2024-I NDA/NA Solved Paper

Paper I: Mathematics

1. Let A and B be matrices of order 3×3. If $|A| = \frac{1}{2\sqrt{2}}$ and $|B| = \frac{1}{729}$, then what is the value of $|2B(adj(3A))|$?

(*a*) 27 (*b*) $\frac{27}{2\sqrt{2}}$ (*c*) $\frac{27}{2}$ (*d*) 1

2. If z is any complex number and $iz^3 + z^2 - z + i = 0$, where $i = \sqrt{-1}$, then what is the value of $(|z| + 1)^2$?

(*a*) 1 (*b*) 4 (*c*) 81 (*d*) 121

3. What is the sum of all four digit numbers formed by using all digits 0, 1, 4, 5 without repetition of digits?

(*a*) 44440 (*b*) 46460 (*c*) 46440 (*d*) 64440

4. If x, y and z are the cube roots of unity, then what is the value of $xy + yz + zx$?

(*a*) 0 (*b*) 1 (*c*) 2 (*d*) 3

5. A man has 7 relatives (4 women and 3 men). His wife also has 7 relatives (3 women and 4 men). In how many ways can they invite 3 women and 3 men so that 3 of them are man's relatives and 3 of them are his wife's relatives?

(*a*) 340 (*b*) 484 (*c*) 485 (*d*) 469

6. A triangle PQR is such that 3 points lie on the side PQ, 4 points on QR and 5 points on RP respectively. Triangles are constructed using these points as vertices. What is the number of triangles so formed?

(*a*) 205 (*b*) 206 (*c*) 215 (*d*) 220

7. If $\log_b a = p$, $\log_d c = 2p$ and $\log_f e = 3p$, then what is $(ace)^{1/p}$ equal to?

(*a*) bd^2f^3 (*b*) bdf (*c*) b^3d^2f (*d*) $b^2d^2f^2$

8. If $-\sqrt{2}$ and $\sqrt{3}$ are roots of the equation $a_0 + a_1x + a_2x^2 + a_3x^3 + x^4 = 0$ where a_0, a_1, a_2, a_3 are integers, then which one of the following is correct?

(*a*) $a_2 = a_3 = 0$ (*b*) $a_2 = 0$ and $a_3 = -5$
(*c*) $a_0 = 6$, $a_3 = 0$ (*d*) $a_1 = 0$ and $a_2 = 5$

9. Let z_1 and z_2 be two complex numbers such that $\left|\frac{z_1 + z_2}{z_1 - z_2}\right| = 1$, then what is $Re\left(\frac{z_1}{z_2}\right) + 1$ equal to?

(*a*) –1 (*b*) 0 (*c*) 1 (*d*) 5

10. If $26! = n8^k$, where k and n are positive integers, then what is the maximum value of k?

(*a*) 6 (*b*) 7 (*c*) 8 (*d*) 9

11. Consider the following statements in respect of two non-singular matrices A and B of the same order n:

1. $adj(AB) = (adjA)(adjB)$ 2. $adj(AB) = adj(BA)$
3. $(AB)adj(AB) - |AB|I_n$ is a null matrix of order n

How many of the above statements are correct?

(*a*) None (*b*) Only one statement
(*c*) Only two statements (*d*) All three statements

12. Consider the following statements in respect of a non-singular matrix A of order n:

1. $A(adjA^T) = A(adjA)^T$
2. If $A^2 = A$, then A is identity matrix of order n
3. If $A^3 = A$, then A is identity matrix of order n

Which of the statements given above are correct?

(*a*) 1 and 2 only (*b*) 2 and 3 only
(*c*) 1 and 3 only (*d*) 1, 2 and 3

13. How many four-digit natural numbers are there such that all of the digits are even?

(*a*) 625 (*b*) 500 (*c*) 400 (*d*) 256

14. If $\omega \neq 1$ is a cube root of unity, then what are the solutions of $(z - 100)^3 + 1000 = 0$?

(*a*) $10(1 - \omega)$, $10(10 - \omega^2)$, 100
(*b*) $10(10 - \omega)$, $10(10 - \omega^2)$, 90
(*c*) $10(1 - \omega)$, $10(10 - \omega^2)$, 1000
(*d*) $(1 + \omega)$, $(10 + \omega^2)$, –1

15. What is $(1 + i)^4 + (1 - i)^4$ equal to, where $i = \sqrt{-1}$?

(*a*) 4 (*b*) 0 (*c*) –4 (*d*) –8

16. Consider the following statements in respect of a skew-symmetric matrix A of order 3:

1. All diagonal elements are zero.
2. The sum of all the diagonal elements of the matrix is zero.
3. A is orthogonal matrix.

CLICK HERE To Discover more

Which of the statements given above are correct?

(a) 1 and 2 only (b) 2 and 3 only
(c) 1 and 3 only (d) 1, 2 and 3

17. Four digit numbers are formed by using the digits 1, 2, 3, 5 without repetition of digits. How many of them are divisible by 4?

(a) 120 (b) 24 (c) 12 (d) 6

18. What is the remainder when 2^{120} is divided by 7?

(a) 1 (b) 3 (c) 5 (d) 6

19. For what value of n is the determinant

$$\begin{vmatrix} C(9,4) & C(9,3) & C(10,n-2) \\ C(11,6) & C(11,5) & C(12,n) \\ C(m,7) & C(m,6) & C(m+1,n+1) \end{vmatrix} = 0 \text{ for every } m > n?$$

(a) 4 (b) 5 (c) 6 (d) 7

20. If ABC is a triangle, then what is the value of the determinant

$$\begin{vmatrix} \cos C & \sin B & 0 \\ \tan A & 0 & \sin B \\ 0 & \tan(B+C) & \cos C \end{vmatrix} ?$$

(a) –1 (b) 0 (c) 1 (d) 3

21. What is the number of different matrices, each having 4 entries that can be formed using 1, 2, 3, 4 (repetition is allowed)?

(a) 72 (b) 216 (c) 254 (d) 768

22. Let $A = \{x \in R: -1 < x < 1\}$. Which of the following is/are bijective functions from A to itself?

1. $f(x) = x|x|$ 2. $g(x) = \cos(\pi x)$

Select the correct answer using the code given below:

(a) 1 only (b) 2 only
(c) Both 1 and 2 (d) Neither 1 nor 2

23. Let R be a relation on the open interval (–1, 1) and is given by $R = \{(x, y): |x + y| < 2\}$. Then which one of the following is correct?

(a) R is reflexive but neither symmetric nor transitive
(b) R is reflexive and symmetric but not transitive
(c) R is reflexive and transitive but not symmetric
(d) R is an equivalence relation

24. For any three non-empty sets A, B, C, what is $(A \cup B) - \{(A - B) \cup (B - A) \cup (A \cap B)\}$ equal to?

(a) Null set (b) A
(c) B (d) $(A \cup B) - (A \cap B)$

25. If a, b, c are the sides of triangle ABC, then what is

$$\begin{vmatrix} a^2 & b\sin A & c\sin A \\ b\sin A & 1 & \cos A \\ c\sin A & \cos A & 1 \end{vmatrix}$$ equal to?

(a) Zero (b) Area of triangle
(c) Perimeter of triangle (d) $a^2 + b^2 + c^2$

26. If a, b, c are in AP; b, c, d are in GP; c, d, e are in HP, then which of the following is/are correct?

1. a, c and e are in GP
2. $\frac{1}{a}, \frac{1}{c}, \frac{1}{e}$ are in GP

Select the correct answer using the code given below:

(a) 1 only (b) 2 only
(c) Both 1 and 2 (d) Neither 1 nor 2

27. What is the number of solutions of $\log_4(x - 1) = \log_2(x - 3)$?

(a) Zero (b) One (c) Two (d) Three

28. For $x \geq y > 1$, let $\log_x\left(\frac{x}{y}\right) + \log_y\left(\frac{y}{x}\right) = k$, then the value of k can never be equal to

(a) –1 (b) $-\frac{1}{2}$ (c) 0 (d) 1

29. If $A = \begin{bmatrix} \sin 2\theta & 2\sin^2\theta - 1 & 0 \\ \cos 2\theta & 2\sin\theta\cos\theta & 0 \\ 0 & 0 & 1 \end{bmatrix}$, then which of the following statements is/are correct?

1. $A^{-1} = adjA$ 2. A is skew-symmetric matrix
3. $A^{-1} = A^T$

Select the correct answer using the code given below:

(a) 1 only (b) 1 and 2 (c) 1 and 3 (d) 2 and 3

30. What is the coefficient of x^{10} in the expansion of $(1 - x^2)^{20}\left(2 - x^2 - \frac{1}{x^2}\right)^{-5}$?

(a) –1
(b) 1
(c) 10
(d) Coefficient of x^{10} does not exist

31. If the 4th term in the expansion of $\left(mx + \frac{1}{x}\right)^n$ is $\frac{5}{2}$, then what is the value of mn?

(a) –3 (b) 3 (c) 6 (d) 12

32. If a, b and c ($a > 0$, $c > 0$) are in GP, then consider the following in respect of the equation $ax^2 + bx + c = 0$:

1. The equation has imaginary roots.
2. The ratio of the roots of the equation is 1:ω where ω is a cube root of unity.
3. The product of roots of the equation is $\left(\frac{b^2}{a^2}\right)$.

Which of the statements given above are correct?

(a) 1 and 2 only (b) 2 and 3 only
(c) 1 and 3 only (d) 1, 2 and 3

33. If $x^2 + mx + n$ is an integer for all integral values of x, then which of the following is/are correct?

1. m must be an integer 2. n must be an integer

Select the correct answer using the code given below:

(a) 1 only (b) 2 only
(c) Both 1 and 2 (d) Neither 1 nor 2

34. In a binomial expansion of $(x + y)^{2n+1}(x - y)^{2n+1}$, the sum of middle terms is zero. What is the value of $\left(\frac{x^2}{y^2}\right)$?

(a) 1 (b) 2 (c) 4 (d) 8

35. Let $A = \{1, 2, 3, 4, 5\}$ and $B = (6, 7\}$. What is the number of onto functions from A to B?

(*a*) 10 (*b*) 20 (*c*) 30 (*d*) 32

36. What is $\frac{\sqrt{3}\cos 10^\circ - \sin 10^\circ}{\sin 25^\circ \cos 25^\circ}$ equal to?

(*a*) 1 (*b*) $\sqrt{3}$ (*c*) 2 (*d*) 4

37. What is $(\sin 9^\circ - \cos 9^\circ)$ equal to?

(*a*) $-\frac{\sqrt{5-\sqrt{5}}}{2}$ (*b*) $-\frac{\sqrt{5-\sqrt{3}}}{2}$

(*c*) $\frac{\sqrt{5-\sqrt{5}}}{2}$ (*d*) $\frac{\sqrt{5-\sqrt{5}}}{4}$

38. If in a triangle ABC, $\sin^3 A + \sin^3 B + \sin^3 C = 3\sin A \sin B \sin C$, then what is the value of the determinant $\begin{vmatrix} a & b & c \\ b & c & a \\ c & a & b \end{vmatrix}$; where a, b, c are sides of the triangle?

(*a*) $a + b + c$ (*b*) $ab + bc + ca$

(*c*) $(a + b)(b + c)(c + a)$ (*d*) 0

39. If $\cos^{-1}x = \sin^{-1}x$, then which one of the following is correct?

(*a*) $x = 1$ (*b*) $x = \frac{1}{2}$ (*c*) $x = \frac{1}{\sqrt{2}}$ (*d*) $x = \frac{1}{\sqrt{3}}$

40. What is the number of solutions of $(\sin\theta - \cos\theta)^2 = 2$ where $-\pi < \theta < \pi$?

(*a*) Only one (*b*) Only two (*c*) Four (*d*) No solution

41. ABC is a triangle such that angle $C = 60^\circ$, then what is $\frac{\cos A + \cos B}{\cos\left(\frac{A-B}{2}\right)}$ equal to?

(*a*) 2 (*b*) $\sqrt{2}$ (*c*) 1 (*d*) $\frac{1}{\sqrt{2}}$

42. What is $\sqrt{15 + \cot^2\left(\frac{\pi}{4} - 2\cot^{-1}3\right)}$ equal to?

(*a*) 1 (*b*) 7 (*c*) 8 (*d*) 16

43. What is the value of $\sin 10^\circ \cdot \sin 50^\circ + \sin 50^\circ \cdot \sin 250^\circ + \sin 250^\circ \cdot \sin 10^\circ$ equal to?

(*a*) $-\frac{1}{4}$ (*b*) $-\frac{3}{4}$ (*c*) $\frac{3\sin 10^\circ}{4}$ (*d*) $-\frac{3\cos 10^\circ}{4}$

44. What is $\tan^{-1}\left(\frac{a}{b}\right) - \tan^{-1}\left(\frac{a-b}{a+b}\right)$ equal to?

(*a*) $-\frac{\pi}{4}$ (*b*) $\frac{\pi}{4}$

(*c*) $\tan^{-1}\left(\frac{a^2-b^2}{a^2+b^2}\right)$ (*d*) $\tan^{-1}\left(\frac{2ab}{a^2+b^2}\right)$

45. Under which one of the following conditions does the equation $(\cos\beta - 1)x^2 + (\cos\beta)x + \sin\beta = 0$ in x have a real root for $\beta \in [0, \pi]$?

(*a*) $1 - \cos\beta < 0$ (*b*) $1 - \cos\beta \le 0$

(*c*) $1 - \cos\beta > 0$ (*d*) $1 - \cos\beta \ge 0$

46. In a triangle ABC, $AB = 16$ cm, $BC = 63$ cm and $AC = 65$ cm. What is the value of $\cos 2A + \cos 2B + \cos 2C$?

(*a*) –1 (*b*) 0 (*c*) 1 (*d*) $\frac{76}{65}$

47. If $f(\theta) = \frac{1}{1+\tan\theta}$ and $\alpha + \beta = \frac{5\pi}{4}$, then what is the value of $f(\alpha)$ $f(\beta)$?

(*a*) $-\frac{1}{2}$ (*b*) $\frac{1}{2}$ (*c*) 1 (*d*) 2

48. If $\tan\alpha$ and $\tan\beta$ are the roots of the equation $x^2 - 6x + 8 = 0$, then what is the value of $\cos(2\alpha + 2\beta)$?

(*a*) $\frac{13}{75}$ (*b*) $\frac{13}{85}$ (*c*) $\frac{17}{85}$ (*d*) $\frac{19}{85}$

49. What is the value of $\tan 65^\circ + 2\tan 45^\circ - 2\tan 40^\circ - \tan 25^\circ$?

(*a*) 0 (*b*) 1 (*c*) 2 (*d*) 4

50. Consider the following statements:

1. In a triangle ABC, if $\cot A \cdot \cot B \cdot \cot C > 0$, then the triangle is an acute angled triangle.
2. In a triangle ABC, if $\tan A \cdot \tan B \cdot \tan C > 0$, then the triangle is an obtuse angled triangle.

Which of the statements given above is/are correct?

(*a*) 1 only (*b*) 2 only

(*c*) Both 1 and 2 (*d*) Neither 1 nor 2

51. If (a, b) is the centre and c is the radius of the circle $x^2 + y^2 + 2x + 6y + 1 = 0$, then what is the value of $a^2 + b^2 + c^2$?

(*a*) 19 (*b*) 18 (*c*) 17 (*d*) 11

52. If $(1, -1, 2)$ and $(2, 1, -1)$ are the end points of a diameter of a sphere $x^2 + y^2 + z^2 + 2ux + 2vy + 2wz - 1 = 0$, then what is $u + v + w$ equal to?

(*a*) –2 (*b*) –1 (*c*) 1 (*d*) 2

53. The number of points represented by the equation $x = 5$ on the xy-plane is

(*a*) Zero (*b*) One

(*c*) Two (*d*) Infinitely many

54. If $<l, m, n>$ are the direction cosines of a normal to the plane $2x - 3y + 6z + 4 = 0$,

then what is the value of $49(7l^2 + m^2 - n^2)$?

(*a*) 0 (*b*) 1 (*c*) 3 (*d*) 71

55. A line through $(1, -1, 2)$ with direction ratios $<3, 2, 2>$ meets the plane $x + 2y + 3z = 18$. What is the point of intersection of line and plane?

(*a*) (4, 4, 1) (*b*) (2, 4, 1) (*c*) (4, 1, 4) (*d*) (3, 4, 7)

56. If p is the perpendicular distance from origin to the plane passing through (1, 0, 0), (0, 1, 0) and (0, 0, 1), then what is $3p^2$ equal to?

(*a*) 4 (*b*) 3 (*c*) 2 (*d*) 1

57. If the direction cosines $< l, m, n >$ of a line are connected by relation $l + 2m + n = 0$, $2l - 2m + 3n = 0$, then what is the value of $l^2 + m^2 - n^2$?

(*a*) $\frac{1}{101}$ (*b*) $\frac{29}{101}$ (*c*) $\frac{41}{101}$ (*d*) $\frac{92}{101}$

58. If a variable line passes through the point of intersection of the lines $x + 2y - 1 = 0$ and $2x - y - 1 = 0$ and meets the coordinate axes in A and B, then what is the locus of the mid-point of AB?

(*a*) $3x + y = 10xy$ (*b*) $x + 3y = 10xy$

(*c*) $3x + y = 10$ (*d*) $x + 3y = 10$

59. What is the equation to the straight line passing through the point $(-\sin\theta, \cos\theta)$ and perpendicular to the line $x\cos\theta + y\sin\theta = 9$?

(*a*) $x\sin\theta - y\cos\theta - 1 = 0$ (*b*) $x\sin\theta - y\cos\theta + 1 = 0$

(*c*) $x\sin\theta - y\cos\theta = 0$ (*d*) $x\cos\theta - y\sin\theta + 1 = 0$

60. Two points P and Q lie on line $y = 2x + 3$. These two points P and Q are at a distance 2 units from another point $R(1, 5)$. What are the coordinates of the points P and Q?

(*a*) $\left(1+\frac{2}{\sqrt{5}}, 5+\frac{4}{\sqrt{5}}\right), \left(1-\frac{2}{\sqrt{5}}, 5-\frac{4}{\sqrt{5}}\right)$

(*b*) $\left(3+\frac{2}{\sqrt{5}}, 5+\frac{4}{\sqrt{5}}\right), \left(-1-\frac{2}{\sqrt{5}}, 5-\frac{4}{\sqrt{5}}\right)$

(*c*) $\left(1-\frac{2}{\sqrt{5}}, 5+\frac{4}{\sqrt{5}}\right), \left(1+\frac{2}{\sqrt{5}}, 5-\frac{4}{\sqrt{5}}\right)$

(*d*) $\left(3-\frac{2}{\sqrt{5}}, 5+\frac{4}{\sqrt{5}}\right), \left(-1+\frac{2}{\sqrt{5}}, 5-\frac{4}{\sqrt{5}}\right)$

61. If two sides of a square lie on the lines $2x + y - 3 = 0$ and $4x + 2y + 5 = 0$, then what is the area of the square in square units?

(*a*) 6.05 (*b*) 6.15 (*c*) 6.25 (*d*) 6.35

62. ABC is a triangle with $A(3, 5)$. The mid-points of sides AB, AC are at $(-1,2)$, $(6, 4)$ respectively. What are the coordinates of centroid of the triangle ABC?

(*a*) $\left(\frac{8}{3}, \frac{11}{3}\right)$ (*b*) $\left(\frac{7}{3}, \frac{7}{3}\right)$ (*c*) $\left(2, \frac{8}{3}\right)$ (*d*) $\left(\frac{8}{3}, 2\right)$

63. ABC is an acute angled isosceles triangle. Two equal sides AB and AC lie on the lines $7x - y - 3 = 0$ and $x + y - 5 = 0$. If θ is one of the equal angles, then what is $\cot\theta$ equal to?

(*a*) $\frac{1}{3}$ (*b*) $\frac{1}{2}$ (*c*) $\frac{2}{3}$ (*d*) 2

64. In the parabola $y^2 = 8x$, the focal distance of a point P lying on it is 8 units. Which of the following statements is/are correct?

1. The coordinates of P can be $(6, 4\sqrt{3})$
2. The perpendicular distance of P from the directrix of parabola is 8 units.

Select the correct answer using the code given below:

(*a*) 1 only (*b*) 2 only

(*c*) Both 1 and 2 (*d*) Neither 1 nor 2

65. What is the eccentricity of the ellipse if the angle between the straight lines joining the foci to an extremity of the minor axis is 90°?

(*a*) $\frac{1}{3}$ (*b*) $\frac{1}{2}$ (*c*) $\frac{1}{\sqrt{3}}$ (*d*) $\frac{1}{\sqrt{2}}$

66. Let $\vec{a} = \hat{i} - \hat{j} + \hat{k}$ and $\vec{b} = \hat{i} + 2\hat{j} - \hat{k}$. If $\vec{a} \times (\vec{b} \times \vec{a}) = \alpha\hat{i} - \beta\hat{j} + \gamma\hat{k}$, then what is the value of $\alpha + \beta + \gamma$?

(*a*) 8 (*b*) 7 (*c*) 6 (*d*) 1

67. If a vector of magnitude 2 units makes an angle $\frac{\pi}{3}$ with $2\hat{i}$, $\frac{\pi}{4}$ with $3\hat{j}$ and an acute angle θ with $4\hat{k}$, then what are the components of the vector?

(*a*) $(1, \sqrt{2}, 1)$ (*b*) $(1, -\sqrt{2}, 1)$

(*c*) $(1, -\sqrt{2}, -1)$ (*d*) $(1, \sqrt{2}, -1)$

68. Consider the following in respect of moment of a force:

1. The moment of force about a point is independent of point of application of force.
2. The moment of a force about a line is a vector quantity.

Which of the statements given above is/are correct?

(*a*) 1 only (*b*) 2 only

(*c*) Both 1 and 2 (*d*) Neither 1 nor 2

69. For any vector $\vec{r}$, what is $(\vec{r}\cdot\hat{i})(\vec{r}\times\hat{i}) + (\vec{r}\cdot\hat{j})(\vec{r}\times\hat{j}) + (\vec{r}\cdot\hat{k})(\vec{r}\times\hat{k})$ equal to?

(*a*) $\vec{0}$ (*b*) $\vec{r}$ (*c*) $2\vec{r}$ (*d*) $3\vec{r}$

70. Let $\vec{a}$ and $\vec{b}$ are two vectors of magnitude 4 inclined at an angle $\frac{\pi}{3}$, then what is the angle between $\vec{a}$ and $\vec{a} - \vec{b}$?

(*a*) $\frac{\pi}{2}$ (*b*) $\frac{\pi}{3}$ (*c*) $\frac{\pi}{4}$ (*d*) $\frac{\pi}{6}$

71. Let $y_1(x)$ and $y_2(x)$ be two solutions of the differential equation $\frac{dy}{dx} = x$. If $y_1(0) = 0$ and $y_2(0) = 4$, then what is the number of points of intersection of the curves $y_1(x)$ and $y_2(x)$?

(*a*) No point (*b*) One point

(*c*) Two points (*d*) More than two points

72. The differential equation, representing the curve $y = e^x(a\cos x + b\sin x)$ where a and b are arbitrary constants, is

(*a*) $\frac{d^2y}{dx^2} + 2y = 0$ (*b*) $\frac{d^2y}{dx^2} + 2\frac{dy}{dx} + 2y = 0$

(*c*) $\frac{d^2y}{dx^2} - 2\frac{dy}{dx} + 2y = 0$ (*d*) $\frac{d^2y}{dx^2} + y = 0$

73. If $f(x) = ax - b$ and $g(x) = cx + d$ are such that $f(g(x)) = g(f(x))$, then which one of the following holds?

(*a*) $f(d) = g(b)$ (*b*) $f(b) + g(d) = 0$

(*c*) $f(a) + g(c) = 2a$ (*d*) $f(d) + g(b) = 2d$

74. What is $\int_{-1}^{1}(3\sin x - \sin 3x)\cos^2 x\,dx$ equal to?

(*a*) $-\frac{1}{4}$ (*b*) 0 (*c*) $\frac{1}{2}$ (*d*) $\frac{1}{4}$

75. What are the order and degree respectively of the differential equation $\left\{2 - \left(\frac{dy}{dx}\right)^2\right\}^{0.6} = \frac{d^2y}{dx^2}$?

(*a*) 2, 2 (*b*) 2, 3 (*c*) 5, 2 (*d*) 2, 5

76. If $\frac{dy}{dx} = 2e^xy^3, y(0) = \frac{1}{2}$ then what is $4y^2(2 - e^x)$ equal to?

(*a*) 1 (*b*) 2 (*c*) 3 (*d*) 4

77. Let $p = \int_a^b f(x)dx$ and $q = \int_a^b |f(x)|dx$. If $f(x) = e^{-x}$, then which one of the following is correct?

(*a*) $p = 2q$ (*b*) $p = -q$ (*c*) $4p = q$ (*d*) $p = q$

78. What is $\int_0^{\frac{\pi}{2}} \frac{a + \sin x}{2a + \sin x + \cos x} dx$ equal to?

(*a*) $\frac{\pi}{4}$ (*b*) $\frac{\pi}{2}$ (*c*) 1 (*d*) 0

79. The non-negative values of b for which the function $\frac{16x^3}{3} - 4bx^2 + x$ has neither maximum nor minimum in the range $x > 0$ is

(*a*) $0 < b < 1$ (*b*) $1 < b < 2$ (*c*) $b > 2$ (*d*) $0 \le b < 1$

80. Which one of the following is correct in respect of $f(x) = \frac{1}{\sqrt{|x| - x}}$ and $g(x) = \frac{1}{\sqrt{x - |x|}}$?

(*a*) $f(x)$ has some domain and $g(x)$ has no domain

(*b*) $f(x)$ has no domain and $g(x)$ has some domain

(*c*) f(x) and $g(x)$ have the same domain

(*d*) $f(x)$ and $g(x)$ do not have any domain

Consider the following for the next **two (02)** items that follow:

Given that $\int \frac{3\cos x + 4\sin x}{2\cos x + 5\sin x} dx = \frac{\alpha x}{29} + \frac{\beta}{29} \ln|2\cos x + 5\sin x| + c$

81. What is the value of α?

(*a*) 7 (*b*) 13 (*c*) 17 (*d*) 26

82. What is the value of β?

(*a*) 7 (*b*) 13 (*c*) 17 (*d*) 26

Consider the following for the next **two (02)** items that follow:

Lel $f(x) = \frac{x}{\ln x}$; $(x > 1)$

83. Consider the following statements:

1. $f(x)$ is increasing in the interval (e, ∞)
2. $f(x)$ is decreasing in the interval $(1, e)$
3. $9\ln 7 > 7\ln 9$

Which of the statements given above are correct?

(*a*) 1 and 2 only (*b*) 2 and 3 only

(*c*) 1 and 3 only (*d*) 1, 2 and 3

84. Consider the following statements:

1. $f''(e) = \frac{1}{e}$
2. $f(x)$ attains local minimum value at $x = e$
3. A local minimum value of $f(x)$ is e

Which of the statements given above are correct?

(*a*) 1 and 2 only (*b*) 2 and 3 only

(*c*) 1 and 3 only (*d*) 1, 2 and 3

Consider the following for the next **two (02)** items that follow:

Let $f(x)$ and $g(x)$ be two functions such that $g(x) = x - \frac{1}{x}$ and $fog(x) = x^3 - \frac{1}{x^3}$.

85. What is $g[f(x) - 3x]$ equal to?

(*a*) $x^3 - \frac{1}{x^3}$ (*b*) $x^3 + \frac{1}{x^3}$ (*c*) $x^2 - \frac{1}{x^2}$ (*d*) $x^2 + \frac{1}{x^2}$

86. What is $f''(x)$ equal to?

(*a*) $-\frac{2}{x^3}$ (*b*) $2x + \frac{2}{x^3}$ (*c*) $6x + 3$ (*d*) $6x$

Consider the following for the next **two (02)** items that follow:

Let $f(x) = |x| + 1$ and $g(x) = [x] - 1$, where [.] is the greatest integer function.

Let $h(x) = f(x)/g(x)$

87. Consider the following statements:

1. $f(x)$ is differentiable for all $x < 0$
2. $g(x)$ is continuous at $x = 0.0001$
3. The derivative of $g(x)$ at $x = 2.5$ is 1

Which of the statements given above are correct?

(*a*) 1 and 2 only (*b*) 2 and 3 only

(*c*) 1 and 3 only (*d*) 1, 2 and 3

88. What is $\lim_{x \to 0-} h(x) + \lim_{x \to 0+} h(x)$ equal to?

(*a*) $-\frac{3}{2}$ (*b*) $-\frac{1}{2}$ (*c*) $\frac{1}{2}$ (*d*) $\frac{3}{2}$

Consider the following for the next **two (02)** items that follow:

Let $\varphi(a) = \int_a^{a+100\pi} |\sin x| dx$

89. What is $\varphi(a)$ equal to?

(*a*) 0 (*b*) a (*c*) $100a$ (*d*) 200

90. What is $\varphi'(a)$ equal to?

(*a*) 0 (*b*) π (*c*) 100 (*d*) 200

Consider the following for the next **two (02)** items that follow:

A differentiable function $f(x)$ has a local maximum at $x = 0$.
Let $y = 2f(x) + ax - b$.

91. Which of the following is/are correct?

1. $f'(0) = 0$
2. $f''(0) < 0$

Select the correct answer using the code given below:

(*a*) 1 only (*b*) 2 only

(*c*) Both 1 and 2 (*d*) Neither 1 nor 2

92. The function y has a relative maxima at $x = 0$ for

(*a*) $a > 0$, b = 0 (*b*) for all b and $a = 0$

(*c*) for all $b > 0$ only (*d*) for all a and $b = 0$

Consider the following for the next **two (02)** items that follow:

Let $f(x) = |x - 1|$, $g(x) = [x]$ and $h(x) = f(x)g(x)$ where [.] is greatest integer function.

93. What is $\int_{-1}^{0} h(x)dx$ equal to?

(*a*) $-\frac{3}{2}$ (*b*) –1 (*c*) 0 (*d*) $\frac{1}{2}$

94. What is $\int_0^2 h(x)dx$ equal to ?

(*a*) $-\frac{3}{2}$ (*b*) –1 (*c*) 0 (*d*) $\frac{1}{2}$

CLICK HERE To Discover more

Consider the following for the next **two (02)** items that follow:

Let $\int \frac{dx}{\sqrt{x+1}-\sqrt{x-1}} = \alpha(x+1)^{\frac{3}{2}} + \beta(x-1)^{\frac{3}{2}} + c$

95. What is the value of α?

(a) $\frac{1}{3}$ (b) $\frac{2}{3}$ (c) 1 (d) $\frac{4}{3}$

96. What is the value of β?

(a) $-\frac{2}{3}$ (b) $-\frac{1}{3}$ (c) $\frac{1}{3}$ (d) $\frac{2}{3}$

Consider the following for the next **two (02)** items that follow:

The circle $x^2 + y^2 - 2x = 0$ is partitioned by line $y = x$ in two segments. Let A_1, A_2 be the areas of major and minor segments respectively.

97. What is the value of A_1?

(a) $\frac{\pi-2}{4}$ (b) $\frac{\pi+2}{4}$ (c) $\frac{3\pi-2}{4}$ (d) $\frac{3\pi+2}{4}$

98. What is the value of $\frac{2(A_1+A_2)}{A_1-3A_2}$?

(a) π (b) 1 (c) –1 (d) $-\pi$

Consider the following for the next **two (02)** items that follow:

Let $3f(x) + f\left(\frac{1}{x}\right) = \frac{1}{x} + 1$

99. What is $f(x)$ equal to?

(a) $\frac{1}{8x} - \frac{x}{8} + \frac{1}{4}$ (b) $\frac{3}{8x} - \frac{x}{8} + \frac{3}{4}$

(c) $\frac{3}{8x} + \frac{x}{8} + \frac{1}{4}$ (d) $\frac{3}{8x} - \frac{x}{8} + \frac{1}{4}$

100. What is $8\int_1^2 f(x)dx$ equal to?

(a) $\ln(8\sqrt{e})$ (b) $\ln(4\sqrt{e})$ (c) $\ln 2$ (d) $\ln 2 - 1$

101. A bag contains 5 black and 4 white balls. A man selects two balls at random. What is the probability that both of these are of the same colour?

(a) $\frac{1}{6}$ (b) $\frac{5}{108}$ (c) $\frac{4}{9}$ (d) $\frac{5}{18}$

102. If a random variable (x) follows binomial distribution with mean 5 and variance 4, and $5^{23}P(X=3) = \lambda 4^{\lambda}$, then what is the value of λ?

(a) 3 (b) 5 (c) 23 (d) 25

103. From data (–4, 1), (–1, 2), (2, 7) and (3, 1), the regression line of y on x is obtained as $y = a + bx$, then what is the value of $2a + 15b$?

(a) 6 (b) 11 (c) 17 (d) 21

104. Let $x + 2y + 1 = 0$ and $2x + 3y + 4 = 0$ are two lines of regression computed from some bivariate data. If θ is the acute angle between them, then what is the value of $488\tan 3\theta$?

(a) 191 (b) 161 (c) 131 (d) 121

105. If two random variables X and Y are connected by relation $\frac{2X-3Y}{5X+4Y} = 4$ and X follows Binomial distribution with parameters $n = 10$ and $p = \frac{1}{2}$, then what is the variance of Y?

(a) $\frac{810}{361}$ (b) $\frac{9}{19}$ (c) $\frac{21}{361}$ (d) $\frac{121}{361}$

106. If a, b, c are in HP, then what is $\frac{1}{b-a} + \frac{1}{b-c}$ equal to?

1. $\frac{2}{b}$ 2. $\frac{1}{a} + \frac{1}{c}$ 3. $\frac{1}{2}\left(\frac{1}{a} + \frac{1}{b} + \frac{1}{c}\right)$

Select the correct answer using the code given below:

(a) 1 only (b) 2 only (c) 3 only (d) 1, 2 and 3

107. An edible oil is sold at the rates 150, 200, 250, 300 rupees per litre in four consecutive years. Assuming that an equal amount of money is spent on oil by a family in every year during these years, what is the average price of oil in rupees (approximately) per litre?

(a) 210 (b) 220 (c) 230 (d) 240

108. If the letters of the word "TIRUPATI" are written down at random, then what is the probability that both Ts are always consecutive?

(a) $\frac{1}{2}$ (b) $\frac{1}{4}$ (c) $\frac{1}{7}$ (d) $\frac{1}{14}$

109. Let $m = 77^n$. The index n is given a positive integral value at random. What is the probability that the value of m will have 1 in the units place?

(a) $\frac{1}{2}$ (b) $\frac{1}{3}$ (c) $\frac{1}{4}$ (d) $\frac{1}{n}$

110. Three different numbers are selected at random from the first 15 natural numbers. What is the probability that the product of two of the numbers is equal to third number?

(a) $\frac{1}{91}$ (b) $\frac{2}{455}$ (c) $\frac{1}{65}$ (d) $\frac{6}{455}$

Consider the following for the next **two (02)** items that follow:

Let A and B be two events such that $P(A \cup B) \geq 0.75$ and $0.125 \leq P(A \cap B) \leq 0.375$.

111. What is the minimum value of $P(A) + P(B)$?

(a) 0.625 (b) 0.750 (c) 0.825 (d) 0.875

112. What is the maximum value of $P(A) + P(B)$?

(a) 0.75 (b) 1.125 (c) 1.375 (d) 1.625

Consider the following for the next **two (02)** items that follow:

A, B and C are three events such that $P(A) = 0.6$, $P(B) = 0.4$, $P(C) = 0.5$, $P(A \cup B) = 0.8$, $P(A \cap C) = 0.3$ and $P(A \cap B \cap C) = 0.2$ and $P(A \cup B \cup C) \geq 0.85$.

113. What is the minimum value of $P(B \cap C)$?

(a) 0.1 (b) 0.2 (c) 0.35 (d) 0.45

114. What is the maximum value of $P(B \cap C)$?

(a) 0.1 (b) 0.2 (c) 0.35 (d) 0.45

Consider the following for the next **two (02)** items that follow:

An unbiased coin is tossed n times. The probability of getting at least one tail is p and the probability of at least two tails is q and $p - q = \frac{5}{32}$.

115. What is the value of n?

(a) 4 (b) 5 (c) 6 (d) 7

116. What is the value of $p + q$?

(a) $\frac{57}{32}$ (b) $\frac{53}{32}$ (c) $\frac{51}{32}$ (d) 1

Consider the following for the next **two (02)** items that follow:

x_i	1	2	3	…	n
f_i	1	2^{-1}	2^{-2}	…	$2^{-(n-1)}$

117. What is $\sum_i^n x_i f_i$ equal to?

(*a*) $\frac{2^{n+1}-n+2}{2^{n-1}}$ (*b*) $\frac{2^{n+1}-n-2}{2^{n-1}}$

(*c*) $\frac{2^{n+1}+n+2}{2^{n-1}}$ (*d*) $\frac{2^{n+1}-n-2}{2^n}$

118. What is the mean of the distribution?

(*a*) $\frac{2^{n+1}-n+2}{2^n-1}$ (*b*) $\frac{2^{n+1}-n-2}{2^{n-1}}$

(*c*) $\frac{2^{n+1}-n-2}{2^n-1}$ (*d*) $\frac{2^{n+1}-n+2}{2^n}$

Consider the following for the next **two (02)** items that follow:

The marks obtained by 10 students in a Statistics test are 24, 47, 18, 32, 19, 15, 21, 35, 50 and 41.

119. What is the mean deviation of the largest five observations ?

(*a*) 4.8 (*b*) 5.5

(*c*) 6 (*d*) 7.5

120. What is the variance of the largest five observations?

(*a*) 14.6 (*b*) 21.8

(*c*) 25.2 (*d*) 46.8

Paper II: General Ability

PART-A

Antonyms

Directions: Each item in this section consists of a sentence with an underlined word followed by four words or groups of words. Select the option that is opposite in meaning to the underlined word and mark your response on the Answer Sheet accordingly.

1. Mohan was living in a deplorable condition.

(*a*) reprehensible (*b*) opprobrious

(*c*) despicable (*d*) commendable

2. These exercises will counteract the effects of stress and tension.

(*a*) exacerbate (*b*) foil

(*c*) thwart (*d*) contravene

3. You have to persevere with difficult students.

(*a*) give up (*b*) persist (*c*) carry on (*d*) stand firm

4. Their new colour scheme is hideous.

(*a*) appalling (*b*) beautiful (*c*) grotesque (*d*) macabre

5. Everywhere they go, they squander their earnings.

(*a*) fritter away (*b*) splurge

(*c*) squabble (*d*) manage

Cloze

Directions: In this section, there is a passage having some blank spaces, each blank space is followed by four individual words or group of words. Select a word or group of words you consider the most appropriate for filling the blank space, and indicate your response on the Answer Sheet accordingly.

The Earth's climate is___**6.**___ changing and evolving. Some of ___**7.**___ changes have been due to natural causes but others can be attributed to ___**8.**___activities such as deforestation, emissions from industry and transport, etc., which have led to the ___**9.**___ of gases and aerosols in ___**10.**___atmosphere. These gases are known as greenhouse gases because they trap heat and ___**11.**___ air temperatures near the ground, acting like a greenhouse on the surface of the ___**12.**___In order to create and strengthen the scientific and analytical capacity ___**13.**___assessment of climate change in the country, different studies under Climate Change Action Programme ___**14.**___ Many important bilateral and multilateral meetings and negotiations are held ___**15.**___ regular intervals

6. (*a*) passionately (*b*) continually

(*c*) deadly (*d*) thoughtfully

7. (*a*) these (*b*) those

(*c*) this (*d*) that

8. (*a*) practical (*b*) geological

(*c*) human (*d*) animal

9. (*a*) assimilation (*b*) absolution

(*c*) collection (*d*) accumulation

10. (*a*) an (*b*) a

(*c*) the (*d*) no article

11. (*a*) raise (*b*) hike

(*c*) rise (*d*) balance

12. (*a*) crust. (*b*) core

(*c*) mantle (*d*) planet

13. (*a*) for (*b*) of

(*c*) in (*d*) to

14. (*a*) are developed. (*b*) are initiated

(*c*) have developed (*d*) have initiated

15. (*a*) with (*b*) at

(*c*) in (*d*) on

Sentence Completion

Directions: Each of the following items features one part of a sentence, followed by four alternatives. Complete the sentence by choosing the correct alternative and mark your response on the Answer Sheet accordingly.

16. He paused

(*a*) with a few moments. (*b*) for a few moments.

(*c*) by a few moments. (*d*) into a few moments.

17. Late at night, our car

(*a*) broke down on the highway.

(*b*) broke up on the highway.

(*c*) broke into the highway.

(*d*) broke out on the highway.

18. All the countries signed the treaty
(*a*) beneath Germany and France.
(*b*) except Germany and France.
(*c*) among Germany and France.
(*d*) during Germany and France.

19. I reminded her
(*a*) to turn off the lights at night.
(*b*) to call off the lights at night.
(*c*) to drop off the lights at night.
(*d*) to break off the lights at night.

20. They told us about the woman
(*a*) whom lived next door. (*b*) which lived next door.
(*c*) who lived next door. (*d*) whose lived next door.

21. I'll see you
(*a*) at the end of February. (*b*) on the end of February.
(*c*) along the end of February. (*d*) for the end of February.

22. I dislike films
(*a*) who have sad endings. (*b*) that have sad endings.
(*c*) whose have sad endings. (*d*) whom have sad endings.

23. The thieves denied
(*a*) having stealing the money. (*b*) stealing the money.
(*c*) had stolen the money. (*d*) having to steal the money.

24. Did you
(*a*) drop out to see Sunita on your way home?
(*b*) drop in to see Sunita on your way home?
(*c*) drop behind to see Sunita on your way home?
(*d*) drop away to see Sunita on your way home?

25. Would you like to
(*a*) meeting her? (*b*) meet her?
(*c*) met her? (*d*) meet with her?

Idioms and Phrases

Directions: Given below are some idioms/phrases followed by four alternative meanings to each. Select the most appropriate response from the options (*a*), (*b*), (*c*) or (*d*), and mark your response on the Answer Sheet accordingly.

26. Be bad news
(*a*) feelings of hate
(*b*) someone who behaves in a dishonest way
(*c*) someone who is considered undesirable
(*d*) to be ill

27. Back to the drawing board
(*a*) to draw comparisons
(*b*) to be a member of planning group
(*c*) to start planning again because the previous plan has failed
(*d*) to be fast at understanding a situation

28. Be in the eye of the storm
(*a*) to look at something quickly
(*b*) to fail miserably at a sport
(*c*) to see something that you do not want to see
(*d*) to be in the midst of a controversy

29. Life in the fast lane
(*a*) to lead a selfless life
(*b*) to have a happy life without complaints
(*c*) life without money or comforts
(*d*) an exciting and eventful lifestyle

30. To pass the buck
(*a*) to collect money from a group of people
(*b*) to shift the responsibility of something to someone
(*c*) to have a short conversation with someone
(*d*) to have the credentials for a particular job

Ordering of Words in a Sentence

Directions: Each of the following items in this section consists of a sentence, the parts of which have been jumbled as *P*, *Q*, *R* and *S*. Rearrange the jumbled parts of the sentences into sequence and select the correct sequence as (*a*), (*b*), (*c*), and (*d*) given below and mark your response on the Answer Sheet accordingly.

31. include basic freedoms (P) the fundamental rights are (Q)
guaranteed to the individual (R) basic rights and (S)
(*a*) QSPR (*b*) QRSP (*c*) SQRP (*d*) RQSP

32. for many millennia (P) been in the making (Q)
of a historical process that has (R) the Indian nation is the product (S)
(*a*) SRQP (*b*) SQPR (*c*) PRSQ (*d*) RSQP

33. an epoch that was imbued (P) for its people the start of (Q)
with a new vision (R) India's Independence represented (S)
(*a*) SQPR (*b*) QRPS (*c*) SPQR (*d*) RQSP

34. science and mathematics exhibition (P) for a discussion on the forthcoming (Q)
to be present before the Principal (R) all students have been instructed (S)
(*a*) SQPR (*b*) RPQS (*c*) SRQP (*d*) QPRS

35. two bowlers and two batsmen respectively (P) to the new team (Q)
with the selection of another player (R) the team now has (S)
(*a*) QPRS (*b*) SQRP (*c*) RQSP (*d*) RPSQ

Word Classes

Directions: Each of the following sentences has an underlined word. Read the sentence carefully and find which word class the underlined word belongs to. Indicate your response on the Answer Sheet accordingly.

36. You are most welcome to visit my humble abode.
(*a*) Noun (*b*) Adjective (*c*) Adverb (*d*) Participle

37. The situation is beyond our control.

(*a*) Adjective (*b*) Adverb

(*c*) Conjunction (*d*) Preposition

38. I didn't tell him anything except that I needed the money.

(*a*) Adjective (*b*) Adverb

(*c*) Preposition (*d*) Conjunction

39. He dry-cleaned my coat nicely.

(*a*) Adjective (*b*) Adverb

(*c*) Relative pronoun (*d*) Conjunction

40. Would you like to buy this new item?

(*a*) Determiner (*b*) Conjunction

(*c*) Interjection (*d*) Adjective

Passage

Directions: Read the following passage carefully and answer the items based on it. You are required to select your answers based solely on the contents of the passage and the opinion of the author.

The grouping or assemblage of plants, animals and microbes we observe when we study a natural forest, a grassland, a pond, a coral reef or some other undisturbed area, is referred to as the area's biota or biotic community. The plant portion of the biotic community includes all vegetation, from large trees down through to microscopic algae. Likewise, the animal portion includes everything from large mammals, birds, reptiles and amphibians through to earthworms, tiny insects and mites. Microbes encompass a large array of microscopic bacteria, fungi and protozoans. Thus, the biotic community comprises a plant community, an animal community and a microbial community.

The particular kind of biotic community found in a given area is, in large part, determined by abiotic factors such as the amount of water or moisture present, the temperature, the salinity, or the type of soil in the area. These abiotic factors both support and limit the particular community. For example, a relative lack of available moisture prevents the growth of most species of plants, but supports certain species, such as cacti; these kinds of areas are deserts. Land with plenty of available moisture and a suitable temperature supports forests. The presence of water is the major factor that sustains aquatic communities.

The first step in investigating a biotic community may be simply to catalogue all the species present. Species are the different kinds of plants, animals and microbes in the community. A given species includes all those individuals which have a strong similarity in appearance to one another and which are distinct in appearance from other such groups. Each species in a biotic community is represented by a certain population - that is, by a certain number of individuals that make up the interbreeding, reproducing group.

41. Which one of the following does ***not*** belong to the biotic community?

(*a*) Water (*b*) Human (*c*) Protozoa (*d*) Bush

42. The nature of the biotic community largely depends on:

1. Biotic components
2. Abiotic components

Select the correct answer using the code given below:

(*a*) 1 only (*b*) 2 only

(*c*) Both 1 and 2 (*d*) Neither 1 nor 2

43. Which of the following is ***not*** an abiotic factor?

(*a*) Temperature (*b*) Humidity

(*c*) Algae (*d*) Moisture

44. In the passage, the word 'aquatic community' refers to:

(*a*) Biotic community inhabiting the land

(*b*) Biotic community found in water

(*c*) Biotic community found in the air

(*d*) Assemblage of rain and moisture

45. Species are defined on the basis of:

(*a*) Similarities only

(*b*) Differences only

(*c*) Both similarities and differences

(*d*) None of the above

Synonyms

Directions: Each item in this section consists of a sentence with an underlined word followed by four words/group of words. Select the option that is nearest in meaning to the underlined word and mark your response on the Answer Sheet accordingly.

46. The king's son was banished due to the political rivalry.

(*a*) deported (*b*) called back

(*c*) accepted (*d*) notified

47. He gave a dazzling performance at the opera.

(*a*) brilliant (*b*) dismal (*c*) pathetic (*d*) puerile

48. She rebuffed all suggestions from her friends.

(*a*) took (*b*) rejected (*c*) criticized (*d*) granted

49. He disowned his royal legacy and became a commoner.

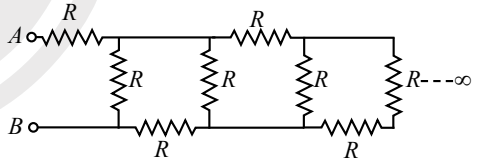
(*a*) accepted (*b*) abandoned (*c*) allowed (*d*) questioned

50. The public was sceptical about the new government policy.

(*a*) hopeful (*b*) anxious (*c*) doubtful (*d*) expectant

PART-B

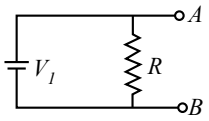
51. An infinite combination of resistors, each having resistance $R = 4\Omega$, is given below. What is the net resistance between the points *A* and *B*? (Each resistance is of equal value, $R = 4$)



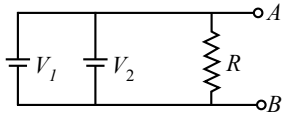
(*a*) 0Ω (*b*) $2+2\sqrt{5}\Omega$

(*c*) $2+\sqrt{5}\Omega$ (*d*) $\infty\Omega$

52. An electric circuit is given below. V_1 = 1V and Resistance R = 1000 Ω.



The current through the resistance *R* is very close to 1 mA and the voltage across point *A* and *B*, $V_{AB} = 1\text{V}$. Now the circuit is changed to:



where value of V_2= 5V. The internal resistances of both the batteries are 0.1 Ω. The current through the resistance *R* is about:

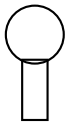
(*a*) 1.0 mA (*b*) 1.2 mA (*c*) 3.0 mA (*d*) 5.0 mA

CLICK HERE To Discover more

53. If the current through an electrical machine running on direct current is 15A and the machine runs for 10 minutes, the charge that passes through the machine during this time is:

(*a*) 1.50 C (*b*) 150 C (*c*) 900 C (*d*) 9000 C

54. Which one of the following is the best shape of a solid metal rod to form the top end of a lightning conductor?

(*a*)  (*b*)  (*c*)  (*d*) 

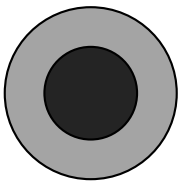
55. Which of the following forces is/are fundamental in nature?

1. Gravitational force
2. Electromagnetic forces
3. Strong and weak nuclear forces

Select the correct answer using the code given below:

(*a*) 1 only (*b*) 1 and 2 only
(*c*) 2 and 3 only (*d*) 1, 2 and 3

56. A spherical shell of outer radius R and inner radius $R/2$ contains a solid sphere of radius $R/2$ (see figure). The density of the material of the solid sphere is ρ and that of the shell is $\rho/2$. What is the average mass density of the larger sphere thus formed?



(*a*) $3\rho/4$ (*b*) $9\rho/16$ (*c*) $7\rho/8$ (*d*) $5\rho/8$

57. The human eye is like a camera that has a lens with:

(*a*) fixed focal length and fixed aperture size.
(*b*) variable focal length and fixed aperture size.
(*c*) fixed focal length and variable aperture size.
(*d*) variable focal length and variable aperture size.

58. Under Article 371A of the Constitution of India, with respect to which of the following item(s) the Acts of the Parliament of India shall not apply to the State of Nagaland, unless the Legislative Assembly of the State of Nagaland by a resolution so decides?

1. Religious or social practices of Nagas
2. Naga customary law and procedure
3. Ownership and transfer of land and its resources
4. Boundaries of Nagaland with other states

Select the answer using the code given below:

(*a*) 1 only (*b*) 2 and 3 only
(*c*) 1, 2 and 3 only (*d*) 1, 2, 3 and 4

59. Under Article 191 of the Constitution of India, a person shall be disqualified for being chosen as, and for being, a member of the Legislative Assembly or Legislative Council of a state if the person holds any office of profit under:

1. The Government of India.
2. Any State Government.

Select the correct answer using the code given below:

(*a*) 1 only (*b*) 2 only
(*c*) Both 1 and 2 (*d*) Neither 1 nor 2

60. Consider the following UN Declarations/Covenants:

1. Universal Declaration of Human Rights
2. Convention on the Elimination of All Forms of Discrimination Against Women
3. International Covenant of Economic, Social and Cultural Rights
4. Convention on Refugees

Which one of the following is the correct chronological order (starting with the earliest) of the above?

(*a*) 1, 4, 3, 2 (*b*) 1, 2, 3, 4
(*c*) 1, 3, 2, 4 (*d*) 4, 1, 2, 3

61. Which one of the following statements regarding the objectives of the Second Five-Year Plan is ***not*** correct?

(*a*) Development of the basic and heavy industry sector
(*b*) Increase in national income to raise living standards
(*c*) Expansion of the consumer goods sector
(*d*) Expansion of employment opportunities

62. Consider the following statements about the emergence of urban centres in India from circa 6th Century BCE:

1. All of them developed away from the capitals of *mahajanpadas*.
2. Major towns were located along routes of communication.
3. Many were bustling centres of commercial, cultural and political activity.

How many of the above statements is/are correct?

(*a*) 1 (*b*) 2
(*c*) 3 (*d*) None

63. Consider the following statements about ancient Indian inscriptions:

1. The earliest inscriptions are in Sanskrit.
2. Kharosthi script, used in inscriptions in the north-west, was deciphered with the help of coins of Indo-Greek kings who ruled over the area.
3. Most of the inscriptions mention grand, unique events, and routine agricultural practices do not find mention.

How many of the above statements is/are correct?

(*a*) 1 (*b*) 2 (*c*) 3 (*d*) None

64. The relative atomic mass of boron (which exists in two isotopic forms ^{10}B and ^{11}B) is 10·81. What will be the abundance of ^{10}B and ^{11}B, respectively (consider a sample of 100 atoms)?

(*a*) 19% and 81% (*b*) 81% and 19%
(*c*) 38% and 62% (*d*) 62% and 38%

65. Which among the following are essential constituents of Portland cement ?

(*a*) Sand, lime, clay
(*b*) Silica, alumina, lime
(*c*) Silica, lime, graphite powder
(*d*) Sand, graphene, clay

66. Litmus, a well-known acid-base indicator, is derived from:

(*a*) Fungi (*b*) Lichens
(*c*) Bacteria (*d*) Termite

67. What is the oxidation state of Vanadium in V_2O_5?

(*a*) +2 (*b*) +4
(*c*) +3 (*d*) +5

68. Match List-I with List-II and select the correct answer using the code given below the Lists:

List-I (*Allotrope of Carbon*)	**List-II** (*Property*)
A. Graphite	1. Thinnest and strongest material
B. Diamond	2. Hardest natural substance
C. Fullerene	3. Very light and strong material
D. Graphene	4. Soft and slippery material

Code:

	A	**B**	**C**	**D**
(*a*)	4	2	3	1
(*b*)	4	3	2	1
(*c*)	1	3	2	4
(*d*)	1	2	3	4

69. Consider the following statements regarding the International Date Line:

1. It is roughly 180° meridian, which deviates slightly East and West to avoid land areas surrounded by the Atlantic Ocean.
2. The date to the East of this line is (24 hours) earlier than to the West.

Which of the statements given above is/are correct?

(*a*) 1 only (*b*) 2 only
(*c*) Both 1 and 2 (*d*) Neither 1 nor 2

70. Which of the following statements regarding 'aurora' is/are correct?

1. The solar wind upon reaching the Earth's atmosphere is directed towards two magnetic poles and a colourful display of lights is seen in the night sky.
2. The particles interact with the different gases of the atmosphere and each gas glows with a particular colour.
3. In April 2023, aurora was captured in the night sky in India by the Indian Astronomical Observatory at Hanle, Ladakh.

Select the answer using the code given below:

(*a*) 1 only (*b*) 2 and 3 only
(*c*) 1 and 3 only (*d*) 1, 2 and 3

71. Which of the following statements regarding Barchan is/are correct?

1. It is a crescent shaped mound of sand, which is deposited by the wind blowing constantly from one direction in a desert.
2. The windward side has a convex steep slope with maximum height at the centre.
3. Two ends of Barchan are called horns and point opposite to the direction the wind blows.

Select the answer using the code given below:

(*a*) 1 only (*b*) 1 and 2 only
(*c*) 2 and 3 only (*d*) 1, 2 and 3

72. Which of the following statements regarding Regur soil is/are correct?

1. It is a light coloured, clayey and fertile soil.
2. It is developed on Deccan basaltic lava under hot and humid conditions.
3. Cotton is extensively cultivated in this soil.

Select the answer using the code given below:

(*a*) 1 and 2 (*b*) 2 and 3
(*c*) 2 only (*d*) 3 only

73. Which of the following statements regarding clouds is/are correct?

1. Clouds are classified on the basis of altitude and their form.
2. According to altitude they are classified as High, Middle and Low clouds.
3. Stratus, Nimbostratus and Stratocumulus are high clouds.

Select the answer using the code given below:

(*a*) 1 only (*b*) 1 and 2 only
(*c*) 2 and 3 only (*d*) 1, 2 and 3

74. Consider the following statements regarding 'fronts':

1. The movement of a front causes a slow change in weather in the area over which it moves.
2. Cold fronts are associated with thunderstorms.
3. Warm front is the boundary between an advancing mass of warm air where it is overriding and rising above a mass of colder air.

Which of the statements given above is/are correct?

(*a*) 1 only (*b*) 1 and 2 only
(*c*) 2 and 3 only (*d*) 1, 2 and 3

75. Consider the following statements regarding soils:

1. Soils having a very high content of sodium and calcium and pH of more than 7.0 are alkaline soils.
2. Black cotton soil had developed on the Deccan basaltic lava under hot and humid conditions.
3. Laterite soils are characterised by a deep weathered layer from which silica has been leached.

Which of the statements given above is/are correct?

(*a*) 1 only (*b*) 1 and 2 only
(*c*) 2 and 3 only (*d*) 1, 2 and 3

76. Consider the following characteristics of a grassland:

1. An extensive area of mid latitude grasslands are devoid of trees and shrubs.
2. The climate is characterised by hot summers, cold winters and relatively low rainfall occurring mainly in spring and summer.
3. In humid parts, grasses grow to a meter or more in height.

On the basis of the above characteristics, select the correct grassland from the options given below:

(*a*) Steppes (*b*) Prairies
(*c*) Savanna (*d*) Pampas

77. Which of the following statements regarding animal cell membrane is correct?

(*a*) They are composed of phospholipids only.
(*b*) They are composed of proteins only.
(*c*) They are composed of phospholipids and proteins only.
(*d*) They are composed of phospholipids, proteins and cholesterol (lipid).

78. Which of the following is ***not*** a part of compound microscope?

(*a*) Mirror (*b*) Stage
(*c*) Clip (*d*) Retina

79. Which one of the following is the correct sequence in increasing complexity?

(*a*) Protein - Organism - Tissue - Organ
(*b*) Protein - Organ - Tissue - Organism
(*c*) Protein - Organism - Organ - Tissue
(*d*) Protein - Tissue - Organ - Organism

80. Consider the following cell types:

1. Monocyte
2. Chondrocyte
3. Basophil
4. Lymphocyte

How many of the above belong to animal cell types?

(*a*) 1 (*b*) 2 (*c*) 3 (*d*) 4

81. In the human digestive system, which one among the following is the role of the pancreas?

(*a*) Secretion of surfactants to break up lipid droplets

(*b*) Storage and regulated release of bile

(*c*) Secretion of lipase, amylase and protease

(*d*) Neutralizing stomach acids

82. Consider the following statements:

1. DNA replication takes place when chromatin is opened up.
2. Chromatin organises itself into rod-shaped chromosomes before cell division.
3. Both prokaryotes and eukaryotes have the same process for cell division.

Which of the statements given above is/are correct?

(*a*) 1 only (*b*) 1 and 2 only

(*c*) 1, 2 and 3 (*d*) 3 only

83. A uniform meter scale of mass 0.24 kg is made of steel. It is kept on two wedges, W_1 and W_2, in a horizontal position. W_1 is at a distance of 0.2 m from one of its ends, while W_2 is at distance of 0.4 m from the other end. If the force on the scale is N_1 due to W_1 and N_2 due to W_2, then: (take g = 10.0 ms^{-2})

(*a*) $N_1 = 1.6$ N and $N_2 = 0.8$ N (*b*) $N_1 = 0.8$ N and $N_2 = 1.6$ N

(*c*) $N_1 = 0.6$ N and $N_2 = 1.8$ N (*d*) $N_1 = 1.8$ N and $N_2 = 0.6$ N

84. Escape speed from the Earth is close to 11.2 km s^{-1}. On another planet whose radius is half of the Earth's radius and whose mass density is four times that of the Earth, the escape speed in km s^{-1} will be close to:

(*a*) 11.2 (*b*) 15.8 (*c*) 5.6 (*d*) 7.9

85. Which one of the following does ***not*** apply to sound waves in fluids?

(*a*) They transport energy

(*b*) They need a medium to travel

(*c*) They are transverse

(*d*) They travel faster in liquids than in gases

86. A ball of 0.1 kg mass is dropped on a hard floor from a height of 0.45 m and rises to a height of 0.20 m. If it was in touch with the floor for 0.1 s, the net force it applied on the floor while bouncing is: (take the gravitational acceleration g = 10 m s^{-2})

(*a*) 1.0 N (*b*) 6.0 N

(*c*) 3.0 N (*d*) 5.0 N

87. Which one of the following statements regarding simple pendulum is correct?

Simple pendulum has a time period independent of amplitude:

(*a*) only for small amplitudes because then the net force on its bob is independent of its displacement.

(*b*) for any amplitude because the net force on the bob is always proportional to its displacement.

(*c*) for any amplitude because the net force on the bob is independent of its displacement.

(*d*) only for small amplitudes because then the net force on its bob is proportional to its displacement.

88. Which one of the following about different frictional forces is correct?

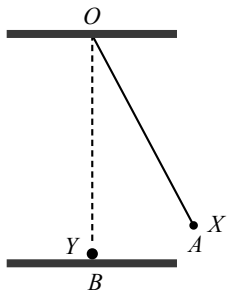
(*a*) Kinetic friction > Static friction > Rolling friction

(*b*) Static friction > Rolling friction > Kinetic friction

(*c*) Static friction > Kinetic friction > Rolling friction

(*d*) Static friction > Kinetic friction = Rolling friction

89. A metallic bob *X* of mass *m* is released from position A. It collides elastically with another identical bob *Y* placed at rest at position B on a horizontal frictionless table. The angle *AOB* is 30°.



How high does the bob X rise immediately after the collision?

(*a*) To the same height as that of position A on the other side in the same trajectory

(*b*) To half the height as that of position A on the other side along the same trajectory

(*c*) The same height at position A

(*d*) It stops at position B

90. Consider the two statements given below:

Statement-I: Infrared waves are also called heat waves.

Statement-II: Water molecules readily absorb infrared waves.

Select the correct answer using the code given below:

(*a*) Both the statements are individually true and Statement-II is the correct explanation of Statement-I.

(*b*) Both the statements are individually true, but Statement-II is not the correct explanation of Statement-I.

(*c*) Statement-I is true, but Statement-II is false.

(*d*) Statement-II is true, but Statement-I is false.

91. Which of the following statements are correct?

1. British 'trade surplus' with India in the nineteenth century meant that the value of British exports to India was much higher than the value of British imports from India.
2. India played a crucial role in the late-nineteenth-century world economy by helping Britain balance its deficits.
3. Britain grew opium in India and exported it to China and, therefore, for a while after the 1820 s, opium became India's single largest export.
4. The nineteenth century saw export of Indian raw materials decline, and that of manufactured goods increase.

Select the answer using the code given below:

(*a*) 1 and 2 only (*b*) 3 and 4 only

(*c*) 1, 2, 3 and 4 (*d*) 1, 2 and 3 only

92. Match List-I with List-II and select the correct answer using the code given below the Lists:

List-I (*Unit in use in early India*)		List-II (*Content*)
A.	*Muhurta*	1. Measure of weight
B.	*Raktika*	2. Measure of time

C. *Angula* 3. Metre of poetry

D. *Pada* 4. Measure of length

Code:

	A	B	C	D
(*a*)	2	1	4	3
(*b*)	2	4	1	3
(*c*)	3	4	1	2
(*d*)	3	1	4	2

93. First coins in Indian history bearing the names and images of rulers were issued by the:

(*a*) Mauryas (*b*) Pushyabhutis

(*c*) Guptas (*d*) Indo-Greeks

94. Social theorists in the nineteenth and twentieth centuries emphasised the emergence of industrialisation, urbanisation, secularisation and bureaucratisation as hallmarks of:

(*a*) Modernity (*b*) Feudalism

(*c*) Kingship (*d*) Medievalism

95. Consider the following events:

1. Launch of Non-Cooperation Movement
2. All-India Khilafat Conference in Delhi
3. Passing of the Rowlatt Act
4. Jallianwala Bagh incident

Which one of the following is the correct chronological order of the given events (earliest to latest)?

(*a*) 1, 2, 3, 4 (*b*) 3, 4, 2, 1

(*c*) 3, 2, 4, 1 (*d*) 2, 3, 4, 1

96. Match List-I with List-II and select the correct answer using the code given below the Lists:

List-I		List-II
A. Upari	1.	Peasants directly responsible for the payment of revenue
B. Pattadar	2.	Category of tenancy tenure held under the Marathas
C. Mirasidar	3.	Gifts of land or land revenue
D. Inam lands	4.	Co-parcenary title holder and designated revenue payer in southern India

Code:

	A	B	C	D
(*a*)	2	1	4	3
(*b*)	2	4	1	3
(*c*)	3	4	1	2
(*d*)	3	1	4	2

97. Which of the following statements about Vijayanagara king Krishnadevaraya's expeditions are correct?

1. In the early years of his reign he marched against the ruler of Orissa.
2. In 1520CE, he captured the fort of Raichur from Ismail Adil Khan.
3. Krishnadevaraya restored Sultan Mahmud Shah to power and assumed the title of Yavana-rajya-sthapan-acharya.

Select the answer using the code given below:

(*a*) 1 and 3 only (*b*) 2 and 3 only

(*c*) 1, 2 and 3 (*d*) 1 and 2 only

98. Water gas is a mixture of:

(*a*) CO_2 and H_2 (*b*) CO and H_2

(*c*) CO_2 and H_2O (*d*) CO and H_2O

99. Human body works in the pH range of:

(*a*) 6.8 – 7.2 (*b*) 7.0 – 7.8 (*c*) 6.5 – 7.5 (*d*) 7.5 – 8.0

100. Which one among the following statements with reference to the properties of water is ***not*** correct?

(*a*) The specific heat of water is abnormally high:

(*b*) Latent heat of fusion of water is very low.

(*c*) Density of water is higher than ice.

(*d*) Pure water is a non-conductor of electricity.

101. Which one among the following compounds has a sweet and fruity smell?

(*a*) Ethyl alcohol (*b*) Acetic acid

(*c*) Ethyl acetate (*d*) Acetophenone

102. What is the coordination number of $Na^+$and Cl^- ions in NaCl lattice?

(*a*) 6, 1 (*b*) 1, 6 (*c*) 6, 6 (*d*) 5, 5

103. Which one among the following is present in the nettle leaf hairs that causes burning pain?

(*a*) Methanoic acid (*b*) Ethanoic acid

(*c*) Benzoic acid (*d*) Acetic acid

104. Which one among the following is known as Milk of Magnesia?

(*a*) Magnesium bicarbonate (*b*) Magnesium carbonate

(*c*) Magnesium sulphate (*d*) Magnesium hydroxide

105. Soap with water forms:

(*a*) Metallotropic liquid crystal

(*b*) Thermotropic liquid crystal

(*c*) Homogeneous solution

(*d*) Lyotropic liquid crystal

106. Which among the following is the correct composition of Borax?

(*a*) Sodium, Boron, Magnesium and Hydrogen

(*b*) Sodium, Boron, Oxygen and Hydrogen

(*c*) Potassium, Boron, Oxygen and Hydrogen

(*d*) Sodium, Boron, Nitrogen and Hydrogen

107. Which one among the following oxides has the highest melting point?

(*a*) Na_2O (*b*) MgO (*c*) Fe_2O_3 (*d*) CuO

108. Which of the following statements regarding neap tides is/are correct?

1. It occurs every 14 – 15 days, which coincides with the first and third quarter of the Moon.
2. This tide has a small tidal range because the gravitational forces of the Moon and the Sun are in quadrature.

Select the answer using the code given below:

(*a*) 1 only (*b*) 2 only

(*c*) Both 1 and 2 (*d*) Neither 1 nor 2

109. Which of the following statements regarding earthquakes is/are correct?

1. The point on the Earth's surface directly above the focus is called the epicentre of the earthquake.
2. Earthquakes generate Primary and Secondary waves that radiate outward from the earthquake focus.
3. Deep-focus earthquakes are likely to cause more damage than shallow-focus earthquakes.

CLICK HERE To Discover more

Select the answer using the code given below:
(*a*) 1 only (*b*) 1 and 2 only
(*c*) 2 and 3 only (*d*) 1, 2 and 3

110. Which of the following statements regarding air temperature is/are correct?

1. Air temperature is measured at a standard height of 1.2 m (4.0 feet) above the ground surface.
2. The average rate of temperature decrease with height is termed as the environmental temperature lapse rate.

Select the answer using the code given below:
(*a*) 1 only (*b*) 2 only
(*c*) Both 1 and 2 (*d*) Neither 1 nor 2

111. Which of the following statements regarding humidity is/are correct?

1. It is a ratio between the actual amount of water vapour present in the atmosphere and the maximum amount it can hold at a given temperature.
2. When the relative humidity is high, more water evaporates from the skin.
3. Higher the air temperature lower the relative humidity of the air.

Select the answer using the code given below:
(*a*) 1 only (*b*) 2 and 3 only
(*c*) 1 and 3 only (*d*) 1, 2 and 3

112. Which of the following statements regarding cyclones and anti-cyclones is/are correct?

1. In the Northern Hemisphere, cyclones rotate counter clockwise and anticyclones rotate clockwise.
2. Cyclones are often associated with cloudy or rainy weather, whereas anticyclones are often associated with fair weather.
3. In the Southern Hemisphere, the cyclonic spiral will be clockwise because the Coriolis force acts to the left.

Select the answer using the code given below:
(*a*) 1 only (*b*) 1 and 2 only
(*c*) 2 and 3 only (*d*) 1, 2 and 3

113. Identify the sea-port in India on the basis of the given characteristics:

1. It is more than a century old port on the west coast of India.
2. It is a natural harbour protected by a breakwater and also by a mole.
3. A deep draft channel of about 14 metres depth permits large vessels to enter the harbour.

Select the correct sea-port from the options given below:
(*a*) Mormugao Port (*b*) Deendayal Port
(*c*) Cochin Port (*d*) Jawaharlal Nehru Port

114. Identify the Iron and Steel Plant on the basis of the given characteristics:

1. It receives coal from Jharia and iron-ore from Sundargarh and Kendujhar.
2. Power for the electric furnaces is procured from Hirakund.
3. Water is obtained from Koel and Sankh rivers.

Select the correct Iron and Steel Plant from the options given below:
(*a*) Bhilai Steel Plant (*b*) Durgapur Steel Plant
(*c*) Rourkela Steel Plant (*d*) Bokaro Steel Plant

115. Which of the following statements regarding Earth's internal structure is/are correct?

1. The oceanic crust is heavier than the continental crust.
2. Most of the Earth's internal heat is contained within the mantle.
3. Large convective cells in the crust circulate heat and drive plate-tectonic processes.

Select the answer using the code given below:
(*a*) 3 only (*b*) 1 and 2 only
(*c*) 2 and 3 only (*d*) 1, 2 and 3

116. Which of the following statements regarding the given rivers is/are correct?

1. Tsangpo crosses over into India under the name of Dihang.
2. Godavari has the second largest river basin covering about 10 percent of the area of India.
3. Rivers Chambal and Betwa are the important tributaries of river Ganga which join river Ganga directly in Uttar Pradesh.

Select the answer using the code given below:
(*a*) 1 only (*b*) 1 and 2 only
(*c*) 2 and 3 only (*d*) 1, 2 and 3

117. Which of the following statements regarding the World Climate Types and their relation with Inter Tropical Convergence Zone (ITCZ) is/are correct?

1. Tropical Wet Climate is one of the world's rainiest due to the dominance of the ITCZ over it.
2. Tropical Savanna Climate experiences a distinctive alternation of wet and dry seasons, caused chiefly by the seasonal shift in latitude of the subtropical highs and ITCZ.
3. The Tropical Monsoonal Climate experiences heavy rainfall as a consequence of the nearness of the ITCZ for much of the year.

Select the answer using the code given below:
(*a*) 1 only (*b*) 1 and 2 only
(*c*) 2 and 3 only (*d*) 1, 2 and 3

118. Which of the following statements regarding tropical cyclones is/are correct?

1. These storms develop during the summer and autumn in every tropical ocean except the South Atlantic and eastern South Pacific Oceans.
2. Tropical cyclones that occur in the North Atlantic and eastern North Pacific Oceans are known as typhoons.
3. Tropical cyclones that occur in the Indian and South Pacific Oceans are called cyclones.

Select the answer using the code given below:
(*a*) 3 only (*b*) 1 and 2 only
(*c*) 1 and 3 only (*d*) 1, 2 and 3

119. Identify the land biome on the basis of the given characteristics:

1. Their climates are characterised by high rainfall and temperatures that vary from cold to mild.
2. These forests contain primarily deciduous trees - including maple, oak, hickory and beechwood.
3. Raccoons, opossums, bats and squirrels are found in the trees.

Select the correct land biome from the options given below:
(*a*) Tropical forest (*b*) Temperate forest
(*c*) Boreal forest (*d*) Mediterranean forest

120. Leaves of most plants appear green because the chlorophyll present in it:

(*a*) absorbs red and blue light while reflecting green light.

(*b*) absorbs green light only.

(*c*) absorbs green light while reflecting red and blue light.

(*d*) reflects red light and absorbs blue and green light.

121. In most prokaryotes, the chromosome number is:

(*a*) 4 (*b*) 3 (*c*) 2 (*d*) 1

122. Bacterial DNA is referred to as naked because it is ***not*** associated with:

(*a*) any scaffold (*b*) proteins

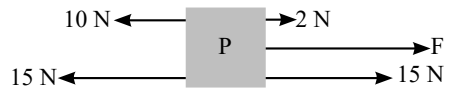
(*c*) ribozymes (*d*) plasmid

123. Which one among the following cells produces antibodies against a foreign antigen?

(*a*) Lymphocytes (*b*) Erythrocytes

(*c*) Eosinophils (*d*) Platelets

124. If the block *P* as shown in the figure below were to be at rest, what should the magnitude of force *F* be?



(*a*) 5 N (*b*) 6 N (*c*) 8 N (*d*) 10 N

125. Of the following, which does not belong to a nuclear reactor?

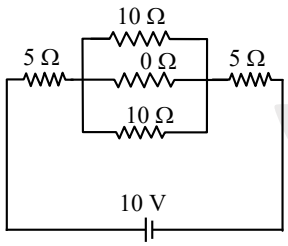
(*a*) A turbine

(*b*) A heat exchanger

(*c*) A mechanism to reduce CO_2 emission

(*d*) A reaction chamber

126. Consider the following electric circuit:



The current in the above electric circuit is:

(*a*) 1 A (*b*) (10/15) A

(*c*) 2 A (*d*) 1.5 A

127. A microscope may be a combination of:

(*a*) two convex lenses.

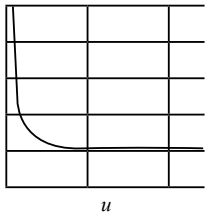
(*b*) a convex and a concave lens.

(*c*) two concave lenses.

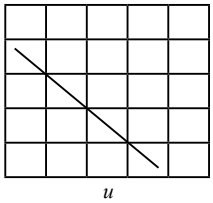
(*d*) a convex lens and a convex mirror.

128. For a human eye, where *u* is the distance of an object from the eye, *f* is the focal length of the lens and *v* is the distance of image from the eye, which is the correct schematic graph?

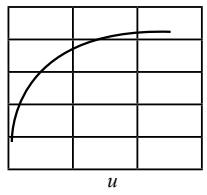
(*a*)



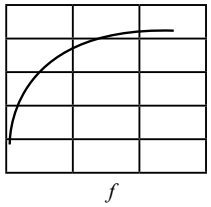
(*b*)



(*c*)



(*d*)



129. Which of the following statements with regard to the phenomenon of the primary rainbow formation by water droplets is/are correct?

1. It involves refraction and one internal reflection of sunlight.
2. It involves refraction of sunlight only.
3. It is formed as the inner bow.
4. It may involve more than one internal reflection as well as refraction of sunlight.

Select the answer using the code given below:

(*a*) 1 only (*b*) 1 and 3

(*c*) 3 and 4 (*d*) 2 and 3

130. Which one of the following scientists mentioned that an electron in an atom could revolve in certain stable orbits without the emission of radiant energy?

(*a*) Ernest Rutherford (*b*) J.J. Thomson

(*c*) Niels Bohr (*d*) Albert Einstein

131. LIGO experiment confirmed one of the predictions of:

(*a*) String theory (*b*) Special theory of relativity

(*c*) Quantum mechanics (*d*) General theory of relativity

132. A block of mass 2 kg, moving with the initial speed of 3 m/s comes to rest on a rough horizontal surface after travelling a distance of 3 m . The magnitude of the frictional force is:

(*a*) 9 N (*b*) 3 N

(*c*) 18 N (*d*) 1 N

133. Which one of the following is primarily responsible for conduction of current in a metal?

(*a*) Bound electrons

(*b*) Free electrons

(*c*) Both bound and free electrons

(*d*) Ions

134. Which of the following were features of the postal system of India as described by Ibn Battuta?

1. The foot post carries a ringing bell in one hand.
2. The horse post is called *uluq*, stationed at a distance of every four miles.
3. The foot post or *dawa* has one station at every four *kos* of distance.
4. The foot post is quicker than horse post.

Select the correct answer using the code given below:

(*a*) 1, 2 and 4 (*b*) 1 and 2 only

(*c*) 2 and 3 only (*d*) 1, 3 and 4

135. Which one of the following texts is a commentary written by Chakrapanidatta (11 Century CE from Bengal) on the *Sushrut Samhita*?

(*a*) *Sabdachandrika* (*b*) *Bhanumati*

(*c*) *Nitiratnakara* (*d*) *Lohasarvasava*

136. Consider the following statements about the arrival of tobacco in India:

1. Tobacco plant arrived first in the Deccan.
2. Tobacco spread to northern India in the early years of the seventeenth century.

Which of the statements given above is/are correct

(*a*) 1 only (*b*) 2 only

(*c*) Both 1 and 2 (*d*) Neither 1 nor 2

137. Consider the following Women's Associations and their important associates in early twentieth century India:

1. Women's Indian Association of 1917	:	Margaret Cousins
2. National Council of Women in India of 1925	:	Sarala Devi Chaudhurani
3. Bharat Stree Mahamandal of 1910	:	Lady Meherbai Tata

Which of the above pairs is/are correctly matched?

(*a*) 1, 2 and 3 (*b*) 2 and 3 only

(*c*) 1 and 2 only (*d*) 1 only

138. Consider the following statements about the issue of separate electorate during the early decades of the twentieth century in India as a means to secure adequate representation for the deprived social categories in the absence of universal adult franchise:

1. The All India Depressed Classes Association of M.C. Rajah was staunchly in favour of joint electorate.
2. The All India Depressed Classes Leaders' Conference demanded separate electorate.
3. The Communal Award in September 1932 recognised the right to separate electorate for the 'untouchables'.

Which of the statements given above are correct?

(*a*) 1 and 2 only (*b*) 2 and 3 only

(*c*) 1 and 3 only (*d*) 1, 2 and 3

139. Which of the following statements with regard to the famous 'silk routes' are correct?

1. Silk routes refer to East-bound European silk cargoes along these routes.
2. There were several silk routes, over land and by sea, joining together vast regions of Asia with Europe and northern Africa.
3. They are known to have existed since before the Christian Era and thrived almost till the fifteenth century.
4. Besides silk, Chinese pottery, textiles and spices from India and South-east Asia travelled the same route.

Select the answer using the code given below:

(*a*) 1, 2 and 3 (*b*) 1, 3 and 4

(*c*) 2, 3 and 4 (*d*) 1, 2 and 4

140. Consider the following statements about Ajanta paintings:

1. The surface of the rock was coated with clay mixed with rice husk and gum and a coat of lime was applied over this.
2. The outline drawing was done first on the lime coating and colours were added subsequently.

Which of the statements given above is/are correct?

(*a*) 1 only (*b*) 2 only

(*c*) Both 1 and 2 (*d*) Neither 1 nor 2

141. Which of the following statements with regard to the Square Kilometer Array (SKA) project is/are correct?

1. SKA is a state of the art, mega science international facility to build the world's biggest and most sensitive radio telescope for addressing a wide variety of cutting-edge science goals.
2. The Government of India has accorded its approval for India's participation in the international mega science project.

Select the answer using the code given below:

(*a*) 1 only (*b*) 2 only

(*c*) Both 1 and 2 (*d*) Neither 1 nor 2

142. Exercise Desert Cyclone is a joint military exercise between India and:

(*a*) Kuwait (*b*) Saudi Arabia

(*c*) United Arab Emirates (*d*) Oman

143. Which of the following statements with regard to the constitution of Finance Commission is/are correct?

1. The Government of India has recently constituted the Sixteenth Finance Commission under the Chairmanship of Dr. Arvind Panagariya.
2. Finance Commission is constituted in pursuance to Article 263 of the Constitution of India.

Select the answer using the code given below:

(*a*) 1 only (*b*) 2 only

(*c*) Both 1 and 2 (*d*) Neither 1 nor 2

144. Recently the Ministry of Environment, Forest and Climate Change has submitted three nominations from India for Wetland City Accreditation (WCA) under the Ramsar Convention on Wetlands. Which one among the following cities is not one among them?

(*a*) Indore (*b*) Bhopal

(*c*) Udaipur (*d*) Jodhpur

145. Which of the following statements is/are correct?

1. In India, 12th March is celebrated as the National Youth Day.
2. National Youth Day is celebrated to commemorate the birth anniversary of Swami Vivekananda.

Select the answer using the code given below:

(*a*) 1 only (*b*) 2 only

(*c*) Both 1 and 2 (*d*) Neither 1 nor 2

146. Consider the following statements about *INS Sagardhwani*:

1. It is an oceanographic research vessel of Naval Physical and Oceanographic Laboratory (NPOL) of DRDO.
2. Recently it embarked on the Sagar Maitri Mission-4 to establish long-term scientific partnerships with Indian Ocean Rim countries in Ocean Research and Development.

Which of the statements given above is/are correct?

(*a*) 1 only (*b*) 2 only

(*c*) Both 1 and 2 (*d*) Neither 1 nor 2

147. Who among the following is the Chairman of the Committee constituted by the Government of India to examine the issue of holding simultaneous elections in the country and to make recommendations thereon?

(*a*) Union Home Minister Shri Amit Shah

(*b*) Chief Justice of India Shri Dhananjaya Yeshwant Chandrachud

(*c*) Former President of India Shri Ram Nath Kovind

(*d*) Chief Election Commissioner of India Shri Rajiv Kumar

148. In January 2024, India's first all-girls' Sainik School was inaugurated at:

(*a*) Bhopal (*b*) Kohima

(*c*) Vrindavan (*d*) Namsai

149. In February 2024, Government of India has decided to scrap the Free Movement Regime (FMR) between India and:

(*a*) Myanmar (*b*) Bhutan

(*c*) Bangladesh (*d*) Nepal

150. Who among the following is the author of the book *Why Bharat Matters*?

(*a*) L.K. Advani (*b*) S. Jaishankar

(*c*) Mohan Bhagwat (*d*) Pranab Mukherjee

CLICK HERE To Discover more

ANSWER KEY

Paper I: Mathematics

1. (*d*)	**2.** (*b*)	**3.** (*d*)	**4.** (*a*)	**5.** (*c*)	**6.** (*a*)	**7.** (*a*)	**8.** (*c*)	**9.** (*c*)	**10.** (*b*)
11. (*b*)	**12.** (*d*)	**13.** (*b*)	**14.** (*b*)	**15.** (*d*)	**16.** (*a*)	**17.** (*d*)	**18.** (*a*)	**19.** (*c*)	**20.** (*b*)
21. (*d*)	**22.** (*a*)	**23.** (d)	**24.** (*a*)	**25.** (*a*)	**26.** (*c*)	**27.** (*b*)	**28.** (*d*)	**29.** (*c*)	**30.** (*a*)
31. (*b*)	**32.** (*d*)	**33.** (*c*)	**34.** (*a*)	**35.** (*c*)	**36.** (*d*)	**37.** (*a*)	**38.** (*d*)	**39.** (*c*)	**40.** (*b*)
41. (*c*)	**42.** (*c*)	**43.** (*b*)	**44.** (*b*)	**45.** (*d*)	**46.** (*a*)	**47.** (*b*)	**48.** (*b*)	**49.** (*c*)	**50.** (*a*)
51. (*a*)	**52.** (*a*)	**53.** (*d*)	**54.** (*b*)	**55.** (*c*)	**56.** (*d*)	**57.** (*b*)	**58.** (*b*)	**59.** (*b*)	**60.** (*a*)
61. (*a*)	**62.** (*b*)	**63.** (*b*)	**64.** (*c*)	**65.** (*d*)	**66.** (*)	**67.** (*a*)	**68.** (*b*)	**69.** (*a*)	**70.** (*b*)
71. (*a*)	**72.** (*c*)	**73.** (*d*)	**74.** (*b*)	**75.** (*d*)	**76.** (*a*)	**77.** (*d*)	**78.** (*a*)	**79.** (*d*)	**80.** (*a*)
81. (*d*)	**82.** (*a*)	**83.** (*d*)	**84.** (*d*)	**85.** (*a*)	**86.** (*d*)	**87.** (*a*)	**88.** (*a*)	**89.** (*d*)	**90.** (*a*)
91. (*c*)	**92.** (*b*)	**93.** (*a*)	**94.** (*d*)	**95.** (*a*)	**96.** (*c*)	**97.** (*d*)	**98.** (*a*)	**99.** (*d*)	**100.** (*a*)
101. (*c*)	**102.** (*c*)	**103.** (*b*)	**104.** (*a*)	**105.** (*a*)	**106.** (*)	**107.** (*c*)	**108.** (*b*)	**109.** (*c*)	**110.** (*c*)
111. (*d*)	**112.** (*c*)	**113.** (*b*)	**114.** (*c*)	**115.** (*b*)	**116.** (*a*)	**117.** (*b*)	**118.** (*c*)	**119.** (*c*)	**120.** (*d*)

Paper II: General Ability

1. (*d*)	**2.** (*a*)	**3.** (*a*)	**4.** (*b*)	**5.** (*d*)	**6.** (*b*)	**7.** (*a*)	**8.** (*c*)	**9.** (*d*)	**10.** (*c*)
11. (*a*)	**12.** (*d*)	**13.** (*a*)	**14.** (*b*)	**15.** (*b*)	**16.** (*b*)	**17.** (*a*)	**18.** (*b*)	**19.** (*a*)	**20.** (*c*)
21. (*a*)	**22.** (*b*)	**23.** (*b*)	**24.** (*b*)	**25.** (*b*)	**26.** (*c*)	**27.** (*c*)	**28.** (*d*)	**29.** (*d*)	**30.** (*b*)
31. (*a*)	**32.** (*a*)	**33.** (*a*)	**34.** (*c*)	**35.** (*c*)	**36.** (*a*)	**37.** (*d*)	**38.** (*c*)	**39.** (*b*)	**40.** (*a*)
41. (*a*)	**42.** (*b*)	**43.** (*c*)	**44.** (*b*)	**45.** (*c*)	**46.** (*a*)	**47.** (*a*)	**48.** (*b*)	**49.** (*b*)	**50.** (*c*)
51. (*b*)	**52.** (*c*)	**53.** (*d*)	**54.** (*a*)	**55.** (*d*)	**56.** (*a*)	**57.** (*d*)	**58.** (*c*)	**59.** (*c*)	**60.** (*a*)
61. (*c*)	**62.** (*b*)	**63.** (*b*)	**64.** (*a*)	**65.** (*b*)	**66.** (*b*)	**67.** (*d*)	**68.** (*a*)	**69.** (*d*)	**70.** (*d*)
71. (*a*)	**72.** (*b*)	**73.** (*b*)	**74.** (*c*)	**75.** (*d*)	**76.** (*b*)	**77.** (*d*)	**78.** (*d*)	**79.** (*d*)	**80.** (*d*)
81. (*c*)	**82.** (*b*)	**83.** (*a*)	**84.** (*a*)	**85.** (*c*)	**86.** (*d*)	**87.** (*d*)	**88.** (*c*)	**89.** (*d*)	**90.** (*a*)
91. (*d*)	**92.** (*a*)	**93.** (*d*)	**94.** (*a*)	**95.** (*b*)	**96.** (*b*)	**97.** (*a*)	**98.** (*b*)	**99.** (*b*)	**100.** (*b*)
101. (*c*)	**102.** (*c*)	**103.** (*a*)	**104.** (*d*)	**105.** (*d*)	**106.** (*b*)	**107.** (*b*)	**108.** (*c*)	**109.** (*b*)	**110.** (*c*)
111. (*c*)	**112.** (*d*)	**113.** (*a*)	**114.** (*c*)	**115.** (*b*)	**116.** (*b*)	**117.** (*d*)	**118.** (*c*)	**119.** (*b*)	**120.** (*a*)
121. (*d*)	**122.** (*b*)	**123.** (*a*)	**124.** (*c*)	**125.** (*c*)	**126.** (*b*)	**127.** (*a*)	**128.** (*d*)	**129.** (*b*)	**130.** (*c*)
131. (*d*)	**132.** (*b*)	**133.** (*b*)	**134.** (*a*)	**135.** (*b*)	**136.** (*c*)	**137.** (*d*)	**138.** (*a*)	**139.** (*c*)	**140.** (*c*)
141. (*c*)	**142.** (*c*)	**143.** (*a*)	**144.** (*d*)	**145.** (*b*)	**146.** (*c*)	**147.** (*c*)	**148.** (*c*)	**149.** (*a*)	**150.** (*b*)

EXPLANATION

Paper I: Mathematics

1. (*d*) For a 3 × 3 matrix, det (adj (A)) = $(\det(A))^2$.

According to question,

$$\det(3A) = 3^3 \det(A) = 27 \times \frac{1}{2\sqrt{2}} = \frac{27\sqrt{2}}{4}$$

$$\det(\text{adj}(3A)) = (\det(3A))^2 = \left(\frac{27\sqrt{2}}{4}\right)^2$$

$$= \frac{729 \times 2}{16} = \frac{729}{8}$$

$$\det(2B) = 2^3 \det(B) = \frac{8 \times 1}{729} = \frac{8}{729}$$

Now,

$\det(2B(\text{adj}(3A))) = \det(2B) \cdot \det(\text{adj}(3A))$

$$= \frac{8}{729} \times \frac{729}{8} = 1.$$

2. (*b*) $iz^3 + z^2 - z + i = 0$

$\Rightarrow iz^3 + z^2 + (i^2)z + i = 0 \quad (i = \sqrt{-1})$

$\Rightarrow iz^3 + i^2 z + z^2 + i = 0$

$\Rightarrow iz(z^2 + i) + 1(z^2 + i) = 0$

$\Rightarrow (z^2 + i)(iz + 1) = 0$

$\Rightarrow (z^2 + i)\, i(z - i) = 0$

$z^2 = -i$ or $z = i$

If $z = i$, then $|z| = |i| = 1$

If $z^2 = -i$, then $|z^2| = 1 \Rightarrow |z| = 1$

Therefore, the value of $(|z| + 1)^2 = (1 + 1)^2 = 4$

3. (*d*) Given digits are 0, 1, 4, 5

Sum of digits = 0 + 1 + 4 + 5 = 10.

Sum of all 4 digits formed = (n – 1)!(sum of 4 digits)(111 ...)n times

= (4 – 1)!(10) (1111)

= (3)! × 11110 = 6 × 11110 = 66660

$\therefore$ Numbers without zero = 66660 – (1 + 4 + 5) × 2 ! × 111 = 64440

4. (*a*) The cube roots of unity to the equation $z^3 = 1$ are 1, ω, ω^2 where ω is a primitive cube root of unity.

We know the identities:

$\omega^2 + \omega + 1 = 0 \Rightarrow \omega^2 + \omega = -1$

$xy + yz + zx = \omega + \omega^3 + \omega^2 = 0.$

5. (*c*) There are 4 possibilities:

(i) 3 ladies from husband's side and 3 gentleman from wife's side = $^4C_3 \times {}^4C_3$ = 4 × 4 = 16.

(ii) 3 gentleman from husband's side and 3 ladies from wife's side = $^3C_3 \times {}^3C_3 = 1 \times 1 = 1$

(iii) Two ladies & one gentleman from husband's side and one lady and two gentleman from wife's side

$= (^4C_2 \times {}^3C_1)(^3C_1 \times {}^4C_2) = (3 \times 6)^2 = 324$

(iv) One lady and two gentleman from husband's side and 2 ladies and one gentleman from wife's side

$= (^4C_1 \times {}^3C_2) \times (^3C_2 \times {}^4C_1) = (4 \times 3)^2 = 144.$

$\therefore$ Total no. of ways are = 16 + 1 + 324 + 144 = 485.

6. (*a*) There are total 12 points.

Since 3 points are required to form a triangle:

$^{12}C_3 = 220$

$PQ = {}^3C_3 = 1,$

The number of triangles formed by 4 points $QR = {}^4C_3 = 4$ and the number of triangles formed by 5 points on $RP = {}^5C_3 = 10$

Hence required number of triangles

= 220 – (1 + 4 + 10) = 205.

7. (*a*) Given $\log_b a = p$, $\log_d c = 2p$, $\log_f e = 3p$

Expressing these logs in exponential form:-

$\log_b a = p \Rightarrow b^p = a$

$\log_d c = 2p \Rightarrow d^{2p} = c$

$\log_f e = 3p \Rightarrow f^{3p} = e$

Now, $(ace)^{1/p} = (b^p \times d^{2p} \times f^{3p})^{1/p}$

$\therefore (ace)^{1/p} = (b^1 \times d^2 \times f^3)^{p/p}$

$= b \times d^2 \times f^3$

8. (*c*) We can construct the polynomial by forming its factors from these roots.

$$\left(x - \sqrt{2}\right)\left(x + \sqrt{2}\right)\left(x - \sqrt{3}\right)\left(x + \sqrt{3}\right)$$

$$\Rightarrow \left(x^2 - (\sqrt{2})^2\right)\left(x^2 - (\sqrt{3})^2\right)$$

$\Rightarrow (x^2 - 2)(x^2 - 3)$

$\Rightarrow (x^2 - 2)(x^2 - 3) = x^4 - 3x^2 - 2x^2 + 6 = x^4 - 5x^2 + 6$

Here, $a_0 = 6$, $a_1 = 0$, $a_2 = -5$, $a_3 = 0$

9. (*c*) Given condition, $\left|\frac{z_1 + z_2}{z_1 - z_2}\right| = 1$

$\Rightarrow |z_1 + z_2| = |z_1 - z_2|$ (implies both lie on same circle)

For this to be thrice, $z_1 + z_2$ must be orthogonal to $z_1 - z_2$ in the complex plane.

$\Rightarrow (z_1 + z_2)(\overline{z_1 - z_2}) = 0$

$\Rightarrow (z_1 + z_2)(\bar{z}_1 - \bar{z}_2) = 0$

$\Rightarrow z_1\bar{z}_1 - z_1\bar{z}_2 + z_2\bar{z}_1 - z_2\bar{z}_2 = 0$

$\Rightarrow |z_1|^2 - z_1\bar{z}_2 + z_2\bar{z}_1 - |z_2|^2 = 0$

$\Rightarrow |z_1|^2 - |z_2|^2 = z_1\bar{z}_2 - z_2\bar{z}_1$

Taking real part of both sides,

$|z_1|^2 - |z_2|^2 = 0 \Rightarrow |z_1|^2 = |z_2|^2 \Rightarrow |z_1| = |z_2|$

Also, $\left(\frac{z_1}{z_2}\right) = (e^{i\theta}) = \cos\theta + i\sin\theta$

$e^{i\pi/2} = \cos\pi/2 + i\sin\pi/2 = i$

$$\Rightarrow \text{Re}\left(\frac{z_1}{z_2}\right) + 1 = \text{Re}\left(\frac{1}{i}\right) + 1$$

= 1

10. (*b*) Using formula, $\sum_{i=1}^{\infty} \left|\frac{n}{p^i}\right|$

Here p = 2 and n = 26,

$$\left[\frac{26}{2}\right] + \left[\frac{26}{4}\right] + \left[\frac{26}{8}\right] + \left[\frac{26}{16}\right] + \left[\frac{26}{32}\right] + \ldots\ldots$$

$\Rightarrow 13 + 6 + 3 + 1 + 0 = 23$

The highest power of 2 in 26! is 23. Since $8 = 2^3$, the highest power of 8 that divides 26! is:

$$\left[\frac{23}{3}\right] = [7.6667] = 7.$$

Thus, the maximum value of k is 7.

11. (*b*) We know that adj(AB) = (adjB) (adjA) ...(*i*)

Also, adj(BA) = (adjA)(adjB) ...(*ii*)

Since A(adjA) = |A| I_n ...(*iii*)

$\Rightarrow$(AB)(adjAB)=|AB|I_n(From using(*iii*)

From (*i*) and (*ii*) we can conclude that statement. 1. and 2 are incorrect. Also from (*iii*) we can conclude that statement 3 is correct.

12. (*d*) (1) For any matrix A, $\text{adj}(A^T) = (\text{adj}(A))^T$

$\Rightarrow A(\text{adj}(A^T)) = A(\text{adj}(A))^T$

Hence this statement is correct

(2) I = identity matrix

We know $I^n = I$

$\Rightarrow A^2 = A$ (A is identity matrix).

(3) Also, $A^3 = A \Rightarrow$ A is identity matrix of order n.

Hence all the three statements are correct.

13. (*b*) According to question the digits are 0, 2, 4, 6, 8

Therefore 4 -digit natural numbers are

$4 \times 5 \times 5 \times 5 = 500$

14. (*b*) $x^3 = k^3 \Rightarrow x = k, k\omega, k\omega^2$

$(z - 100)^3 = (-10)^3$

$\Rightarrow z - 100 = -10, -10\omega, -10\omega^2$

$\Rightarrow z = 90, 10(10 - \omega), 10(10 - \omega^2)$

Hence option (*b*) is correct.

15. (*d*) Given $(1 + i)^4 + (1 - i)^4$

$\because (1 + i)^{2n} + (1 - i)^{2n} = (2i)^n (1 + (-1)^n)$

$\therefore 2n = 4, \Rightarrow n = 2$

Here, $(2i)^2 (1+ (-1)^2)$

$= -4 (2)$

$= -8$

16. (*a*) Statement 1: Let A be a skew-symmetric matrix

$$\text{as } A = \begin{bmatrix} 0 & 1 & -2 \\ -1 & 0 & 3 \\ 2 & -3 & 0 \end{bmatrix}$$

$$|A| = \begin{cases} n - \text{odd} \to 0 \\ n\text{-even} \to \text{ perfect square} \end{cases}$$

Statement 2: Tr(A) = 0, $\sum(A) = 0$

[All diagonal elements are zero]

Statement 3:A is orthogonal matrix if

$|A| = 1$ or -1

$A^{-1} = A^T \Rightarrow A^{-1} = \text{adj}A$ or $-\text{adj}A$

Hence 1 and 2 are correct but A is not an orthogonal matrix.

17. (*d*) A number is divisible by 4 if,

I. Number is even.

II. Last two digits are divisible by 4.

Here given digits are 1, 2, 3, 5

$\therefore 3 \times 2 \times 1 = 6$

18. (*a*)

$$\left(2^3\right)^{40} = (8)^{40} = (1+7)^{40}$$

$$= 1 + {}^{40}C_1(7)^1 + {}^{40}C_2(7)^2 + \ldots\ldots {}^{40}C_{40}(7)^{40}$$

$= 1$ (Remainder).

Since

${}^{40}C_1(7)^1 + {}^{40}C_2(7)^2 \ldots\ldots {}^{40}C_{40}(7)^{40}$

is perfectly divisible by 7 giving remainder zero.

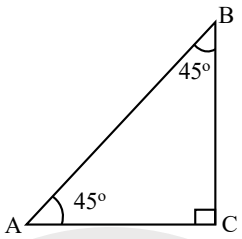
19. (*c*) we know that, ${}^nC_{r-1} + {}^nC_r = {}^{n+1}C_r$

Using $C_3 \to C_3 - (C_1 + C_2)$ we get

$$\begin{vmatrix} C(9,4) & C(9,3) & {}^{10}C_{n-2} - {}^{10}C_4 \\ C(11,6) & C(11,5) & {}^{12}C_n - {}^{12}C_6 \\ C(m,7) & C(m,6) & {}^{m+1}C_{n+1} - {}^{m+1}C_7 \end{vmatrix} = 0$$

putting n = 6 we get colum 3 zero.

20. (*b*) Let us assume a triangle with following angles.



we get the value of determinant as

$$= \begin{vmatrix} 0 & 1/\sqrt{2} & 0 \\ 1 & 0 & 1/\sqrt{2} \\ 0 & -1 & 0 \end{vmatrix} = 0$$

21. (*d*) Since repetition is allowed we get following cases:

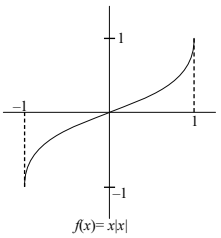
(i) $[4 \times 4 \times 4 \times 4]_{i \times 4} \Rightarrow 256$ cases

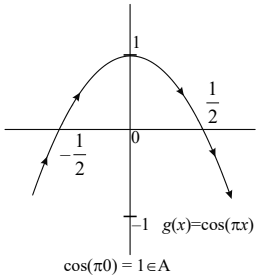
(ii) $\begin{bmatrix} 4 \\ 4 \\ 4 \\ 4 \end{bmatrix} \Rightarrow 256$ cases

(iii) $\begin{bmatrix} 4 & \times & 4 \\ 4 & \times & 4 \end{bmatrix} \Rightarrow 256$ cases

Hence total cases are 768

22. (*a*)





$\cos(\pi 0) = 1 \in A$

$f(x) = x|x|$ is a one-one & onto function. Hence bijective.

$g(x) = \cos(\pi x)$ is a many one function hence this is not bijective.

23. (*d*) For Reflexive $-1 < x < 1$

$\Rightarrow -2 \cdot < x + x < 2 \Rightarrow |x + x| < 2 \Rightarrow (x, x) \in R$

For symmetric: $|x + y| < 2$.

then $|y + x| < 2 \Rightarrow$

For $(x, y) \in R \Rightarrow (y, x) \in R$.

For transitive:

$|x + y| < 2$,

$|y + z| < 2$

when $z \in (-1,1)$

$\Rightarrow x \in (-1,1)$ and $y \in (-1,1)$

$\Rightarrow |x + z| < 2$

Hence R is an equivalence relation.

24. (*a*) We know that,

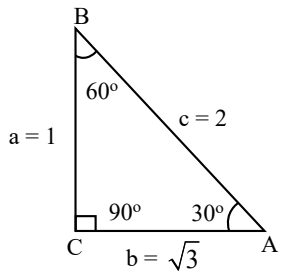
$A \cup B = (A - B) \cup (B - A) \cup (A \cap B)$

$\Rightarrow (A \cup B) - \left[(A - B) \cup (B - A) \cup (A \cap B) = \phi^\circ\right.$

Hence it is a null set.

25. (*a*) $$\begin{vmatrix} a^2 & b\sin A & c\sin A \\ b\sin A & 1 & \cos A \\ c\sin A & \cos A & 1 \end{vmatrix}$$

$$= \begin{vmatrix} 1 & \sqrt{3}/2 & 1 \\ \sqrt{3}/2 & 1 & \sqrt{3}/2 \\ 1 & \sqrt{3}/2 & 1 \end{vmatrix}$$



$$= \frac{1}{4} - 0 + \left(-\frac{1}{4}\right) = 0$$

26. (*c*) Since a, b, c are in A.P.

$$\therefore b = \frac{a + c}{2} \quad \ldots(i)$$

$\because b, c, d$ are in G.P.

$\therefore c^2 = bd$ $\quad \ldots(ii)$

Also, $\because c, d, e$ are in H.P.

$$\therefore d = \frac{2ce}{c + e} \quad \ldots(iii)$$

Substituting

c, d,e as 3,4,6 respectively.

We get $b = 9/4, a = 1.5$ from (*ii*) and (*i*) respectively

1. $a = 1.5, c = 3, e = 6$ are in G.P [As $c^2 = a.$]

2.

$$\frac{1}{a} = \frac{1}{1.5}, \frac{1}{c} = \frac{1}{3}, \frac{1}{e} = \frac{1}{6} \text{ are in G.P}$$

$$\left[\text{As } \frac{1}{c^2} = \frac{1}{a} \times \frac{1}{e}\right]$$

Hence both statement are correct.

27. (*b*) Given, $\log_4(x-1) = \log_2(x-3)$

$$\Rightarrow \frac{\log(x-1)}{2\log 2} = \frac{\log(x-3)}{\log 2}$$

$$\Rightarrow \frac{\log(x-1)}{\log(x-3)} = 2$$

$$\Rightarrow \log_{(x-3)}(x-1) = 2$$

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

$$\Rightarrow (x-1) = x^2 + 9 - 6x$$

$$\Rightarrow x(x-5) - 2(x-5)$$

$$\Rightarrow x = 5 \text{ or } x = 2$$

$x = 2$ is not possible, Hence there is one solution $x = 5$

28. (*d*) Given, $\log_x\left(\frac{x}{y}\right) + \log_y\left(\frac{y}{x}\right) = k$

$$\Rightarrow \frac{\log x - \log y}{\log x} + \frac{\log y - \log x}{\log y} = k$$

$$\Rightarrow \log x \cdot \log y - (\log y)^2$$

$$+\log x \cdot \log y - (\log x)^2 = k \log x \log y$$

$$\Rightarrow -\frac{(\log x)^2 + (\log y)^2 - 2\log x \log y}{\log x \log y} = k$$

$$\Rightarrow \frac{-[\log x - \log y]^2}{\log x \cdot \log y} = k$$

$\therefore$ k is always negative $\Rightarrow k \le 0$

Hence $k \neq 1$, option (*d*) is, correct, answer.

29. (*c*) Here we have

$$A = \begin{bmatrix} \sin 2\theta & 2\sin^2\theta - 1 & 0 \\ \cos 2\theta & 2\sin\theta \cdot \cos\theta & 0 \\ 0 & 0 & 1 \end{bmatrix}$$

$$= \begin{bmatrix} \sin 2\theta & -\cos 2\theta & 0 \\ \cos 2\theta & \sin 2\theta & 0 \\ 0 & 0 & 1 \end{bmatrix}$$

Here $|A| = 1$

$\therefore$ A is orthogonal matrix.

$\Rightarrow A^{-1} = \text{adj}\, A$ ...(*i*)

Also, $A^{-1} = A^{\top}$ ...(*ii*)

Since diagonal are not zero, therefore it is not a skew-symmetric matrix.

Hence (*i*) and (*ii*) implies that only option statement 1 and 3 are correct

30. (*a*)

$$\left(1-x^2\right)^{20}\left(2 - x^2 - \frac{1}{x^2}\right)^{-5}$$

$$\Rightarrow -\left(x^2 + \frac{1}{x^2} - 2\right)^{-5}\left(1-x^2\right)^{20}$$

$$\Rightarrow -\left(\left(x - \frac{1}{x}\right)^2\right)^{-5}\left(1-x^2\right)^{20}$$

$$\Rightarrow -\left(\frac{x^2-1}{x}\right)^{-10}\left(1-x^2\right)^{20} \Rightarrow -\left(\frac{x}{x^2-1}\right)^{10}\left(1-x^2\right)^{20}$$

$$\Rightarrow -x^{10} \cdot \left(1-x^2\right)^{-10} \cdot \left(1-x^2\right)^{20}$$

$$\Rightarrow -x^{10} \cdot \left(1-x^2\right)^{10}$$

$$\Rightarrow -x^{10} \cdot \left(1 - {}^{10}C_1 x^2 + {}^{10}C_2 x^4 - {}^{10}C_3 x^6 \ldots\right)$$

Therefore coefficient of x^{10} is (–1)

31. (*b*) We are given, $\left(mx + \frac{1}{x}\right)^n$

For the 4th term we get the following expansion:

$${}^nC_3 (mx)^{n-3} \cdot \left(\frac{1}{x}\right)^3 = \frac{5}{2}$$

$$\Rightarrow {}^nC_3 (m)^{n-3} (x)^{n-6} = \frac{5}{2} \cdot x^0$$

$$\Rightarrow n - 6 = 0 \Rightarrow n = 6$$

$$\Rightarrow {}^6C_3 \cdot m^3 = \frac{5}{2}$$

$$\Rightarrow 20 \cdot m^3 = \frac{5}{2} \Rightarrow m^3 = \frac{1}{8} \Rightarrow m = \frac{1}{2}$$

Therefore $mn = \frac{1}{2} \times 6 = 3$.

32. (*d*) Since a,b and c are in G.P for the given equation $ax^2 + bx + c = 0$

Discriminant $D = b^2 - 4ac < 0$

$\Rightarrow -3ac < 0$ [imaginary Roots]

$$\text{Roots} = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a} = \frac{-b \pm \sqrt{-3ac}}{2a}$$

$$= \frac{-\sqrt{ac} \pm \sqrt{3}i\sqrt{ac}}{2a} \left\{b = \sqrt{ac}\,(G \cdot P)\right\}$$

$$= \frac{-\sqrt{ac}}{a} \cdot \left[\frac{-1 \pm \sqrt{3}i}{2}\right]$$

$$\Rightarrow k\omega \text{ and } k\omega^2 \qquad \left[\text{Let } k = \frac{\sqrt{ac}}{a}\right]$$

Ratio of roots is $k\omega : k\omega^2 = 1 : \omega$

Also product of roots:

$$\omega^2 \cdot k^2 = \frac{c}{a} \Rightarrow \frac{ac}{a^2} = \left(\frac{b^2}{a^2}\right)$$

Hence all the statements are correct.

33. (*c*) Given $x^2 + mx + n$

By completing the square,

$$\Rightarrow \left(x + \frac{m}{2}\right)^2 - \frac{m^2}{4} + n$$

$$\Rightarrow \left(x + \frac{m}{2}\right)^2 + \left(n - \frac{m^2}{4}\right) \leftarrow \text{Integer}$$

Since x is an integer $\Rightarrow m$ is even integer [$\because m = 2$ int.]

Also $n = \frac{m^2}{4} \Rightarrow n$ is integer [$\because m$ is even int.]

Hence statement 1 and 2 both are correct.

34. (*a*) Given, $(x+y)^{2n+1}(x-y)^{2n+1}$

$\Rightarrow (x^2 - y^2)^{2n+1}$

Let $n = 1$

$\therefore (x^2 - y^2)^{2n+1} \Rightarrow (x^2 - y^2)^3$

$\Rightarrow (x^2)^3 - 3(x^2)^2 y^2 + 3(x^2)(y^2)^2 - (y^2)^3$

$\Rightarrow -3x^4y^2 + 3x^2y^4 = 0 \Rightarrow 3x^4y^2 = 3x^2y^4$

$$\Rightarrow x^2 = y^2 \Rightarrow \frac{x^2}{y^2} = 1$$

35. (*c*) Here $n(A) = m = 5$

$n(B) = n = 2$

$m > n$

Number of onto functions

$= (n)^m - \{{}^nC_1(n-1)^m - {}^nC_2(n-2)^m + {}^nC_3(n-3)^m \ldots\} = 2^5 - \{{}^2C_1(2-1)^5 - {}^2C_2(0)^5\}$

$= 32 - (2) = 30$

36. (*d*) Given $\frac{\sqrt{3}\cos 10^\circ - \sin 10^\circ}{\sin 25^\circ \cos 25^\circ}$

{Multiply and dividing by 2}

$$\Rightarrow \frac{\left[\frac{\sqrt{3}}{2}\cos 10^\circ - \frac{1}{2}\sin 10^\circ\right] \times 2 \times 2}{2\sin 25^\circ \cos 25^\circ}$$

$$\Rightarrow \frac{\sin(60^\circ - 10^\circ)}{\sin(50^\circ)} \times 4 = 4$$

37. (*a*) Given $(\sin 9^\circ - \cos 9^\circ)$

Let $x = \sin 9^\circ - \cos 9^\circ$

$x^2 = 1 - \sin 18^\circ$

$$x^2 = 1 - \left(\frac{\sqrt{5}-1}{4}\right)$$

$$x = \pm\frac{\sqrt{5-\sqrt{5}}}{2}$$

CLICK HERE To Discover more

$$x = -\frac{\sqrt{5-\sqrt{5}}}{2}$$

$$\left[\because \cos\theta < \sin\theta \text{ when } \frac{\pi}{4} < \theta < \frac{\pi}{2}\right]$$

38. (*d*) For $A = B = C = 60^\circ$ [equilateral triangle]

We have $\sin^3 A + \sin^3 B + \sin^3 C = 3 \sin A \sin B \sin C$

$$\frac{3\sqrt{3}}{8} + \frac{3\sqrt{3}}{8} + \frac{3\sqrt{3}}{8} = 3 \times \frac{\sqrt{3}}{2} \times \frac{\sqrt{3}}{2} \times \frac{\sqrt{3}}{2}$$

$\Rightarrow$ LHS = RHS, Hence it is a equilateral triangle

$$\therefore \begin{vmatrix} a & b & c \\ b & c & a \\ c & a & b \end{vmatrix} \Rightarrow \begin{vmatrix} s & s & s \\ s & s & s \\ s & s & s \end{vmatrix} [\text{since } a = b = c = s]$$

$\Rightarrow$ 0 [when two rows or colums are similar]

39. (*c*) Given, $\cos^{-1} x = \sin^{-1} x$

Let, $\cos^{-1} x = \sin^{-1} x = A$

using pythagorean identity

$\cos^2\theta + \sin^2\theta = 1$

$\Rightarrow \cos^2 A + \sin^2 A = 1$

$\Rightarrow x^2 + x^2 = 1 [\because \cos A = x \ \& \ \sin A = x]$

$\Rightarrow 2x^2 = 1$

$$\Rightarrow x = \pm\frac{1}{\sqrt{2}}$$

Since a must be in the interval where $\cos^{-1}x = \sin^{-1}x$ and in this interval both are negative, we take the positive root

i.e.,x = $\frac{1}{\sqrt{2}}$

40. (*b*) For $(\sin\theta - \cos\theta)^2 = 2$ where $-\pi < \theta < \pi$

$\Rightarrow 1 - \sin 2\theta = 2 \Rightarrow \sin 2\theta = -1 \Rightarrow -2\pi < 2\theta < 2\pi$

Therefore solutions within the interveal

$-\pi < \theta < \pi$ are : $\theta = -\frac{\pi}{4}, \frac{3\pi}{4}$

Hence two solutions

41. (*c*) Given $C = 60^\circ$, Let us asume ABC be an equilateral triangle

$\therefore A = B = C = 60^\circ$

$$\therefore \frac{\cos A + \cos B}{\cos\left(\frac{A-B}{2}\right)} = \frac{\frac{1}{2}+\frac{1}{2}}{1} = \frac{1}{1} = 1$$

42. (*c*) $\sqrt{15 + \cot^2\left(\frac{\pi}{4} - 2\cot^{-1} 3\right)}$

Solving, $\frac{\pi}{4} - 2\cot^{-1} 3$

$$\Rightarrow \frac{\pi}{4} - 2\tan^{-1}\left(\frac{1}{3}\right)$$

$$\Rightarrow \tan^{-1}(1) - \tan^{-1}\left(\frac{\frac{2}{3}}{1-\frac{1}{9}}\right)$$

$$\Rightarrow \tan^{-1}(1) - \tan^{-1}\left(\frac{3}{4}\right)$$

$$\Rightarrow \tan^{-1}\left(\frac{1-\frac{3}{4}}{1+\frac{3}{4}}\right)$$

$$\Rightarrow \tan^{-1}\left(\frac{1}{7}\right) \Rightarrow \cot^{-1}(7)$$

Now

$\sqrt{15 + (\cot(\cot^{-1} 7))^2}$

$= \sqrt{15 + 49}$

$= \sqrt{64} = 8$

43. (*b*) Using, $\sin A \sin B = \frac{\cos(A-B) - \cos(A+B)}{2}$ we get

$\frac{1}{2}(\cos 40^\circ - \cos 60^\circ + \cos 200^\circ - \cos 300^\circ + \cos 240^\circ - \cos 260^\circ)$

$$\Rightarrow \frac{1}{2}\left(-\frac{3}{2} + \cos 40^\circ + \cos 200^\circ - \cos 260^\circ\right)$$

$$\Rightarrow \frac{1}{2}\left(\frac{-3}{2} + 2\cos 120^\circ \cos 80^\circ - \cos 260^\circ\right)$$

[using cos (A+B) property]

$$\Rightarrow \frac{1}{2}\left(\frac{-3}{2} + 2\times\left(\frac{-1}{2}\right)\cos 80^\circ - \cos 260^\circ\right)$$

$$\Rightarrow \frac{1}{2}\left(\frac{-3}{2} + (-1)(\cos 80^\circ - \cos 260^\circ)\right) = \frac{-3}{4}$$

44. (*b*) Given, $\tan^{-1}\left(\frac{a}{b}\right) - \tan^{-1}\left(\frac{a-b}{a+b}\right)$

$$\Rightarrow \tan^{-1}\left(\frac{a}{b}\right) + \tan^{-1}\left(\frac{b-a}{b+a}\right)$$

$$\Rightarrow \tan^{-1}\left(\frac{a}{b}\right) + \tan^{-1}\left[\frac{1-\frac{a}{b}}{1+\frac{a}{b}}\right]$$

$$\Rightarrow \tan^{-1}\left(\frac{a}{b}\right) + \tan^{-1} 1 - \tan^{-1}\left(\frac{a}{b}\right)$$

$$\Rightarrow \tan^{-1} 1 = \frac{\pi}{4}$$

45. (*d*) For real root $D \geq 0$

$\therefore \cos^2\beta - 4(\cos\beta - 1)(\sin\beta) \geq 0$

$\cos^2\beta + 4\sin\beta(1 - \cos\beta) \geq 0$

we get

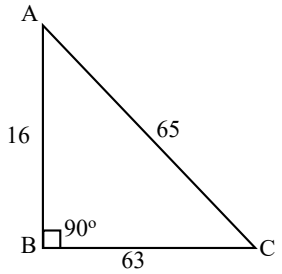
$(\cos\beta)^2 \geq 0, 4\sin\beta \geq 0, 1 - \cos\beta \geq 0$

Since $\beta \in [0, \pi]$

Hence $1 - \cos\beta \geq 0$

46. (*a*) We know that in a right angled triangle

$\cos 2A + \cos 2B + \cos 2C = -1$



47. (*b*) For $\alpha + \beta = \frac{5\pi}{4}$ we get $\alpha = \pi, \beta = \frac{\pi}{4}$

$$\therefore f(\pi) f\left(\frac{\pi}{4}\right) = \left(\frac{1}{1+\tan\pi}\right)\left(\frac{1}{1+\tan\frac{\pi}{4}}\right)$$

$$= \left(\frac{1}{1+0}\right)\left(\frac{1}{1+1}\right) = 1\times\frac{1}{2} = \frac{1}{2}$$

48. (*b*) Given $x^2 - 6x + 8 = 0$

$\Rightarrow (x-2)(x-4) = 0 \Rightarrow x = 2, x = 4$

$\therefore \tan\alpha = 2, \tan\beta = 4$

$$\tan(\alpha + \beta) = \frac{2+4}{1-2\times 4} = \frac{6}{-7}$$

Now, $\cos 2(\alpha + \beta)$

$$= \frac{1-\tan^2(\alpha+\beta)}{1+\tan^2(\alpha+\beta)} = \frac{1-\left(\frac{36}{49}\right)}{1+\frac{36}{49}} = \frac{13}{85}$$

49. (*c*) Given $\tan 65^\circ + 2\tan 45^\circ - 2\tan 40^\circ - \tan 25^\circ$

$\Rightarrow \tan 65^\circ - \tan 25^\circ - 2\tan 40^\circ + 2$ [$\because 2\tan 45^\circ = 2$]

$\Rightarrow 2 + 2\tan 40^\circ - 2\tan 40^\circ$ [$\because 2\tan 40^\circ = \tan 65^\circ - \tan 25^\circ$]

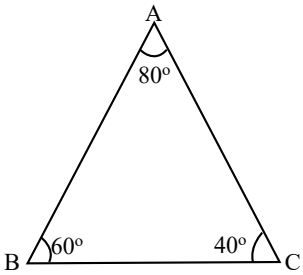
$\Rightarrow 2$

50. (*a*) Let ABC be any acute angled triangle as follow:

Statement 1 is correct as in first quadrant

$\cot 80^\circ \ \cot 60^\circ \ \cot 40^\circ > 0$

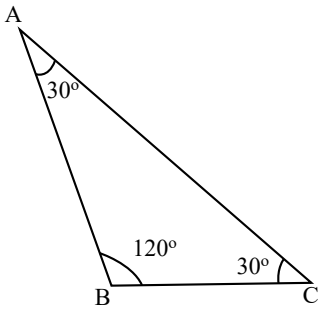
(+) (+) (+)



Also let's take obtuse angled triangle

$\therefore$ tan 30°. tan 120°. tan 30°.

$\Rightarrow \frac{1}{\sqrt{3}} \times (-\sqrt{3}) \times \frac{1}{\sqrt{3}} \Rightarrow -\frac{1}{\sqrt{3}} < 0$



Hence statement II in incorrect

51. (*a*) Given (a, b) is centre and c is the radius.

$\therefore x^2 + y^2 + 2x + 6y + 1 = 0$ (Given).

$\Rightarrow c(-1, -3)$ and $r = \sqrt{1+9-1} = 3$

$\Rightarrow a = -1, b = -3, c = 3$ (radius r)

Therefore, $a^2 + b^2 + c^2 = 1 + 9 + 9 = 19$

52. (*a*) Equation of sphere given is:

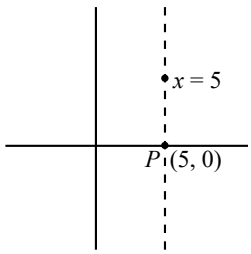
$x^2 + y^2 + z^2 + 2ux + 2vy + 2wz - 1 = 0$

$\Rightarrow c(-u, -v, -w)$

$\Rightarrow u = \frac{-3}{2}, \ v = 0. \ w = \frac{-1}{2}$

$\therefore u + v + w = \frac{3}{2} + 0 + \frac{(-1)}{2} = \frac{-4}{2} = -2$

53. (*d*) The graph of $x = 5$ can be represented as follows:



Hence, there are infinite number of points on the given line.

54. (*b*) For the given equation

$2x - 3y + 6z + 4 = 0$

d.r's are $\vec{n} = (2, -3, 6)$

dc's $= \left(\frac{2}{7}, \frac{-3}{7}, \frac{6}{7}\right)$

Therefore,

$49\left(7\left(\frac{4}{49}\right) + \left(\frac{9}{49}\right) - \frac{36}{49}\right)$

$= 28 + 9 - 36 \Rightarrow 37 - 36 = 1$

55. (*c*) $\frac{x-1}{3} = \frac{y+1}{2} = \frac{z-2}{2} = r$

$x = 3r + 1, y = 2r - 1, z = 2r + 2$

$\Rightarrow 3r + 1 + 4r - 2 + 6r + 6 = 18$

$\Rightarrow 13r = 13 \Rightarrow r = 1$

$\therefore x = 3r + 1 = 4$

$y = 2r - 1 = 1$

$z = 2r + 2 = 4$

56. (*d*) Equaiton of plane is: $x + y + z = 1$

$\Rightarrow x + y + z - 1 = 0$

$\Rightarrow P = \frac{1-11}{\sqrt{3}} \Rightarrow P = \frac{1}{\sqrt{3}}$

$\therefore 2P^2 = 3 \times \frac{1}{3} = 1$

57. (*b*) Given equations are:

$l + 2m + n = 0$

$2l - 2m + 3n = 0$

$\Rightarrow \frac{l}{8} = \frac{m}{-1} = \frac{n}{-6} = k$

$\therefore l = 8k, m = -k, n = -6k$

$l^2 + m^2 + n^2 = 1$

$\Rightarrow 64k^2 + k^2 + 36k^2 = 1 \Rightarrow k^2 = \frac{1}{101}$

$\therefore l^2 + m^2 - n^2 + n^2 - n^2$

(from $l^2 + m^2 - n^2$)

(adding n^2 and subtracting n^2)

$\Rightarrow 1 - 2n^2 \Rightarrow 1 - 2(36k^2)$

$\Rightarrow 1 - \frac{72}{101} \Rightarrow \frac{29}{101}$

58. (*b*) From the given two equaitons

$x + 2y - 1 = 0$ and $2x - y - 1 = 0$

we have, $x + 2y - 1 = 0$ ...(*i*)

$2x - y - 1 = 0$ ...(*ii*)

Point of intersection,

$\frac{x}{2-1} = \frac{-y}{-1+2} = \frac{1}{-1-2}$

$x = \frac{3}{5}, \ y = \frac{1}{5}$

These points satisfy the given equation in option (*b*) only.

59. (*b*) Given equation of line $x \cos\theta + y \sin\theta = 9$ … (*i*)

Since, this line is perpendicular to the lines passing through $(-\sin\theta, \cos\theta)$

$\therefore$ eq. (*i*) becomes

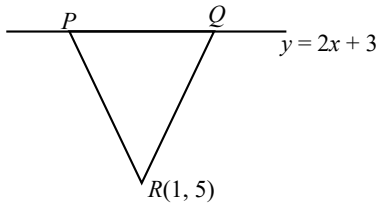
$x \sin\theta - y \cos\theta + \lambda = 0$

$\Rightarrow -\sin^2\theta - \cos^2\theta + \lambda = 0$

$\Rightarrow \lambda = 1$

Hence, $x \sin\theta - y \cos\theta + 1 = 0$

60. (*a*) According to question we get the following:



From the eq. $2x + 3$ we can interpret that y is more than 2 times of x.

i.e., $(a, 2a + 3)$ ..... eq. (i)

Only option (*a*) satisfies this condition.

61. (*a*) Slope of the line $2x + y = 3$ is equal to the $4x + 2y = -5$ i.e $m = -2$

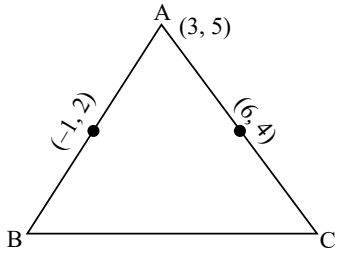
$\therefore$ These two lines are parallel to each other.

Distance between parallel line $= \frac{|C_1 - C_2|}{\sqrt{a^2 + b^2}}$ (Side of Square)

$= \frac{|-6-5|}{2\sqrt{5}} = \frac{11}{2\sqrt{5}}$

$\therefore$ Area of the Square $= \left(\frac{11}{2\sqrt{5}}\right)^2 = \frac{121}{20} = 6.05$

62. (*b*)



Since (–1, 2) is the mid point of AB

$\therefore$ B = (–5, –1)

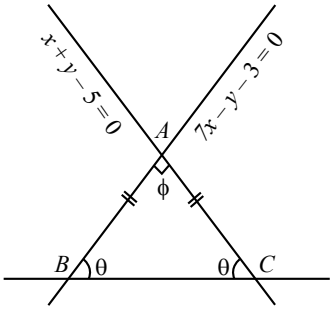
Similarly C = (9, 3)

$\therefore$ Centroid of ABC

$= \left(\frac{3-5+9}{3}, \frac{5-1+3}{3}\right) = \left(\frac{7}{3}, \frac{7}{3}\right)$

63. (*b*) Slope of $7x - y - 3 = 0$ is $m_1 = 7$ and slope of $x + y - 5 = 0$ is $m_2 = -1$

Let ϕ is the angle between lines.



$\therefore \tan\phi = \left|\frac{m_1 - m_2}{1 + m_1 m_2}\right| = \frac{7+1}{1+(-7)} = \frac{8}{6}$

$\tan\phi = \frac{4}{3} \Rightarrow \cos\phi = \frac{3}{5}$

From the fig $\phi + 2\theta = 180$

$\theta = 90 - \frac{\phi}{2}$

$\cot\theta = \cot\left(90 - \frac{\phi}{2}\right) = \tan\left(\frac{\phi}{2}\right)$

$\therefore \tan\left(\frac{\phi}{2}\right) = \sqrt{\frac{1-\cos\phi}{1+\cos\phi}} = \sqrt{\frac{2}{8}} = \frac{1}{2}$

64. (*c*) The given eqn can be rewritten as $y^2 = 4 \times 2x$

$\therefore F = (2, 0)$

Since $(6, 4\sqrt{3})$ satisfy the eqn $y^2 = 8x$

$\therefore (6, 4\sqrt{3})$ lies on the eq^n $y^2 = 8x$

$\therefore$ The distance from (2, 0) to $(6, 4\sqrt{3})$ is 8.

Hence *p* can be $(6, 4\sqrt{3})$.

Since the distance from focus to the point is equal to the distance from point to the directrix.

$\therefore$ The perpendicular distance of *p* from the directrix is 8 units.

65. (*d*) Let ellipse be $\frac{x^2}{a^2} + \frac{y^2}{b^2} = 1$

$\therefore$ Its foci are $S_1(ae, 0)$ and $S_2(-ae, 0)$ and extremity of the minor axis is B(0, *b*)

$\therefore$ Slope of $m_{S_1B} \times m_{S_2B} = -1$

$\Rightarrow \left(\frac{b-0}{0-ae}\right)\left(\frac{b-0}{0+ae}\right) = -1$

$\Rightarrow e = \frac{1}{\sqrt{2}}$

66. (*) Since $\vec{a} \times (\vec{b} \times \vec{a}) = \vec{b}(\vec{a}.\vec{a}) - \vec{a}(\vec{a}.\vec{b})$

Now, $\vec{a} \cdot \vec{a} = 3$ and $\vec{a} \cdot \vec{b} = -2$

$\therefore \vec{a} \times (\vec{b} \times \vec{a}) = 3\vec{b} + 2\vec{a} = 5\hat{i} + 4\hat{j} - \hat{k}$

$\therefore \alpha = 5, \beta = -4, \text{and} \gamma = -1$

$\therefore \alpha + \beta + \gamma = 0$

67. (*a*) $l = \cos\frac{\pi}{3} = \frac{1}{2}$

$m = \cos\frac{\pi}{4} = \frac{1}{\sqrt{2}}$

$n = \cos\theta$

$\because l^2 + m^2 + n^2 = 1$

$\Rightarrow \left(\frac{1}{2}\right)^2 + \left(\frac{1}{\sqrt{2}}\right)^2 + n^2 = 1$

$\Rightarrow n = \pm\frac{1}{2} \Rightarrow \cos\theta = \frac{1}{2}$

$(l, m, n) = \left(\frac{1}{2}, \frac{1}{\sqrt{2}}, \frac{1}{2}\right) = \left(1, \sqrt{2}, 1\right)$

68. (*b*) Statement 1: The moment of force depends on where the force is applied relative to the point because the position vector would change if the point of application changes. Therefore, this statement is incorrect.

Statement 2: The moment of force about a line can be considered as the component of the moment of the force that is perpendicular to the line. This is indeed a vector quantity since it has both magnitude and direction. Therefore this is correct statement

69. (*a*) Let $\vec{r} = x\hat{i} + y\hat{j} + z\hat{k}$

$\vec{r} \times \hat{i} = 0 + (-\hat{k}y) + z\hat{j}$ and $\vec{r}.\hat{i} = x$

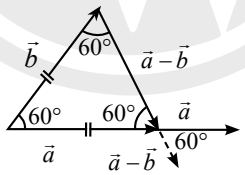
$\vec{r} \times \hat{j} = x\hat{k} + 0 + (-z\hat{i})$ and $\vec{r} \cdot \hat{j} = y$

$\vec{r} \times \hat{k} = -x\hat{j} - y\hat{i} + 0$ and $\vec{r} \cdot \hat{k} = z$

$\Rightarrow x(-y\hat{k} + z\hat{j}) + y(x\hat{k} - z\hat{i}) + z(-x\hat{j} + y\hat{i}) = 0$

$\therefore (\vec{r} \cdot \hat{i})(\vec{r} \times \hat{i}) + (\vec{r} \cdot \hat{j})(\vec{r} \times \hat{j}) + (\vec{r} \cdot \hat{k})(\vec{r} \times \hat{k}) = 0$

70. (*b*)



71. (*a*) From the given D.E we have

$\int dy = \int x dx \Rightarrow y = \frac{x^2}{2} + e$

$\because y_1(0) = 0 \Rightarrow 0 = 0 + e \Rightarrow c = 0 \Rightarrow y = \frac{x^2}{2}$

$\because y_2(0) = 4 \Rightarrow 4 = c \Rightarrow y = \frac{x^2}{2} + 4$

y_1 and y_2 can't interesect each other.

72. (*c*) Given $y = e^x (a\cos x + b\sin x)$

Roots of characteristic eqn is r = 1 ± i

$\Rightarrow (r - 1)^2 = i^2$

$\Rightarrow r^2 - 2r + 2 = 0.$

$\therefore y'' - 2y' + 2y = 0 \Rightarrow \frac{d^2y}{dx^2} - 2\frac{dy}{dx} + 2y = 0.$

73. (*d*) $f(g(x)) = a(cx + d) - b$ and $g(f(x)) = c(ax - b) + d$

$\Rightarrow (ad - b) + (bc + d) - 2d = 0$

$\downarrow \qquad \downarrow$

$f(d) \qquad g(b) = 2d.$

74. (*b*) $\because 3\sin x - \sin 3x = 4\sin^3 x$

$\therefore \int_{-1}^{1} 4\sin^3 x \cos^2 x dx$

Since $\sin^3 x$ is an odd function

$\therefore \int_{-1}^{1} 4\sin^3 x \cos^2 x dx = 0.$

75. (*d*) $\left(2 - (y')^2\right)^{\frac{6}{10}} = y''$

$\Rightarrow \left(2 - (y')^2\right)^3 = (y'')^5$

$\Rightarrow \left(2 - (y')^2\right)^3 = (y'')^5$

$\therefore$ order = 2 and degree = 5

76. (*a*) The given D.E can be rewritten as

$\int \frac{dy}{y^3} = \int 2e^x dx$

$\Rightarrow -\frac{1}{2y^2} = 2e^x + c$

$y(0) = \frac{1}{2} \Rightarrow -\frac{2^2}{2} = 2.e^0 + c \Rightarrow c = -4$

$\therefore -\frac{1}{2y^2} = 2e^x - 4 \Rightarrow -\frac{1}{2y^2} = 2[e^x - 2]$

$\Rightarrow -1 = 4y^2 [e^x - 2]] \Rightarrow 4y^2 [2 - e^x] = 1$

77. (*d*) Since e^{-x} is a +ve function

$p = \int_a^b e^{-x} dx = [-e^{-x}]_a^b = -e^{-b} - (-e^{-a}) = e^{-a} - e^{-b}$

$q = \int_a^b |F(x)| = \int_a^b e^{-x}$ [since $|e^{-x}|$ is always non-negative] $= e^{-a} - e^{-b}$

Hence $p = q$

78. (*a*) Let $I = \int_0^{\frac{\pi}{2}} \frac{a + \sin x}{2a + \sin x + \cos x} dx$ ...(*i*)

Now

$I = \int_0^{\frac{\pi}{2}} \frac{a + \sin\left(\frac{\pi}{2} - x\right)}{2a + \sin\left(\frac{\pi}{2} - x\right) + \cos\left(\frac{\pi}{2} - x\right)} dx$

$\Rightarrow I = \int_0^{\frac{\pi}{2}} \frac{a + \cos x}{2a + \cos x + \sin x} dx$ ...(*ii*)

Adding eq (*i*) and eqn (*ii*) Let get

$2I = \int_0^{\frac{\pi}{2}} \frac{2a + \sin x + \cos x}{2a + \sin x + \cos x} \cdot dx$

$\Rightarrow 2I = \int_0^{\frac{\pi}{2}} 1 dx = \frac{\pi}{2} \Rightarrow I = \frac{\pi}{4}$

79. (*d*) Let $f(x) = \frac{16x^3}{3} - 4bx^2 + x$

$f'(x) = 16x^2 - 8bx + 1$

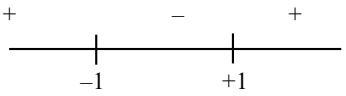
Since D < 0 of the above quadratic eqn

$\Rightarrow b^2 - 4ac < 0$

$\Rightarrow 64b^2 - 64 < 0$

$\Rightarrow b^2 - 1 < 0$

$\Rightarrow (b-1)(b+1) < 0$



$\Rightarrow b \in (-1, 1)$

$\Rightarrow b \in [0, 1)$

80. (*a*) $f(x) = \frac{1}{\sqrt{|x| - x}}$

for domain $|x| > x \Rightarrow x \in (-\infty, 0)$

$g(x) = \frac{1}{\sqrt{x - |x|}} \Rightarrow x > |x|$ (Notpossible)

$\Rightarrow x \in \phi$.

81. (*d*) Let $u = 2\cos x + 5\sin x$

$\Rightarrow du = -2\sin x\,dx + 5\cos x\,dx = (5\cos x - 2\sin x)dx$

Let us take k and m such that:

$3\cos x + 4\sin x = k(5\cos x - 2\sin x) + m(2\cos x + 5\sin x)$

Equating coefficients:

$3 = 5k + 2m$ and $4 = -2k + 5m$

$\Rightarrow 15 = 25\,K + 10\,M$ …(*i*)

$\Rightarrow 8 = -4k + 10\,m$ … (*ii*)

Subtracting (*ii*) from (*i*)

$15 - 8 = 25k + 10m - (-9k + 10m)$

$7 = 29k = k = \frac{7}{29}$ and $m = \frac{26}{29}$

Now we have:

$3\cos x + 4\sin x = \frac{7}{29}[5\cos x - 2\sin x] + \frac{26}{29}(2\cos x + 5\sin x)$

$= \int \frac{3\cos x + 4\sin x}{2\cos x + 5\sin x}dx = \frac{7}{29}|2\cos x + 5\sin x| + \frac{26}{29}x + C$

Given form $\frac{dx}{29} + \frac{B}{29}\ln|2\cos x + 5\sin x| + C$

$\therefore \alpha = 26, \beta = 7$

82. (*a*)

83. (*d*) Given $f(x) = \frac{x}{\ln x}; (x > 1)$

$f'(x) = \frac{\ln x - 1}{(\ln x)^2}$

For increasing $f'(x) > 0$

$\Rightarrow \ln x - 1 > 0 \Rightarrow x > e$

$\therefore$ The first statement is correct

for decreasing $f'(x) < 0$

$\therefore \ln x - 1 < 0$

$\Rightarrow \ln x < 1 \Rightarrow x < e$

$\therefore$ The 2nd statement is also correct

Now $7 < 9$

$\Rightarrow f(7) < f(9)$

$\Rightarrow \frac{7}{\ln 7} < \frac{9}{\ln 9}$

$\Rightarrow 7\ln 9 < 9\ln 7$

$\therefore$ The 3rd statement is also correct.

84. (*d*) $f'(x) = \frac{\ln x - 1}{(\ln x)^2} = \frac{1}{\ln x} - \frac{1}{(\ln x)^2}$

$\Rightarrow f''(x) = \frac{-1}{x(\ln x)^2} + \frac{2}{x(\ln x)^3}$

$\therefore f''(e) = -\frac{1}{e} + \frac{2}{e} = \frac{1}{e} > 0$

Since $f''(x) > 0$ at $x = \frac{1}{e}$

$\therefore f(x)$ attains local minima at $x = e$

$f(e) = \frac{e}{\ln e} = e$ (local minimum value)

85. (*a*) Given

$g(x) = x - \frac{1}{x}$ and $fog(x) = x^3 - \frac{1}{x^3}$.

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

$f(g(x)) = (g(x))^3 + 3g(x)$

$\therefore f(x) = x^3 + 3x$

Now $f(x) - 3x = x^3 + 3x - 3x = x^3$

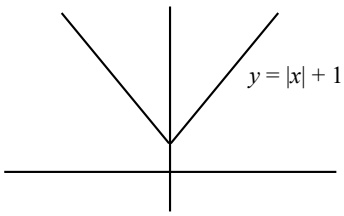
$\therefore g[f(x) - 3x] = x^3 - \frac{1}{x^3}$

86. (*d*) We have $f(x) = x^3 + 3x$

$\Rightarrow f'(x) = 3x^2 + 3$

$\Rightarrow f''(x) = 6x$

87. (*a*) Draw the graph of $f(x) = |x| + 1$



from the graph $f(x)$ is differentiable for all $x < 0$

$g(x) = [x] - 1$

If we take $x = 0.009$ and 0.00011 we get $g(x) = -1$. Hence $g(x)$ is continuous.

If we put $x = 2.5$ in $g(x)$ then we get $g(x) = 1$

$\therefore g'(x) = 0$. Hence it is false

88. (*a*) $\lim_{x\to 0^-} h(x) + \lim_{x\to 0^+} h(x)$

$\lim_{x\to 0^-} \frac{|x|+1}{[x]-1} + \lim_{x\to 0^+} \frac{|x|+1}{[x]-1}$

let $x = -0.0001$ $\quad x = 0.0001$

$= \frac{0+1}{-1-1} + \frac{0+1}{0-1} = -\frac{1}{2} - 1 = -\frac{3}{2}$

89. (*d*) To evaluate $\phi(a)$, we need to understand the behaviour of the integrand $|\sin x|$

$\int_0^{2\pi} |\sin x|\,dx = 2\int_0^{\pi} \sin x dx = 2[-\cos x]_0^{\pi}$

$= 2[-\cos\pi + \cos 0]$

$= 2\,[1+1] = 4$

Therefore, the integral over 50 complete periods is

$\phi(a) = 50 \times 4 = 200$

90. (*a*) $\phi(a) = \int_a^{a+100} |\sin x|\,dx$

$\phi'(a) = \frac{d}{da}\left(\int_a^{a+100} |\sin x|\,dx\right)$

By Leibniz's rule

$\phi'(a) = |\sin(a + 100\,\pi)| - |\sin a|$

$\Rightarrow \phi'(a) = |\sin a| - |\sin a| = 0$

91. (*c*) Given $y = 2f(x) + ax - 8$

$y' = 2f'(x) + a$

Since the given function has local maximum at $x = 0$

$\therefore f'(0) = 0$

and $f''(0) < 0$

So both statements are true.

92. (*b*) We have $y'(x) = 2f'(x) + a$

$y'(0) = 0 \Rightarrow a = 0$

93. (*a*) $f(x) = |x-1|, g(x) = [x]$ and $h(x) = f(x)g(x)$

$h(x) = |x - 1|[x] = -(x - 1)(-1)$ for $x \in (-1, 0)$

$= x - 1, x \in (-1, 0)$

$\int_{-1}^{0} (x-1)dx = \left(\frac{x^2}{2} - x\right)_{-1}^{0} = -\left[\frac{1}{2} + 1\right] = -\frac{3}{2}$

94. (*d*) $h(x) = \begin{cases} 0, & x \in [0,1) \\ x - 1, & x \in [1,2) \end{cases}$

CLICK HERE To Discover more

$\therefore \int_0^2 h(x)\cdot dx = \int_0^1 h(x)dx + \int_1^2 h(x)dx$

$= \int_1^2 (x-1)dx = \left(\frac{x^2}{2} - x\right)_1^2$

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

95. (*a*) Let $I = \int \frac{dx}{\sqrt{x+1} - \sqrt{x-1}}$

$= \int \left(\frac{\sqrt{x+1} + \sqrt{x-1}}{(x+1)-(x-1)}\right) dx$

$= \int \left(\frac{\sqrt{x+1} + \sqrt{x-1}}{2}\right) dx$

$= \frac{1}{2}\left[\frac{(x+1)^{3/2}}{\frac{3}{2}} + \frac{(x-1)^{3/2}}{\frac{3}{2}}\right]$

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

Comparing the given

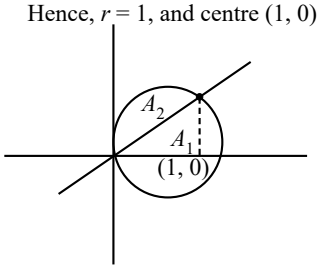
$\alpha = \frac{1}{3}$ and $\beta = \frac{1}{3}$

96. (*c*)

97. (*d*) Given $x^2 + y^2 - 2x = 0$

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

Hence, $r = 1$, and centre $(1, 0)$



$A_2 = \frac{\pi}{4} - \frac{1}{2} = \frac{\pi - 2}{4}$

Similarly

$A_1 = \pi - A_2$

$= \pi - \left(\frac{\pi-2}{4}\right) = \frac{4\pi - \pi + 2}{4} = \frac{3\pi + 2}{4}$

98. (*a*) $\therefore \frac{2(A_1 + A_2)}{A_1 - 3A_2} = \frac{2\left[\frac{(3\pi+2)}{4} + \frac{\pi-2}{4}\right]}{\frac{3\pi+2}{4} - 3\left(\frac{\pi-2}{4}\right)}$

$= \frac{2[\pi]}{\frac{3\pi + 2 - 3\pi + 6}{4}} = \frac{2\pi}{2} = \pi$

99. (*d*) Given $3f(x) + f\left(\frac{1}{x}\right) = \frac{1}{x} + 1$ ...(*i*)

Replace $x \to \frac{1}{x}$

$f(x) + 3f\left(\frac{1}{x}\right) = x + 1$ ...(*ii*)

From eq. (*i*) and eqn. (*ii*)

$f(x) = -\frac{x}{8} + \frac{1}{4} + \frac{3}{8x}$

100. (*a*) $8\int_1^2 f(x)dx = 8\int_1^2 \left(-\frac{x}{8} + \frac{1}{4} + \frac{3}{8x}\right) dx$

$= 8\left[\frac{-x^2}{8.2} + \frac{x}{4} + \frac{3}{8}\log x\right]_1^2$

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

$= \frac{1}{2} + 3\ \log 2$

$= \log\sqrt{e} + \log 8 = \log 8\sqrt{e}$

101. (*c*) $\frac{{}^5C_2 + {}^4C_2}{{}^9C_2} = \frac{4}{9}$

102. (*c*) Mean $= np = 5$

Variance $= npq = 4$

$\therefore \frac{np}{npq} = \frac{5}{4} \Rightarrow q = \frac{4}{5}$

Hence $p = 1 - q = \frac{1}{5}$

$\therefore n = 25$

The value of $5^{23}p(x = 3)$

$= 5^{23}\ {}^{25}C_3 \left(\frac{1}{5}\right)^3 \left(\frac{4}{5}\right)^{22}$

$= \frac{25 \times 24 \times 23}{3 \times 2} \times \frac{4^{22}}{5^2}$

$= 23 \times 4^{23}$

Hence, $\lambda = 23$

103. (*b*)

x	y	xy	x^2	y^2
–4	1	–4	16	1
–1	2	–2	1	4
2	7	14	4	49
3	1	3	9	1
$\Sigma x = 0$	$\Sigma y =$ 11	$\Sigma xy =$ 11	$\Sigma x^2 =$ 30	$\Sigma y =$ 55

$\bar{x} = 0, \bar{y} = \frac{11}{4}$

$b_{yx} = \frac{n\Sigma xy - \Sigma x \Sigma y}{n\Sigma x^2 - (\Sigma x)^2}$

$= \frac{44 - 0}{120 - 0} = \frac{11}{30}$

Regression equation y on x

$y - \bar{y} = b_{yx}(x - \bar{x})$

$y - \frac{11}{4} = \frac{11}{30}(x)$

$y = \frac{11}{4} + \frac{11}{30}x$

Hence, $2a + 15b = 2\left(\frac{11}{4}\right) + 15\left(\frac{11}{30}\right)$
$= 11$

104. (*a*) $x + 2y + 1 = 0 \Rightarrow m_1 = -\frac{1}{2}$

$2x + 3y + 4 = 0 \Rightarrow m_2 = -\frac{2}{3}$

Let 'θ' is the angle between them

$\tan\theta = \left|\frac{m_1 - m_2}{1 + m_1 m_2}\right|$

$\Rightarrow \tan\theta = \frac{1}{8}$

Now, $\tan 3\theta = \frac{3\tan\theta - \tan^3\theta}{1 - 3\tan^2\theta}$

$= \frac{\frac{3}{8} - \frac{1}{512}}{1 - \frac{3}{64}} = \frac{\frac{191}{512}}{\frac{61}{64}} = \frac{191}{488}$

105. (*a*) For random variable x

$n = 10, p = \frac{1}{2}, q = \frac{1}{2}$

Var $(X) = npq = \frac{5}{2}$

Given, $\frac{2X - 3Y}{5X + 4Y} = 4$

$\Rightarrow Y = \frac{-18}{19}X$

$\therefore$ Var (Y) = Var $\left(\frac{-18}{19}X\right)$

$= \left(\frac{-18}{19}\right)^2$ Var (X)

$= \frac{324}{361} \times \frac{5}{2} = \frac{810}{361}$

106. (***) a, b, c are in H.P.

$\Rightarrow \frac{1}{a}, \frac{1}{b}, \frac{1}{c}$ are in A.P.

$\Rightarrow b = \frac{2ac}{a + c}$

$\therefore \frac{1}{b-a} + \frac{1}{b-c} = \frac{2b - (a+c)}{b^2 - (a+c)b + ac}$

$= \frac{2b - \frac{2ac}{b}}{b^2 - 2ac + ac} = \frac{2(b^2 - ac)}{b(b^2 - ac)} = \frac{2}{b}$

$= \frac{a+c}{ac} = \frac{1}{a} + \frac{1}{c}$

Also, $\frac{1}{2}\left(\frac{1}{a} + \frac{1}{b} + \frac{1}{c}\right) = \frac{3}{2b} \neq \frac{2}{b}$

107. (*c*) $\frac{150 + 200 + 250 + 300}{4} = \frac{900}{4}$
$= 225 \approx 230.$

108. (*b*) Favourable outcomes = $\frac{7!}{2!}$

Total outcomes = $\frac{8!}{2!2!}$

Probability = $\frac{\frac{7!}{2!}}{\frac{8!}{2!2!}} = \frac{1}{4}$

109. (*c*) $7^1 = 7$, $7^2 = 49$, $7^3 = 343$, $7^4 = 2401$

Out of every 4 consecutive positive integral, 1 value of '*n*' for $m = 77^n$ ends with 1.

Hence, the probability that the value of *m* will have 1 in the units place is $\frac{1}{4}$.

110. (*c*) Favourable outcomes

(2, 3, 6), (2, 4, 8), (2, 5, 10), (2, 6, 12), (2, 7, 14), (3, 4, 12), (3, 5, 15)

No. of favourable outcomes = 7

Total no. of favourable outcomes = 7

Probability = $\frac{7}{{}^{15}C_3} = \frac{1}{65}$

111. (*d*) $P(A \cup B) = P(A) + P(B) - P(A \cap B)$

$\therefore$ Min. value of $P(A) + P(B)$

$0.75 = P(A) + P(B) - 0.125$

$P(A) + P(B) = 0.875$

112. (*c*) Max. value of $P(A) + P(B)$

$1 = P(A) + P(B) - 0.375$

$1.375 = P(A) + P(B)$

113. (*b*) $P(A \cup B \cup C) = P(A) + P(B) + P(C) - P(A \cap B) - P(B \cap C) - P(A \cap C) + P(A \cap B \cap C)$

For min. value, $P(A \cup B \cup C) = 1$

$P(B \cap C)_{\text{min.}} = 0.2$

114. (*c*) For max. value, $P(A \cup B \cup C) = 0.85$

$P(B \cap C)_{\text{max.}} = 0.35$

115. (*b*) Probability of getting at least one tail,

$$p = 1 - {}^nC_0\left(\frac{1}{2}\right)^n$$

Probability of getting at least two tails,

$$q = 1 - {}^nC_0\left(\frac{1}{2}\right)^n - {}^nC_1\left(\frac{1}{2}\right)^n$$

ATQ,

$$1 - {}^nC_0\left(\frac{1}{2}\right)^n - 1 + {}^nC_0\left(\frac{1}{2}\right)^n + {}^nC_1\left(\frac{1}{2}\right)^n = \frac{5}{32}$$

$$\Rightarrow {}^nC_1\left(\frac{1}{2}\right)^n = \frac{5}{32} \Rightarrow n = 5$$

116. (*a*) $p = 1 - {}^nC_0\left(\frac{1}{2}\right)^n = \frac{31}{32}$

$$q = 1 - {}^nC_0\left(\frac{1}{2}\right)^n - {}^nC_1\left(\frac{1}{2}\right)^n = \frac{26}{32}$$

$\therefore\ p + q = \frac{57}{32}$

117. (*b*) $S = \sum_i^n x_i f_i = 1 + \frac{2}{2} + \frac{3}{4} + \ldots\ldots + \frac{n}{2^{(n-1)}}$ ...(*i*)

$$\frac{S}{2} = \frac{1}{2} + \frac{2}{4} + \ldots\ldots + \frac{n-1}{2^{n-1}} + \frac{n}{2^n} \quad \ldots(ii)$$

(*i*) – (*ii*)

$$\frac{S}{2} = 1 + \left(\frac{1}{2} + \frac{1}{4} + \ldots\ldots\frac{1}{2^{n-1}}\right) - \frac{n}{2^n}$$

$$\frac{S}{2} = 1 - \frac{n}{2^n} + \frac{\frac{1}{2}\left(1 - \left(\frac{1}{2}\right)^{n-1}\right)}{1 - \frac{1}{2}}$$

$$\frac{S}{2} = 1 - \frac{n}{2^n} + \frac{2^{n-1} - 1}{2^{n-1}}$$

$$S = \frac{2^{n+1} - n - 2}{2^{n-1}}$$

118. (*c*) Mean = $\frac{\Sigma x_i f_i}{\Sigma f_i}$

$$= \frac{\frac{2^{n+1} - n - 2}{2^{n-1}}}{\frac{\frac{1}{2}\left(1 - \left(\frac{1}{2}\right)^n\right)}{1 - \frac{1}{2}}} = \frac{2^{n+1} - n - 2}{2^n - 1}$$

119. (*c*) Largest five observations are 32, 35, 41, 47, 50

$$\bar{x} = \frac{32 + 35 + 41 + 47 + 50}{5} = 41$$

M.D. = $\frac{\Sigma |x_i - \bar{x}|}{n}$

$$= \frac{9 + 6 + 0 + 6 + 9}{5} = 6$$

120. (*d*) Variance = $\frac{\Sigma |x_i - \bar{x}|^2}{n}$

$$= \frac{81 + 36 + 0 + 36 + 81}{5} = 46.8$$

Paper II: General Ability

1. (*d*) Deplorable means deserving strong condemnation.

Commendable: deserving praise or approval

Reprehensible: morally wrong and deserving criticism

Opprobrious: expressing severe criticism and blame

Despicable: very unpleasant or cruel

2. (*a*) Counteract means to act against something to reduce its effect.

Exacerbate: make (a problem, bad situation, or negative feeling) worse

Foil: prevent (something considered wrong or undesirable) from succeeding

Thwart: prevent (someone) from accomplishing something

Contravene: violate the prohibition or order of (a law, treaty, or code of conduct)

3. (*a*) Persevere means to continue in a course of action even in the face of difficulty or with little or no prospect of success.

Give up: cease trying; surrender

Persist: continue firmly or obstinately in an opinion or a course of action in spite of difficulty, opposition, or failure

Carry on: continue with an activity or task

Stand firm: maintain one's position or opinion firmly, especially in the face of opposition

4. (*b*) Hideous means extremely unpleasant or ugly.

Beautiful: possessing qualities that give great pleasure or satisfaction to see, hear, think about, etc.; delighting the senses or mind

Appalling: causing shock or dismay; horrific

Grotesque: comically or repulsively ugly or distorted

Macabre: disturbing and horrifying because of involvement with or depiction of death and injury

5. (*d*) Squander means to waste (something, especially money or time) in a reckless and foolish manner.

Manage: control or organize (something or someone) effectively

Fritter away: waste time, money, or energy on trifling matters

Splurge: spend money freely or extravagantly

Squabble: argue over petty and trivial matters

6. (*b*) Continually means regularly or frequently, which fits the context of the sentence referring to the ongoing changes in Earth's climate.

7. (*a*) "These" is used to refer to changes that have been mentioned previously in the passage.

8. (*c*) The sentence discusses activities caused by human actions, such as deforestation and industrial emissions.

9. (*d*) Accumulation refers to the gradual build-up of gases and aerosols in the atmosphere due to human activities.

10. (*c*) The sentence refers to specific gases and aerosols that are known as greenhouse gases.

11. (*a*) Greenhouse gases trap heat and raise air temperatures near the ground.

12. (*d*) The greenhouse effect acts like a greenhouse on the surface of the planet.

13. (*a*) "For" indicates the purpose of strengthening the scientific and analytical capacity.

14. (*b*) The sentence talks about studies being started or initiated under the Climate Change Action Programme.

15. (*b*) "At regular intervals" means at consistent and predetermined times.

16. (*b*) "Paused for" indicates a brief stop or interruption.

17. (*a*) "Broke down" means to stop working, especially due to a mechanical failure.

"Broke up" means to disintegrate or break into pieces.

"Broke into" means to forcibly enter.

"Broke out" means to escape or erupt suddenly.

18. (*b*) "Beneath" implies physically under.

"Except" indicates exclusion, meaning all countries signed the treaty except Germany and France.

"Among" is used for groups.

"During" refers to a period of time.

19. (*a*) turn off - an instance of turning or switching something off

"Call off" means to cancel or abandon.

"Drop off" means to deliver or deposit.

"Break off" means to separate or discontinue abruptly

20. (*c*) "Who" is the correct pronoun for referring to people.

"Whom" is an object pronoun, Which" is used for things, "Whose" is a possessive pronoun

21. (*a*) "At the end of" refers to a specific point in time.

22. (*b*) "That" is the relative pronoun used to introduce restrictive clauses referring to things.

23. (*b*) The present participle "stealing" is used after the verb "denied" to show an action they are refuting.

24. (*b*) "Drop in" means to visit casually or briefly.

"Drop out" typically refers to leaving a course or activity.

25. (*b*) This option correctly uses the base form of the verb "meet" after the modal verb "would like to."

After modal verbs, we use the base form of the verb (infinitive) to express the action.

26. (*c*) When someone or something is described as "bad news," it means they are : considered undesirable or not good to have around.

27. (*c*) Back to the drawing board means to start over again because the previous attempt was unsuccessful.

28. (*d*) Be in the eye of the storm refers to being in the center of a difficult or chaotic situation.

29. (*d*) Life in the fast lane means living a busy, exciting, and sometimes risky lifestyle, often associated with success and wealth.

30. (*b*) To pass the buck means to transfer responsibility or blame to someone else.

31. (*a*) The sentence talks about fundamental rights guaranteed to individuals and includes basic freedoms. So, the correct sequence is Q (the fundamental rights are) S (basic right and) P (include basic freedoms) R (guaranteed to the individual).

32. (*a*) The sentence discusses the Indian nation as the product of a historical process. So, the correct sequence is S (the Indian nation is the product) R (of a historical process that has) P (been in the making) Q (for many millennia).

33. (*a*) The sentence talks about India's Independence representing the start of an epoch imbued with a new vision. So, the correct sequence is S (India's Independence represented) Q (for its people the start of) P (an epoch that was imbued) R (with a new vision).

34. (*c*) The sentence instructs all students to be present before the Principal for a discussion on the forthcoming science and mathematics exhibition. So, the correct sequence is S (all students have been instructed) R (to be present before the Principal) Q (science and mathematics exhibition) P (for a discussion on the forthcoming).

35. (*c*) The sentence states that the team now has two bowlers and two batsmen respectively with the selection of another player. So, the correct sequence is R (with the selection of another player) Q (to the new team) S (the team now has) P (two bowlers and two batsmen respectively).

36. (*a*) "Abode" is a noun, referring to a place of residence.

37. (*d*) "Beyond" is used to express a relationship of space or understanding, placing one thing outside the range or limits of another. So, it functions as a preposition.

38. (*c*) "Except" is used here to introduce a phrase indicating a contrast or exception, making it a preposition.

39. (*b*) "Nicely" modifies the verb "dry-cleaned," indicating how the action was performed, making it an adverb. So, the word class of "(nicely)" is Adverb.

40. (*a*) "This" is specifically classified as a demonstrative determiner, which is used to point out or indicate a specific item.

41. (*a*) The biotic community consists of plants, animals, and microbes. Water, which is mentioned as an abiotic factor that supports and limits these communities, does not itself belong to the biotic components.

42. (*b*) The passage states that the kind of biotic community found in a given area is largely determined by abiotic factors such as the amount of water or moisture, temperature, salinity, and soil type. Thus, it is the abiotic components that largely determine the nature of the biotic community.

43. (*c*) "Algae" is a living organism and part of the biotic community, so it's not an abiotic factor.

44. (*b*) The passage explains that water sustains aquatic communities, implying that these are communities located in water environments.

45. (*c*) The passage describes a species as a group of individuals that show strong similarities in appearance among themselves and are distinct in appearance from other groups, thereby using both similarities and differences to define species.

46. (*a*) "Banished" means to be sent away from a country or place as an official punishment.

Deported: expelled from a country, typically as an official punishment

Called back: asked to return

Accepted: agreed to

Notified: informed

47. (*a*) "Dazzling" refers to something extremely impressive, bright, or skillful.

Brilliant: exceptionally clever or talented

Dismal: depressing; dreary

Pathetic: arousing pity, especially through vulnerability or sadness

Puerile: childishly silly and trivial

48. (*b*) Rebuffed: rejected

Rejected: dismissed as inadequate, inappropriate, or not to one's taste

Took: accepted or received (something offered)

Criticized: indicate the faults of (someone or something) in a disapproving way

Granted: agree to give or allow (something requested) to

49. (*b*) Disowned: abandoned, rejected

Abandoned: left completely and no longer used or wanted

Accepted: consent to receive (a thing offered)

Allowed: gave (someone) permission to do something

Questioned: asked questions of

50. (*c*) Sceptical: doubtful

Doubtful: feeling uncertain about something

Hopeful: feeling or inspiring optimism about a future event

Anxious: feeling or showing worry, nervousness, or unease about something with an uncertain outcome

Expectant: having or showing an excited feeling that something is about to happen, especially something pleasant

51. (*b*) The infinite resistor problem solved using the concept of symmetry

Thus, we can set up the following equation from the combination of resistors

$$R = 4 + \frac{1}{\frac{1}{R} + \frac{1}{4}}$$

Solving for R yields a quadratic equation:

$R^2 - 4R - 16 = 0$

Using the quadratic formula, we find the positive solution for R (since resistance cannot be negative):

$R = 2 + 2\sqrt{5}\Omega$

52. (*c*) When different voltage batteries with internal resistances are parallel-connected, equivalent internal resistance r is:

$$\frac{1}{r} = \frac{1}{r_1} + \frac{1}{r_2} = \frac{1}{0.1} + \frac{1}{0.1}$$

$r = 0.05\Omega$

Using the formula for parallel batteries with internal resistances:

$$V = \frac{\frac{V_1}{r_1} + \frac{V_1}{r_2}}{\frac{1}{r_1} + \frac{1}{r_2}}$$

$$V = \frac{\frac{1}{0.1} + \frac{5}{0.1}}{\frac{1}{0.1} + \frac{1}{0.1}} = \frac{1+5}{2} = 3V$$

The total voltage = 3V, combined internal resistance = 0.05 Ω

Applying Ohm's Law:

$$I = \frac{V_{total}}{R + r_{total}} = \frac{3V}{1000\Omega + 0.05\Omega}$$

$$\approx \frac{3V}{1000.05\Omega}$$

$I \approx 0.003A = 3$ mA

53. (*d*) We know that

$$I = \frac{Q}{t}$$

Here, I = 15 A

t = 10 min = 600 sec

Q = It

Charge passes through the machine during this time

Q = 15 × 600 C

Q = 9000 C

54. (*a*) The shape of the top end of a lightning conductor is a spike or sharp end.

The intensity of electric current is higher near pointed objects. During a lightning strike, the current is drawn to the pointed conductor, which then channels it directly into the ground.

55. (*d*) There are four fundamental forces-gravitational force, electrostatic force, strong and weak nuclear forces. Every force comes under any of these four major types.

56. (*a*) First, let's calculate the mass of the solid sphere:

Mass of solid sphere

$$= \frac{4}{3}\pi\left(\frac{R}{2}\right)^3 \rho = \frac{4}{3}\pi\frac{R^3}{8}\rho = \frac{1}{6}\pi R^3\rho$$

Next, we calculate the mass of the spherical shell. Since the shell has a density of $\frac{\rho}{2}$, its mass is:

Mass of shell =

$$\frac{4}{3}\pi\left(R^3 - \left(\frac{R}{2}\right)^3\right)\frac{\rho}{2} = \frac{4}{3}\pi\left(R^3 - \frac{R^3}{8}\right)$$

$$\frac{\rho}{2} = \frac{4}{3}\pi\frac{7R^3}{8}\frac{\rho}{2} = \frac{7}{12}\pi R^3\rho$$

The total mass of the system (solid sphere + shell) is:

Total mass

$$= \frac{1}{6}\pi R^3\rho + \frac{7}{12}\pi R^3\rho = \frac{1}{6}\pi R^3\rho + \frac{14}{24}\pi R^3\rho$$

$$= \frac{1}{6}\pi R^3\rho + \frac{7}{12}\pi R^3\rho$$

$$= \frac{4}{24}\pi R^3\rho + \frac{14}{24}\pi R^3\rho = \frac{18}{24}\pi R^3\rho = \frac{3}{4}\pi R^3\rho$$

The total volume of the larger sphere is simply the volume of a sphere with radius R:

$$\text{Total volume} = \frac{4}{3}\pi R^3$$

Now, the average mass density (ρ) is the total mass divided by the total volume:

$$\bar{\rho} = \frac{\text{Total mass}}{\text{Total volume}} = \frac{\frac{3}{4}\pi R^3\rho}{\frac{4}{3}\pi R^3} = \frac{3}{4}\rho$$

57. (*d*) The human eye, like a camera lens, adjusts its focal length and pupil size which functions similarly to a camera's aperture to focus on objects and regulate light intake, enabling adaptation to different lighting conditions and distances.

58. (*c*) Article 371A of the Indian Constitution grants Nagaland special provisions. Parliament's laws on Nagas' religious/social practices, customary law, and land ownership don't apply unless the state's Legislative

CLICK HERE To Discover more

Assembly agrees. This ensures cultural preservation. However, state boundary decisions remain under Parliament's jurisdiction.

59. (*c*) Article 191 of the Indian Constitution states that a person cannot be a member of a state legislature if they hold any office of profit under the Government of India or any State Government. This rule helps to avoid conflicts of interest and ensures that legislators act in the public interest without personal financial incentives from the government.

60. (*a*) **1.** Universal Declaration of Human Rights - 1948

4. Convention on Refugees- 1951

3. International Covenant of Economic, Social and Cultural Rights - 1966

2. Convention on the Elimination of All Forms of Discrimination Against Women - 1979

61. (*c*) The main focus of the Second Five-Year Plan in India was on the development of the heavy and basic industries. It did not prioritize the expansion of the consumer goods sector, making option (*c*) the incorrect statement regarding the plan's objectives.

62. (*b*) **First Statement:** Incorrect. Some urban centers developed as capitals of the mahajanapadas, like Patliputra in Magadha.

Second **Statement:** Correct. Major towns often developed along key trade routes and communication lines, enhancing their economic and strategic importance.

Third **Statement:** Correct. These cities became hubs for commerce, culture, and politics, greatly influencing the broader region.

63. (*b*) **First Statement:** Incorrect. The earliest inscriptions in India, such as those of Ashoka, are primarily in Prakrit, not Sanskrit.

Second **Statement:** Correct. The Kharosthi script, prevalent in the northwest region of ancient India, was deciphered in part through the examination of coins from the Indo-Greek kings.

Third **Statement:** Correct. Ancient inscriptions typically focus on significant events and rarely discuss mundane activities like routine agricultural practices.

64. (*a*) We need to determine the relative abundances of isotopes ^{10}B and ^{11}B such that the average atomic mass of boron is 10.81.

Let us suppose, abundance of $^{10}B = x$

$\therefore$ Abundance of $^{11}B = (100 - x)$

$$\frac{10x + 11(100 - x)}{100} = 10.81$$

$10x + 1100 - 11x = 1081$

$x = 19$

Thus, the abundance of ^{10}B is 19%, and for ^{11}B (which is 100 − x):

$100 - 19 = 81$

Therefore, the abundances are 19% for ^{10}B and 81% for ^{11}B.

65. (*b*) Portland cement is mostly used in construction work. It is made from lime (calcium oxide), silica (silicon dioxide), alumina, iron oxide, and gypsum (calcium sulphate).

66. (*b*) The most commonly used natural indicator is litmus. It is extracted from lichens. It has a mauve (purple) colour in distilled water. When added to an acidic solution, it turns red and when added to a basic solution, it turns blue. It is available in the form of a solution, or in the form of strips of paper, known as litmus paper. Generally, it is available as red and blue litmus paper.

67. (*d*) Oxygen typically has an oxidation state of –2. With five oxygen atoms, the total oxidation state contributed by the oxyen is $5 \times -2 = -10$.

Let x be the oxidation state of vanadium. Since there are two vanadium atoms, their combined oxidation state is 2x.

Setting up the equation for charge balance.

$2x + (-10) = 0$

$2x = 10$

$x = +5$

Therefore, the oxidation state of vanadium in V_2O_5 is + 5.

68. (*a*) A. **Graphite** is known for being a soft and slippery material, which is due to its layered structure, allowing layers to slide over each other easily. Therefore, A matches with 4.

B. **Diamond** is renowned for being the hardest natural substance due to its extremely strong tetrahedral bonding between carbon atoms. Therefore, B matches with 2.

C. **Fullerene** refers to molecules composed entirely of carbon, taking the form of a hollow sphere, ellipsoid, or tube. Fullerenes are known for their strength and lightness. Therefore, C matches with 3.

D. **Graphene** is a single layer of carbon atoms arranged in a hexagonal lattice and is acclaimed as the thinnest and strongest material known. Therefore, D matches with 1.

69. (*d*) (*i*) The International Date Line is roughly along the 180° meridian, but it deviates in several places to avoid dividing land areas and to accommodate international boundaries, mainly in the Pacific Ocean , not the Atlantic Ocean as mentioned.

(*ii*) The second statement is incorrect as it states the date to the East of this line is 24 hours earlier than to the West. In fact, the date to the East is one day (24 hours) ahead, not earlier, than the date to the West.

70. (*d*) Statements 1, 2 and 3 are correct.

The solar wind, composed of charged particles from the sun, interacts with Earth's magnetic field and is directed towards the magnetic poles. This interaction causes the particles to collide with gases in the Earth's atmosphere, creating the auroras, which are visible as colorful displays of light near the poles.

colors of the aurora depend on the type of gas the particles interact with. Oxygen produces green and red light, while nitrogen produces blue and purple hues.

In April 2023, aurora was captured in the night sky in India by the Indian Astronomical Observatory at Hanle, Ladakh.

71. (*a*) Barchans are indeed crescent-shaped sand mounds that form in deserts where the wind consistently blows from one direction. However, statement 2 is incorrect because the windward side of a Barchan is actually gently sloping, not steep. Statement 3 correctly describes the horns of a Barchan pointing opposite to the wind direction, but since statement 2 is incorrect, the complete answer is only statement 1.

72. (*b*) Regur soil, also known as black soil, is dark and made from volcanic rocks under hot and humid conditions, as stated in statement 2. It's ideal for growing cotton, which is confirmed in statement 3. However, statement 1 is incorrect because Regur soil is dark, not light-colored.

73. (*b*) Clouds are indeed classifi ed based on their altitude and form, and according to altitude, they are categorized as high, middle, and low clouds, which is correct in statements 1 and 2. However, statement 3 is incorrect because Stratus, Nimbostratus, and Stratocumulus are not high clouds; they belong to the low and middle cloud categories.

74. (*c*) Cold fronts often bring thunderstorms due to the rapid upward movement of warm air, which is mentioned in statement 2. Statement 3 is correct because a warm front is where warmer air moves over and replaces colder air. Statement 1 is incorrect; fronts usually cause rapid, not slow, changes in weather.

75. (*d*) Alkaline soils are indeed rich in sodium and calcium and have a pH above 7.0. Black cotton soil develops from volcanic rocks in hot, humid climates. Laterite soils are formed through deep weathering processes that remove silica, making all the provided descriptions accurate.

76. (*b*) Prairies are vast grasslands located in mid-latitudes, known for having few trees or shrubs, have a climate with hot summers and cold winters, and receive low rainfall mainly in spring and summer. In their more humid regions, prairie grasses can grow quite tall.

77. (*d*) The cell membrane includes phospholipids, proteins and cholesterol. This composition ensures the structural stability and functionality of the cell.

78. (*d*) The retina is part of the human eye, not the compound microscope. A compound microscope consists of components that assist in viewing small objects, such as the mirror (for directing light), the stage (where the specimen is placed), and the clip (to hold the slide in place).

79. (*d*) Proteins are complex molecules forming the building blocks of cells. Tissues are groups of similar cells performing specific functions. Organs are made up of tissues working together for more complex functions. Finally, organisms are complete living entities made up of multiple organs.

80. (*d*) All four listed cell types—Monocyte, Chondrocyte, Basophil, and Lymphocyte are animal cell types. Monocytes, lymphocytes, and basophils are types of white blood cells found in the immune system. Chondrocytes are cells found in cartilage tissue.

81. (*c*) The pancreas plays a crucial role in the human digestive system by secreting digestive enzymes: lipase, which breaks down fats; amylase, which digests carbohydrates; and protease, which breaks down proteins. Meanwhile, the gall bladder stores and regulates the release of bile.

82. (*b*) DNA replication involves the opening up of the chromatin to allow the replication machinery access to the DNA. Before cell division, chromatin condenses into rod-shaped chromosomes to ensure proper distribution of genetic material. However, cell division differs between prokaryotes, which use binary fission, and eukaryotes, which can undergo mitosis or meiosis.

83. (*a*) Given, m = 0.24 kg

$g = 10\ m/s^2$

Total length of the scale, L = 1 meter

Position of W_1 from one end = 0.2 m

Position of W_2 from the other end = 0.4 m

Total Weight of the Meter Scale

$W = m \times g = 0.24\ kg \times 10\ m/s^2 = 2.4\ N$

The weight acts at the midpoint, so the distance from W_1 to the midpoint is 0.5 − 0.2 = 0.3m, and the distance from W_2 to the midpoint is 0.5 − 0.4 = 0.1m.

Now, applying the principle of moments about the point where W_1 is acting, we have: $N_1 \times 0.2m + W \times 0.3m = N_2 \times 0.8m$

Substituting the known values: $N_1 \times 0.2 + 2.4 \times 0.3 = N_2 \times 0.8$

$$0.2N_1 + 0.72 = 0.8\ N_2 \quad ...(i)$$

Since the scale is in equilibrium, the total upward force must equal the total downward force: $N_1 + N_2 = W$

$$N_1 + N_2 = 2.4N \quad ...(ii)$$

Solving these two equations simultaneously, we get:

$N_1 = 1.6$ N and $N_2 = 0.8$ N

84. (*a*) For escape velocity the formula is,

$$v_e = \sqrt{\frac{8}{3}G\pi R^2\rho}$$

Planet's radius is half of the Earth's radius and mass density is four times that of the Earth

$$v_e = \sqrt{\frac{8}{3}G\pi\left(\frac{R}{2}\right)^2(4\rho)}$$

$$v_e = \sqrt{\frac{\frac{8}{3}G\pi R^2}{4}(4\rho)}$$

$$v_e = \sqrt{\frac{8}{3}G\pi R^2\rho} = 11.2\,km\,s^{-1}.$$

85. (*c*) Sound waves in air (and other fluid media) are classified as longitudinal waves because the medium's particles vibrate in a direction that is parallel to the movement of the sound wave itself.

86. (*d*) The initial velocity v_i just before impact, $v_i = \sqrt{2gh_1}$

where $g = 10\ m/s^2$ and $h_1 = 0.45$ m:

$$v_i = \sqrt{2\times10\times0.45} = \sqrt{9} = 3\,m/s$$

The final velocity v_f just after the bounce, as the ball starts to rise to a lesser height h_2 = 0.20 m, $v_f = \sqrt{2gh_2}$ $v_f = \sqrt{2\times10\times0.20} = \sqrt{4} = 2\,m/s$

Thus, the change in velocity v is

$\Delta v = v_f + v_i = 2 + 3 = 5$ m/s

The impulse J equals the change in momentum, and using the impulse-momentum theorem:

$J = m\Delta v = 0.1 \times 5 = 0.5$ kg·m/s

The contact time t with the floor is 0.1s, so the average force F exerted by the ball on the floor is:

$$F = \frac{J}{t} = \frac{0.5}{0.1} = 5\,N$$

87. (*d*) For a simple pendulum, the time period is independent of amplitude only when the amplitude is small. This is because the restoring force is approximately proportional to the displacement from the equilibrium position, which is a condition for simple harmonic motion. For larger amplitudes, this approximation no longer holds true, and the time period does become dependent on the amplitude.

88. (*c*) Static friction is greater than kinetic friction because it takes more force to overcome the initial resistance of an object at rest compared to when it's already in motion. Rolling friction, which occurs when one object rolls over another, is typically lower than both static and kinetic friction.

89. (*d*) The bob A will not ascend because in an elastic collision between two bodies of equal mass, their velocities are interchanged. Consequently, post-collision, bob A will come to a halt while bob B will move forward with the velocity initially possessed by bob A.

90. (*a*) Infrared waves are indeed often referred to as heat waves because they are commonly associated with heat transfer. Additionally, water molecules have a strong absorption spectrum

in the infrared region, meaning they readily absorb infrared waves, which contributes to their heating.

91. (*d*) **Statement 1 is correct:** The British trade surplus with India means Britain exported more valuable goods to India than it imported, leading to a surplus.

Statement 2 is correct: India helped Britain manage its trade deficits with other countries by providing a surplus through trade.

Statement 3 is correct: Britain cultivated opium in India and exported it to China, making it India's largest export at the time.

Statement 4 is incorrect: The 19th century saw an increase in the export of Indian raw materials and a decrease in manufactured goods, opposite to what the statement claims.

92. (*a*) **Muhurta:** Muhurta refers to a specific measure of time in ancient Indian systems. It is typically a unit used to denote a certain period, roughly equivalent to 48 minutes.

Raktika: Raktika is a lesser-known term and in some contexts, it could refer to a measure of weight, particularly in ancient or historical texts.

Angula: Angula is an ancient Indian unit of length. It is equivalent to the width of a finger, approximately three-quarters of an inch.

Pada: In the context of ancient Indian literature, 'Pada' refers to the metre of poetry, describing the structural components of verses in classical Indian texts.

93. (*d*) The first coins to bear the names and images of rulers were issued by the Indo-Greeks, who established control over the north-western part of the subcontinent c. second century BCE.

94. (*a*) Social theorists in the nineteenth and twentieth centuries highlighted the rise of industrialization, urbanization, secularization, and bureaucratization as defining features of modernity.

95. (*b*) Launch of Non-Cooperation Movement - 1920

All-India Khilafat Conference in Delhi- Nov. 1919

Passing of the Rowlatt Act - 18 Mar.1919

Jallianwala Bagh incident- April.1919

96. (*b*) **Upari:** This refers to a category of tenancy tenure that was held under the Marathas, specifically a type of secondary or subordinate tenancy.

Pattadar: This term is used in southern India to describe a co-parcenary title holder who is directly responsible for the payment of revenue to the government.

Mirasidar: In southern India, particularly in regions like Tamil Nadu, a Mirasidar is a hereditary landowner who holds a title to the land and is typically responsible for direct payments of land revenue.

Inam **lands:** These are lands or land revenues granted as gifts, typically to individuals for their service to a ruler or as a charitable grant, and are exempt from general tax obligations.

97. (*a*) He led military campaigns against the gajapati kingdom of oridssa, reflecting his efforts to expand and consolidate.

Krishnaraya then restored sultan mahamud shah to power, and assumed, in com-memoration of the act, the tittle of yavana-raj-ya -sthapan-acharya.

98. (*b*) Water gas is an equimolar mixture of carbon monoxide and hydrogen. It is prepared by passing steam over red hot coke.

99. (*b*) The human body works within the pH range of 7.0 to 7.8.

100. (*b*) (a) This statement is correct. Water has a high specific heat capacity, which means it requires a lot of energy to change its temperature.

(b) This statement is incorrect. The amount of heat energy that is required to change 1 kg of a solid into liquid at atmospheric pressure at its melting point is known as the latent heat of fusion. Water has a high latent heat of fusion.

This property contributes to water's effectiveness in regulating environments and temperature.

(c) This statement is correct. Water is denser than ice, which is why ice floats in liquid water.

(d) This statement is correct. Pure water does not contain enough free ions to conduct electricity effectively.

101. (*c*) Ethyl acetate is known for its pleasant, sweet, and fruity aroma, which is why it is often used in food flavourings and fragrances.

102. (*c*) NaCl has a face-centered cubic (fcc) arrangement (also called cubic close packing, i.e., ccp). In NaCl, each Na^+ is surrounded by six Cl^- ions and each Cl^- is surrounded by six Na^+ ions. In other words, the Na^+ ions as well as Cl^- ions have a coordination number of six, i.e., this structure has 6 : 6 coordination ratio.

103. (*a*) Methanoic acid, also known as formic acid, is the substance found in the hairs of nettle leaves that causes the characteristic burning sensation and pain when the skin comes into contact with nettles.

104. (*d*) Magnesium hydroxide is commonly referred to as Milk of Magnesia. It is frequently used as an antacid .

105. (*d*) Soap molecules in water can arrange themselves into structures known as lyotropic liquid crystals, where the soap molecules form micelles or other complex structures that are crucial for their cleansing action. This arrangement allows them to interact with both water and oily substances, effectively cleaning surfaces by emulsifying grease and dirt.

106. (*b*) Borax, also known as sodium tetraborate decahydrate, is a compound made up of sodium, boron, oxygen, and hydrogen. Its chemical formula is $Na_2B_4O_7 \cdot 10H_2O$, indicating the presence of these elements.

107. (*b*) Magnesium oxide (MgO) has a very high melting point, about 2852°C. This makes it the oxide with the highest melting point among the options given, significantly higher than that of sodium oxide (Na_2O), iron(III) oxide (Fe_2O_3), and copper (II) oxide (CuO). In MgO, strong ionic bonds and lattice structure contribute to its high melting point.

108. (*c*) Neap tides occur every 14 to 15 days during the fi rst and third quarter moons, when the gravitational pull between the Moon and Sun is at a right angle, reducing their combined effect on Earth's tides, thus creating a smaller tidal range.

109. (*b*) The point directly above the earthquake's focus on the Earth's surface is indeed called the epicenter, and earthquakes do generate primary and secondary waves that radiate outward. However, statement 3 is incorrect because shallow-focus earthquakes generally cause more damage than deep-focus ones.

110. (*c*) Air temperature is measured at a standard height of 1.2 meters above the ground to avoid surface heat effects. Additionally, the environmental temperature lapse rate describes how the temperature decreases with altitude, making both statements correct.

111. (*c*) Higher the air temperature lowers the relative humidity of the air.

This statement is generally correct. As air temperature increases, its capacity to hold water vapor increases. If the actual amount of water vapor in the air remains constant while the temperature increases, the relative humidity decreases.

112. (*d*) **Rotation Direction:** In the Northern Hemisphere, cyclones rotate counter-clockwise and anticyclones rotate clockwise due to the Coriolis effect.

Weather Associations: Cyclones typically bring cloudy or rainy weather due to ascending, cooling air, while anticyclones are associated with fair weather due to descending, warming air.

Southern Hemisphere Rotation: In the Southern Hemisphere, the rotation directions are reversed; cyclones rotate clockwise and anticyclones counter-clockwise, again due to the Coriolis effect.

113. (*a*) Mormugao Port is a port on the western coast of India, in the coastal state of Goa. Commissioned in 1885 on the site of a natural harbour, it is one of India's oldest ports. It is a natural harbour protected by a breakwater and also by a mole. A deep draft channel with 14.4 mtrs. depth permits large vessels to enter the harbour.

114. (*c*) (i) **Raw Materials:** Rourkela receives coal from Jharia and iron-ore from Sundargarh and Kendujhar, important for steel production.

(ii) **Power Source:** Electric power is sourced from Hirakund Dam, crucial for the plant's operations.

(iii) **Water Supply:** Water needed for the plant comes from the Koel and Sankh rivers.

115. (*b*) Statement (3) Large convective cells in the crust circulate heat and drive plate-tectonic processes. which is incorrect.

Large convective cells are present in the mantle, not the crust. These convective cells circulate heat and drive plate tectonics.

116. (*b*) (i) The Brahmaputra rises in Tibet, where it is known as Tsangpo and runs a long distance till it crosses over into India in Arunachal Pradesh under the name of Dihang.

(ii) The Godavari River has a coverage area of 312, 812 km2 (120, 777 sq mi), which is nearly one-tenth of the area of India.

(iii) The Chambal and Betwa rivers are important tributaries, but not of the Ganga. They are tributaries of the Yamuna River, which is a significant tributary of the Ganges. They join the Yamuna, not the Ganga directly.

117. (*d*) (i) **Tropical Wet Climate:** Dominated by the ITCZ, it's one of the rainiest due to its nearly constant ITCZ presence, leading to high rainfall all year.

(ii) **Tropical Savanna Climate:** Features distinct wet and dry seasons due to the seasonal shift of the ITCZ and subtropical highs, influencing rainfall patterns.

(iii) **Tropical Monsoonal Climate:** Experiences heavy rainfall as the ITCZ remains nearby for much of the year, coupled with monsoonal winds.

118. (*c*) (i) Tropical cyclones typically form in all tropical oceans except the South Atlantic and eastern South Pacific during summer and autumn, which is correct.

(ii) The statement is incorrect because tropical cyclones in both these regions are called hurricanes, not typhoons. Typhoons occur in the northwestern Pacific.

(iii) This statement is correct as tropical cyclones in these regions are indeed referred to as cyclones.

119. (*b*) (i) Temperate forests are characterized by high rainfall and temperatures that range from cold in the winter to mild in the summer. This matches the climate description given.

(ii) Temperate forests are primarily composed of deciduous trees such as maple, oak, hickory, and beech. These trees shed their leaves annually and are prevalent in these forests, fitting the description provided.

(iii) Common animals in temperate forests include raccoons, opossums, bats, and squirrels. These species are well adapted to the varied climate and abundant food sources available in these forests.

120. (*a*) Leaves of most plants appear green because chlorophyll, the pigment primarily responsible for photosynthesis, absorbs light predominantly in the red and blue wavelengths but reflects green light. This reflected green light is what we see, giving the leaves their characteristic green color.

121. (*d*) Prokaryotes generally have a single, circular chromosome that contains all their genetic information.

122. (*b*) Bacterial DNA is referred to as naked because it is not associated with histone proteins and absence of nuclear envelope around it.

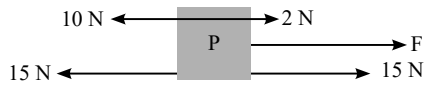
123. (*a*) Lymphocytes, both B and T lymphocytes are responsible for immune responses of the body. B lymphocytes (B cells) are the type of cells in the immune system that produce antibodies. These antibodies are specialized proteins designed to bind to specific antigens on pathogens, marking them for destruction by other immune cells.

124. (*c*) To keep the box at rest, the forces acting on it must balance each other out to maintain equilibrium. Therefore,

$10N + 15N = 2N + F + 15N$

$25 = 17 + F$

$F = 25 - 17 = 8N$



125. (*c*) Nuclear reactors are primarily used for generating electricity through nuclear fission reactions. The components typically found in a nuclear reactor include a reaction chamber (where the nuclear reaction occurs), a heat exchanger (to transfer heat produced by the reaction), and a turbine (to convert heat energy into mechanical energy, which is then used to generate electricity).

126. (*b*) In BDEC,

$$\frac{1}{R_{parallel}} = \frac{1}{10} + \frac{1}{10} = \frac{2}{10} = \frac{1}{5}$$

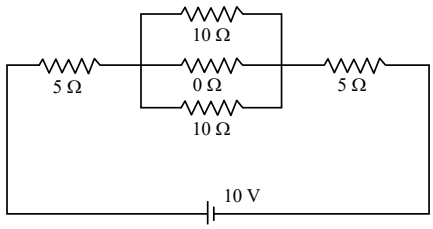
$R_{parallel} = 5\Omega$

Solving Further, $R_{eq} = 5 + 5 + 5 = 15\Omega$

According to ohm's law, V=IR

$10 = I*15$

$$I = \frac{10}{15}A$$



127. (*a*) A typical microscope utilizes a system of lenses to magnify small objects or details that are too tiny to be seen with the naked eye. The basic compound microscope, which

CLICK HERE To Discover more

is commonly used in laboratories and educational settings, consists of two specific types of lenses:

(I) Objective Lens: This is the lens closest to the object being viewed. It has a short focal length and is typically a convex lens, which is designed to capture and magnify the image of the object.

(II) Eyepiece Lens (Ocular Lens): This lens is closer to the eye of the observer. It further magnifies the image formed by the objective lens. Like the objective lens, the eyepiece is also typically a convex lens.

128. (*d*) This can be derived from the lens formula. Solving for v, $v = uf/u - f$

This graph will show a hyperbolic relationship. As u increases (object moves further away), v approaches f from the right side.

129. (*b*) The primary rainbow is formed when sunlight enters a water droplet, undergoes refraction (bending of light), one internal reflection inside the droplet, and then exits, undergoing another refraction. This process separates the light into its constituent colors, creating the rainbow. The primary rainbow is the innermost of the two rainbows typically seen and forms at an angle of about 42 degrees to the line of sight.

130. (*c*) The scientist who mentioned that an electron in an atom could revolve in certain stable orbits without the emission of radiant energy is Niels Bohr.

131. (*d*) The LIGO (Laser Interferometer Gravitational-Wave Observatory) experiment confirmed the existence of gravitational waves, which were one of the predictions made by Albert Einstein's General Theory of Relativity.

132. (*b*) Work-energy principle states that the work done by all forces acting on an object equals the change in its kinetic energy.

Therefore,

$$KE = \frac{1}{2}mv^2$$

$$KE = \frac{1}{2} \times 2kg \times (3m/s)^2$$

KE = 9 Joules

Now, Work done by friction equal to the change in kinetic energy since it comes to rest,

Work = F × d = –KE = – 9 J

Friction force, F × 3 m = 9 N N = 3 N

133. (*b*) The primary agents responsible for the conduction of electrical current in a metal are free electrons. In metals, electrons are not tightly bound to individual atoms but are instead shared and move freely among the lattice of atomic nuclei.

134. (*a*) **Ibn Battuta describes the postal system:** In India the postal system is of two kinds. The horsepost, called uluq, is run by royal horses stationed at a distance of every four miles. The foot-post has three stations per mile; it is called dawa, that is one-third of a mile .

135. (*b*) Chakrapanidatta, a prominent 11th-century physician and scholar from Bengal, is known for his significant contributions to Ayurvedic medicine, including several commentaries on classical texts. Among the works attributed to him, the notable commentary on the Sushruta Samhita is "Bhanumati."

136. (*c*) Tobacco plant, which arrived first in the Deccan, spread to northern India in the early years of the seventeenth century. During the reign of Emperor Akbar, tobacco was introduced by the Portuguese in the late 16th century.

137. (*d*) **Statement-I:** The Women's Indian Association (WIA) was founded at Adyar, Madras, in 1917 by Annie Besant, Margaret Cousins, Dorothy Jinarajadasa, and others to liberate women from the deplorable condition women suffered in socio-economic and political matters during the 19th and the early 20th century.

Statement-II: The NCWI was founded by Lady Aberdeen of the ICW and Lady Meherbai Tata (wife of Dorabji Tata), as the Indian representative of the ICW.

Statement-III: Bharat Stree Mahamandal was a women's organisation in India founded by Sarala Devi Chaudhurani in Prayagraj in 1910.

138. (*a*) **Statement-I:** M.C. Rajah advocated for joint electorates, arguing that separate electorates would isolate the depressed classes from broader society.

Statement-II: This group, notably led by Dr. B.R. Ambedkar, sought separate electorates to ensure independent political representation for the depressed classes.

Statement-III: Although the Communal Award initially proposed separate electorates, the ensuing Poona Pact led by Gandhi resulted in reserved seats in general electorates instead of separate ones.

139. (*c*) **Multiple Routes:** The Silk Routes included several overland and maritime paths linking Asia with Europe and North Africa.

Historical **Longevity:** These routes were active from before the Christian Era until the 15th century.

Varied **Trade Goods:** Not only silk but also Chinese pottery, Indian and Southeast Asian textiles and spices traveled these routes.

140. (*c*) The first coating on the rock was of clay mixed with rice husk and gum. A coat of lime was done over this which was carefully smoothed and polished. This polished surface provided the ground on which first-created paintings were created. The outline drawing was in dark brown or black and subsequently colours were added.

141. (*c*) Square Kilometer Array is a state of the art, mega science international facility to build the world's biggest and most sensitive radio telescope for addressing a wide variety of cutting-edge science goals.

The SKAO, collocated in Australia (SKA-Low) and South Africa (SKA-Mid) with operational headquarters in the UK, is expected to revolutionize radio astronomy, while driving the growth of many important new state-of-the-art technologies.

Other ten countries involved are - Australia, Canada, China, India, Italy, New Zealand, South Africa, Sweden, and the Netherlands.

142. (*c*) Exercise 'Desert Cyclone' signifies further strengthening of bonds of friendship and trust between India and the UAE.

143. (*a*) The Finance Commission is not established under Article 263 but under Article 280 of the Constitution of India, which is why statement 2 is incorrect.

144. (*d*) The Ministry of Environment, Forest and Climate Change (MoEF&CC) of India has submitted nominations for

Wetland City Accreditation (WCA) under the Ramsar Convention for three cities: Indore and Bhopal in Madhya Pradesh, and Udaipur in Rajasthan.

145. (*b*) **Statement-I:** This statement is incorrect. In India, National Youth Day is actually celebrated on January 12th, not March 12th.

Statement-II: This statement is correct. National Youth Day is indeed celebrated on January 12th every year to honor the teachings and contributions of Swami Vivekananda.

146. (*c*) (i) **INS Sagardhwani:** It is an oceanographic research vessel operated by the Naval Physical and Oceanographic Laboratory (NPOL) of DRDO, designed for conducting oceanographic and acoustic research.

(ii) **Sagar Maitri Mission-4:** This mission involved INS Sagardhwani embarking on an initiative to establish long-term scientific partnerships with Indian Ocean Rim countries, focusing on ocean research and development.

147. (*c*) Shri Ram Nath Kovind, the former President of India, is the chairman of the committee formed by the Government of India to examine the issue of holding simultaneous elections in the country. This committee was established to consider the feasibility of and provide recommendations for conducting simultaneous elections to various legislative bodies across the nation.

148. (*c*) India's first all-girls Sainik School was inaugurated in Vrindavan, Uttar Pradesh, by Defence Minister Rajnath Singh. This initiative aims to provide military education to girls and enhance their opportunities in the armed forces.

149. (*a*) In February 2024, the Government of India decided to scrap the Free Movement Regime(FMR) with Myanmar. This decision was taken to ensure the country's internal security and maintain the demographic structure of India's northeastern states that border Myanmar.

150. (*b*) Dr. S. Jaishankar, the current Minister of External Affairs of India, is the author of "Why Bharat Matters." The book discusses India's evolving role on the global stage and its significance in foreign policy.

CLICK HERE To Discover more