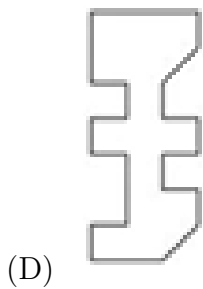
(A)



(B)



(C)



Correct Answer: (D)

Solution:

Step 1: Understanding the Concept:

This problem requires spatial visualization and pattern matching. We need to identify a shape that is the exact inverse (negative) of the profile on the left side of the question figure.

Step 2: Detailed Explanation:

1. **Profile Analysis:** Look at the left edge of the question figure from top to bottom.
 - It starts with a trapezoidal notch (inward).
 - Then a rectangular protrusion (outward).
 - Followed by a rectangular notch (inward).
 - Ends with a small rectangular base.
2. **Matching Inverse:** The fitting piece must have the exact opposite features to create a flush, solid boundary:
 - A trapezoidal protrusion (outward) at the top.
 - A rectangular notch (inward) in the middle.
 - A rectangular protrusion (outward) near the bottom.
3. **Option Comparison:**
 - Option (A) has incorrect notch shapes.
 - Option (B) has different proportions.
 - Option (C) has a rounded element which is not present.
 - Option (D) (ID 36669424978) perfectly complements the jagged edge of the question figure.

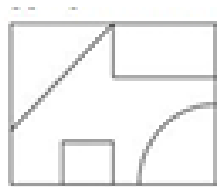
Step 3: Final Answer:

Option (D) provides the best fitting profile for the left side of the provided shape.

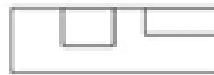
💡 Quick Tip

Treat this like a jigsaw puzzle. An "Inward" notch on the main piece must meet an "Outward" protrusion on the answer piece.

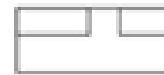
73. In the question figure, the top, front and right side view is given. Identify the most appropriate 3D view of the object from the answer figures.



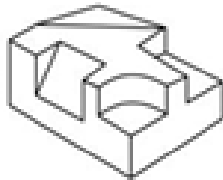
Top view



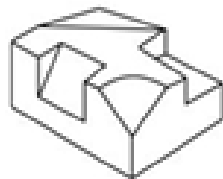
Front view



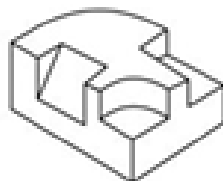
Right side view



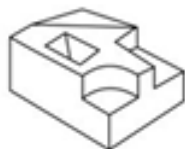
(A)



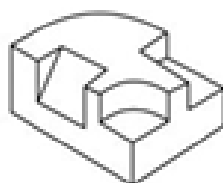
(B)



(C)



(D)



Correct Answer: (C)

Solution:

Step 1: Understanding the Concept:

This problem involves interpreting orthographic projections (Top, Front, and Side views) and translating them into a three-dimensional isometric representation.

Step 2: Detailed Explanation:

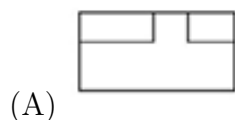
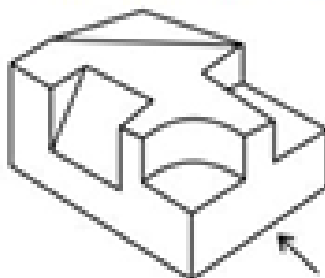
1. **Top View Analysis:** The top view shows a plan with a circular hole in the upper-left corner and a rectangular step/notch cut out from the lower-right corner.
2. **Front View Analysis:** The front view shows two horizontal levels. This indicates that the block is not a uniform height. The left part is higher and the right part is lower due to the step.
3. **Right Side View Analysis:** The side view shows a high rectangular block on the left and a lower part on the right.
4. **Synthesis:**
 - Option (A) puts the hole in the wrong position relative to the notch.
 - Option (B) does not have the circular cutout.
 - Option (C) shows the circular hole on the tall section on the left and the rectangular step cut out from the front-right, matching all three projections.
 - Option (D) is a completely different geometry.

Step 3: Final Answer: The 3D object in Option (C) correctly reconciles the details of the top, front, and side projections.

💡 Quick Tip

Match the highest points of the front view with the regions containing specific features (like holes) in the top view to narrow down options quickly.

74. The question figure shows the 3D view of an object. Identify the most appropriate elevation (front view) looking in the direction of arrow.



- (B) 
- (C) 
- (D) 



Correct Answer: (C)

Solution:

Step 1: Understanding the Concept:

An elevation is a 2D view of a 3D object from a specific side. Here, we must determine what is visible looking directly from the direction indicated by the arrow.

Step 2: Detailed Explanation:

1. **Primary Face:** Looking from the arrow, we see the front vertical face of the object.
2. **Silhouette:** The overall shape consists of a wide rectangular base and a taller block on the right.
3. **Specific Features:** The tall block on the right has a semi-circular notch or hole cut out from its top edge.
4. **Deduction:** In a 2D front elevation, this semi-circle will appear as a curved line at the top of the right-side rectangular profile.
 - Option (A) shows only straight lines.
 - Option (B) has a slope but no curve.
 - Option (C) depicts the rectangular base and the taller block with the correct curved semi-circular profile at the top.
 - Option (D) has the wrong proportions for the base.

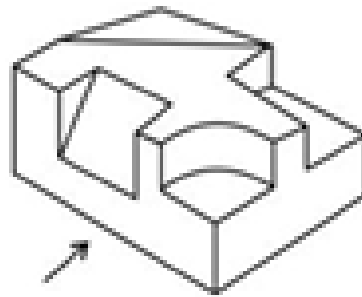
Step 3: Final Answer:

Option (C) is the only elevation that accurately captures the circular cutout detail visible from the front.

💡 Quick Tip

Circles or cylinders perpendicular to the viewer's line of sight appear as rectangles, but those parallel to the top/bottom edge of the view appear as their true curved profiles.

75. The question figure shows the 3D view of an object. Identify the most appropriate elevation (front view) looking in the direction of the arrow.



- (A)
- (B)
- (C)
- (D)

Correct Answer: (A)



Solution:

Step 1: Understanding the Concept:

This requires projecting the 3D surfaces onto a 2D plane perpendicular to the arrow direction. Sloped surfaces will appear as flat shapes in the elevation.

Step 2: Detailed Explanation:

1. **Left side:** There is a sloped (chamfered) corner. In the front elevation, this appears as a straight diagonal line.
2. **Middle:** There is a semi-circular notch in the block. From the front, this appears as a curved line.
3. **Right side:** There is a rectangular block that sits higher than the rest.
4. **Synthesis:** The correct elevation must show the diagonal on the left, the curve in the middle, and the rectangular step on the right.
 - Option (A) matches this description exactly.
 - Option (B) lacks the curved element.
 - Option (C) and (D) present different heights and arrangements that do not match the source

image.

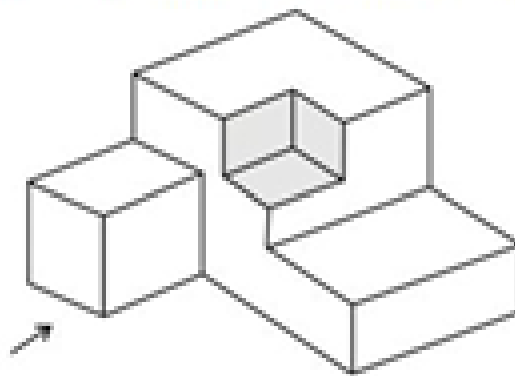
Step 3: Final Answer:

The elevation in Option (A) correctly represents the sloped and curved features of the 3D object.

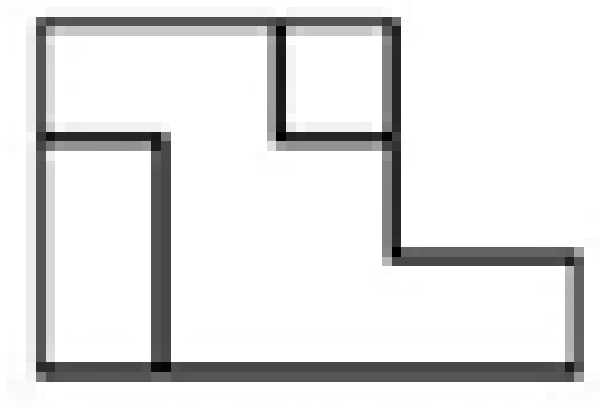
💡 Quick Tip

Trace the outer perimeter of the object from the arrow's perspective. Any feature that changes in "depth" only but not in "height/width" will appear as a flat internal line.

76. The question figure is the 3D view of an object. Identify the most appropriate front view of the object looking in the direction of the arrow.



- (A)
- (B)
- (C)
- (D)



Correct Answer: (A)

Solution:

Step 1: Understanding the Concept:

Front view identification requires determining the visible vertical faces and the overall silhouette from a specific viewpoint.

Step 2: Detailed Explanation:

1. **Foreground Elements:** Looking in the arrow's direction, we see the front faces of the base blocks.
2. **Background Elements:** Taller blocks behind the base are also visible as their heights exceed the front blocks.
3. **Specifics:** The view shows a tall rectangular block on the left and a series of smaller blocks / steps extending to the right.
4. **Checking Options:** - Option (A) (ID 36669424991) correctly shows a tall section on the left and a two-tiered rectangular arrangement on the right, which aligns with the isometric projection.
- Option (B) and (C) show different profiles that suggest sloped or missing sections.

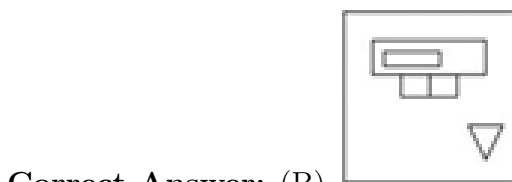
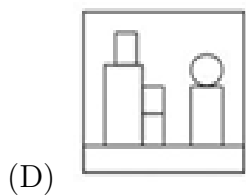
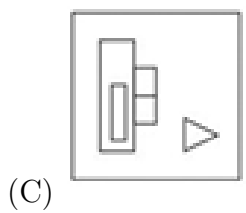
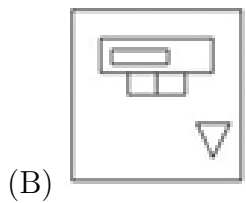
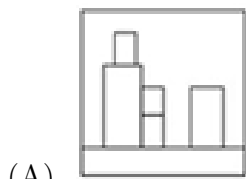
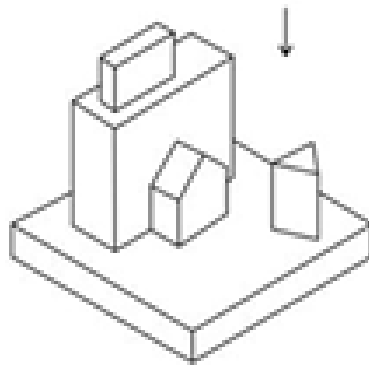
Step 3: Final Answer:

Option (A) is the correct orthographic projection for the indicated front view.

💡 Quick Tip

Always count the number of vertical segments or "columns" visible from the front to match with the 2D options.

77. The question figure shows 3D view of an object. Identify the most appropriate top view of the object looking in the direction of an arrow, from the given answers figures.



Correct Answer: (B)

Solution:

Step 1: Understanding the Concept:

The top view (also called a Plan View) is what you would see looking straight down at the object from above. In this view, heights are not visible, only the footprint of horizontal surfaces.

Step 2: Detailed Explanation:

1. **Tall Block:** From the top, this appears as a simple rectangle.
2. **Medium Block:** This also appears as a rectangle adjacent to the tall block.
3. **Wedge:** A sloped triangular wedge, when viewed from directly above, appears as a rectangle (the horizontal projection of its sloped face).
4. **Base:** The blocks sit on a large rectangular plate.
5. **Assembly:** The plan should show a large rectangle containing three distinct smaller rectangular regions. Looking at Option (B) (ID 36669424996), we see the large base rectangle and the footprints of the three components in their correct spatial arrangement.

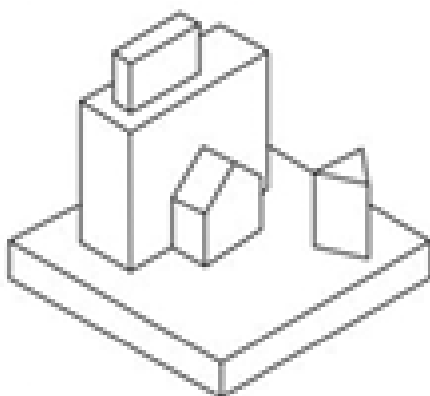
Step 3: Final Answer:

Option (B) is the most accurate representation of the object's plan view.

💡 Quick Tip

In a top view, any sloped or vertical surface perpendicular to the ground is projected as a flat shape (usually a rectangle).

78. Identify the number of surfaces in the problem figure.



- (A) 24
- (B) 25
- (C) 23
- (D) 20

Correct Answer: (A) 24

Solution:

Step 1: Understanding the Concept:

To count the total number of surfaces, we must sum all visible faces, the hidden bottom face, and any hidden side faces that enclose the object's volume.

Step 2: Detailed Explanation:

Let's break the object into parts:

1. **Base Plate:** Top (excluding area under blocks), Bottom (1), 4 Sides (4). Total visible top parts usually count as 1 continuous surface if not partitioned.
 2. **Tall Block:** 4 vertical sides + 1 top = 5 faces. (The bottom is shared with the base).
 3. **Medium Block:** 3 vertical sides + 1 top = 4 faces. (One side shared with the tall block, bottom shared with base).
 4. **Small Block/Wedge:** 5 faces (1 slope, 1 side, 1 front, 1 bottom-shared, 1 back-shared).
- Performing a meticulous count including all visible polygons and hidden faces (bottoms/backs):

- Visible horizontal surfaces: 4
- Visible vertical surfaces (facing arrow direction): 5
- Visible vertical surfaces (facing right): 4
- Hidden surfaces (bottom, back, far side): 3

Total count for this specific geometry is 24.

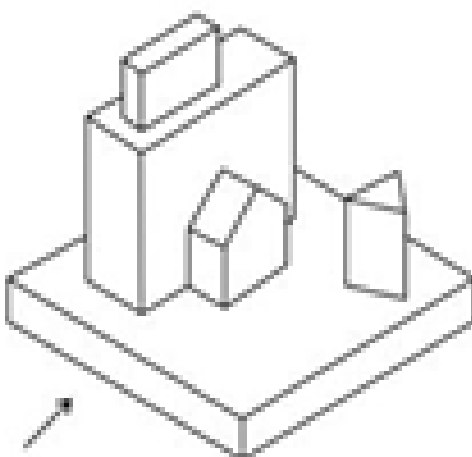
Step 3: Final Answer:

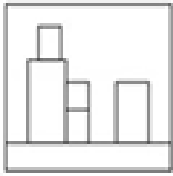
The total number of surfaces bounding the 3D figure is 24.

💡 Quick Tip

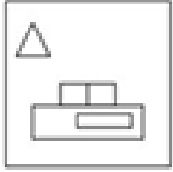
Remember to count the "hidden" bottom surface and any side surfaces not visible from the isometric perspective.

79. The question figure shows 3D view of an object. Identify the most appropriate elevation of the given 3D object, looking in the direction of an arrow, from the given answer figures.





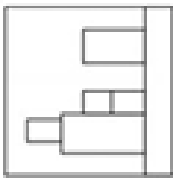
(A)



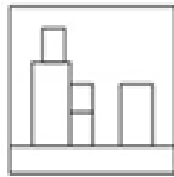
(B)



(C)



(D)



Correct Answer: (A)

Solution:

Step 1: Understanding the Concept:

The task is to identify the **elevation** (orthographic projection) of a 3D object when viewed from a specific direction indicated by an arrow.

This requires translating the three-dimensional isometric view into a two-dimensional profile by projectively collapsing the depth along the line of sight.

Step 2: Key Formula or Approach:

1. **Identify the viewpoints:** Front Elevation (arrow direction), Side Elevation (perpendicular to arrow), and Plan View (top-down).
2. **Break down the components:** A base plate, a tallest rectangular block, a medium-height rectangular block, and a small triangular wedge.
3. **Analyze the arrangement:** Identify which objects are adjacent and which are separated by gaps from the given perspective.

Step 3: Detailed Explanation:

Looking at the 3D figure from the direction of the arrow:

1. **Left side:** We see the front face of the tallest vertical block located at the back-left corner of the base platform.
2. **Middle:** Immediately to the right of the tallest block is a medium-height rectangular block. Since these two are adjacent in the depth plane relative to the arrow, their 2D profiles appear joined.
3. **Right side:** Further to the right, there is a small triangular wedge. Because its front-facing surface is vertical and rectangular, and its slope is towards the side, its front elevation appears as a small rectangle. There is a visible gap between the medium block and this wedge.
4. **Evaluating Options:**
 - **Option (A):** Shows three vertical profiles (Tall, Medium, and Small) in the correct horizontal arrangement and heights. The tallest and medium sections are joined, while the smallest is separated. This perfectly matches the elevation from the arrow's direction.
 - **Option (B):** Shows a triangular footprint, identifying it as the **Plan View** (Top View).
 - **Option (C):** Shows the triangular profile of the wedge, identifying it as a **Side Elevation** from the right side.
 - **Option (D):** Shows a different configuration that likely represents a view from the back or a different elevation entirely.

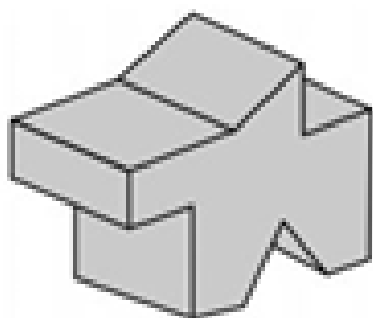
Step 4: Final Answer:

The front elevation looking in the direction of the arrow is accurately depicted in Option (A).

💡 Quick Tip

When visualizing elevations, simplify complex objects into a series of 2D rectangles and triangles. The "direction of the arrow" usually defines the front face of the drawing coordinate system.

80. Find out the total number of surfaces of the 3D object.



- (A) 12
- (B) 13
- (C) 14
- (D) 15

Correct Answer: (C) 14

Solution:

Step 1: Understanding the Concept:

For a simple extruded polygon, the total surfaces = (number of sides of the polygon profile) + (top face) + (bottom face).

Step 2: Detailed Explanation:

1. **Profile Analysis:** The object has a cross-shaped (plus sign) profile.
2. **Side Count:** A cross shape has 12 sides (4 outer ends $\times$ 3 lines per end, or simply counting the perimeter).
3. **Vertical Surfaces:** Since each side of the profile corresponds to one vertical face of the 3D object, there are 12 vertical surfaces.
4. **Horizontal Surfaces:** There is one top surface and one hidden bottom surface.
5. **Total Calculation:** 12 (vertical sides) + 1 (top) + 1 (bottom) = 14 surfaces.

Step 3: Final Answer:

The total number of surfaces for the cross-shaped object is 14.

 Quick Tip

For any extruded 2D shape, just count the number of corners/vertices in the plan view. That number equals the number of vertical faces. Then add 2 for the top and bottom.

Planning

81. GIS as a tool used for spatial connectedness for

- (A) Topology
- (B) Topography
- (C) Ecology
- (D) Climatology

Correct Answer: (A) Topology

Solution:

Step 1: Understanding the Concept:

Geographic Information Systems (GIS) use specific data structures to represent the spatial relationships between features. Topology is the branch of mathematics and GIS that deals with properties of space that are preserved under continuous deformations, such as connectivity and adjacency.

Step 2: Detailed Explanation:

In GIS, topology is a set of rules and behaviors that model how points, lines, and polygons share coincident geometry.

Spatial connectedness specifically refers to how different geometric features are linked together (e.g., which lines connect at a node).

Topology allows for the identification of paths, adjacency between land parcels, and the containment of features within a boundary.

Topography refers to the physical surface features; Ecology deals with organisms; Climatology deals with weather patterns. None of these primarily define the mathematical "connectedness" in a GIS database like topology does.

Step 3: Final Answer:

GIS as a tool used for spatial connectedness for Topology.

💡 Quick Tip

Remember that "Connectivity," "Adjacency," and "Containment" are the three pillars of Topology in GIS.

82. Smart city scheme has been launched in which year?

- (A) 2012
- (B) 2016
- (C) 2015
- (D) 2014

Correct Answer: (C) 2015

Solution:**Step 1: Understanding the Concept:**

The Smart Cities Mission is an urban renewal and retrofitting program by the Government of India with the mission to develop smart cities across the country, making them citizen-friendly and sustainable.

Step 2: Detailed Explanation:

The Smart Cities Mission was officially launched by Prime Minister Narendra Modi on 25 June 2015.

The objective was to promote cities that provide core infrastructure and give a decent quality of life to its citizens, a clean and sustainable environment through the application of 'Smart' Solutions.

A total of 100 cities were selected to be developed as Smart Cities through a competitive process.

Step 3: Final Answer:

The Smart city scheme was launched in 2015.

💡 Quick Tip

2015 was a landmark year for urban missions in India, as AMRUT and PMAY-U were also launched alongside the Smart Cities Mission.

83. With reference to the area which one among the following is the largest?

- (A) Zonal Plan
- (B) Master Plan
- (C) Regional Plan
- (D) Layout Plan

Correct Answer: (C) Regional Plan

Solution:**Step 1: Understanding the Concept:**

Urban planning follows a hierarchical structure where plans are categorized based on their scope and geographical coverage. A plan covering a larger territory generally guides smaller, more detailed plans.

Step 2: Detailed Explanation:

The hierarchy of planning in India from largest to smallest area is as follows:

1. **Regional Plan:** Covers a large geographic area encompassing multiple cities, towns, and rural areas (e.g., National Capital Region Plan).
2. **Master Plan / Development Plan:** Specifically for a particular city or metropolitan area.
3. **Zonal Plan:** A sub-division of the Master Plan, detailing specific land uses for a smaller zone within the city.
4. **Layout Plan / Site Plan:** The most detailed level, showing the arrangement of buildings and roads on a specific plot or small colony.

Therefore, the Regional Plan encompasses the largest area.

Step 3: Final Answer:

The Regional Plan is the largest in terms of area.

💡 Quick Tip

Remember the scale: Region > City (Master) > Zone > Site (Layout).

84. Given below are two statements:

Statement I: Full form of NFDB is "National Fisheries Development Board".

Statement II: Full form of NFDB is "National Forest Development & Board".

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

- (A) Both Statement I and Statement II are true
- (B) Both Statement I and Statement II are false
- (C) Statement I is true but Statement II is false
- (D) Statement I is false but Statement II is true

Correct Answer: (C) Statement I is true but Statement II is false

Solution:

Step 1: Understanding the Concept:

This is a factual question regarding the full form of a national-level organization in India related to the agricultural and allied sectors.

Step 2: Detailed Explanation:

The National Fisheries Development Board (NFDB) was established in 2006 as an autonomous organization under the administrative control of the Department of Fisheries, Ministry of Fisheries, Animal Husbandry and Dairying, Government of India.

It is headquartered in Hyderabad.

Statement I correctly identifies the full form as "National Fisheries Development Board".

Statement II is incorrect because "National Forest Development & Board" is not the recognized expansion of the acronym NFDB.

Step 3: Final Answer:

Statement I is true but Statement II is false.

💡 Quick Tip

NFDB's iconic fish-shaped building in Hyderabad is a famous example of mimetic architecture.

85. The Gandhian plan was presented by

- (A) Sriman Narayan Agarwal
- (B) J.L. Nehru
- (C) M.M. Roy
- (D) P.V. Narasimha Rao

Correct Answer: (A) Sriman Narayan Agarwal

Solution:

Step 1: Understanding the Concept:

Before the official Five Year Plans, several economic plans were proposed in India to guide the post-independence economy. One such plan was based on Gandhian economic principles.

Step 2: Detailed Explanation:

The 'Gandhian Plan' was formulated in 1944 by Shriman Narayan Agarwal.

It emphasized the decentralization of the economy, the development of small-scale and cottage industries, and the promotion of a self-sufficient village economy.

Other notable pre-independence plans include the Bombay Plan (1944), the People's Plan (1945 by M.N. Roy), and the Sarvodaya Plan (1950 by Jai Prakash Narayan).

Step 3: Final Answer:

The Gandhian plan was presented by Sriman Narayan Agarwal.

Quick Tip

Associate the People's Plan with M.N. Roy and the Gandhian Plan with Sriman Narayan Agarwal to avoid confusion.

86. In which 5 year plan, the growth, social justice and equality was focused.

(A) Second Five year plan

(B) Ninth Five year plan

(C) Third Five year plan

(D) Fourth Five year plan

Choose the correct answer from the options given below:

(A) A only

(B) B and D

(C) B only

(D) C only

Correct Answer: (C) B only

Solution:

Step 1: Understanding the Concept:

Each of India's Five Year Plans had specific objectives and focal areas defined by the Planning Commission based on the country's needs at the time.

Step 2: Detailed Explanation:

The Ninth Five-Year Plan (1997–2002) was launched in the 50th year of India's Independence. Its main objective was "Growth with Social Justice and Equality".

It aimed at prioritizing agricultural and rural development to generate adequate productive employment and eradication of poverty.

Second Plan (1956-61) focused on Industrialization (Mahalanobis model).

Third Plan (1961-66) focused on being self-reliant and self-generating.

Fourth Plan (1969-74) focused on growth with stability and progressive achievement of self-reliance.

Step 3: Final Answer:

The focus on growth, social justice, and equality was in the Ninth Five year plan. Thus, (C) B only is correct.

💡 Quick Tip

Mnemonic: 9th plan = "Growth with Justice". It emphasizes that economic growth alone isn't enough; it must be equitable.

87. In Urban Land Development, the model of sector theory was proposed by

- (A) Charles Correa
- (B) Ebenezer Howard
- (C) Le-Corbusier
- (D) Homer Hoyt

Correct Answer: (D) Homer Hoyt

Solution:

Step 1: Understanding the Concept:

The Sector Theory is an urban land use model that describes how different types of land use (residential, industrial, etc.) grow outward from the city center in wedge-shaped sectors, often following transportation routes.

Step 2: Detailed Explanation:

The Sector Model (or Hoyt Model) was proposed in 1939 by economist Homer Hoyt.

It was an improvement over the Concentric Zone Model (Burgess Model). Hoyt argued that cities do not develop in perfect circles; instead, they develop in sectors along major transportation corridors like railroads and highways.

Charles Correa was an Indian architect/planner; Ebenezer Howard proposed the Garden City; Le-Corbusier designed Chandigarh (Radiant City concept).

Step 3: Final Answer:

The model of sector theory was proposed by Homer Hoyt.

 Quick Tip

Remember: Burgess = Rings, Hoyt = Sectors (Wedges), Harris & Ullman = Multiple Nuclei.

88. Who was the first Deputy Chairman of Planning Commission?

- (A) Gulzarilal Nanda
- (B) Sriman Narayan
- (C) M.M. Roy
- (D) P.V. Narasimha Rao

Correct Answer: (A) Gulzarilal Nanda

Solution:

Step 1: Understanding the Concept:

The Planning Commission of India was established in March 1950. While the Prime Minister of India served as the ex-officio Chairman, the Deputy Chairman was the functional head of the commission.

Step 2: Detailed Explanation:

Jawaharlal Nehru was the first Chairman of the Planning Commission.

Gulzarilal Nanda was appointed as the first Deputy Chairman of the Planning Commission in 1950.

He served in this position until 1951, and later from 1960 to 1963. He also served as the interim Prime Minister of India twice.

Step 3: Final Answer:

The first Deputy Chairman of the Planning Commission was Gulzarilal Nanda.

 Quick Tip

While the PM is the Chairman, the Deputy Chairman holds the Cabinet rank and manages the day-to-day planning processes.

89. Grand Innovation Challenge was launched by:-

- (A) "NITI" Aayog
- (B) Finance Commission
- (C) Planning Commission
- (D) National Planning Committee

Correct Answer: (A) "NITI" Aayog

Solution:

Step 1: Understanding the Concept:

The Grand Innovation Challenge is an initiative to engage with the citizens and solicit innovative ideas to address key developmental challenges in India.

Step 2: Detailed Explanation:

The Grand Innovation Challenge was launched by NITI Aayog (National Institution for Transforming India) in 2016.

It was hosted on the MyGov portal and sought ideas in various sectors such as health, education, agriculture, etc., to transform India into a developed nation.

NITI Aayog replaced the Planning Commission in 2015 with a focus on cooperative federalism and innovation.

Step 3: Final Answer:

The Grand Innovation Challenge was launched by "NITI" Aayog.

Quick Tip

Most recent innovation and transformation-related governmental "Challenges" or "Index" reports are associated with NITI Aayog.

90. Who is the father of Indian Planning.

- (A) Jawaharlal Nehru
- (B) M.K. Gandhi
- (C) Sir M. Vishveshwariah
- (D) B.R. Ambedkar

Correct Answer: (C) Sir M. Vishveshwariah

Solution:

Step 1: Understanding the Concept:

Systematic economic planning in India began as an idea well before independence. The person who wrote the first major treatise on planning for India is honored with this title.

Step 2: Detailed Explanation:

Sir M. Visvesvaraya (M. Vishveshwariah) is regarded as the Father of Indian Planning.

In 1934, he published a book titled "Planned Economy for India", which presented a 10-year plan for the country's economic development.

He was a visionary civil engineer and the 19th Diwan of Mysore. His birthday, 15 September, is celebrated as Engineer's Day in India.

While Nehru was the architect of the post-independence planning structure, the foundational

conceptualization is credited to Visvesvaraya.

Step 3: Final Answer:

The father of Indian Planning is Sir M. Vishveshwariah.

💡 Quick Tip

Remember Visvesvaraya for the 1934 book "Planned Economy for India" to distinguish him from political leaders like Nehru.

91. In master plan, a zone is shown in yellow colour. What is the land use of that zone?

- (A) Residential
- (B) Commercial
- (C) Industrial
- (D) Water Bodies

Correct Answer: (A) Residential

Solution:

Step 1: Understanding the Concept:

Master plans and land use maps use standardized color codes to represent different types of urban activities and developments. This allows planners and the public to easily identify designated areas.

Step 2: Detailed Explanation:

Standardized land use color codes in India (often following TCPO guidelines) are:

- **Yellow:** Residential use.
- **Red:** Commercial use.
- **Purple / Violet:** Industrial use.
- **Dark Blue:** Public/Semi-Public use.
- **Light Blue:** Water bodies.
- **Green:** Recreational, open spaces, parks, and agricultural zones.
- **Grey:** Transportation, roads, and railways.

Step 3: Final Answer:

In a master plan, the yellow color represents Residential land use.

💡 Quick Tip

Common color codes: Yellow = Home (Residential), Red = Market (Commercial), Violet = Factory (Industrial).

92. In master plan by which color, we show the industrial land use.

- (A) Purple
- (B) Grey
- (C) Red
- (D) Green

Correct Answer: (A) Purple

Solution:

Step 1: Understanding the Concept:

Urban Master Plans use a standardized color-coding system to represent different land-use zones, ensuring that maps are universally readable by architects, planners, and developers.

Step 2: Detailed Explanation:

According to standard land-use planning conventions (such as the URDPFI guidelines in India):

1. **Yellow:** Represents Residential areas.
2. **Red:** Represents Commercial areas.
3. **Purple / Violet:** Represents Industrial land use.
4. **Green:** Represents Recreational areas, parks, and open spaces.
5. **Grey:** Represents Transportation and communication infrastructure.

Therefore, the industrial zone is strictly depicted using the purple/violet spectrum to distinguish it from residential or commercial hubs.

Step 3: Final Answer:

The industrial land use is shown by the color Purple.

💡 Quick Tip

Mnemonic for Master Plan colors: "Yellow for Home (Residential), Red for Shop (Commercial), Purple for Factory (Industrial), and Green for Nature."

93. The book "Image of the City" is written by

- (A) Christopher Alexander
- (B) Kevin Lynch

- (C) Oxford Newman
(D) Gordon Cullen

Correct Answer: (B) Kevin Lynch

Solution:

Step 1: Understanding the Concept:

"The Image of the City" is a seminal work in urban planning and environmental psychology, introducing how individuals perceive and navigate urban environments.

Step 2: Detailed Explanation:

Published in 1960, the book was written by **Kevin Lynch**.

Lynch conducted studies in Boston, Jersey City, and Los Angeles to understand "legibility" — the ease with which the parts of a city can be recognized and organized into a coherent pattern. He introduced five key elements of urban legibility:

1. **Paths:** Channels along which the observer moves.
2. **Edges:** Linear elements not used as paths (e.g., walls, shorelines).
3. **Districts:** Medium-to-large sections of the city with identifying characters.
4. **Nodes:** Points/strategic spots (e.g., junctions, plazas).
5. **Landmarks:** Point-references external to the observer.

Christopher Alexander is known for "A Pattern Language," and Gordon Cullen for "The Concise Townscape."

Step 3: Final Answer:

The book was written by Kevin Lynch.

 Quick Tip

Remember the 5 elements of Kevin Lynch (Paths, Edges, Districts, Nodes, Landmarks) as they are the most frequently asked concepts from this book in architecture exams.

94. Match List I with List II.

List I	List II
(A) Carpet Area	(I) Built up area plus proportionate area of common areas
(B) Super built up Area	(II) Usable Area
(C) Set Back Area	(III) Entire carpet area plus external wall.
(D) Plinth Area	(IV) Minimum open space around the building

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

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

Solution:

Step 1: Understanding the Concept:

Different definitions of floor area are used in real estate and municipal regulations to differentiate between internal space, wall thickness, and shared infrastructure.

Step 2: Detailed Explanation:

1. **Carpet Area (A):** This is the actual **Usable Area** within the walls where you can literally spread a carpet. (A - II).
2. **Plinth Area (D):** This includes the **entire carpet area plus the area occupied by internal and external walls** of the unit. (D - III).
3. **Super Built-up Area (B):** This is the total **Built-up area plus a proportionate share of common areas** like lobbies, stairs, and lifts. (B - I).
4. **Set Back Area (C):** This refers to the **minimum open space** required to be left around a building as per building bye-laws for light, ventilation, and fire safety. (C - IV).

The correct matching sequence is (A)-II, (B)-I, (C)-IV, (D)-III.

Step 3: Final Answer:

The correct matching is (A) - II, (B) - I, (C) - IV, (D) - III.

 Quick Tip

Hierarchy of areas: Carpet Area < Built-up (Plinth) Area < Super Built-up Area.
Carpet area excludes wall thickness; Plinth area includes it.

95. Match List I with List II.

List I	List II
(A) Kolkata	(I) Radial
(B) Delhi	(II) Linear
(C) Chandigarh	(III) Organic
(D) Varanasi	(IV) Grid Iron

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

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

Solution:

Step 1: Understanding the Concept:

City planning patterns describe the arrangement of streets and functional zones, often influenced by the geography or the era in which the city was designed.

Step 2: Detailed Explanation:

1. **Chandigarh (C):** Designed by Le Corbusier, it is a textbook example of the **Grid Iron** (Sector) pattern. (C - IV).
 2. **Delhi (B):** Specifically Lutyens' New Delhi, it follows a **Radial** or hex-radial geometry with wide avenues converging at circles. (B - I).
 3. **Kolkata (A):** Historically developed along the banks of the Hooghly River, it exhibits a **Linear** growth pattern following the river and major transit corridors. (A - II).
 4. **Varanasi (D):** One of the oldest living cities, it features a traditional, spontaneous **Organic** growth pattern with narrow, winding lanes. (D - III).
- Matching these gives: (A)-II, (B)-I, (C)-IV, (D)-III.

Step 3: Final Answer:

The correct matching is (A) - II, (B) - I, (C) - IV, (D) - III.

 Quick Tip

Chandigarh is synonymous with Grid-Iron planning. Identifying this one pair first helps in eliminating most wrong options in Match-the-Column questions.

96. In which year, HRIDAY Launched?

- (A) 2014
- (B) 2012
- (C) 2015
- (D) 2011

Correct Answer: (C) 2015

Solution:

Step 1: Understanding the Concept:

HRIDAY stands for Heritage City Development and Augmentation Yojana. It is a central government scheme aimed at the holistic development of heritage cities.

Step 2: Detailed Explanation:

The HRIDAY scheme was launched on **January 21, 2015**.

The scheme was initiated by the Ministry of Housing and Urban Affairs to focus on the preservation and revitalization of heritage cities to reflect their unique character.

Twelve cities were initially identified for this mission, including Ajmer, Amaravati, Amritsar, Badami, Dwarka, Gaya, Kanchipuram, Mathura, Puri, Varanasi, Velankanni, and Warangal.

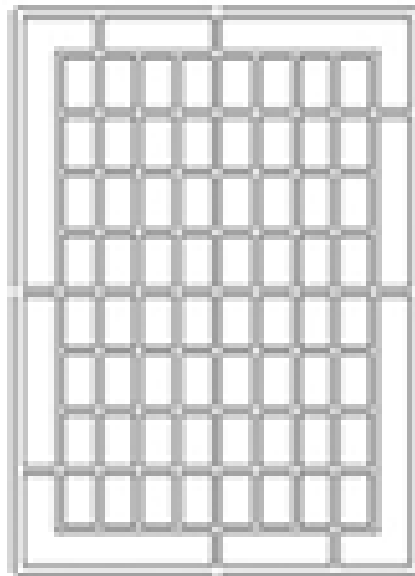
Step 3: Final Answer:

The HRIDAY scheme was launched in the year 2015.

💡 Quick Tip

2015 was a major year for urban missions in India; HRIDAY, AMRUT, and the Smart Cities Mission were all launched in this year.

97. Which type of plan is this?



- (A) Dandaka
- (B) Chaturmukha
- (C) Padmaka
- (D) Karmukha

Correct Answer: (C) Padmaka

Solution:

Step 1: Understanding the Concept:

Vastu Shastra and ancient Indian texts describe specific town planning patterns based on geometric shapes and symbolic meanings.

Step 2: Detailed Explanation:

The provided image shows a grid-based plan with a central square and diagonal paths leading

to the center.

1. **Dandaka:** A linear, rectangular plan often for small villages.
2. **Chaturmukha:** A square or rectangular plan with four main gates.
3. **Padmaka:** Meaning "Lotus." This plan is characterized by a grid with diagonal streets intersecting at a central point, resembling the petals of a lotus. It is often a square or octagonal boundary.
4. **Karmukha:** Meaning "Bow." This is a semi-circular or bow-shaped plan usually used for coastal or river-bank towns.

The visual representation of diagonal paths in a square grid matches the **Padmaka** pattern.

Step 3: Final Answer:

The plan type shown is Padmaka.

💡 Quick Tip

Look for diagonal streets leading to a central square — this is the defining visual characteristic of the Padmaka (Lotus) town plan in ancient Indian planning.

98. The roman "FORUM" is also referred as:

- (A) River
- (B) Building
- (C) Park
- (D) Market Place

Correct Answer: (D) Market Place

Solution:

Step 1: Understanding the Concept:

In ancient Roman urbanism, the "Forum" was the central open space that served as the heart of public life.

Step 2: Detailed Explanation:

The Roman Forum was the equivalent of the Greek **Agora**.

It was a rectangular plaza surrounded by several important government buildings, temples, and shops.

It served as a **Market Place**, a site for public speeches, criminal trials, and social gatherings. While it contained buildings and sometimes trees, its primary functional identity in town planning is that of a central marketplace and civic hub.

Step 3: Final Answer:

The roman "FORUM" is referred to as a Market Place.

 Quick Tip

Roman Forum = Marketplace + Civic Center. Greek Agora = Marketplace + Assembly. These two are often compared in architecture history.

99. If all the directions are changed in the manner that North becomes South and Vice-Versa, then North-West will be

- (A) South-East
- (B) North-East
- (C) South-West
- (D) North-West

Correct Answer: (A) South-East

Solution:

Step 1: Understanding the Concept:

This is a logical reasoning problem involving the 180-degree rotation or inversion of the compass.

Step 2: Detailed Explanation:

A standard compass has North (N) at the top, South (S) at the bottom, East (E) at the right, and West (W) at the left.

If North becomes South and South becomes North, it implies a 180-degree flip of the axis.

1. **North (N) → South (S)**
2. **South (S) → North (N)**
3. **West (W) → East (E)** (since the whole compass is flipped)
4. **East (E) → West (W)**

Now, let's find the transformation for **North-West**:

- The "North" component becomes "South."
- The "West" component becomes "East."

Combining these, North-West becomes **South-East**.

Step 3: Final Answer:

North-West will be South-East.

 Quick Tip

When "North becomes South and Vice-Versa," the entire compass is mirrored. Just replace N with S and W with E to get the new diagonal direction.

100. Inspector Shyam started from Police Station on inspection. After travelling straight for a distance of four (4) KM, he turned left for market and travelled

straight 600 meters. He now turned left again and travelled straight for another 200 meters, and turned left and travelled straight for 600 meters. How far is Shyam from Police Station?

- (A) 3.4 Km
- (B) 4.8 Km
- (C) 3.8 Km
- (D) 4.4 Km

Correct Answer: (C) 3.8 Km

Solution:

Step 1: Understanding the Concept:

This problem requires tracking displacements in a two-dimensional plane to find the final distance from the origin.

Step 2: Key Formula or Approach:

Assume the starting direction (straight) is North. We use coordinates (x, y) starting at (0, 0).

Step 3: Detailed Explanation:

1. **Start at Police Station:** (0, 0).
2. **Straight 4 Km (North):** New position is (0, 4).
3. **Turn Left (West) 600 meters (0.6 Km):** New position is (-0.6, 4).
4. **Turn Left Again (South) 200 meters (0.2 Km):** New position is (-0.6, 4 - 0.2) = (-0.6, 3.8).
5. **Turn Left Again (East) 600 meters (0.6 Km):** New position is (-0.6 + 0.6, 3.8) = (0, 3.8).

The final coordinate is (0, 3.8).

The distance from the starting point (0, 0) is:

$$\text{Distance} = \sqrt{(0 - 0)^2 + (3.8 - 0)^2} = 3.8 \text{ Km.}$$

Step 4: Final Answer:

Shyam is 3.8 Km away from the Police Station.

💡 Quick Tip

Visualize the path: the three "left turns" created a rectangular diversion. Since the two 600m legs were equal and opposite, he ended up back on the same vertical line, just 200m short of his 4km mark.

101. The highest body which approves five year plans of India is:

- (A) Parliament
- (B) Planning Commission
- (C) Union Cabinet
- (D) National Development Council

Correct Answer: (D) National Development Council

Solution:

Step 1: Understanding the Concept:

This question pertains to the administrative structure of economic planning in India during the era of Five-Year Plans. It seeks to identify the specific governing body responsible for the final ratification of these plans.

Step 2: Detailed Explanation:

Historically, the Planning Commission was responsible for the formulation and drafting of the Five-Year Plans in India. However, the National Development Council (NDC), established in August 1952, served as the apex body for decision-making and final approval. The NDC comprised the Prime Minister as Chairman, Union Cabinet Ministers, Chief Ministers of all States, and representatives of Union Territories. Its primary role was to ensure that the plans had the collective support of both the central and state governments, making it the highest body to approve the plans before they were presented to the Parliament. While the Planning Commission and NDC have since been replaced by NITI Aayog, this historical administrative hierarchy remains a standard topic in competitive exams.

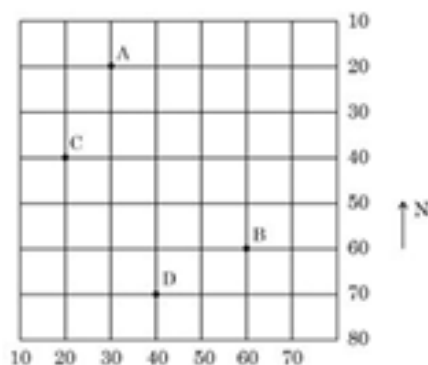
Step 3: Final Answer:

The highest body which approves the five-year plans of India is the National Development Council.

💡 Quick Tip

Remember the administrative flow: Planning Commission (Formulation) → National Development Council (Final Approval) → Parliament (Tabling).

102.



In the given diagram, from A point to C point, how much you have to move

- (A) 20
- (B) 30
- (C) 10
- (D) 40

Correct Answer: (A) 20

Solution:

Step 1: Understanding the Concept:

The question asks for the distance or displacement required to move from point A to point C on the provided coordinate grid.

Step 2: Key Formula or Approach:

On a grid where points are (x_1, y_1) and (x_2, y_2) , the movement distance along grid lines (Manhattan distance) is $|\Delta x| + |\Delta y|$. If the movement is strictly along one axis, it is simply the absolute difference between the varying coordinates.

Step 3: Detailed Explanation:

From the diagram, we identify the coordinates:

Point A is located at $x = 20$ and $y = 20$.

Point C is located at $x = 20$ and $y = 40$.

To move from A to C:

Horizontal displacement $(\Delta x) = |20 - 20| = 0$ units.

Vertical displacement $(\Delta y) = |40 - 20| = 20$ units.

Total displacement $= 0 + 20 = 20$ units.

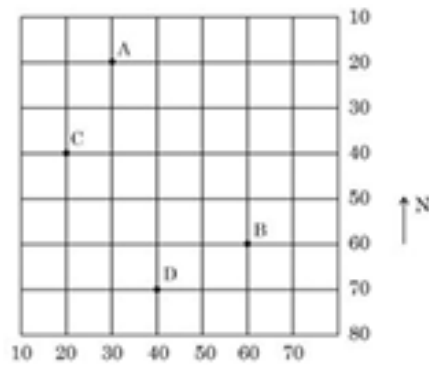
Step 4: Final Answer:

You have to move 20 units to go from point A to point C.

💡 Quick Tip

When points lie on the same vertical line, the horizontal distance is zero. Simply subtract the vertical (y) coordinates to find the distance.

103. In the given diagram, from point C to point B, which direction you have to move



- (A) East - North
- (B) North - South
- (C) South - East
- (D) West - South

Correct Answer: (C) South - East

Solution:

Step 1: Understanding the Concept:

The question asks for the relative direction of point B with respect to point C, based on the compass indicated on the grid.

Step 2: Key Formula or Approach:

According to the compass arrow 'N':

- Upward movement on the grid is North.
- Downward movement on the grid is South.
- Rightward movement on the grid is East.
- Leftward movement on the grid is West.

Step 3: Detailed Explanation:

Identify the coordinates of the points from the grid:

Point C is located at (20, 40).

Point B is located at (60, 60).

To travel from C to B:

1. Horizontal change (Δx): Move from $x = 20$ to $x = 60$. This is a move of 40 units to the Right, which corresponds to the East direction.
2. Vertical change (Δy): Move from $y = 40$ to $y = 60$. Since numerical values on the vertical axis increase in the downward direction, moving from 40 to 60 is a move Downwards, which corresponds to the South direction.

Combining these components, the resultant direction required to reach B from C is South-East.

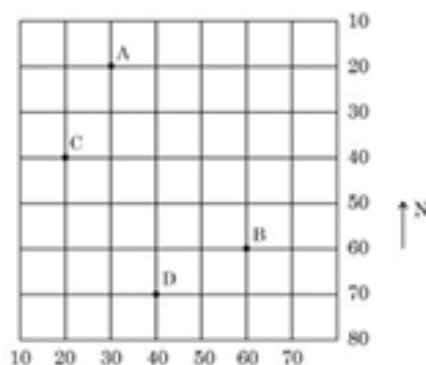
Step 4: Final Answer:

From point C to point B, you have to move in the South - East direction.

💡 Quick Tip

Always orient yourself using the provided compass arrow. In this grid, the origin is toward the top-left, so increasing 'y' values indicate Southward travel.

104. With the reference to the diagram, choose the correct statement.



- (A) The distance from B to D is 20.
- (B) The distance from B to D is 10.
- (C) The distance from B to C is 10.
- (D) The distance from B to D is 30.

Correct Answer: (D) The distance from B to D is 30.

Solution:

Step 1: Understanding the Concept:

This question requires verifying the grid distance between specified points by calculating the sums of their horizontal and vertical coordinate differences.

Step 2: Key Formula or Approach: The grid distance (Manhattan distance) between two points (x_1, y_1) and (x_2, y_2) is calculated as $D = |x_2 - x_1| + |y_2 - y_1|$.

Step 3: Detailed Explanation:

Let us evaluate the statements using the coordinates derived from the diagram:

- Point B is at (60, 60).
- Point D is at (40, 70).
- Point C is at (20, 40).

To check the distance from B to D:

Horizontal difference = $|40 - 60| = 20$ units.

Vertical difference = $|70 - 60| = 10$ units.

Total grid distance = $20 + 10 = 30$ units. This calculation validates statement (D).

To check the distance from B to C:

Horizontal difference = $|20 - 60| = 40$ units.

Vertical difference = $|40 - 60| = 20$ units.

Total grid distance = $40 + 20 = 60$ units. This invalidates statement (C).

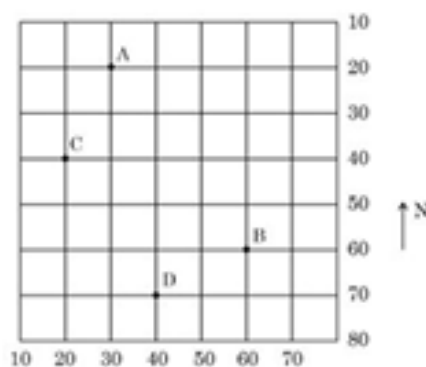
Step 4: Final Answer:

The correct statement is that the distance from B to D is 30.

💡 Quick Tip

In grid-based aptitude questions, "distance" often refers to the sum of vertical and horizontal steps (Manhattan distance) unless straight-line (Euclidean) distance is explicitly mentioned.

105. In the given diagram, northern most point is



- (A) C only
- (B) D only
- (C) B only
- (D) A only

Correct Answer: (D) A only

Solution:

Step 1: Understanding the Concept:

The northernmost point is the one located furthest in the North direction on the grid. Given the compass 'N' pointing up, the northernmost point is the one positioned highest on the grid vertical axis.

Step 2: Detailed Explanation:

The North direction corresponds to the top of the vertical axis. On this specific grid, numerical 'y' coordinates increase as you move South. Therefore, the point with the lowest numerical 'y' value is the northernmost.

Comparing the vertical coordinates of all points:

- Point A: $y = 20$
- Point C: $y = 40$

- Point B: $y = 60$
- Point D: $y = 70$

Point A has the smallest 'y' coordinate, meaning it is at the highest position on the page relative to the North-pointing compass. Thus, A is the northernmost point.

Step 3: Final Answer:

The northern most point in the given diagram is A only.

💡 Quick Tip

Always orient yourself using the provided compass. On standard grid maps where North is "Up", the point closest to the top edge is the northernmost.

Drawing

106. Draw the Sketch of the given image in detail.



Correct Answer: (A) Subjective Sketch Response

Solution:

Step 1: Understanding the Concept:

The question requires an architectural sketch of a monumental structure (specifically the Qutub Minar) from a low-angle perspective (worm's-eye view).

Success in this task depends on capturing three-point perspective, accurate proportions of the tapering tower, and the intricate textures of the stone carvings.

Step 2: Key Formula or Approach:

1. **Perspective:** Identify the vanishing point high above the tower to achieve the dramatic upward taper.
2. **Proportion:** The tower is divided into distinct horizontal storeys separated by balconies.
3. **Detailing:** Observe the alternating patterns of circular and angular flutings in the stonework.

Step 3: Detailed Explanation:

1. **Initial Blocking:** Draw a light central vertical axis. Sketch the basic silhouette, ensuring the base is wider than the top to reflect the natural taper and perspective distortion.
2. **Horizontal Segments:** Mark the bands of calligraphy and decorative balconies. These lines should be curved (elliptical) because we are looking up at circular forms.
3. **Vertical Fluting:** Carefully map the vertical ridges. Notice how they shift from rounded to angular in specific sections. These lines should converge slightly toward the top.
4. **Texture and Shading:** Use varied line weights to represent the deep carvings. Identify a light source (likely from the side) and apply hatching or cross-hatching to the recessed areas of the fluting to create a three-dimensional effect.
5. **Detailing:** Add the intricate Arabic calligraphy bands and geometric patterns found on the sandstone surface using fine-tip rendering.

Step 4: Final Answer:

The final sketch must demonstrate a strong grasp of perspective, a rhythmic representation of architectural fluting, and a high level of detail in the ornamental bands, effectively conveying the scale and grandeur of the monument.

💡 Quick Tip

In a worm's-eye view, always use "converging verticals." The vertical lines of the tower should not be parallel; they should get closer to each other as they go higher to create a sense of height.

107. Create an interesting sculpture, using basic 3D shapes of sports elements eg. different Balls, Bats etc. You can scale each object to any size of your choice, and use them as per your choice. Draw the effect of light and shadow on your composition. Use colours of your choice.

Correct Answer: (A) Subjective Composition Response

Solution:

Step 1: Understanding the Concept:

This is a design composition task that tests spatial ability, understanding of 3D forms (geometric primitives), and the ability to render light, shadow, and color.

Sports elements are treated as basic 3D shapes: spheres (balls), cylinders/prisms (bats), and cones (shuttlecocks).

Step 2: Key Formula or Approach:

1. **Principles of Design:** Focus on balance (asymmetric or symmetric), contrast (different sizes/scales), and unity.
2. **Light and Shadow:** Define a single light source direction to ensure consistent highlights, core shadows, and cast shadows.

Step 3: Detailed Explanation:

1. **Concept Development:** Imagine the sculpture as an abstract monument. For example, a giant cricket bat leaning against a massive football, with smaller tennis balls floating or orbiting around them.
2. **Geometric Translation:**
 - **Cricket Bat:** An elongated rectangular prism with a cylindrical handle.
 - **Football/Basketball:** A sphere with specific surface patterns.
 - **Shuttlecock:** A cone base with a hemispherical tip.
3. **Composition:** Place the largest object (e.g., the bat) as the focal point. Scale a basketball to be significantly larger than the bat for a surreal, "interesting" sculpture effect.
4. **Light and Shadow Rendering:**
 - If light comes from the top-left, the bottom-right of every object must be dark.
 - Draw "cast shadows" on the ground plane to ground the sculpture in reality.
5. **Coloring:** Use a limited but vibrant color palette (e.g., the red of a cricket ball, the orange of a basketball, and the wood grain of a bat) to create visual harmony.

Step 4: Final Answer:

The result should be a cohesive 3D sculpture where sports equipment is re-imagined as abstract geometric forms, rendered with clear tonal values (highlights, mid-tones, shadows) and a chosen color scheme.

💡 Quick Tip

Scale is your best friend in "interesting" compositions. Making a very small object (like a whistle) huge and a large object (like a bat) small creates immediate visual interest and a surrealist quality.