

NDA/NA SOLVED PAPER 2023-II

MATHEMATICS

- If $z\bar{z} = |z + \bar{z}|$, where $z = x + iy$, $i = \sqrt{-1}$ then the locus of z is a pair of :
 - Straight lines
 - rectangular hyperbolas
 - parabolas
 - circles
- If $1! + 3! + 5! + 7! + \dots + 199!$ is divided by 24, what is the remainder?
 - 3
 - 6
 - 7
 - 9
- What is the value of $\sqrt{12+5i} + \sqrt{12-5i}$, where $i = \sqrt{-1}$?
 - 24
 - 25
 - $5\sqrt{2}$
 - $5(\sqrt{2}-1)$
- If $A = \begin{bmatrix} 1 \\ 2 \\ 3 \end{bmatrix}$, then what is value of $\det(I + AA')$, where I is the 3×3 identity matrix?
 - 15
 - 6
 - 0
 - 1
- If A, B and C are square matrices of order 3 and $\det(BC) = 2\det(A)$, then what is the value of $\det(2A^{-1}BC)$?
 - 16
 - 8
 - 4
 - 2
- If the n^{th} term of a sequence is $\frac{2n+5}{7}$, then what is the sum of its first 140 terms?
 - 2840
 - 2780
 - 2920
 - 5700
- Let A be a skew-symmetric matrix of order 3. What is the value of $\det(4A^4) - \det(3A^3) + \det(2A^2) - \det(A) + \det(-I)$ Where I is the identity matrix of order 3?
 - 1
 - 0
 - 1
 - 2
- If $A = \begin{bmatrix} 0 & 3 & 4 \\ -3 & 0 & 5 \\ -4 & -5 & 0 \end{bmatrix}$, then which one of the following statements is correct?
 - A^2 is symmetric matrix with $\det(A^2) = 0$
 - A^2 is symmetric matrix with $\det(A^2) \neq 0$
 - A^2 is skew-symmetric matrix with $\det(A^2) = 0$
 - A^2 is skew-symmetric matrix with $\det(A^2) \neq 0$
- If $A = \begin{bmatrix} 2 & 0 & 0 \\ 0 & 3 & 0 \\ 0 & 0 & 4 \end{bmatrix}$, then which of the following statements are correct?
 - A^n will always be singular for any positive integer n .
 - A^n will always be a diagonal matrix for any positive integer n .
 - A^n will always be a symmetric matrix for any positive integer n .

Select the correct answer using the code given below:

 - 1 and 2 only
 - 2 and 3 only
 - 1 and 3 only
 - 1, 2 and 3
- If $(a+b), 2b, (b+c)$ are in HP, then which one of the following is correct?
 - a, b and c are in AP
 - $a-b, b-c$ and $c-a$ are in AP
 - a, b and c are in GP
 - $a-b, b-c$ and $c-a$ are in GP
- Let $t_1, t_2, t_3, \dots$ be in GP. What is $(t_1 t_3 \dots t_{21})^{\frac{1}{11}}$ equal to?
 - t_{10}
 - t_{10}^2
 - t_{11}
 - t_{11}^2
- Which one of the following is a square root of $-\sqrt{-1}$?
 - $1+i$
 - $\frac{1-i}{\sqrt{2}}$
 - $\frac{1+i}{\sqrt{2}}$
 - $\frac{1}{\sqrt{2}}i$
- What is the maximum number of points of intersection of 10 circles?
 - 45
 - 60
 - 90
 - 120
- A set S contains $(2n+1)$ elements. There are 4096 subset of S which contain at most n elements. what is n equal to?
 - 5
 - 6
 - 7
 - 8
- If $\begin{vmatrix} x^2-3x & x-1 & x+3 \\ x+1 & -2x & x-4 \\ x-3 & x+4 & 3x \end{vmatrix} = ax^4 + bx^3 + cx^2 + dx + e$, then what is the value of e ?
 - 1
 - 0
 - 1
 - 2

16. If all elements of a third order determinant are equal to 1 or -1, then the value of the determinant is:
 (a) 0 only
 (b) an even number but not necessarily 0
 (c) an odd number
 (d) 0, 1 or -1
17. If $A = \begin{bmatrix} 2 & -1 & 0 \\ -1 & 3 & 0 \\ 1 & 0 & 1 \end{bmatrix}$, then what is the value of $\det[\text{adj}(\text{adj}A)]$?
 (a) 5 (b) 25
 (c) 125 (d) 625
18. If $A = \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix}$, then what is $23A^3 - 19A^2 - 4A$ equal to?
 (a) Null matrix of order 3
 (b) Identity matrix of order 3
 (c) $\begin{bmatrix} 2 & 0 & 0 \\ 0 & 2 & 0 \\ 0 & 0 & 2 \end{bmatrix}$
 (d) $\begin{bmatrix} 7 & 0 & 0 \\ 0 & 7 & 0 \\ 0 & 0 & 7 \end{bmatrix}$
19. The value of the determinant of a matrix A of order 3 is 3. If C is the matrix of cofactors of the matrix A, then what is the value of determinant of C^2 ?
 (a) 3 (b) 9
 (c) 81 (d) 729
20. If $A_k = \begin{bmatrix} k-1 & k \\ k-2 & k+1 \end{bmatrix}$, then what is $\det(A_1) + \det(A_2) + \det(A_3) + \dots + \det(A_{100})$ equal to?
 (a) 100 (b) 1000
 (c) 9900 (d) 10000
21. The Cartesian product $A \times A$ has 16 elements among which are (0, 2) and (1, 3). Which of the following statements is/are correct?
 1. It is possible to determine set A
 2. $A \times A$ contains the element (3, 2).
 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
22. Let $A = \{1, 2, 3, \dots, 20\}$. Define a relation R from A to A by $R = \{(x, y) : 4x - 3y = 1\}$, where $x, y \in A$. Which of the following statements is/are correct?
 1. The domain of R is $\{1, 4, 7, 10, 13, 16\}$.
 2. The range of R is $\{1, 5, 9, 13, 17\}$.
 3. The range of R is equal to codomain of R.
 Select the correct answer using the code given below:
 (a) 1 only (b) 2 only
 (c) 1 and 2 (d) 2 and 3
23. Consider the following statements:
 1. The relation f defined by $f(x) = \begin{cases} x^3, & 0 \leq x \leq 2 \\ 4x, & 2 \leq x \leq 8 \end{cases}$ is a function
 2. The relation g defined by $g(x) = \begin{cases} x^2, & 0 \leq x \leq 4 \\ 3x, & 4 \leq x \leq 8 \end{cases}$ is a function.
 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
24. Consider the following statements:
 1. $A = (A \cup B) \cup (A - B)$
 2. $A \cup (B - A) = (A \cup B)$
 3. $B = (A \cup B) - (A - B)$
 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
25. A function satisfies $f(x-y) = \frac{f(x)}{f(y)}$, where $f(y) \neq 0$. If $f(1) = 0.5$, then what is $f(2) + f(3) + f(4) + f(5) + f(6)$ equal to?
 (a) $\frac{15}{32}$ (b) $\frac{17}{32}$
 (c) $\frac{29}{64}$ (d) $\frac{31}{64}$
26. What is $2 \cot\left(\frac{1}{2} \cos^{-1} \frac{\sqrt{5}}{3}\right)$ equal to?
 (a) -1 (b) 1
 (c) $3 + \sqrt{5}$ (d) $3 - \sqrt{5}$
27. If $\sec^{-1} p - \csc^{-1} q = 0$, where $p > 0, q > 0$; then what is the value of $p^{-2} + q^{-2}$?
 (a) 1 (b) 2
 (c) $\frac{1}{2}$ (d) $\frac{1}{2\sqrt{2}}$
28. What is $1 + \sin^2\left(\cos^{-1}\left(\frac{3}{\sqrt{17}}\right)\right)$ equal to?
 (a) $\frac{25}{17}$ (b) $\frac{8}{17}$
 (c) $\frac{9}{17}$ (d) $\frac{47}{17}$

29. If $\tan(\pi \cos \theta) = \cot(\pi \sin \theta)$, $0 < \theta < \frac{\pi}{2}$; then what is the

value of $8\sin^2\left(\theta + \frac{\pi}{4}\right)$

- (a) 16 (b) 2
(c) 1 (d) $\frac{1}{2}$

30. If $\tan \alpha = \frac{1}{7}$, $\sin \beta = \frac{1}{\sqrt{10}}$; $0 < \alpha, \beta < \frac{\pi}{2}$ then what is the value of $\cos(\alpha + 2\beta)$?

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

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

Consider the equation $(1-x)^4 + (5-x)^4 = 82$.

31. What is the number of real roots of the equation?
(a) 0 (b) 2
(c) 4 (d) 8
32. What is the sum of all the roots of the equation?
(a) 24 (b) 12
(c) 10 (d) 6

DIRECTIONS : Consider the following for the next two (03) items that follow:

Consider equation-I: $z^3 + 2z^2 + 2z + 1 = 0$ and

equation-II: $z^{1985} + z^{100} + 1 = 0$

33. What are the roots of equation - I?
(a) 1, ω , ω^2 (b) -1, ω , ω^2
(c) 1, $-\omega$, ω^2 (d) -1, $-\omega$, $-\omega^2$
34. Which one of the following is a root of equation-II?
(a) -1 (b) $-\omega$
(c) $-\omega^2$ (d) ω
35. What is the number of common roots of equation-I and equation-II?
(a) 0 (b) 1
(c) 2 (d) 3

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

A quadratic equation is given by

$(a+b)x^2 - (a+b+c)x + k = 0$, where a, b, c are real.

36. If $k = \frac{c}{2}$, ($c \neq 0$), then the roots of the equation are:
(a) Real and equal

- (b) Real and unequal
(c) Real iff $a > c$
(d) Complex but not real

37. If $k = c$, then the roots of the equation are:

- (a) $\frac{a+c}{a+b}$ and $\frac{b}{a+b}$ (b) $\frac{a+c}{a+b}$ and $-\frac{b}{a+b}$
(c) 1 and $\frac{c}{a+b}$ (d) -1 and $-\frac{c}{a+b}$

DIRECTIONS : Consider the following for the next three (03) items that follow:

Let $(1+x)^n = 1 + T_1x + T_2x^2 + T_3x^3 + \dots + T_nx^n$

38. What is $T_1 + 2T_2 + 3T_3 + \dots + nT_n$ equal to?

- (a) 0 (b) 1
(c) 2^n (d) $n2^{n-1}$

39. What is $1 - T_1 + 2T_2 - 3T_3 + \dots + (-1)^n nT_n$ equal to?

- (a) 0 (b) -2^{n-1}
(c) $n2^{n-1}$ (d) 1

40. What is $T_1 + T_2 + T_3 + \dots + T_n$ equal to?

- (a) 2^n (b) $2^n - 1$
(c) 2^{n-1} (d) $2^n + 1$

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

Let $f(x) = x^2 - 1$ and $\text{gof}(x) = x - \sqrt{x} + 1$

41. Which one of the following is a possible expression for $\text{g}(x)$?

- (a) $\sqrt{x+1} - \sqrt[4]{x+1}$ (b) $\sqrt{x+1} - \sqrt[4]{x+1} + 1$
(c) $\sqrt{x+1} + \sqrt[4]{x+1}$ (d) $x+1 - \sqrt{x+1} + 1$

42. What is $\text{g}(15)$ equal to?

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

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

Let a function f be defined on $\mathbb{R} - \{0\}$ and

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

43. What is $f(0.5)$ equal to?

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

44. If f is differentiable, then what is $f'(0.5)$ equal to?

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

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

A function is defined by

$$f(x) = \begin{vmatrix} x+1 & 2 & 3 \\ 2 & x+4 & 6 \\ 3 & 6 & x+9 \end{vmatrix}$$

45. The function is decreasing on:

(a) $\left[-\frac{28}{3}, 0\right]$ (b) $\left[0, \frac{28}{3}\right]$

(c) $\left[0, \frac{50}{3}\right]$ (d) $\left[0, \frac{56}{3}\right]$

46. The function attains local minimum value at:

(a) $x = -\frac{28}{3}$ (b) $x = -1$

(c) $x = 0$ (d) $x = \frac{28}{3}$

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

Given that $4x^2 + y^2 = 9$

47. What is the maximum value of y?

(a) $\frac{3}{2}$ (b) 3

(c) 4 (d) 6

48. What is the maximum value of xy?

(a) $\frac{9}{4}$ (b) $\frac{3}{2}$

(c) $\frac{4}{9}$ (d) $\frac{2}{3}$

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

A function is defined by $f(x) = \pi + \sin^2 x$

49. What is the range of the function?

(a) $[0, 1]$ (b) $[\pi, \pi+1]$

(c) $[\pi-1, \pi+1]$ (d) $[\pi-1, \pi-1]$

50. What is the period of the function?

(a) 2π

(b) π

(c) $\frac{\pi}{2}$

(d) The function is non-periodic

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

A parabola passes through (1, 2) and satisfies the differential equation $\frac{dy}{dx} = \frac{2y}{x}$, $x > 0, y > 0$.

51. What is the directrix of the parabola?

(a) $y = -\frac{1}{8}$ (b) $y = \frac{1}{8}$

(c) $x = -\frac{1}{8}$ (d) $x = \frac{1}{8}$

52. What is the length of latus rectum of the parabola?

(a) 1 (b) $\frac{1}{2}$

(c) $\frac{1}{4}$ (d) $\frac{1}{8}$

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

Let $f(x) = \frac{a^{x-1} b^{x-1}}{a^{x-1} b^{x-1}}$ and $g(x) = x-1$.

53. What is $\lim_{x \rightarrow 1} \frac{f(x)-1}{g(x)}$ equal to?

(a) $\frac{\ln(ab)}{4}$ (b) $\frac{\ln(ab)}{2}$

(c) $\ln(ab)$ (d) $2 \ln(ab)$

54. What is $\lim_{x \rightarrow 1} f(x)^{\frac{1}{g(x)}}$ equal to?

(a) $\sqrt{ab}$ (b) ab

(c) $2ab$ (d) $\frac{\sqrt{ab}}{2}$

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

Let $f(x) = \sqrt{2-x} + \sqrt{2+x}$.

55. What is the domain of the function?

(a) $(-2, 2)$ (b) $[-2, 2]$

(c) $\mathbb{R} - (-2, 2)$ (d) $\mathbb{R} - [-2, 2]$

56. What is the greatest value of the function?

(a) $\sqrt{3}$ (b) $\sqrt{6}$

(c) $\sqrt{8}$ (d) 4

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

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

Let $h(x) = \frac{f(g(x))}{g(f(x))}$.

57. What is $\lim_{x \rightarrow 0^+} h(x)$ equal to?

(a) -2 (b) -1

(c) 0 (d) 1

58. What is $\lim_{x \rightarrow 0^-} h(x)$ equal to?

(a) -2 (b) -1

(c) 0 (d) 2

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

$$\text{Let } f(x) = \begin{cases} \frac{x-3}{|x-3|} + a; & x < 3 \\ a-b; & x = 3 \text{ and} \\ \frac{x-3}{|x-3|} + b; & x > 3 \end{cases}$$

$f(x)$ be continuous at $x = 3$.

59. What is the value of a ?
 (a) -1 (b) 1
 (c) 2 (d) 3
60. What is the value of b ?
 (a) -1 (b) 1
 (c) 2 (d) 3

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

$$\text{Let } I = \int_{-2\pi}^{2\pi} \frac{\sin^4 x + \cos^4 x}{1 + 3^x} dx$$

61. What is $\int_0^{\pi} (\sin^4 x + \cos^4 x) dx$ equal to?

- (a) $\frac{3\pi}{8}$ (b) $\frac{3\pi}{4}$
 (c) $\frac{3\pi}{2}$ (d) 3π

62. What is I equal to?

- (a) 0 (b) $\frac{3\pi}{4}$
 (c) $\frac{3\pi}{2}$ (d) 3π

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

$$\text{Let } f(x) = \begin{cases} ax(x+1) + b, & x < 1 \\ x-1 & 1 \leq x \leq 2 \end{cases}$$

63. If the function $f(x)$ is differentiable at $x = 1$, then what is the value of $(a + b)$?

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

64. What is $\lim_{x \rightarrow 0} f(x)$ equal to?

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

65. If $f(x) = \ln |x|$ where $0 < x < 1$, then what is $f'(0.5)$ equal to?

- (a) -2 (b) -1
 (c) 0 (d) 2

66. If $f'(x) = \cos(\ln x)$ and $y = f\left(\frac{2x-3}{x}\right)$, then what is $\frac{dy}{dx}$

equal to?

- (a) $\cos\left(\ln\left(\frac{2x-3}{x}\right)\right)$ (b) $-\frac{3}{x^2} \sin\left(\ln\left(\frac{2x-3}{x}\right)\right)$
 (c) $\frac{3}{x^2} \cos\left(\ln\left(\frac{2x-3}{x}\right)\right)$ (d) $-\frac{3}{x^2} \cos\left(\ln\left(\frac{2x-3}{x}\right)\right)$

67. What is $\int_0^{8\pi} |\sin x| dx$ equal to?

- (a) 2 (b) 4
 (c) 8 (d) 16

68. What is the area between the curve $f(x) = x|x|$ and x -axis for $x \in [-1, 1]$?

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

69. What are the order and the degree respectively of the differential equation $x^2 \left(\frac{d^3 y}{dx^3} \right)^2 + \left(\frac{dy}{dx} \right)^4 + \sin x = 0$?

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

70. What is the differential equation of all parabolas of the type $y^2 = 4a(x-b)$?

- (a) $\frac{d^2 y}{dx^2} + \left(\frac{dy}{dx} \right)^2 = 0$ (b) $\frac{d^2 y}{dx^2} + x^2 \left(\frac{dy}{dx} \right)^2 = 0$
 (c) $y^2 \frac{d^2 y}{dx^2} + \left(\frac{dy}{dx} \right)^2 = 0$ (d) $y \frac{d^2 y}{dx^2} + \left(\frac{dy}{dx} \right)^2 = 0$

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

Let $a_1, a_2, a_3 \dots$ be in AP such that

$$a_1 + a_5 + a_{10} + a_{15} + a_{20} + a_{25} + a_{30} + a_{34} = 300.$$

71. What is

$$a_1 + a_5 - a_{10} - a_{15} - a_{20} - a_{25} + a_{30} + a_{34}$$

equal to?

- (a) 0 (b) 25
 (c) 125 (d) 250

72. What is $\sum_{n=1}^{34} a_n$ equal to?

- (a) 900 (b) 1025
 (c) 1200 (d) 1275

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

$$\text{Let } p = \cos\left(\frac{\pi}{5}\right)\cos\left(\frac{2\pi}{5}\right) \text{ and } q = \cos\left(\frac{4\pi}{5}\right)\cos\left(\frac{8\pi}{5}\right).$$

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

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

74. What is the value of pq ?

- (a) $-\frac{1}{16}$ (b) $-\frac{1}{4}$
(c) $\frac{1}{4}$ (d) $\frac{1}{16}$

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

$$\text{Let } p = \frac{1}{3} - \frac{\tan 3x}{\tan x} \text{ and } q = 1 - 3 \tan^2 x, 0 < x < \pi, x \neq \frac{\pi}{2}.$$

75. What is pq equal to

- (a) 1 (b) 2
(c) $\frac{8}{3}$ (d) $-\frac{8}{3}$

76. For how many values of x does $\frac{1}{p}$ become zero?

- (a) No value (b) Only one value
(c) Only two values (d) Only three values

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

$$\text{Let } \sin x + \sin y = \sqrt{3}(\cos y - \cos x); x + y = \frac{\pi}{2},$$

$$0 < x, y < \frac{\pi}{2}.$$

77. What is a value of $\sin 3x + \sin 3y$?

- (a) -1 (b) 0
(c) 1 (d) 3

78. What is a value of $\cos^3 x + \cos^3 y$?

- (a) $\frac{3\sqrt{3}}{8}$ (b) $\frac{3\sqrt{6}}{8}$
(c) $\frac{3\sqrt{6}}{4}$ (d) 1

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

The angles A, B and C of a triangle ABC are in the ratio 3 : 5 : 4.

79. What is the value of $a + b + \sqrt{2}c$ equal to?

- (a) 3a (b) 2b
(c) 3b (d) 2c

80. What is the ratio of $a^2 : b^2 : c^2$?

- (a) $2 : 2 + \sqrt{3} : 3$ (b) $2 : 2 - \sqrt{3} : 2$
(c) $2 : 2 + \sqrt{3} : 2$ (d) $2 : 2 - \sqrt{3} : 3$

81. What is the equation of directrix of parabola $y^2 = 4bx$, where $b < 0$ and $b^2 + b - 2 = 0$?

- (a) $x + 1 = 0$ (b) $x - 2 = 0$
(c) $x - 1 = 0$ (d) $x + 2 = 0$

82. The points $(-a, -b)$, $(0, 0)$, (a, b) and (a^2, ab) are:

- (a) lying on the same circle
(b) vertices of a square
(c) vertices of a parallelogram that is not a square
(d) collinear

83. Given that $16p^2 + 49q^2 - 4r^2 - 56pq = 0$, which one of the following is a point on a pair of straight lines $(px + qy + r)(px + qy - r) = 0$?

- (a) $\left(2, \frac{7}{2}\right)$ (b) $\left(2, -\frac{7}{2}\right)$
(c) $(4, -7)$ (d) $(4, 7)$

84. If $3x + y - 5 = 0$ is the equation of a chord of the circle $x^2 + y^2 - 25 = 0$, then what are the coordinates of the mid-point of the chord?

- (a) $\left(\frac{3}{4}, \frac{1}{4}\right)$ (b) $\left(\frac{3}{2}, \frac{1}{2}\right)$
(c) $\left(\frac{3}{4}, -\frac{1}{4}\right)$ (d) $\left(\frac{3}{2}, -\frac{1}{2}\right)$

85. Consider the following in respect of the equation $\frac{x^2}{24-k} + \frac{y^2}{k-16} = 2$.

- The equation represents an ellipse if $k = 19$.
- The equation represents a hyperbola if $k = 12$.
- The equation represents a circle if $k = 20$.

How many of the statements given above are correct?

- (a) Only one (b) Only two
(c) All three (d) None

86. Consider the following statements in respect of hyperbola

$$\frac{x^2}{\cos^2 \theta} - \frac{y^2}{\sin^2 \theta} = 1:$$

- The two foci are independent of θ .
- The eccentricity is $\sec \theta$.
- The distance between the two foci is 2 units.

How many of the statements given above are correct?

- (a) Only one (b) Only two
(c) All three (d) None

87. Consider the following in respect of the circle $4x^2 + 4y^2 - 4ax - 4ay + a^2 = 0$:
- The circle touches both the axes.
 - The diameter of the circle is $2a$.
 - The centre of the circle lies on the line $x + y = a$.
- How many of the statements given above are correct
- Only one
 - Only two
 - All three
 - None
88. For what value of k is the line $(k-3)x - (5-k^2)y + k^2 - 7k + 6 = 0$ parallel to the line $x + y = 1$?
- $-1, 1$
 - $-1, 2$
 - $1, -2$
 - $2, -2$
89. The line $x + y = 4$ cuts the line joining $P(-1, 1)$ and $Q(5, 7)$ at R . What is $PR : RQ$ equal to?
- $1 : 1$
 - $1 : 2$
 - $2 : 1$
 - $1 : 3$
90. What is the sum of the intercepts of the line whose perpendicular distance from origin is 4 units and the angle which the normal makes with positive DIRECTIONS of x -axis is 15° ?
- 8
 - $4\sqrt{6}$
 - $8\sqrt{6}$
 - 16
91. What is the length of projection of the vector $\hat{i} + 2\hat{j} + 3\hat{k}$ on the vector $2\hat{i} + 3\hat{j} - 2\hat{k}$?
- $\frac{1}{\sqrt{17}}$
 - $\frac{2}{\sqrt{17}}$
 - $\frac{3}{\sqrt{17}}$
 - $\frac{2}{\sqrt{14}}$
92. If $(\vec{a} \times \vec{b})^2 + (\vec{a} \cdot \vec{b})^2 = 144$ and $|\vec{b}| = 4$, then what is the value of $|\vec{a}|$?
- 3
 - 4
 - 5
 - 6
93. If θ is the angle between vectors $\vec{a}$ and $\vec{b}$ such that $\vec{a} \cdot \vec{b} \geq 0$, then which one of the following is correct?
- $0 \leq \theta \leq \pi$
 - $\frac{\pi}{2} \leq \theta \leq \pi$
 - $0 \leq \theta \leq \frac{\pi}{2}$
 - $0 < \theta < \frac{\pi}{2}$
94. The vectors $60\hat{i} + 3\hat{j}$, $40\hat{i} - 8\hat{j}$ & $\beta\hat{i} - 52\hat{j}$ are collinear if:
- $\beta = 20$
 - $\beta = 40$
 - $\beta = -40$
 - $\beta = 26$
95. Consider the following in respect of the vectors $\vec{a} = (0, 1, 1)$ and $\vec{b} = (1, 0, 1)$:
- The number of unit vectors perpendicular to both $\vec{a}$ and $\vec{b}$ is only one.
 - The angle between the vectors is $\frac{\pi}{3}$.
- Which of the statement given above is/are correct?
- 1 only
 - 2 only
 - both 1 and 2
 - Neither 1 nor 2
96. If L is the line with DIRECTIONS ratios $< 3, -2, 6 >$ and passing through $(1, -1, 1)$, then what are the coordinates of the points on L whose distance from $(1, -1, 1)$ is 2 units?
- $\left(-\frac{11}{7}, \frac{13}{7}, \frac{19}{7}\right)$ and $\left(\frac{1}{7}, \frac{3}{7}, \frac{5}{7}\right)$
 - $\left(\frac{19}{7}, -\frac{11}{7}, \frac{13}{7}\right)$ and $\left(-\frac{1}{7}, \frac{3}{7}, -\frac{5}{7}\right)$
 - $\left(\frac{13}{7}, \frac{11}{7}, \frac{19}{7}\right)$ and $\left(-\frac{1}{7}, -\frac{3}{7}, \frac{5}{7}\right)$
 - $\left(\frac{13}{7}, -\frac{11}{7}, \frac{19}{7}\right)$ and $\left(\frac{1}{7}, -\frac{3}{7}, -\frac{5}{7}\right)$
97. Which one of the planes is parallel to the line $\frac{x-2}{3} = \frac{y-3}{4} = \frac{z-4}{5}$?
- $2x + 2y + z - 1 = 0$
 - $2x - y - 2z + 5 = 0$
 - $2x + 2y - 2z + 1 = 0$
 - $x - 2y + z - 1 = 0$
98. What is the angle between the lines $2x = 3y = -z$ and $6x = -y = -4z$?
- 0°
 - 30°
 - 60°
 - 90°
99. What is the equation of the sphere concentric with the sphere $x^2 + y^2 + z^2 - 2x - 6y - 8z - 5 = 0$ and which passes through the origin?
- $x^2 + y^2 + z^2 - 2x - 8z = 0$
 - $x^2 + y^2 + z^2 - 2x - 6y = 0$
 - $x^2 + y^2 + z^2 - 6y - 8z = 0$
 - $x^2 + y^2 + z^2 - 2x - 6y - 8z = 0$
100. A point P lies on the line joining $A(1, 2, 3)$ and $B(2, 10, 1)$. If z -coordinate of P is 7, what is the sum of other two coordinates?
- 15
 - 13
 - 11
 - 9
101. The sum of deviations of n numbers from 10 and 20 are p and q respectively. If $(p - q)^2 = 10000$, then what is the value of n ?
- 10
 - 20
 - 50
 - 100

102. If $\bar{X} = 20$ is the mean of 10 observations $x_1, x_2, \dots, x_{10}$, then what is the value of $\sum_{i=1}^{10} \left(\frac{3x_i - 4}{5} \right)$?
- (a) 0 (b) 12
(c) 112 (d) 1012
103. If the mean and the sum of squares of 10 observations are 40 and 16160 respectively, then what is the standard deviation?
- (a) 16 (b) 6
(c) 5 (d) 4
104. Three dice are thrown. What is the probability of getting a sum which is a perfect square?
- (a) $\frac{17}{108}$ (b) $\frac{5}{108}$
(c) $\frac{19}{108}$ (d) $\frac{23}{108}$
105. A, B, C and D are mutually exclusive and exhaustive events. If $2P(A) = 3P(B) = 4P(C) = 5P(D)$, then what is $77P(A)$ equal to?
- (a) 12 (b) 15
(c) 20 (d) 30
106. Two distinct natural numbers from 1 to 9 are picked at random. What is the probability that their product has 1 in its unit place?
- (a) $\frac{1}{81}$ (b) $\frac{1}{72}$
(c) $\frac{1}{18}$ (d) $\frac{1}{36}$
107. Two dice are thrown. What is the probability that difference of number on them is 2 or 3?
- (a) $\frac{7}{36}$ (b) $\frac{7}{18}$
(c) $\frac{5}{18}$ (d) $\frac{11}{36}$
108. What is the mean of the numbers 1, 2, 3, ..., 10 with frequencies ${}^9C_0, {}^9C_1, {}^9C_2, \dots, {}^9C_9$, respectively?
- (a) 1.1×2^8 (b) 1.2×7^4
(c) 5.5 (d) 0.55
109. The probability that a person recovers from a disease is 0.8. What is the probability that exactly 2 persons out of 5 will recover from the disease?
- (a) 0.00512 (b) 0.02048
(c) 0.2048 (d) 0.0512
110. Suppose that there is a chance for a newly constructed building to collapse, whether the design is faulty or not. The chance that the design is faulty is 10%. The chance that the building collapses is 95% if the design is faulty, otherwise it is 45%. If it is seen that the building has collapsed, then what is the probability that it is due to faulty design?
- (a) 0.10 (b) 0.19
(c) 0.45 (d) 0.95
111. If r is the coefficient of correlation between x and y , then what is the correlation coefficient between $(3x + 4)$ and $(-3y + 3)$?
- (a) $-r$ (b) r
(c) $\sqrt{3}r$ (d) $-\sqrt{3}r$
112. A fair coin is tossed 6 times. What is the probability of getting a result in the 6th toss which is different from those obtained in the first five tosses?
- (a) $\frac{7}{16}$ (b) $\frac{1}{16}$
(c) $\frac{1}{32}$ (d) $\frac{1}{64}$
113. If H is the Harmonic Mean of three numbers ${}^{10}C_4, {}^{10}C_5$, and ${}^{10}C_6$, then what is the value of $\frac{270}{H}$?
- (a) 1 (b) $\frac{14}{17}$
(c) $\frac{17}{14}$ (d) $\frac{1}{31}$
114. In a class, there are n students including the students P and Q. What is the probability that P and Q sit together if seats are assigned randomly?
- (a) $\frac{1}{n}$ (b) $\frac{2}{n}$
(c) $\frac{4}{n}$ (d) $\frac{1}{2n}$
115. In a Binomial distribution $B(n, p)$, $n = 6$ and $9P(X = 4) = P(X = 2)$. What is p equal to?
- (a) $\frac{1}{4}$ (b) $\frac{1}{2}$
(c) $\frac{3}{4}$ (d) $\frac{4}{5}$

DIRECTIONS: Consider the following for the next five(05) items that follow:

Three boys, P, Q, R and three girls S, T, U are to be arranged in a row for a group photograph.

116. What is the probability that all three boys sit together?

- (a) $\frac{1}{5}$ (b) $\frac{1}{4}$
(c) $\frac{1}{3}$ (d) $\frac{1}{12}$

117. What is the probability that boys and girls sit alternatively?

- (a) $\frac{4}{5}$ (b) $\frac{1}{10}$
(c) $\frac{5}{6}$ (d) $\frac{1}{7}$

118. What is the probability that no two girls sit together?

- (a) $\frac{2}{5}$ (b) $\frac{3}{5}$
(c) $\frac{1}{18}$ (d) $\frac{1}{5}$

119. What is the probability that P and Q take the two end positions?

- (a) $\frac{1}{15}$ (b) $\frac{7}{15}$
(c) $\frac{14}{15}$ (d) $\frac{11}{45}$

120. What is the probability that Q and U sit together?

- (a) $\frac{2}{3}$ (b) $\frac{1}{4}$
(c) $\frac{5}{6}$ (d) $\frac{1}{3}$

GENERAL ABILITY

PART - A: ENGLISH

FILL IN THE BLANKS

DIRECTIONS : In this section, each of the following sentences has a blank space and is followed by four words. Select the word you consider most appropriate to fill in the blank space and indicate your response on the Answer Sheet accordingly.

- As the Southwest monsoon _____ through most of July, flash floods caused by the waters of the Narmada hit Jabalpur town.
(a) lashed (b) flourished
(c) occupied (d) dried
- Given the scale of the challenges that _____ us today, our company proposes more viable plans for sustainability.
(a) supports (b) conflict
(c) confronts (d) convince
- It is a really tough course, I am just worried that I won't be able to go the _____.
(a) way (b) distance
(c) far (d) route
- The _____ of the advancement made in agricultural productivity in India has been remarkable.
(a) extent (b) context
(c) distance (d) syntax
- This essay _____ and examines various systems for water appropriation and agricultural practices adapted by society in the arid conditions of Rajasthan.
(a) confuses (b) enhances
(c) controls (d) explores

6. India has been able to successfully _____ its population through family planning programmes.

- (a) sterilise (b) stabilise
(c) stratify (d) establish
7. Adolescence is the _____ wherein a child enters adulthood.
(a) threshold (b) position
(c) condition (d) period
8. The British who ruled India for 200 years were here to _____ India's natural resources.
(a) spoil (b) implore
(c) exploit (d) drill
9. Endangered species have a fifty per cent or greater probability of _____ within five years or two generations whichever is longer.
(a) distinction (b) extinction
(c) complication (d) completion
10. The first law of thermodynamics states that where as energy can be _____ from one form into another, it cannot be created or destroyed.
(a) reduced (b) induced
(c) performed (d) transformed

SPOTTING ERRORS

DIRECTIONS : Each item in this section has a sentence with three underlined parts labelled (a), (b) and (c). Read each sentence to find out whether there is any error in any underlined part and indicate your response in the Answer Sheet against the corresponding letter, i.e., (a) or (b) or (c). If you find no error, your response should be indicated as (d).

- Bread, butter and (a) / jam common breakfast items (b) / that are consumed by many households. (c) / No error (d)
- Ten thousand dollars is (a) / the prize money being offered (b) / by the game show hosts. (c) / No error (d)
- Three hundred and sixty five (a) / create up the number of (b) / days (c) / in a calendar year. (d) / No error (d)
- The process of removing (a) / wool from the body of (b) / an animal is called sharing. (c) / No error (d)
- Many people came (a) / from faraway places to (b) / at the temple on the auspicious day. (c) / No error (d)
- After reading foreword of (a) / the book on environmental (b) / issues in India, (c) / I decided to meet its author. (d) / No error (d)
- The guidance from the mentors (a) / and teachers (b) / facilitated the (c) / smooth conduct of elections to the (d) / Students' council. (c) / No error (d)
- The Principal of our school (a) / felicitated the students in (b) / the prize distribution ceremony. (c) / No error (d)
- If you were to (a) / come to Chennai to settle down (b) / it will be the best possible decision. (c) / No error (d)
- They had promised to delivered (a) / the bags before mid-March (b) / to enable us to inaugurate the shop. (c) / No error (d)

SYNONYMS

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

21. He is always captious.
(a) worried (b) passionate
(c) faultfinding (d) jovial
22. Geomorphologists ascertain several wonderful facts about our earth.
(a) verify (b) invert
(c) increase (d) omit
23. The Colonel ordered the Soldiers to meet him in the commissary.
(a) office (b) field
(c) playground (d) canteen
24. The doctor dismembered the patient's finger first and then cured the ailment.
(a) stitched (b) dissected
(c) plastered (d) splintered
25. Mr. Kumar works as a bursar in the sports academy.
(a) secretary (b) accountant
(c) coach (d) trainer
26. His intentions are insidious.
(a) pious (b) inadvertent
(c) deceitful (d) naive
27. Respect for other human beings is intrinsic to the teachings of all religions.
(a) inconsistent (b) peripheral
(c) inherent (d) existential
28. He completed the onerous task with relative ease.
(a) smooth (b) complex
(c) risky (d) wearying
29. Alfred was a potentate during the Middle Ages.
(a) Monarch (b) lenient
(c) liberal (d) democrat
30. I abandoned the task due to indolence.
(a) difficulty (b) laziness
(c) ugliness (d) helplessness

USAGE OF PAIRED WORDS

DIRECTIONS : In the following questions a pair of similar sounding words is provided. You are required to select the options that most appropriately describes the meaning of both the words and mark your response in the Answer Sheet accordingly.

31. 'Principal' and 'Principle'
(a) 'Principal' means belief system, and 'principle' means head of an educational institution
(b) 'Principal' means head of an educational institution, and 'principle' means original sum on which interest is charged
- (c) 'Principle' means moral rule, and 'principal' means head of an educational institution.
- (d) 'Principal' means original sum on which interest is charged, and 'principle' means head of an educational institution.
32. 'Plane' and 'Plain'
(a) 'Plane' means a flat surface, and 'plain' means something that flies.
(b) 'Plane' means the flat surface, and 'plain' means not elaborate.
(c) 'Plane' means something that flies, and 'plain' means flat surface.
(d) 'Plane' means not elaborate, and 'plain' means flat surface.
33. 'Pail' and 'Pale'
(a) 'Pale' means inferior or unimpressive, and 'pail' means faded.
(b) 'Pale' means faded or light in shade, and 'pail' means inferior or unimpressive.
(c) 'Pale' means faded or light in shade, and 'pail' means a bucket.
(d) 'Pale' means a bucket, and 'pail' means inferior or unimpressive.
34. 'Metal' and 'Mettle'
(a) 'Metal' is a hard shiny material that is a good conductor, and 'mettle' means malleable metal.
(b) 'Metal' is a hard shiny material that is a good conductor, and 'mettle' means metallic substance.
(c) 'Metal' means mental resilience, and 'mettle' is a hard shiny material that is a good conductor.
(d) 'Metal' is a hard shiny material that is a good conductor, and 'mettle' means mental resilience.
35. 'Hail' and 'Hale'
(a) 'Hail' means pellets of frozen rain, and 'hale' means wind storm
(b) 'Hail' means pellets of frozen rain, and 'hale' means strong and healthy
(c) 'Hail' means pellets of frozen rain, and 'hale' means to greet with enthusiastic approval
(d) 'Hail' means strong and healthy, and 'hale' means pellets of frozen rain
36. 'Conscious' and 'Conscience'
(a) 'Conscious' means sense of right and wrong, and 'conscience' means awareness about something
(b) 'Conscious' means alert, and 'conscience' means presence of mind
(c) 'Conscious' means intent, and 'conscience' means unprincipled action
(d) 'Conscious' means aware, and 'conscience' means sense of right and wrong
37. 'Dissent' and 'Descent'
(a) 'Dissent' means having ideas different from general beliefs or official position, and 'descent' means movement towards a lower place

- (b) 'Dissent' means having ideas different from general beliefs or official position, and 'descent' means being of acceptable standard
- (c) 'Dissent' means being of acceptable standard, and 'descent' means movement towards a lower place
- (d) 'Dissent' means being of acceptable standard, and 'descent' means ideas different from general beliefs or official position
38. 'Devise' and 'Device'
- (a) 'Device' means to determine, and 'devise' means a piece of equipment meant for accomplishing a specific task.
- (b) 'Device' means finding a new way to do something, and 'devise' means to determine
- (c) 'Device' means a piece of equipment meant for accomplishing a specific task, and 'devise' means finding a new way to do something
- (d) 'Device' means finding a new way to do something, and 'devise' means a piece of equipment meant for accomplishing a specific task.
39. 'Discrete' and 'Discreet'
- (a) 'Discrete' means separate and distinct categories of objects, and 'discreet' means misuse of authority
- (b) 'Discrete' means separate and distinct categories of objects, and 'discreet' means maintaining confidentiality
- (c) 'Discrete' means being careful in what one says or does, and 'discreet' means separate and distinct categories of objects
- (d) 'Discrete' means misuse of authority and 'discreet' means being careful in what one says or does
40. 'Eminent' and 'Imminent'
- (a) 'Eminent' means, important and famous, and 'imminent' means something about to happen
- (b) 'Eminent' means something unpleasant about to happen, and 'imminent' means important and famous person
- (c) 'Eminent' means important and famous person, and 'imminent' means inherent or existing within
- (d) 'Eminent' means inherent or existing within, and 'imminent' means something about to happen
43. His ostentatious behaviour surprised everyone.
- (a) tawdry (b) modest
- (c) gaudy (d) apparent
44. The experience of Covid Pandemic was excruciating for much of the population.
- (a) gnawing (b) gruelling
- (c) harrowing (d) mild
45. A trip to the hills was refreshing.
- (a) conniving (b) wearying
- (c) revivifying (d) rejuvenating

COMPREHENSION

DIRECTIONS : Carefully read the given passage and answer the questions that follow. You are required to select your answers solely based on the contents of the passage and the opinion of the author only.

People by and large are concerned with and pursue self-interest. They are unlikely to be motivated to use renewable resources in a prudent and sustainable fashion. They are unlikely to be motivated under the following conditions : if their resource catchments are vast, so that degradation of any particular portion affects them very little; or if they have open before them possibilities of substitution as any one resource element is depleted; or if their control over the resource base is tenuous, so that others may, at any time, deplete a resource they value, even if they use it in a restrained fashion. Indeed, exhaustive use is highly likely when any one of these three conditions obtains. It is only when people perceive their resource catchments as limited, possibilities of substitution of exhausted resource elements as not readily feasible, and their own control over the resource base as secure, will they be motivated to use the resources in a prudent fashion. People, rooted in a locality, and retaining control over their resource base are most likely to fulfil all three prerequisites for sustainable resource use; and therefore to behave in ways conducive to the conservation of biodiversity within their localities.

46. Why, according to the writer can't people be motivated to use a resource prudently?
1. They feel that others may overuse the resource
 2. It is possible to substitute the resource
 3. Abundance of the resource availability
- Select the correct answer using the code given below :
- (a) 1 only (b) 2 only
- (c) 2 and 3 only (d) 1, 2 and 3
47. When do people use resources exhaustively ?
- (a) When the substitution of resource is felicitated by NGOs
- (b) When the resource is about to expand
- (c) When the resources use has little impact
- (d) When they desire desperately for sustainable development

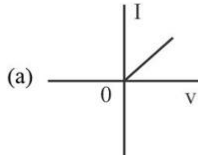
ANTONYMS

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

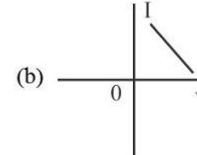
41. Many metals are malleable in nature and property.
- (a) hard (b) strong
- (c) tender (d) weak
42. To neglect a warning is to invite danger.
- (a) disregard (b) ignore
- (c) regard (d) overlook

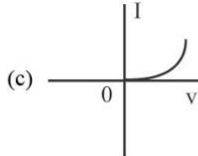
48. The self-interest of people affects the use of renewable resources
 (a) positively (b) erratically
 (c) affirmatively (d) indifferently
49. People rooted in a locality
 (a) cause harm to available resources
 (b) generate resources
 (c) believe in conservation and reproduction of resources
 (d) consume resources freely
50. Which among the following is closest in meaning with the word 'deplete' ?
 (a) exhaust (b) complete
 (c) replete (d) desperate

PART- B: GENERAL KNOWLEDGE

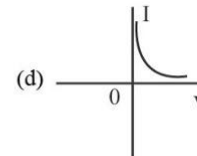
51. The streaming of light beams coming from the Sun through trees is said to have suggested that light travels in straight line. The particles on the path of light beams are visible to us because
 (a) dust particles in the air reflect light into our eyes
 (b) dust particles in the air scatter light into our eyes
 (c) dust particles in the air refract light into our eyes
 (d) dust particles in the air polarize light into our eyes
52. The flash of lightning is seen before the thunderstorm is heard. It verifies that
 (a) sound travels much faster than light
 (b) light travels much faster than sound
 (c) light and sound both travel with same speed
 (d) intensity of flash of lightning is very high during thunderstorm
53. The potential difference between the two end terminals of an electric heater is 220 V and the current through it is 0.5 A. What would be the current through the heater if the potential difference across the terminals of the heater is reduced to 120 V?
 (a) 1.0 A (b) 0.5 A
 (c) 0.27 A (d) 0.7 A
54. The heating element in an electric iron is usually made of
 (a) Constantan (b) Tungsten
 (c) Nichrome (d) Copper
55. Sita, 1.5 m high, stands before a plane mirror fixed on a wall to view her full image. What should be the minimum height of the plane mirror so that Sita can view her image fully ?
 (a) 0.50 m (b) 0.35 m
 (c) 0.75 m (d) 0.25 m
56. Galvanization is a method of protecting iron from rusting by coating with a thin layer of
 (a) Gallium (b) Aluminum
 (c) Zinc (d) Silver
57. Which one of the following alloys contains a non-metal as one of its constituent ?
 (a) Brass (b) Bronze
 (c) Amalgam (d) Steel
58. Buckminster fullerene, which looks like a football, is an allotropic form of
 (a) Phosphorus (b) Sulfur
 (c) Carbon (d) Tin
59. Which one of the following graphs correctly represents the current (I) - voltage (V) variation for a rectangular piece of a semiconductor wafer?
- 

(a)



(b)
- 

(c)



(d)
60. The green plants in a terrestrial ecosystem absorb sunlight that falls on their leaves and convert it into food energy. The percentage of solar radiation absorbed by all green plants for the process of photosynthesis is about
 (a) 1% (b) 5%
 (c) 8% (d) 10%
61. Consider the following reaction :
 $\text{Fe}_2\text{O}_3(\text{s}) + 2\text{Al}(\text{s}) \rightarrow 2\text{Fe}(\text{s}) + \text{Al}_2\text{O}_3(\text{s})$
 Which of the following statements about the given reaction is NOT correct?
 (a) It is an example of displacement reaction
 (b) It is highly endothermic reaction
 (c) Fe_2O_3 acts as oxidizing agent
 (d) This reaction is applicable to joining of railway tracks
62. Match List I with List II and select the correct answer using the code given below the Lists:
- | List I (Chemical process) | List II (Reaction) |
|--|---------------------------------|
| A. Electrolysis of water | 1. Double displacement reaction |
| B. Burning of coal | 2. Combination reaction |
| C. Iron nail immersed in copper sulphate solution | 3. Decomposition reaction |
| D. Addition of barium chloride solution to aluminium sulphate solution | 4. Displacement reaction |
- Code :**
- | | A | B | C | D |
|-----|---|---|---|---|
| (a) | 3 | 4 | 2 | 1 |
| (b) | 4 | 2 | 1 | 3 |
| (c) | 3 | 2 | 4 | 1 |
| (d) | 4 | 1 | 2 | 3 |

63. Which one of the following processes involves chemical reaction ?
 (a) Evaporation of petrol
 (b) Dissolution of salt in water
 (c) Storing of oxygen gas under pressure in a gas cylinder
 (d) Burning of magnesium ribbon in air
64. Which one of the following metals does NOT react with cold water to liberate hydrogen gas ?
 (a) Potassium (b) Iron
 (c) Calcium (d) Sodium
65. Consider the following reaction :

$$2\text{HgO} \xrightarrow{\Delta} 2\text{Hg} + \text{O}_2$$

 The respective state of HgO, Hg and O₂ in the above reaction is
 (a) Liquid, solid, gas (b) Solid, solid, gas
 (c) Liquid, solid, liquid (d) Solid, liquid, gas
66. The two important features of sexual reproduction in higher organisms that create genetic diversity in offspring are
 (a) Mitosis and fertilization
 (b) Meiosis and fertilization
 (c) Mitosis and binary fission
 (d) Meiosis and conjugation
67. Eukaryotic cells are much more complex as compared to prokaryotes. Which one of the following structures is exclusively present in a eukaryotic cell?
 (a) Cell wall (b) Plasma membrane
 (c) Nucleic acid (d) Mitochondria
68. An important cause of tooth decay by the bacterium *Streptococcus mutans* is because of their ability to attach to teeth surface by producing slime layer from
 (a) Sugar (b) Alcohol
 (c) Saliva (d) Teichoic acid
69. In angiosperms, pollen grain germinates to produce two male gametes. Which one of the following functions is carried out by these gametes ?
 (a) Both the gametes fuse with a single egg cell
 (b) Both the gametes fuse with two different egg cells
 (c) One gamete fuses with the egg cell and the other one eventually degenerate
 (d) One gamete fuses with the egg cell and the other one fuses with a diploid secondary nucleus
70. In a sexually reproducing organism, which one of the following statements is appropriate both for the parent and offspring?
 (a) Chromosome number increases but DNA content remains constant
 (b) Both chromosome number and DNA content remains constant
 (c) Chromosome number decreases but DNA content remains constant
 (d) Both chromosome number and DNA content decreases
71. Relationship between a flower and honey-bee will help the flower for / in
 (a) Faster development
 (b) Pollination
 (c) Quick germination of pollen
 (d) Increase in size
72. Which one of the following was NOT a way in which kings in ancient India attempted to claim a higher status ?
 (a) Identifying with a variety of deities
 (b) Assuming pompous titles
 (c) Imposing high taxes
 (d) Conquests and annexation of territories
73. Which one of the following statements about the Bhakti movement is NOT correct?
 (a) The Bhakti movement avoided traditions that promoted diversity
 (b) In northern India, the Bhakti movement revolved around the worship of Rama and Krishna
 (c) The Bhakti movement relied on the devotion of God, both with and without attributes
 (d) While Tulsidas represented the tradition of devotion with attributes, Sant Kabir followed the path of devotion without attributes
74. The 'Reign of Terror' in revolutionary France referred to
 (a) Bands of revolutionaries moving around to terrorise people who did not participate in the revolution
 (b) The royal forces punishing people who participated in the revolution
 (c) Trial and beheading persons considered enemies of the republic by the revolutionary tribunal
 (d) The general atmosphere of insecurity perceived by people after the beheading of the king
75. In which one of the following ways did the First World War Not impact Europe?
 (a) From a continent of creditors it turned into a continent of debtors
 (b) Soldiers came to be placed higher in social status than civilians
 (c) Popular support decreased for conservative dictatorship which had come into being recently
 (d) National honour occupied centre stage in the public sphere
76. " ... the immediate ending of British rule in India is an urgent necessity ... " was a resolution of
 (a) Non Co-operation Movement
 (b) Quit India Movement
 (c) Individual Movement
 (d) Civil Disobedience Movement
77. Which one among the following pairs of mine and mineral is NOT correctly matched?
 (a) Bailadila : Iron Ore
 (b) Zawar : Zinc
 (c) Ghatsila : Copper
 (d) Kudremukh : Bauxite

78. Which one of the following is the usual unit of measurement for Air Pressure used in India ?
 (a) Centimeter (b) Millibar
 (c) Milligram (d) Milliliter
79. Which one of the following is the oldest era in Geological History determining the age of various rock types ?
 (a) Precambrian (b) Mesozoic
 (c) Cenozoic (d) Paleozoic
80. A geographical grid has :
 1. Lines that run east to west around the globe to mark latitude
 2. Lines that run north to south from north pole to south pole indicate longitude
 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
81. In which one of the following layers of the atmosphere all weather phenomenon occur ?
 (a) Mesosphere (b) Troposphere
 (c) Thermosphere (d) Stratosphere
82. In which one of the following states 'Roopkund' lake is located?
 (a) Kerala (b) Manipur
 (c) Himachal Pradesh (d) Uttarakhand
83. Ram records the odometer readings of his car for the distance covered from 2000 km at the start of his journey and 2400 km at the end of the journey after 8 hours. What is the average speed of the car ?
 (a) 50 km/h (b) 60 km/h
 (c) 70 km/h (d) 80 km/h
84. Ms. Rani decides to convert her AC generator into a DC generator. Which one of the following she would need to use?
 (a) A split-ring type commutator
 (b) Slip rings and brushes
 (c) A stronger magnetic field
 (d) A rectangular wire loop
85. Ramesh cannot see distinctly objects kept beyond 2 m. This defect can be corrected by using a lens of power
 (a) + 0.5 D (b) - 0.5 D
 (c) + 0.2 D (d) - 0.2 D
86. Which of the following statements are correct about the electrical resistance and resistivity of a wire?
 1. Both quantities depend on the area of cross-section of the wire
 2. Both depend on the temperature
 3. Resistance of the wire is directly proportional to the resistivity of the wire
 4. Resistivity of the wire is directly proportional to the length of the wire
 Select the correct answer using the code given below :
 (a) 1 and 2 (b) 1 and 3
 (c) 2 and 3 (d) 2 and 4
87. A liquid is heated up to a certain temperature. Which one of the following situation would correspond to the boiling of the liquid ?
 (a) When atmospheric pressure becomes equal to the vapour pressure
 (b) When atmospheric pressure becomes less than vapour pressure
 (c) When atmospheric pressure becomes higher than the vapour pressure
 (d) When vapour pressure becomes equal to the air pressure
88. Which one of the following is NOT an example of organic compound?
 (a) Ammonium cyanate (b) Marsh gas
 (c) Urea (d) Cane sugar
89. Which one of the following acid is used by goldsmith for cleaning of gold and silver articles ?
 (a) Sulphuric acid (b) Nitric acid
 (c) Hydrochloric acid (d) Phosphoric acid
90. What is the action of litmus on ethanol?
 (a) Litmus is neutral towards ethanol
 (b) Ethanol turns blue litmus to red; confirming acidic nature of ethanol
 (c) Ethanol turns red litmus to blue; confirming basic nature of ethanol
 (d) Ethanol decolorizes litmus through bleaching action
91. Which one of the following metal is NOT an essential component in stainless steel ?
 (a) Iron (b) Nickel
 (c) Chromium (d) Tin
92. Match List-I with List-II and select the correct answer using the code given below the Lists :
- | List I (Process) | List II
(Separation method) |
|--|--------------------------------|
| A. Separation of acetone and water from their mixture | 1. Chromatography |
| B. Separation of water and kerosene oil from their mixture | 2. Centrifugation |
| C. Separation of cream from milk | 3. Distillation |
| D. Separation of pigments from plant extract | 4. Separating Funnel |
- Code :**
- | | A | B | C | D |
|-------|---|---|---|---|
| (a) 3 | 2 | 4 | 1 | 3 |
| (b) 4 | 2 | 1 | 3 | 1 |
| (c) 3 | 4 | 2 | 1 | 3 |
| (d) 4 | 1 | 2 | 3 | 1 |
93. Which one of the following is NOT a requirement for photosynthesis ?
 (a) Chlorophyll (b) CO₂
 (c) Water (d) O₂

94. In flowering plants, DNA content of the parent plant gets halved during
 (a) Seed germination (b) Fruit formation
 (c) Flower bud formation (d) Pollen formation
95. Which one of the following is the correct sequence during sexual reproduction in Angiosperms?
 (a) Egg → zygote → embryo → seed
 (b) Embryo → egg → zygote → seed
 (c) Egg → embryo → zygote → seed
 (d) Egg → seed → zygote → embryo
96. Which one of the following combinations of events represents the correct sequence during reproduction in flowering plants ?
 (a) Ovule → fruit; egg → embryo; zygote → seed; ovary → egg
 (b) Embryo → egg; ovary → fruit; ovule → zygote; zygote → seed
 (c) Ovary → fruit; zygote → egg; embryo → ovule; seed → fruit
 (d) Egg → zygote; zygote → embryo; ovule → seed; ovary → fruit
97. The book 'Nation First : The Golden Saga of 82 Years' is the history of which one of the following organizations?
 (a) Indo-Tibetan Border Police
 (b) Border Security Force
 (c) Central Reserve Police Force
 (d) Central Industrial Security Force
98. Consider the following statements regarding Sanchi and its archaeological findings:
 1. When Sanchi was discovered in 1818, three of its four gateways were still standing, the fourth was lying on the spot where it had fallen
 2. Animals depicted at Sanchi include elephants, horses, monkeys and cattle
 Which of the statements given above is/are correct ?
 (a) Only 1 (b) Only 2
 (c) Both 1 and 2 (d) Neither 1 nor 2
99. Which Five Year Plan of India focused on rapid industrialization based growth process?
 (a) First Five Year Plan
 (b) Second Five Year Plan
 (c) Fifth Five Year Plan
 (d) Seventh Five Year Plan
100. *Chandimangala*, a sixteenth century text, was composed by
 (a) Hema Saraswati (b) Madhav Kandali
 (c) Tukaram (d) Mukundaram Chakrabarti
101. Consider the following statements regarding the royal center in Vijayanagara Empire :
 1. The royal center was located in the south-western part of the settlement
 2. It included over 60 temples
 3. About 30 building complexes at the site have been identified as palaces
 Which of the statements given above is/are correct ?
 (a) 1 only (b) 2 only
 (c) 1, 2 and 3 (d) 1 and 2 only
102. Which one of the following statements is NOT correct ?
 (a) Area wise Madhya Pradesh is the fourth largest state in India
 (b) Horn bill festival is celebrated in Nagaland
 (c) Gujarat state contribute 7.9 per cent share to the National GDP
 (d) Telangana is situated in the Deccan plateau in the central stretch of Indian peninsula
103. Which one of the following soils is ideal for growing cotton?
 (a) Regur soil (b) Laterite soil
 (c) Desert soil (d) Mountainous soil
104. Where is Central Institute of Buddhist Studies situated?
 (a) Leh (b) Kullu
 (c) Almora (d) Gangtok
105. Consider the following statements about physical features of India :
 1. The southern point of the Peninsular Plateau is formed by the Nilgiri Hills where the Eastern and the Western Ghats meet
 2. The Cardamom Hills may be regarded as a continuation of the Eastern Ghats
 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
106. Which one of the following is the narrow belt parallel to the Shiwalik foothills where streams and rivers coming from the mountains deposit heavy materials of rocks and boulders?
 (a) Tarai (b) Bhangar
 (c) Bhabar (d) Khadar
107. Which of the following statements about Suez Canal is/are correct?
 1. Suez is a man-made navigation canal
 2. Suez links Mediterranean Sea and the Red Sea
 3. The economic significance of Suez Canal is less than that of Panama Canal
 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

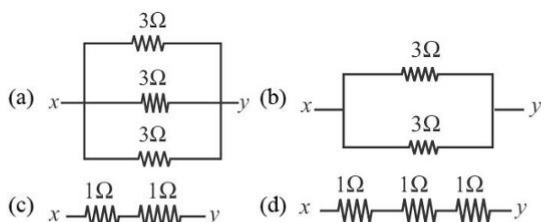
108. An iron nail sinks in water whereas an iron ship floats. Which of the following statements is correct in this regard?

1. Average density of ship is greater than that of the water
2. Average density of iron nail is greater than that of the water
3. Average density of the ship is less than that of the water
4. Average density of the ship is equal to that of the water

Select the correct answer using the code given below :

- (a) 1 and 2 (b) 2 and 3
(c) 2 and 4 (d) 1 and 4

109. Which of the following arrangement of resistors offers minimum effective resistance between points X and Y ?



110. What will happen if a collection of positive and negative charges are passed at a high speed through a magnetic field which is perpendicular to the direction of motion of the charges? (Assume that both kind of charges are NOT going to recombine)

- (a) Both kind of charges will stop moving
- (b) Positive charges and negative charges will separate out
- (c) Positive charges will stop but negative charges will continue moving uninterrupted
- (d) Both kind of charges will keep moving uninterrupted

111. The motion of a particle of mass m is described by the relation, $y = ut\frac{1}{2} + gt^2$, where u is the initial velocity of the particle. The force acting on the particle is

- (a) $F = m\left(\frac{du}{dt}\right)$ (b) $F = mg$
(c) $F = m\left(\frac{dy}{dt}\right)$ (d) $F = -mg$

112. A block of wood (dimensions : $40\text{ cm} \times 20\text{ cm} \times 10\text{ cm}$) is kept on a tabletop in three different positions : (a) with its side of dimensions $20\text{ cm} \times 10\text{ cm}$; (b) with its side of dimensions $10\text{ cm} \times 40\text{ cm}$; and (c) with its side of dimensions $40\text{ cm} \times 20\text{ cm}$. The pressure exerted by the wooden block on the tabletop in these positions is represented by P_A , P_B and P_C respectively. The pressure follows the trend

- (a) $P_A > P_B > P_C$ (b) $P_A < P_B < P_C$
(c) $P_A = P_B = P_C$ (d) $P_A < P_B = P_C$

113. Which one of the following metals can be extracted using carbon as reducing agent?

- (a) Zinc (b) Silver
(c) Gold (d) Aluminum

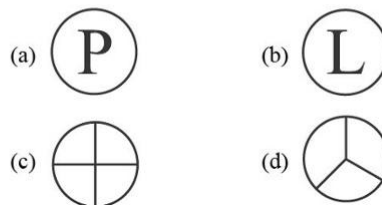
114. Which among the following is NOT true with respect to colloidal solution?

- (a) Particles are uniformly distributed throughout the solution
- (b) Colloidal solution is homogenous in nature
- (c) They show Tyndal effect
- (d) They do not settle down when kept undisturbed

115. Kerosene and petrol mixture can be best separated by

- (a) Sublimation
- (b) Separating funnel
- (c) Fractional distillation
- (d) Compressing and cooling

116. As proposed by Dalton, which of the following symbol represents phosphorus?



117. Which among the following statements with respect to carbon is/ are correct?

1. Carbon forms the basis for all living organisms and many things we use
2. Carbon shows tetra-valency and the property of catenation
3. Carbon forms covalent bonds with itself and other elements
4. Carbon forms compounds containing triple and tetra bonds between carbon atoms

Select the correct answer using the code given below :

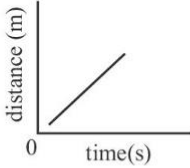
- (a) 1 only (b) 1 and 2 only
(c) 1, 2 and 3 (d) 2 and 4

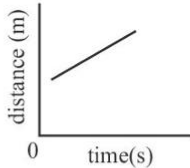
118. Consider the following statements :

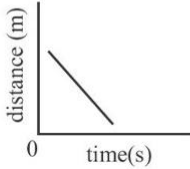
1. Terracotta models of the plough have been found at sites in Cholistan and at Banawali (Haryana).
2. There is evidence of a ploughed field at Kalibangan associated with the mature phase of the Harappan civilization.
3. The ploughed field at Kalibangan had two sets of furrows crossing at right angles to each other suggesting two different crops were grown together in it.

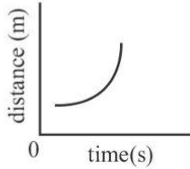
Which of the statements given above are correct ?

- (a) 1, 2 and 3 (b) 2 and 3 only
(c) 1 and 3 only (d) None of the above

119. Which of the following statements about the technological innovations during the Industrial Revolutions are correct?
1. Mule was the nickname for a machine invented in 1779, that allowed the spinning of strong and fine yarn.
 2. Water Frame, invented in 1769 by Richard Arkwright, made it possible to weave pure cotton clothes.
 3. Power loom, invented by Edmund Cartwright in 1787, could be used to weave any kind of materials.
- Select the correct answer using the code given below :
- (a) 1 and 2 only (b) 1, 2 and 3
(c) 2 and 3 only (d) 3 only
120. Who among the following is known as the architect of Indian planning ?
- (a) V.K.R.V. Rao (b) Sukhamoy Chakravarty
(c) P.C. Mahalanobis (d) John Mathai
121. Which one of the following Ashokan Minor Rock Edicts, contains the personal name of the king - Ashoka?
- (a) Maski (b) Bahapur
(c) Bairat (d) Sahasram
122. Arrange the following in correct chronological order
1. Charak Sambita
 2. Bharat's Natyashastra
 3. Sang am Literature
 4. Ashtadhyayi
- Select the correct answer using the code given below :
- (a) 1 - 3 - 4 - 2 (b) 2 - 4 - 1 - 3
(c) 4 - 3 - 1 - 2 (d) 3 - 1 - 2 - 4
123. Which one of the following is NOT an example of Fold Mountain ?
- (a) Mt. Fuji (b) Alps
(c) Andes (d) Rockies
124. Which one of the following is an organic soil ?
- (a) Aridisols (b) Histosols
(c) Oxisols (d) Vertisols
125. The North-south and East-west Road Corridors of India cross each other at which of the following cities ?
- (a) Bhopal (b) Itarsi
(c) Gwalior (d) Jhansi
126. Which one of the following climatic regions of the world have a typical characteristic of seasonal reversal of wind?
- (a) British type Climate
(b) Mediterranean Climate
(c) China type Climate
(d) Monsoon Climate
127. Which one of the following statement is NOT correct?
- (a) Bokaro steel plant is located in Damodar river basin
(b) Jamshedpur steel plant is located on the confluence of Damodar and Barakar
(c) Salem steel plant is located on the bank of Kaveri River
(d) Bhilai steel plant obtains water from Tandula reservoir
128. How many of the following pairs of specialized agriculture and its products are correctly matched ?
1. Apiculture : Honey
 2. Sericulture : Silk
 3. Silviculture : Forestry
 4. Viticulture : Grapes
- Select the correct answer using the code given below :
- (a) 4 (b) 3
(c) 2 (d) 1
129. Which one of the following crops is generally benefitted by the rain caused by western disturbances in India?
- (a) Rice (b) Wheat
(c) Bajra (d) Cotton
130. Which one of the following pairs of city and industry is NOT correctly matched?
- (a) Saharanpur : Paper industry
(b) Chanderi : Cotton textile industry
(c) Bhadohi : Carpet industry
(d) Raniganj : Iron and steel industry
131. Which one of the following graphs represents the equation of motion $v = u + at$; where all quantities are non-zero and symbols carry their usual meanings ?
- (a) 

(b) 

(c) 

(d) 
132. Which one of the following statements is true for sound waves propagating in air ?
- (a) Sound is an electromagnetic wave and transverse in nature
(b) Sound is a mechanical wave and longitudinal in nature
(c) Sound is a mechanical wave and transverse in nature
(d) Sound is an electromagnetic wave and longitudinal in nature
133. A 100 g sphere is moving at a speed of 20 m/s and collides with another sphere of mass 50 g. If the second sphere was at rest prior to the collision and the first sphere comes at rest immediately after the collision, considering the collision to be elastic, the speed of the second sphere would be
- (a) 10 m/s (b) 20 m/s
(c) 30 m/s (d) 40 m/s

134. Which one of the following optical phenomena supports that the light is a transverse wave?
 (a) Refraction (b) Diffraction
 (c) Interference (d) Polarization
135. How many of the following materials can be attracted by a magnet?
 1. Plastic
 2. Carbon
 3. Aluminium
 4. Stainless Steel
 Select the correct answer using the code given below :
 (a) 1 (b) 2
 (c) 3 (d) None
136. Consider the following statements with reference to the Bhoodan Movement:
 1. Vinoba Bhave organized 'The Sarvodaya Samaj' to take up the work of non-violent transformation in India
 2. Jayaprakash Narayan withdrew from active politics to join the Bhoodan Movement in 1953
 3. In the wake of the Bhoodan Movement the first donation of land was made in the village of Pochampalli in Telangana
 How many of the statements given above is/are correct?
 (a) 1 (b) 2
 (c) 3 (d) None
137. Which among the following statements regarding the election of non-permanent members to the United Nations Security Council is/are correct?
 1. Five members coming from Africa and Asia, one from Eastern Europe, two from Latin America and two from Western Europe and other states
 2. Six members are elected each year by the General Assembly for two year term
 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
138. Which one of the following provisions of the Constitution of India deals with District Planning Committee?
 (a) 243ZD (b) 243ZB
 (c) 243ZE (d) 243ZC
139. Consider the following statements about Attorney-General in India:
 1. She/he is the first law officer of the Government of India
 2. She/he has a right to speak in any House of Parliament without any right to vote
 3. She/he is appointed by the President of India
 4. She/he is a whole-time counsel for the Government in the court of law
 How many of the statements given above is/are correct ?
 (a) 1 (b) 2
 (c) 3 (d) 4
140. Which one among the following states was NOT impacted by the Land Boundary Agreement Treaty between India and Bangladesh (2015)?
 (a) West Bengal (b) Assam
 (c) Tripura (d) Arunachal Pradesh
141. The 480 MW Phukot Kamali Hydro Electric Project is situated in
 (a) Thailand (b) Indonesia
 (c) Nepal (d) Bhutan
142. Consider the following statements about a river :
 This river, originates in the Hindu Kush mountain range and flows into Hamoun wetlands after covering a long stretch of about 1,100km. There has been serious conflicts between two neighbouring nations regarding the sharing of water from this river.
 Identify the river from the following :
 (a) Mekong (b) Tarim
 (c) Indus (d) Helman
143. Match List I with List II and select the correct answer using the code given below the Lists :
- | List I
(Bilateral Exercise) | List II
(Participating Country) |
|--------------------------------|------------------------------------|
| A. Garuda Shakti | 1. India and Japan |
| B. Nomadic Elephant | 2. India and Sri Lanka |
| C. Mitra Shakti | 3. India and Mongolia |
| D. Dharma Guardian | 4. India and Indonesia |
- 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 | |
144. Consider the following statements about gallantry awards in India :
 1. Post-independence, first three gallantry awards were instituted on 26th January, 1950
 2. The first three gallantry awards were Ashoka Chakra Class-I, Ashoka Chakra Class-II and Ashoka Chakra Class-III
 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
145. Consider the following statements about Centralized Laboratory Network (CLN) :
 1. CLN works to test vaccines which can be used during pandemic
 2. India is a member of CLN
 3. CLN is a part of the Coalition for Epidemic Preparedness Innovations (CEPI)
 Which of the statements given above is/are correct ?
 (a) 1 only (b) 2 and 3 only
 (c) 1 and 2 only (d) 1, 2 and 3

146. Consider the following statements about Kavach, the automatic train protection system :
1. It is designed and developed by Research Design and Standard Organisation (RDSO) in collaboration with Railway Technical Research Institute (RTRI), Japan
 2. The trials of Kavach were facilitated by the Southern Railway
 3. Kavach is a state-of-the-art electronic system with Safety Integrity Level-4 (STL-4)
- Which of the statements given above is/are correct ?
- (a) 1 only (b) 3 only
(c) 1 and 2 only (d) 1, 2 and 3
147. The Nova Kakhovka dam, which was in news recently, is situated in
- (a) Belarus (b) Turkey
(c) Ukraine (d) Poland
148. Aaron Finch, who recently retired from international cricket, was captain of men's cricket team of which one of the following countries?
- (a) South Africa (b) Australia
(c) England (d) New Zealand
149. Which one of the following is the name of the dashboard launched recently by the Reserve Bank of India to assess and monitor the progress of financial inclusion by capturing relevant parameters ?
- (a) *Pragya* (b) *Antardrishti*
(c) *Divyachakshu* (d) *Antahgyan*
150. 'Sengol', installed in the new Parliament building of India, was seen as a symbol of the path of service, duty and nation in which Empire of the past?
- (a) Gupta Empire (b) Shunga Empire
(c) Pandyan Empire (d) Chola Empire

HINTS & SOLUTIONS

MATHEMATICS

1. (d) Since, $z = x + iy$
Now, $(x + iy)(x - iy) = |x + iy + x - iy|$
 $\Rightarrow x^2 - (iy)^2 = |2x|$
 $\Rightarrow x^2 + y^2 = 2x \Rightarrow x^2 - 2x + 1 + y^2 = 1$
 $\Rightarrow (x - 1)^2 + y^2 = 1$
So locus of z is circle
2. (c) Since, $\frac{1!+3!+5!+7!+\dots+199!}{24}$
 $= \frac{1+6+5 \times 24+7 \times 6 \times 5 \times 24+\dots+199!}{24}$
 $= \frac{1+6}{24} + \frac{24k}{24} = \frac{7}{24} + k \text{ (Where } k \in \mathbb{Z}) = 7$
3. (c) Let $\sqrt{12+5i} = x + iy \Rightarrow 12 + 5i = (x + iy)^2$
 $\Rightarrow x^2 - y^2 = 12$ (i)
and $2xy = 5$ (ii)
On solving (i) and (ii), we get
 $x = \frac{5}{\sqrt{2}}, y = \frac{1}{\sqrt{2}}$
So, $\sqrt{12+5i} = \frac{5}{\sqrt{2}} + \frac{i}{\sqrt{2}}$
Similarly, $\sqrt{12-5i} = \frac{5}{\sqrt{2}} - \frac{i}{\sqrt{2}}$
Now, $\sqrt{12+5i} + \sqrt{12-5i} = \frac{5}{\sqrt{2}} + \frac{i}{\sqrt{2}} + \frac{5}{\sqrt{2}} - \frac{i}{\sqrt{2}}$
 $= 5\sqrt{2}$
4. (a) Since, $I + AA'$
 $= \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix} + \begin{bmatrix} 1 \\ 2 \\ 3 \end{bmatrix} \begin{bmatrix} 1 & 2 & 3 \end{bmatrix}$
 $= \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix} + \begin{bmatrix} 1 & 2 & 3 \\ 2 & 4 & 6 \\ 3 & 6 & 9 \end{bmatrix} = \begin{bmatrix} 2 & 2 & 3 \\ 2 & 5 & 6 \\ 3 & 6 & 10 \end{bmatrix}$
Now, $|I + AA'| = 2(50 - 36) - 2(20 - 18) + 3(12 - 15) = 15$
5. (a) Given $|BC| = 2|A|$
Now, $|2A^{-1}BC| = 2^3|A^{-1}||BC|$
 $= 8 \times \frac{1}{|A|} \times 2|A| = 16$
6. (c) Given, $t_n = \frac{2n+5}{7}$
Since, $t_{140} = \frac{2 \times 140 + 5}{7} = \frac{285}{7}$
 $t_1 = \frac{2 \times 1 + 5}{7} = \frac{7}{7}$
Now, $S_{140} = \frac{140}{2} (t_1 + t_{140}) = 70 \left(\frac{7}{7} + \frac{285}{7} \right) = 2920$
7. (a) Given A is skew symmetric matrix of order 3 (odd)
So $|A| = 0$
Now, $|4A^4| - |3A^3| + |2A^2| - |A| + |-I|$
 $= 4^3|A|^4 - 3^3|A|^3 + 2^2|A|^2 - |A| + (-1)^3|I|$
 $= 0 - 0 + 0 - 0 - 1 = -1$

8. (a) Since the matrix A is skew symmetric of order 3 (odd)
So, $|A| = 0$ and A^2 is symmetric matrix
Now $|A^2| = |A|^2 = 0$
Similarly, $|A^3| = 0$, $|A^4| = 0$
Hence $|4A^4| - |3A^3| + |2A^2| - |A| + (-1)^3 |I_3| = -1$

9. (b) Given $A = \begin{bmatrix} 2 & 0 & 0 \\ 0 & 3 & 0 \\ 0 & 0 & 4 \end{bmatrix}$ is a non-zero diagonal matrix

So A^n is also non-zero diagonal matrix for any $n \in \mathbb{N}$ and diagonal elements of A are positive so A^n is also symmetric thus the statements 2 and 3 are correct.

10. (c) since, $a + b$, $2b$, $b + c$ are in H.P

$$\Rightarrow \frac{1}{a+b}, \frac{1}{2b}, \frac{1}{b+c} \text{ are in A.P}$$

$$\Rightarrow \frac{2}{a+b}, \frac{1}{b}, \frac{2}{b+c} \text{ are in A.P}$$

$$\Rightarrow \frac{1}{b} - \frac{2}{a+b} = \frac{2}{b+c} - \frac{1}{b} \Rightarrow \frac{1}{b} = \frac{a+2b+c}{(a+b)(b+c)}$$

$$\Rightarrow ab + ac + b^2 + bc = ab + 2b^2 + bc$$

$$\Rightarrow b^2 = ac$$

$$\Rightarrow a, b, c \text{ are in G.P.}$$

11. (c) since, $t_1, t_2, t_3, \dots$ in G.P

$$\text{Let } t_n = ar^{n-1}$$

$$\text{Now, } (t_1, t_3, \dots, t_{21})_{11}^{\frac{1}{11}}$$

$$= (a \cdot ar^2 \cdot ar^4 \cdot \dots \cdot ar^{20})_{11}^{\frac{1}{11}} = (a^{11} r^{2+4+\dots+20})_{11}^{\frac{1}{11}}$$

$$= (a^{11} r^{110})_{11}^{\frac{1}{11}} = ar^{10} = t_{11}$$

12. (b) since, $(-\sqrt{-1})^2 = \sqrt{-1} = x + iy$ (let)

$$-i = x^2 - y^2 + 2xyi \Rightarrow 2xy = -1, x^2 - y^2 = 0$$

after solving these equation, we get

$$x = \frac{-1}{\sqrt{2}}, y = \frac{\pm 1}{\sqrt{2}}$$

$$\Rightarrow \sqrt{-1} = \pm \left(\frac{1}{\sqrt{2}} - \frac{i}{\sqrt{2}} \right) \pm \frac{1-i}{\sqrt{2}} = \frac{1-i}{\sqrt{2}} \text{ or } \frac{-1+i}{\sqrt{2}}$$

13. (c) since, maximum number of points of intersection of 10 circle

$$= {}^{10}C_2 \times 2 = \frac{10 \times 9}{2} \times 2 = 90$$

14. (b) Since, $n(s) = 2n + 1$

$$\text{Now, } {}^{2n+1}C_0 + {}^{2n+1}C_1 + {}^{2n+1}C_2 + \dots + {}^{2n+1}C_n + {}^{2n+1}C_{n+1} + {}^{2n+1}C_{n+2} + \dots + {}^{2n+1}C_{2n+1} = 2^{2n+1}$$

$$\Rightarrow 2({}^{2n+1}C_0 + {}^{2n+1}C_1 + \dots + {}^{2n+1}C_n) = 2^{2n+1} = 4096$$

$$\Rightarrow 2^{2n} = 2^{12} \Rightarrow 2n = 12 \Rightarrow n = 6$$

15. (b) If we put $x = 0$

$$\begin{vmatrix} 0 & -1 & 3 \\ 1 & 0 & -4 \\ -3 & 4 & 0 \end{vmatrix} = 0 + 0 + 0 + e$$

it is skew-symmetric of order 3×3

$$\Rightarrow \text{So, } e = 0$$

16. (b) Since, all the elements of 3×3 matrix is -1 or 1 then determinant of the matrix is always an even number.

17. (d) Since, $|A| = 1(6-1) = 5$

$$\text{Now, } |\text{adj}(\text{adj} A)| = |A|^{(n-1)^2} = 5^{(3-1)^2} = 5^4 = 625$$

18. (a) Since, $A = \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix} = I$

$$\Rightarrow A^n = I \text{ (identity matrix)}$$

$$\text{Now, } 23A^3 - 19A^2 - 4A$$

$$23I - 19I - 4I = O$$

19. (c) Given $|A| = 3$, ($\therefore$ where $A_{3 \times 3}$)

$$\text{Since, } C = (\text{adj}(A))'$$

$$\text{Now, } |C| = |\text{adj} A| = |A|^{n-1} = 3^2 = 9$$

$$\text{So, } |C^2| = 9^2 = 81$$

20. (d) Since, $A_K = \begin{bmatrix} K-1 & K \\ K-2 & K+1 \end{bmatrix}$

$$\Rightarrow |A_K| = (K-1)(K+1) - K(K-2)$$

$$= K^2 - 1 - K^2 + 2K = 2K - 1$$

$$\text{Now, } |A_1| + |A_2| + |A_3| + \dots + |A_{100}|$$

$$= (2 \times 1 - 1) + (2 \times 2 - 1) + (2 \times 3 - 1) + \dots$$

$$+ (2 \times 100 - 1)$$

$$= 1 + 3 + 5 + \dots + 199$$

$$= \frac{100}{2} (1 + 199) = 100 \times 100 = 10000$$

21. (c) Since, $n(A \times A) = 16$

and $A \times A$ contain $(0, 2)$ and $(1, 3)$

$$\text{So } A = \{0, 1, 2, 3\}$$

Thus statements 1 and 2 are correct.

22. (b) Since, $R = \{(x, y) : 4x - 3y = 1\}$

$$\text{Now, } 4x - 3y = 1$$

$$\Rightarrow x = \frac{1+3y}{4}$$

$$\text{So, } R = \{(1, 1), (4, 5), (7, 9), (10, 13), (13, 17)\}$$

$$\therefore \text{Domain of } R = \{1, 4, 7, 10, 13\}$$

$$\text{Range of } R = \{1, 5, 9, 13, 17\}$$

23. (a)

25. (d) Since, $f(2-1) = f(1) = \frac{f(2)}{f(1)}$

$$\Rightarrow f(2) = (f(1))^2 = \frac{5}{10} \times \frac{5}{10} = \frac{1}{4}$$

$$f(3-2) = f(1) = \frac{f(3)}{f(2)} = \frac{1}{2} = \frac{f(3)}{\frac{1}{4}} \Rightarrow f(3) = \frac{1}{8}$$

$$\text{Similarly we get } f(4) = \frac{1}{16}, f(5) = \frac{1}{32}, f(6) = \frac{1}{64}$$

$$\text{Now, } f(2) + f(3) + f(4) + f(5) + f(6)$$

$$= \frac{1}{4} + \frac{1}{8} + \frac{1}{16} + \frac{1}{32} + \frac{1}{64} = \frac{31}{64}$$

26. (c) Let, $\frac{1}{2} \cos^{-1} \left(\frac{\sqrt{5}}{3} \right) = \theta \Rightarrow \cos 2\theta = \frac{\sqrt{5}}{3}$

Now, $2 \cot \theta = 2 \sqrt{\frac{1 + \cos 2\theta}{1 - \cos 2\theta}}$

$$2 \sqrt{\frac{1 + \frac{\sqrt{5}}{3}}{1 - \frac{\sqrt{5}}{3}}} = 2 \sqrt{\frac{3 + \sqrt{5}}{3 - \sqrt{5}}} = 3 + \sqrt{5}$$

27. (a) Given, $\sec^{-1} p - \operatorname{cosec}^{-1} q = 0$

$$\Rightarrow \cos^{-1} \left(\frac{1}{p} \right) = \sin^{-1} \left(\frac{1}{q} \right)$$

$$\Rightarrow \left(\frac{1}{p} \right)^2 + \left(\frac{1}{q} \right)^2 = 1$$

$$\Rightarrow p^{-2} + q^{-2} = 1$$

28. (a) Given, $1 + \sin^2 \left(\cos^{-1} \left(\frac{3}{\sqrt{17}} \right) \right)$

$$= 1 + 1 - \left(\cos \left(\cos^{-1} \left(\frac{3}{\sqrt{17}} \right) \right) \right)^2$$

$$= 2 - \left(\frac{3}{\sqrt{17}} \right)^2 = 2 - \frac{9}{17} = \frac{25}{17}$$

29. (c) Given, $\tan(\pi \cos \theta) = \cot(\pi \sin \theta)$

Let $\tan(\pi \cos \theta) = \cot(\pi \sin \theta) = k$
 $\Rightarrow \pi \cos \theta = \tan^{-1} k, \pi \sin \theta = \cot^{-1} k$

Since, $\pi \cos \theta + \pi \sin \theta = \frac{\pi}{2}$

$$\Rightarrow \cos \theta + \sin \theta = \frac{1}{2}$$

$$\Rightarrow \sin \left(\theta + \frac{\pi}{4} \right) = \frac{1}{2\sqrt{2}}$$

$$\Rightarrow 8 \sin^2 \left(\theta + \frac{\pi}{4} \right) = 1$$

30. (c) Since, $\cos(\alpha + 2\beta)$

$$\begin{aligned} &= \cos \alpha \cos 2\beta - \sin \alpha \sin 2\beta \\ &= \cos \alpha (1 - 2\sin^2 \beta) - \sin \alpha (2 \sin \beta \cos \beta) \\ &= \frac{7}{\sqrt{50}} \left(1 - 2 \times \frac{1}{10} \right) - \left(2 \times \frac{1}{\sqrt{10}} \times \frac{3}{\sqrt{10}} \right) \frac{1}{\sqrt{50}} \\ &= \frac{7}{\sqrt{50}} \times \frac{8}{10} - \frac{6}{10\sqrt{50}} = \frac{50}{10\sqrt{50}} = \frac{1}{\sqrt{2}} \end{aligned}$$

31. (b) Given, $(1-x)^4 + (5-x)^4 = 82$

Let, $3-x=y$

$$\Rightarrow ((y-2)^2)^2 + ((y+2)^2)^2 = 82$$

$$\Rightarrow (y^2 - 4y + 4)^2 + (y^2 + 4y + 4)^2 = 82$$

$$\Rightarrow 2[(y^2 + 4)^2 + (4y)^2] = 82$$

$$\Rightarrow y^4 + 8y^2 + 16 + 16y^2 = 41$$

$$\Rightarrow y^4 + 24y^2 - 25 = 0$$

$$\Rightarrow (y^2 + 25)(y^2 - 1) = 0$$

$$\Rightarrow y = \pm 1, \pm 5i$$

$$\text{If } y = 1 \Rightarrow x = 2$$

$$\text{If } y = -1 \Rightarrow x = 4$$

$$\text{If } y = 5i \Rightarrow x = 3 - 5i$$

$$\text{If } y = -5i \Rightarrow x = 3 + 5i$$

$$\text{So, number of real roots} = 2$$

32. (b) Since, sum of all roots
 $= 4 + 2 + 3 - 5i + 3 + 5i = 12$

33. (b) Given the equation-I is

$$z^3 + 2z^2 + 2z + 1 = 0 \Rightarrow z^3 + z^2 + z^2 + z + z + 1 = 0$$

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

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

$$\Rightarrow z = -1, \omega, \omega^2$$

34. (d) Since, the given equation-II is

$$z^{1985} + z^{100} + 1 = 0$$

$$\text{If } z = -1, -1 + 1 + 1 \neq 0$$

$$\text{If } z = -\omega, \omega^{1985} + \omega^{100} + 1 \neq 0$$

$$\text{If } z = -\omega^2, (-\omega^2)^{1985} + (-\omega^2)^{100} + 1 \neq 0$$

$$\text{If } z = \omega, \omega^{1985} + \omega^{100} + 1 = 0$$

$$\text{So, option (d) is correct.}$$

35. (c) Since, the common roots of equation-I and equation-II are ω, ω^2

$$\Rightarrow \text{Number of common roots} = 2$$

36. (b) If $k = \frac{c}{2}, (c \neq 0)$

$$\text{then, the given equation is}$$

$$(a+b)x^2 - (a+b+c)x + \frac{c}{2} = 0$$

$$\text{Now, } D = \{-(a+b+c)\}^2 - 4(a+b) \cdot \frac{c}{2}$$

$$a^2 + b^2 + c^2 + 2ab + 2bc + 2ca - 2ac - 2bc$$

$$(a+b)^2 + c^2 > 0 \quad (\text{since, } c \neq 0)$$

$$\text{So, roots are real and unequal.}$$

37. (c)

38. (d) Given, $(1+x)^n = 1 + T_1 x + T_2 x^2 + \dots + T_n x^n$

$$\text{differentiating both side with respect to } x, \text{ we get}$$

$$\Rightarrow n(1+x)^{n-1} = T_1 + 2T_2 x + 3T_3 x^2 + \dots + nT_n x^{n-1} \dots (i)$$

$$\Rightarrow n(1+1)^{n-1} = T_1 + 2T_2 + 3T_3 + \dots + nT_n \quad \{\text{Putting } x = 1\}$$

$$\Rightarrow T_1 + 2T_2 + 3T_3 + \dots + nT_n = n2^{n-1}$$

39. (d) Putting, $x = -1$ in equation (i) in previous problem, we get

$$n(1-1)^{n-1} = T_1 - 2T_2 + 3T_3 - 4T_4 + \dots + (-1)^{n-1} T_n$$

$$\Rightarrow 1 - T_1 + 2T_2 - 3T_3 + 4T_4 + \dots + (-1)^n T_n = 0 + 1 = 1$$

40. (b) Putting $x = 1$ in given statement $(1+1)^n = 1 + T_1 + T_2 + T_3 + \dots + T_n$

$$\Rightarrow T_1 + T_2 + T_3 + \dots + T_n = 2^n - 1$$

41. (b) Given, $f(x) = x^2 - 1$, go $f(x) = x - \sqrt{x} + 1$

$$\Rightarrow g\{f(x)\} = x - \sqrt{x} + 1$$

$$\Rightarrow g(x^2 - 1) = x - \sqrt{x} + 1$$

$$\text{Let, } x^2 - 1 = t \Rightarrow x^2 = 1 + t \Rightarrow x = (1+t)^{1/2}$$

$$\Rightarrow g(t) = (1+t)^{1/2} - (1+t)^{1/4} + 1$$

$$\Rightarrow g(x) = \sqrt{1+x} - \sqrt[4]{1+x} + 1$$

42. (c) Since, $g(x) = \sqrt{1+x} - \sqrt[4]{1+x} + 1$
 $\Rightarrow g(15) = \sqrt{16} - \sqrt[4]{16} + 1 = 4 - 2 + 1 = 3$

43. (b)

44. (c) Since, $2f(x) + f\left(\frac{1}{x}\right) = x + 3$

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

Put $x = 2, \frac{1}{2}$

$$\Rightarrow 2f'(2) - \frac{1}{4}f'\left(\frac{1}{2}\right) = 1 \quad \dots(i)$$

and, $2f'\left(\frac{1}{2}\right) - 4f'(2) = 1 \quad \dots(ii)$

after solving (i) & (ii), we get

$$f'\left(\frac{1}{2}\right) = 2, f'(2) = \frac{3}{4}$$

So, $f'(0.5) = 2$

45. (a)

46. (c) For local minima

$$f'(x) = 0 \Rightarrow 3x^2 + 28x = 0 \Rightarrow x = -\frac{28}{3}, 0$$

Now, $f''(x) = 6x + 28$

Now, $f''(0) = 28 > 0$ & $f''\left(-\frac{28}{3}\right) > 0$

So, $f(x)$ has local minimum value at $x = 0$

47. (b) Since, $4x^2 + y^2 = 9$

$$\Rightarrow y = \pm\sqrt{9-4x^2}$$

So, max value of $y = 3$

48. (a) Since, $y = \pm\sqrt{9-4x^2}$

$$\text{let } f(x) = xy = x\sqrt{9-4x^2}$$

So, maximum value of $f(x)$ is $\frac{9}{4}$

49. (b) Given a function $f(x) = \pi + \sin^2 x$

Since, $0 \leq \sin^2 x \leq 1 \Rightarrow \pi \leq \pi + \sin^2 x \leq \pi + 1$

So Range = $[\pi, \pi + 1]$

50. (b) Since, period of $\sin^2 x$ is π

$\Rightarrow$ period of $f(x) = \pi + \sin^2 x$ is π

(Sol). 51-52:

Since, $\frac{dy}{dx} = \frac{2y}{x}$

$$\int \frac{dy}{y} = \int \frac{2dx}{x} \Rightarrow \ln y = 2\ln x + \ln c \Rightarrow y = x^2 c$$

it satisfy (1,2)

$$\Rightarrow 2 = 1 \cdot C \Rightarrow C = 2 \Rightarrow y = 2x^2$$

51. (a) Since, $y = 2x^2 \Rightarrow x^2 = \frac{1}{2} y \Rightarrow x^2 = 4 \cdot \frac{1}{8} y$

So, directrix of Parabola is $y = -\frac{1}{8}$

52. (b) Since, length of latus Rectum of Parabola = $4 \times \frac{1}{8} = \frac{1}{2}$

53. (b) Since, $\lim_{x \rightarrow 1} \frac{f(x)-1}{g(x)}$

$$= \lim_{x \rightarrow 1} \frac{a^{x-1} + b^{x-1} - 1}{x-1} = \lim_{x \rightarrow 1} \frac{a^{x-1} + b^{x-1} - 2}{2(x-1)}$$

$$= \lim_{x \rightarrow 1} \left(\frac{a^{x-1} - 1}{2(x-1)} + \frac{b^{x-1} - 1}{2(x-1)} \right) = \frac{1}{2} \ln a + \frac{1}{2} \ln(b)$$

$$= \frac{1}{2} \ln(ab)$$

54. (a) Since, $\lim_{x \rightarrow 1} f(x)^{\frac{1}{g(x)}}$

$$= \lim_{x \rightarrow 1} \left(\frac{a^{x-1} + b^{x-1}}{2} \right)^{\frac{1}{x-1}} \quad (\text{it is form } 1^\infty)$$

$$= e^{\lim_{x \rightarrow 1} \left(\frac{a^{x-1} + b^{x-1}}{2} - 1 \right) \frac{1}{x-1}} = e^{\lim_{x \rightarrow 1} \left(\frac{a^{x-1} - 1}{2(x-1)} + \frac{b^{x-1} - 1}{2(x-1)} \right)}$$

$$= e^{\left(\frac{1}{2} \ln a + \frac{1}{2} \ln b \right)} = e^{\frac{1}{2} \ln(ab)} = \sqrt{ab}$$

55. (b) Given, $f(x) = \sqrt{2-x} + \sqrt{2+x}$

for Domain,

$$2-x \geq 0 \text{ and } 2+x \geq 0$$

$$\Rightarrow 2 \geq x \text{ and } x \geq -2 \Rightarrow -2 \leq x \leq 2$$

$$\Rightarrow x \in [-2, 2]$$

56. (c) If we put $x = 0$

then $f(x) = 2\sqrt{2} = \sqrt{8}$ is greatest value of $f(x)$

(57-58) Since, $h(x) = \frac{f(g(x))}{g(f(x))}$

$$= \frac{f([x]-1)}{g([x])} = \frac{[x]-1}{[x]-1}$$

57. (b) Since, $= \lim_{x \rightarrow 0^+} \frac{[x]-1}{[x]-1} = \frac{-1}{-1} = -1$

58. (a) Since, $= \lim_{x \rightarrow 0^-} h(x)$

$$= \lim_{x \rightarrow 0^-} \frac{[x]-1}{[x]-1} = \lim_{x \rightarrow 0^-} \frac{-1-1}{-1} = -2$$

(Sol. 59-60): Since, the function

$$f(x) = \begin{cases} -1+a & ; x < 3 \\ a-b & ; x = 3 \\ 1+b & ; x > 3 \end{cases}$$

Since, $f(x)$ is continuous at $x = 3$

$$\lim_{x \rightarrow 3^-} f(x) = \lim_{x \rightarrow 3^+} f(x) = f(3)$$

$$-1+a = a-b = 1+b$$

59. (d) $-1+a = 1+1 \Rightarrow a = 3$

60. (b) $\Rightarrow -1 + a = a - b \Rightarrow b = 1$

61. (b) Since, $\int_0^{\pi} (\sin^4 x + \cos^4 x) dx$
 $= \int_0^{\pi} ((\sin^2 x + \cos^2 x)^2 - 2\sin^2 x \cos^2 x) dx$
 $= \int_0^{\pi} \left(1 - \frac{\sin^2 2x}{2}\right) dx = \int_0^{\pi} \left(1 - \frac{1 - \cos 4x}{4}\right) dx$
 $= \frac{1}{4} \int_0^{\pi} (3 + \cos 4x) dx = \frac{1}{4} \left(3x + \frac{\sin 4x}{4}\right)_0^{\pi} = \frac{3\pi}{4}$

62. (c) Since, $I = \int_{-2\pi}^{2\pi} \frac{\sin^4 x + \cos^4 x}{1 + 3^x} dx$

$$I = \int_{-2\pi}^{2\pi} \frac{3^x (\sin^4 x + \cos^4 x)}{1 + 3^x} dx$$

Since, $2I = \int_{-2\pi}^{2\pi} (\sin^4 x + \cos^4 x) dx$

$$\Rightarrow 2I = \frac{1}{4} \left(3x + \frac{\sin 4x}{4}\right)_{-2\pi}^{2\pi}$$

$$\Rightarrow 2I = \frac{1}{4} (3x(4\pi)) \Rightarrow I = \frac{3\pi}{2}$$

63. (a) Since,

$$f(x) = \begin{cases} ax(x+1) + b; & x < 1 \\ x-1 & ; 1 \leq x \leq 2 \end{cases}$$

Since, $f(x)$ is differential at $x = 1$

$$f'(x) = \begin{cases} a(2x+1); & x < 1 \\ 1 & ; 1 \leq x \leq 2 \end{cases}$$

$$\Rightarrow a(3) = 1 \Rightarrow a = \frac{1}{3}$$

since $f(x)$ is continuous at $x = 1$

$$\Rightarrow 2a + b = 0 \Rightarrow b = -\frac{2}{3}$$

$$\text{so, } a + b = -\frac{1}{3}$$

64. (b) Since, $\lim_{x \rightarrow 0} f(x)$

$$= \lim_{x \rightarrow 0} ax(x+1) + b = b = -\frac{2}{3}$$

65. (a) $f(x) = |\ln|x||$; $0 < x < 1 \Rightarrow f(x) = -\ln x$

Now, $f'(x) = -\frac{1}{x} \Rightarrow f'(0.5) = -2$

66. (c) Since, $y = f\left(\frac{2x-3}{x}\right)$

$$\Rightarrow \frac{dy}{dx} = f'\left(\frac{2x-3}{x}\right) \cdot \frac{d}{dx}\left(\frac{2x-3}{x}\right)$$

$$\Rightarrow \frac{dy}{dx} = f'\left(\frac{2x-3}{x}\right) \cdot \left(\frac{3}{x^2}\right) \quad (i)$$

$$\Rightarrow \frac{dy}{dx} = \frac{3}{x^2} \cos\left(\ln\left(\frac{2x-3}{x}\right)\right)$$

67. (d) Since, $|\sin x|$ is periodic function with period π

$$\text{So, } \int_0^{8\pi} |\sin x| dx = 8 \int_0^{\pi} |\sin x| dx$$

$$= 8 \int_0^{\pi} \sin x dx = 0$$

$$= 8(-\cos x)_0^{\pi} = 8(1+1) = 16$$

68. (d)

69. (d) Order = 3
degree = 2

70. (d) Since, $y^2 = 4ax - 4ab$

$$\Rightarrow 2y \frac{dy}{dx} = 4a \Rightarrow y \frac{d^2 y}{dx^2} + \left(\frac{dy}{dx}\right)^2 = 0$$

71. (a) Since,

$$a_1 + a_5 + a_{10} + a_{15} + a_{20} + a_{25} + a_{30} + a_{34}$$

$$= a_1 + a_1 + 4d - a_1 - 9d - a_1 - 14d - a_1 - 19d$$

$$- a_1 - 24d + a_1 + 29d + a_1 + 33d$$

$$= 0$$

72. (d) Given,

$$a_1 + a_5 + a_{10} + a_{15} + a_{20} + a_{25} + a_{30} + a_{34} = 300$$

$$= a_1 + a_1 + 4d + a_1 + 9d + a_1 + 14d + a_1 + 19d$$

$$+ a_1 + 24d + a_1 + 29d + a_1 + 33d = 300$$

$$= 8a_1 + 132d = 300$$

$$= (2a_1 + 33d) = \frac{300}{4} \quad (i)$$

Since, $\sum_{n=1}^{34} a_n = a_1 + a_2 + \dots + a_{34}$

$$= \frac{34}{2} (2a_1 + 33d)$$

$$= 17 \times \frac{300}{4} = 1275$$

73. (c) Since, $p + q$

$$= \cos\left(\frac{\pi}{5}\right) \cdot \cos\left(\frac{2\pi}{5}\right) + \cos\left(\frac{4\pi}{5}\right) \cdot \cos\left(\frac{8\pi}{5}\right)$$

$$= \cos\left(\frac{\pi}{5}\right) \cdot \cos\left(\frac{2\pi}{5}\right) - \cos\left(\frac{\pi}{5}\right) \cdot \cos\left(\frac{2\pi}{5}\right) = 0$$

74. (a) Since, pq

$$= -\cos^2\left(\frac{\pi}{5}\right) \cdot \cos^2\left(\frac{2\pi}{5}\right)$$

$$= -\left(\frac{\sqrt{5}+1}{4}\right)^2 \cdot \left(\frac{\sqrt{5}-1}{4}\right)^2$$

$$= -\frac{(5-1)^2}{16 \times 16} = -\frac{1}{16}$$

$$\begin{aligned}
 75. (d) \text{ Since, } P &= \frac{1}{3} - \frac{\tan 3x}{\tan x} \\
 &= \frac{1}{3} - \frac{3 \tan x - \tan^3 x}{(1 - 3 \tan^2 x) \tan x} \\
 &= \frac{1 - 3 \tan^2 x - 9 + 3 \tan^2 x}{3(1 - 3 \tan^2 x)} = \frac{-8}{3(1 - 3 \tan^2 x)} \\
 \Rightarrow pq &= \frac{-8(1 - 3 \tan^2 x)}{3(1 - 3 \tan^2 x)} = \frac{-8}{3}
 \end{aligned}$$

$$\begin{aligned}
 76. (c) \text{ Since, } \frac{1}{P} &= 0 \\
 \Rightarrow \frac{3(1 - 3 \tan^2 x)}{-8} &= 0 \Rightarrow \tan x = \pm \frac{1}{\sqrt{3}}
 \end{aligned}$$

So, there are two values of x .

Sol. (77-78):

$$\begin{aligned}
 77. (b) \text{ Since, } \sin 3x + \sin 3y \\
 &= \sin \left(3 \cdot \frac{5\pi}{12} \right) + \sin \left(3 \cdot \frac{\pi}{12} \right) \\
 &= -\sin \left(\frac{\pi}{4} \right) + \sin \left(\frac{\pi}{4} \right) = 0
 \end{aligned}$$

$$\begin{aligned}
 78. (b) \text{ Since, } \\
 \cos^3 \left(\frac{5\pi}{12} \right) + \cos^3 \left(\frac{\pi}{12} \right) \\
 &= \left(\frac{\sqrt{3}-1}{2\sqrt{2}} \right)^3 + \left(\frac{\sqrt{3}+1}{2\sqrt{2}} \right)^3 = \frac{3\sqrt{6}}{8}
 \end{aligned}$$

$$\text{Sol. (79-80): Since, } 3x + 5x + 4x = \pi \Rightarrow 12x = \pi \Rightarrow x = \frac{\pi}{12}$$

$$\text{So, } A = \frac{\pi}{4}, B = \frac{5\pi}{12}, C = \frac{\pi}{3}$$

$$\text{Let } \frac{\sin A}{a} = \frac{\sin B}{b} = \frac{\sin C}{c} = K$$

$$\Rightarrow a = \frac{\sin A}{K} = \frac{1}{\sqrt{2}K}$$

$$\Rightarrow b = \frac{\sin B}{K} = \frac{\sqrt{3}+1}{2\sqrt{2}K}$$

$$\Rightarrow c = \frac{\sin C}{K} = \frac{\sqrt{3}}{2K}$$

$$\begin{aligned}
 79. (c) \text{ Since, } a + b + \sqrt{2}c \\
 &= \frac{1}{\sqrt{2}K} + \frac{\sqrt{3}+1}{2\sqrt{2}K} + \frac{\sqrt{3}}{\sqrt{2}K} \\
 &= \frac{2 + \sqrt{3} + 1 + 2\sqrt{3}}{2\sqrt{2}K} = \frac{3 + 3\sqrt{3}}{2\sqrt{2}K} = 3b
 \end{aligned}$$

$$\begin{aligned}
 80. (a) \text{ Since, } a^2 : b^2 : c^2 \\
 \Rightarrow \left(\frac{1}{\sqrt{2}K} \right)^2 : \left(\frac{\sqrt{3}+1}{2\sqrt{2}K} \right)^2 : \left(\frac{\sqrt{3}}{\sqrt{2}K} \right)^2 \\
 \Rightarrow 2 : 2 + \sqrt{3} : 3
 \end{aligned}$$

$$\begin{aligned}
 81. (b) \text{ Given equation of Parabola } y^2 = 4bx \\
 \text{Since, } b^2 + b - 2 = 0 \Rightarrow (b+2)(b-1) = 0 \\
 \Rightarrow b = -2, 1
 \end{aligned}$$

So, equation of directrix is $x = -b$

$$\begin{aligned}
 \Rightarrow x = -(-2) \Rightarrow x = +2 \quad (\text{Since, } b < 0) \\
 \Rightarrow x - 2 = 0
 \end{aligned}$$

$$82. (d) \text{ Let } A(-a, -b), B(0,0), C(a,b), D(a^2, ab)$$

$$\text{Since, Slope of } AB = \frac{b}{a}$$

$$\text{Slope of } BC = \frac{b}{a}$$

$$\text{Slope of } CD = \frac{b}{a}$$

$$\text{Slope of } DA = \frac{b}{a}$$

So, given points are collinear.

$$\begin{aligned}
 83. (b) \text{ Given } 16P^2 + 49Q^2 - 4R^2 - 56PQ = 0 \\
 \Rightarrow (4P - 7Q)^2 = (2R)^2 \Rightarrow 4P - 7Q = \pm 2R \\
 \Rightarrow (4P - 7Q + 2R)(4P - 7Q - 2R) = 0 \\
 \Rightarrow \left(2P - \frac{7}{2}Q + R \right) \left(2P - \frac{7}{2}Q - R \right) = 0
 \end{aligned}$$

$$\text{So } (x, y) = \left(2, \frac{-7}{2} \right)$$

$$84. (b)$$

$$85. (c) \text{ Given the equation}$$

$$\frac{x^2}{24-k} + \frac{y^2}{k-16} = 2$$

If $k = 19 \Rightarrow$ Given equation is ellipse.

If $k = 12 \Rightarrow$ Given equation is hyperbola

If $k = 20 \Rightarrow$ Given equation is circle.

$$86. (c) \text{ Given the equation}$$

$$\frac{x^2}{\cos^2 \theta} - \frac{y^2}{\sin^2 \theta} = 1$$

$$\text{Since } C^2 = \cos^2 \theta + \sin^2 \theta = 1$$

$$\text{So focus} = (0 \pm 1, 0) = (\pm 1, 0)$$

$$e = \frac{c}{a} = \frac{1}{\cos \theta} = \sec \theta$$

$$\text{Distance between the two foci} = 1 + 1 = 2$$

$$87. (b) \text{ Given, } 4x^2 + 4y^2 - 4ax - 4ay + a^2 = 0$$

$$\Rightarrow \left(x - \frac{a}{2} \right)^2 + \left(y - \frac{a}{2} \right)^2 = \left(\frac{a}{2} \right)^2$$

So, this circle touches both the axis,

$$\text{Diameter of circle} = \frac{a}{2} + \frac{a}{2} = a$$

and the centre lies on the line $x + y = a$

88. (b) Since, for parallel lines

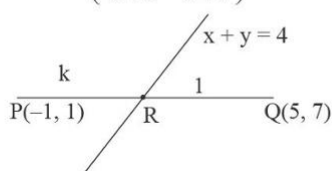
$$\frac{k-3}{1} = \frac{-(5-k^2)}{1}$$

$$\Rightarrow k^2 - 5 = k - 3 \Rightarrow k^2 - k - 2 = 0$$

$$\Rightarrow (k-2)(k+1) = 0 \Rightarrow k = -1, 2$$

89. (b) Let the ratio is $k : 1$

$$\text{So, } R = \left(\frac{5k-1}{k+1}, \frac{7k+1}{k+1} \right)$$



Now,

$$\frac{5k-1}{k+1} + \frac{7k+1}{k+1} = 4$$

$$\Rightarrow 12k = 4k + 4 \Rightarrow k = \frac{1}{2}$$

$$\text{So, } PR : RQ = 1 : 2$$

90. (c) Since, equation of normal is

$$x \cos \alpha + y \sin \alpha = P$$

$$\Rightarrow x \cos 15^\circ + y \sin 15^\circ = 4 \quad \dots(i)$$

$$\text{If } y = 0 \Rightarrow x = \frac{4}{\cos 15^\circ} = a = \text{intercept on X-axis}$$

$$\text{If } x = 0 \Rightarrow y = \frac{4}{\sin 15^\circ} = b = \text{intercept on Y-axis}$$

$$\text{Now, } a + b = \frac{4}{\cos 15^\circ} + \frac{4}{\sin 15^\circ} = 8\sqrt{6}$$

91. (b) Length of projection of the vector $\hat{i} + 2\hat{j} + 3\hat{k}$ on the vector

$$2\hat{i} + 3\hat{j} - 2\hat{k} \text{ is}$$

$$\frac{(\hat{i} + 2\hat{j} + 3\hat{k}) \cdot (2\hat{i} + 3\hat{j} - 2\hat{k})}{|2\hat{i} + 3\hat{j} - 2\hat{k}|} = \frac{2 + 6 - 6}{\sqrt{4 + 9 + 4}} = \frac{2}{\sqrt{17}}$$

92. (a) Given, $(\vec{a} \times \vec{b})^2 + (\vec{a} \cdot \vec{b})^2 = 144$

$$\Rightarrow |\vec{a}|^2 |\vec{b}|^2 \rightarrow \sin^2 \theta + |\vec{a}|^2 |\vec{b}|^2 \cos^2 \theta = 144$$

$$\Rightarrow |\vec{a}|^2 |\vec{b}|^2 = 144$$

$$|\vec{a}|^2 \times 16 = 144 \Rightarrow |\vec{a}| = 3$$

93. (b) Since $\vec{a} \cdot \vec{b} \geq 0 \Rightarrow |\vec{a}| |\vec{b}| \cos \theta \geq 0 \Rightarrow \vec{0} \leq \theta \leq \frac{\pi}{2}$

94. (c) For collinear of given vectors

$$\frac{-8-3}{40-60} = \frac{-52+8}{\beta-40}$$

$$\Rightarrow \frac{-11}{-20} = \frac{-44}{\beta-40}$$

$$\Rightarrow \beta - 40 = -80$$

$$\Rightarrow \beta = -40$$

95. (b) Number of units vectors perpendiculars to $\vec{a}$ and $\vec{b}$ is

$$\text{two i.e., } \frac{\pm \vec{a} \times \vec{b}}{|\vec{a} \times \vec{b}|} \text{ and angle between } \vec{a} \text{ and } \vec{b} \text{ is}$$

$$\cos \theta = \frac{\vec{a} \cdot \vec{b}}{|\vec{a}| |\vec{b}|}$$

$$\Rightarrow \cos \theta = \frac{(0, 1, 1) \cdot (1, 0, 1)}{\sqrt{2} \cdot \sqrt{2}} = \frac{1}{2} \Rightarrow \theta = \frac{\pi}{3}$$

96. (d) Since equation of line is

$$\frac{x-1}{3} = \frac{y+1}{-2} = \frac{z-1}{6} = \lambda \text{ (let)}$$

$$\Rightarrow (x, y, z) = (3\lambda + 1, -2\lambda - 1, 6\lambda + 1)$$

Now,

$$\sqrt{(3\lambda + 1 - 1)^2 + (-2\lambda - 1 + 1)^2 + (6\lambda + 1 - 1)^2} = 2$$

$$= \sqrt{9\lambda^2 + 4\lambda^2 + 36\lambda^2} = 2$$

$$\Rightarrow \sqrt{49\lambda^2} = 2 \Rightarrow \pm 7\lambda = 2 \Rightarrow \lambda = \pm \frac{2}{7}$$

$$\text{So, } (x, y, z) = \left(\frac{13}{7}, \frac{11}{7}, \frac{19}{7} \right) \text{ or } \left(\frac{1}{7}, \frac{-3}{7}, \frac{-5}{7} \right)$$

97. (d) If a line parallel to a plane

$$\text{then } a_1 a_2 + b_1 b_2 + c_1 c_2 = 0$$

$$\text{so option (a), } 3.2 + 2.4 + 1.5 \neq 0$$

$$(b) 2.3 - 1.4 - 2.5 \neq 0$$

$$(c) 2.3 + 2.4 - 2.5 \neq 0$$

$$(d) 1.3 - 2.4 + 1.5 = 0$$

98. (d) Given the lines

$$2x = 3y = -z \text{ and } 6x = -y = -4z$$

$$\Rightarrow \frac{x}{3} = \frac{y}{2} = \frac{z}{-6} \text{ and } \frac{x}{2} = \frac{y}{-12} = \frac{z}{-3}$$

So, angle between lines is given by.

$$\cos \theta = |3.2 + 2(-12) + (-6)(-3)|$$

$$\Rightarrow \cos \theta = 0 \Rightarrow \theta = \frac{\pi}{2} = 90^\circ$$

99. (d) Since, equation of sphere concentric with the sphere

$$x^2 + y^2 + z^2 - 2x - 6y - 8z - 5 = 0 \text{ is}$$

$$x^2 + y^2 + z^2 - 2x - 6y - 8z + k = 0$$

$$\text{Since, } (0, 0, 0) \text{ satisfy } \Rightarrow k = 0$$

$$\text{So, } x^2 + y^2 + z^2 - 2x - 6y - 8z = 0$$

100. (a)

$$\text{Let } AP : BP = k : 1$$

$$7 = \frac{k+3}{k+1} \Rightarrow k = \frac{-2}{3}$$

So ratio is 2 : 3 externally.

$$\text{Now, } x = \frac{2 \times 2 - 3 \times 1}{2 - 3} = -1$$

$$y = \frac{2 \times 10 - 3 \times 2}{2 - 3} = -14$$

$$\Rightarrow x + y = -15$$

101.(a) Since, $\sum (x_i - 10) = P$

and $\sum (x_i - 20) = q$

$\Rightarrow \sum x_i - 10n = P$

$\sum x_i - 20n = q$

Now, $(-10n + 20n)^2 = 10000$

$\Rightarrow 100n^2 = 10000 \Rightarrow n = 10$

102.(c) Since, $\sum_{i=1}^{10} x_i = 10 \times 20 = 200$

Now, $\frac{1}{5} \sum_{i=1}^{10} (3x_i - 4)$

$= \frac{3}{5} \sum_{i=1}^{10} x_i - \frac{4}{5} \times 10 = \frac{3}{5} \times 200 - 4 \times 2 = 112$

103.(d) Since, $\sigma = \sqrt{\frac{\sum x^2}{n} - \left(\frac{\sum x}{n}\right)^2}$

$\Rightarrow \sigma = \sqrt{\frac{16160}{10} - (40)^2}$

$= \sqrt{1616 - 1600} = \sqrt{16} = 4$

104.(a) $n(s) = 6 \times 6 \times 6 = 216$

Since, sum is 4 = (1, 1, 2) → 3 ways

sum is 9 = (1, 2, 6) → 6 ways

= (2, 2, 5) → 3 ways

= (3, 1, 5) → 6 ways

= (1, 4, 4) → 3 ways

= (3, 2, 4) → 6 ways

= (3, 3, 3) → 1 way

Sum is 16 = (4, 6, 6) → 3 ways

= (5, 5, 6) → 3 ways

So, required probability = $\frac{34}{216} = \frac{17}{108}$

105.(d) Let $2P(A) = 3P(B) = 4P(C) = 5P(D) = k$

Now $P(A) + P(B) + P(C) + P(D) = 1$

$\Rightarrow \frac{k}{2} + \frac{k}{3} + \frac{k}{4} + \frac{k}{5} = 1$

$\Rightarrow \frac{30k + 20k + 15k + 12k}{60} = 1$

$\Rightarrow 77k = 60 \Rightarrow k = \frac{60}{77}$

$P(A) = \frac{k}{2} = \frac{30}{77}$

$\Rightarrow 77P(A) = 30$

106.(d) There are only two combination are possible (3, 7), (7, 3) such that their product has 1 in its unit place. So,

required probability = $\frac{2}{9 \times 8} = \frac{1}{36}$

107.(b) When difference is 2 then

{(1, 3), (2, 4), (3, 5), (4, 6), (3, 1), (4, 2), (5, 3), (6, 4)}

When difference is 3 then

{(1, 4), (2, 5), (3, 6), (4, 1), (5, 2), (6, 3)}

So, required probability = $\frac{14}{36} = \frac{7}{18}$

108.(c) Mean = $\frac{\sum f_i \cdot x_i}{\sum f_i} = \frac{1 \times {}^9C_0 + 2 \times {}^9C_1 + \dots + 10 \times {}^9C_9}{{}^9C_0 + {}^9C_1 + {}^9C_2 + \dots + {}^9C_9}$

$= \frac{11 \times 2^8}{2^9} = 5.5$

109.(d) $P(\text{recover from disease}) = 0.8 = \frac{4}{5}$

So, required probability = ${}^5C_2 \left(\frac{4}{5}\right)^2 \left(1 - \frac{4}{5}\right)^3$

$= \frac{5 \times 4}{2} \times \frac{16}{25} \times \frac{1}{125} = 0.0512$

110.(b) Let E_1 = design is faulty

E_2 = design is not faulty

A = building is collapses

Since, $P(E_1) = 10\% = \frac{1}{10}$

$P(E_2) = 90\% = \frac{9}{10}$

$P(A/E_1) = 95\% = \frac{19}{20}$

$P(A/E_2) = 45\% = \frac{9}{20}$

Now $P\left(\frac{E}{A}\right) = \frac{P(E_1) P(A/E_1)}{P(E_1) \cdot P(A/E_1) + P(E_2) P(A/E_2)}$

$= \frac{\frac{1}{10} \times \frac{19}{20}}{\frac{1}{10} \times \frac{19}{20} + \frac{9}{10} \times \frac{9}{20}} = \frac{19}{100} = 0.19$

111.(a) $\therefore r = \frac{\text{cor}(x, y)}{\sqrt{\text{var}(x) \cdot \text{var}(y)}}$

$\text{cor}(3x + 4, -3y + 3) = \sum (3x - 3x')(-3y + 3y')$

$= -9\text{cor}(x, y)$

$\therefore r(3x + 4, -3y + 3) = \frac{-9\text{cor}(x, y)}{\sqrt{9\text{cor}(x) - 9\text{var}(y)}}$

$= \frac{-9\text{cor}(x, y)}{9\sqrt{\text{var}(x) \cdot \text{var}(y)}} = -r$

112.(c) Let $E = \{\text{HHHHHT, TTTTH}\}$

Now, $P(E) = \frac{2}{2^6} = \frac{2}{64} = \frac{1}{32}$

113.(c) Since, Harmonic Mean (H)

$H = \frac{3}{\frac{1}{{}^{10}C_4} + \frac{1}{{}^{10}C_5} + \frac{1}{{}^{10}C_6}}$

$$H = \frac{3}{\frac{1}{210} + \frac{1}{252} + \frac{1}{210}} = \frac{3 \times 105 \times 252}{357}$$

$$\text{Hence, } \frac{270}{H} = \frac{17}{14}$$

- 114.(b) The number of ways in which p and q seat together = $(n-1)! \times 2$

$$\text{So, required Probability} = \frac{2(n-1)!}{n!} = \frac{2}{n}$$

- 115.(a) Since, given $n = 6$

$$\& 9P(x=4) = P(x=2)$$

$$\Rightarrow 9 {}^6C_4 P^4 q^2 = {}^6C_2 P^2 q^4$$

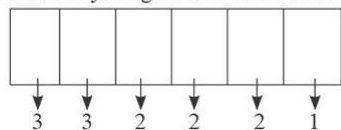
$$\Rightarrow \frac{p^2}{q^2} = \frac{1}{9} \Rightarrow \frac{p}{q} = \frac{1}{3} \Rightarrow q = 3p$$

$$\text{Since } p + q = 1 \Rightarrow p = \frac{1}{4}$$

- 116.(a) The number of ways in which all boys sit together = $4! \times 3!$

$$\text{Required probability} = \frac{4! \times 3!}{6!} = \frac{1}{5}$$

- 117.(b) Since boys & girls seats alternatively



$$\text{Required probability} = \frac{2 \times 3 \times 3 \times 2 \times 2}{6!} = \frac{1}{10}$$

- 118.(d) Required probability = $\frac{3! \times {}^4P_3}{6!} = \frac{1}{5}$

- 119.(a) Since

$$\text{Required probability} = \frac{4! \times 2}{6!} = \frac{1}{15}$$

- 120.(d) Required probability = $\frac{5! \times 2}{6!} = \frac{1}{3}$

5. (d) To state what an essay is about, the phrase 'The essay explores and examines...' is used. Thus, option (d) is the appropriate answer.
6. (b) In the given context, with the implementation of family planning programmes, India has managed to **stabilise** its population. 'Stabilise' means to make something steady.
7. (a) Threshold can be understood as the level, line or a boundary at which something starts to happen. Thus, adolescence is the **threshold** wherein a child enters adulthood.
8. (c) To exploit something means to treat something or someone with an intent to take advantage. In the given sentence, the word 'exploit' is appropriate for it gives the sense that the British used Indian resources for their selfish motives.
9. (b) Endangered species are at the risk of disappearing or **extinction**. The word extinction implies complete disappearance.
10. (d) As per the first law of thermodynamics energy cannot be created or destroyed it can only be **transformed** from one form into another.
11. (b) Note that the verb is missing in the given sentence. 'Bread, butter and jam' is the subject with which the verb 'are' can be used to make a meaningful sentence.
12. (d) There is no error in the sentence. Note that even though 'ten thousand dollars' appears to be a plural subject; it is in fact treated as a singular subject. When a plural noun denotes some specific quantity or amount considered as a whole, the verb is singular.
13. (b) The phrase 'make up' means 'adds up'. Even though 'create' and 'make' have similar meanings, the phrase 'create up' cannot replace 'make up' to give the same meaning for the former does not exist.
14. (c) There is a spelling error in the (c) part of the sentence. The process of removing wool from the body of an animal is called **shearing**.
15. (b) In the given sentence, the second verb 'pray' should be used in the infinitive form to make the sentence grammatically appropriate. Thus, the correct sentence will be 'Many people came from faraway places to pray at the temple on the auspicious day.'
16. (a) Since a particular part of the book is specified, article 'the' should be used before the word 'foreword' in the given sentence. Therefore, the complete sentence will be 'After reading the foreword of the book on environmental issues in India, I decided to meet its author.'
17. (c) The preposition has been incorrectly used in the given sentence. Instead of 'to', 'of' should be used.
18. (d) There is no error in the given sentence.
19. (c) The given sentence is an example of the second conditional. The second conditional is used to imagine present or future situations that are impossible or unlikely in reality. The correct way to structure second conditional sentences is to use the simple past tense in the if-clause and a modal auxiliary.

GENERAL ABILITY

PART- A: ENGLISH

1. (a) 'Lashed' means to hit something with great force. In case of monsoon, 'lashed' suggests the presence of heavy rain.
2. (c) 'Confront' means to face or deal with a difficult situation. Thus, the sentence means that to meet and address the scale of challenges, more viable plans for sustainability are introduced by the company.
3. (b) 'To go the distance' means 'to manage to continue until the end of something'. Thus, option (b) is the correct response.
4. (a) 'Extent' means 'the length or importance of something'. Thus, option (a) is the right answer.

20. (a) The error is in the (a) part of the sentence. The second verb is usually in -ing form or to + infinitive form. Here, 'to deliver' should be used.
21. (c) 'Captious' is used to refer to someone who is a fault-finder or a judgemental person.
22. (a) 'Ascertain' means to find out or to verify. Thus, option (a) is the correct response.
23. (d) A commissary is a food store, canteen or a restaurant in a military base or a prison.
24. (b) To dismember something means to cut it into pieces. Option (b) 'dissected' is the closest in meaning to 'dismembered'.
25. (b) Bursar or accountant is a person who manages accounts and handles the financial matters of an institution.
26. (c) Insidious means spreading gradually or without being noticed, but causing serious harm. Option (c) 'deceitful' is its synonym.
27. (c) Intrinsic means something that is basic to one's nature. Its synonym is 'inherent'.
28. (d) The word 'onerous' is used to refer to something which is tiring and needs a lot of effort. Thus, 'wearying' is its correct synonym.
29. (a) Potentate is a term used to refer to a monarch or a ruler. Thus, option (a) is the right answer.
30. (b) Indolence means laziness. Other synonyms for the same are idleness, lethargy etc.
31. (c) 'Principle' means a moral rule or idea. 'Principal' refers to the head of the institution.
32. (c) 'Plane' refers to the object that flies. 'Plain' means a flat surface.
33. (c) 'Pale' means faded. 'Pail' is used to denote a bucket.
34. (d) Metal refers to hard and shiny material. Mettle means mental resilience.
35. (b) Hail means small balls of ice. Hale implies strong and healthy.
36. (d) Conscious means a state of awareness. Conscience refers to sense of right and wrong.
37. (a) Dissent means 'having ideas different from general beliefs or official position. Descent refers to movement towards a lower place.
38. (c) Device means a piece of equipment which helps in accomplishing a task. Devise implies finding a new way to do something.
39. (b) From the given list, option (b) is the most appropriate option.
40. (a) Eminent implies important and famous. Imminent means something unpleasant which is about to happen.
41. (a) Malleable means something that is soft and mouldable. The correct antonym of malleable is 'hard'.
42. (c) Neglect means to ignore. The opposite of 'neglect' is 'regard' which means to pay attention to something.
43. (b) Ostentatious is used to refer to something that is gawdy or excessively visible with an intention to impress others.
44. (d) Excruciating means extremely painful. The antonym of 'excruciating' from the given list of options is 'mild' which means 'not strong'.
45. (b) Refreshing refers to describe something that is pleasant and makes one feel less tired. The opposite of the word refreshing is 'wearying' which means tiring.
46. (d) It is clearly stated in the beginning of the passage that people lack the motivation to use renewable resources in a sustainable manner for all three reasons on the list- tenuous control over resource base, possibility of substitution, and large number of resources.
47. (c) When the resources use has little impact, people use resources exhaustively.
48. (d) The passage upholds use of resources in a prudent (sensible or careful) fashion. Due to self-interest of people, the use of renewable resources is affected indifferently (disinterestedly or carelessly).
49. (c) People rooted in a locality retain control over their resource base and use them in a sustainable manner. Thus, they believe in conservation and reproduction of resources.
50. (a) Exhaust is closest in meaning to the word 'deplete' for both denote 'decrease'.

PART- B: GENERAL KNOWLEDGE

51. (b) The scattering of light by colloidal particles like dust, smoke, water droplets etc , This phenomenon is known as tyndall effect . It is seen when a fine beam of sunlight enters a dusty room, Thus, the scattering of light makes the particle visible.
52. (b) Light travels much faster than sound. speed of light $c = 3 \times 10^8$ m/s while speed of sound 343.2 metres per second. Therefore the flash of light seen before the thunderstorm heard.
53. (c) We know that $V = IR$,
Resistance of the heater remain same so $R_1 = R_2$
Given $V_1 = 220$ volt $V_2 = 120$ volt
 $I_1 = 0.5$ A
 $I_2 = ?$
 $R_1 = R_2$
 $V_1/I_1 = V_2/I_2$
 $220/0.5 = 120/I_2$
 $I_2 = 0.27$ A
54. (c) The heating element in an electric iron is an alloy consisting of 80% of Nickel and 20% of Chromium. The melting point of Nichrome is 1400 °C with high resistance . due to resistance energy loss convert into heat.
55. (c)
56. (c) Galvanisation is applying a coating of zinc metal to prevent corrosion of iron and steel. It makes a stable compound zinc oxide to react with water.

57. (c) The simplest alloy of steel is a composition of Fe(Iron) and Carbon, with several alloying elements such as manganese, silicon, nickel etc.
58. (c) It is a allotrops of carbon. Buckminster fullerene is a type of fullerene with the formula C₆₀. It has a cage-like fused-ring structure made of twenty hexagons and twelve pentagons, and resembles a soccer ball. Each of its 60 carbon atoms is bonded to its three neighbors.
59. (c)
60. (a) Green plants are autotrophs which trap solar radiation and convert it into food . Plants typically trap 1 percent of the available solar energy in the process of photosynthesis. Photosynthesis is the most important biological process on earth. It makes food and oxygen available to all the heterotrophs.
61. (b) The thermite reaction is an exothermic reaction not endothermic where Iron oxide reacts with Aluminum to give molten Iron and Aluminum oxide.
- This reaction is an example of a single displacement reaction.
62. (c) Electrolysis of water is a decomposition reaction. Burning of coal is a combination reaction. Iron nail emersed in a copper sulphate solution here Iron displaces copper ions from an aqueous solution of copper sulphate. It is a single displacement reaction of one metal by another metal. Here both Al and Ba displaces each other so it is a double displacement reaction $Al_2(SO_4)_3 + BaCl_2 \rightarrow AlCl_3 + BaSO_4$
63. (d) In a chemical reaction, the state of the matter changes and the change is irreversible in nature from the given options (d) is correct. $2Mg + O_2 \rightarrow 2MgO + \text{Heat}$
Other three are not a chemical change.
64. (b) Metals like Fe , Al and Zn do not react with cold as well as hot water. They only react with steam to form the metal oxide and hydrogen.
65. (d) Mercury oxide, also called mercuric oxide or simply mercury oxide, is the inorganic compound with the formula HgO. It has a red or orange color. Mercuryoxide is a solid at room temperature and pressure.
Mercury is a liquid at room temperature.
Oxygen is a gas form.
66. (b) Because meiosis creates cells that are destined to become gametes (or reproductive cells), this reduction in chromosome number is critical — without it, the union of two gametes during fertilization would result in offspring with twice the normal number of chromosomes.
67. (d)
68. (a) Streptococcus mutans, which causes tooth decay, splits the sucrose in food and uses one of the sugars to build its capsule, which sticks tightly to the tooth. The bacteria that are trapped in the capsule use the other sugar to fuel their metabolism and produce slime layer.
69. (d)
70. (b) Both chromosome number and DNA content remain constant, fertilization and replication process ensure the same number of chromosome and DNA content respectively.
71. (b) The relationship between flower and honeybee is beneficial for both because the flowers get pollinated with the help of honeybee and the honeybee obtains nectar from the flower. Thus, both flower and honeybee are mutually benefited.
72. (c) In Ancient India, kings often sought to claim high status and establish their authority by associating themselves with various deities. This practice was prevalent among different dynasties, such as the Kushanas and the Vijayanagara rulers. Pallavas and cholas etc assuming pompous titles, conquest and annexation of territories was also a way to claim a high status.
73. (a) The Bhakti movement led to the emergence of new sects within Hinduism, which led to the development of a diverse and pluralistic religious culture. It helped in the revival of the idea of the guru and the guru-shishya tradition. So Bhakti movement promote the diversity and reform Hinduism.
74. (c) Reign of Terror, a period of the French Revolution from September 5, 1793, to July 27, 1794, with civil war spreading in France. Robespierre, the leader of the Jacobin club, used a revolutionary tribunal to arrest people who seemed to be against the republic nation. They were guillotined, when found guilty. Ex-nobles and clergymen, members of political parties and his own party's dissenters were targeted.
75. (c)
76. (b) On 8 Aug 1942, the all india congress committee, passed a Quit india resolution at Gualiya tank, Bombay calling for an immediate end of british rule.
77. (d) The Kudremukh mines is located in the Ballari-Chitradurga-Chikkamagaluru-Tumakuru belt. These mines are known for its large deposits of iron ore and it is one of the largest in the world. All other options are correctly matched.
78. (b) 1 bar is equal to: 0.986923 atm., 1 atm approx and 100000 pascals.
Millibar, is a unit of air pressure in the metric system, commonly used in meteorology, equal to 100 pascals, 1,000 dynes per square cm.
79. (a) Precambrian era is the oldest era of geological history. The duration of this era is from the beginning of the earth nearly 4.6 billion years or more till about 0.6 billion years ago. In other words Pre- Cambrian alone encompasses 90 per cent of all geological time.
80. (c) Longitude refers to the imaginary lines that bisect the globe through the North and South Poles (the ones that run vertically).
Latitude refers the angular distance of a place north or south of the earth's equator, or of the equator of a celestial object, usually expressed in degrees and minutes.(the one that runs horizontally).

81. (b) Troposphere is the layer of atmosphere where all weather phenomenon occur.
It is the lowest layer of earth's atmosphere, its average height is 13km and its lowest height is at poles which is 8 km and maximum height 18 km at the equator.
82. (d) Roopkund is located in the lap of Trishulmassif in the Himalayas at a height of 5,020 metres (16,470 ft). This lake is locally known as Mystery Lake or Skeleton Lake because the hundreds of ancient human skeletons found at the edge of the lake.
83. (a)
84. (a) An AC generator can be converted into a DC generator by using a split ring type commutator which helps in maintaining a connection between the moving rotor and stator.
85. (b) This condition is known as near sightedness. This defect can be corrected by using the concave lens of power -0.5 D .
86. (c) Resistance is inversely proportional to cross-sectional area but resistivity does not depend on area of cross-section as it has constant area of 1 m^2 .
Resistance of a wire is directly proportional to length of wire whereas resistivity does not depend on length of wire because length of wire is kept constant, i.e. 1 m .
87. (a) When atmospheric pressure becomes equal to the vapour pressure.
88. (a) Ammonium cyanate is an inorganic compound whereas all other are organic compounds. Urea is the first organic compound to be developed in laboratory Friedrich Wöhler in 1828 which is called The Wöhler synthesis.
89. (b) Nitric acid (HNO_3), is a very reactive, highly corrosive, strong oxidizing agent but it does not react with less reactive metals like gold and silver hence it is used by goldsmiths for cleaning gold and silver articles. It is also used in production of fertilizers, making of dyes, in school laboratory and as an oxidizer in liquid fueled rockets.
90. (a) Litmus is neutral towards ethanol i.e. its colour does not change on treating it with ethanol / Ethyl alcohol ($\text{C}_2\text{H}_5\text{OH}$) because OH group attached to it does not dissociate as OH^- ion which is responsible for change in colour.
91. (d) Stainless steel is an alloy which consists of 83% iron, 1% carbon, 15% chromium 1% nickel with carbon (C), silicon (Si) and manganese (Mn) and molybdenum.
Chromium reacts with oxygen and forms a layer of oxide of chromium which makes resistant to corrosion.
92. (c) Distillation works on the principle of difference in boiling point of liquids separating funnels work on the principle of difference in densities of immiscible liquids centrifugal work on principle of sedimentation paper chromatography principle of partition chromatography or adsorption chromatography
93. (d) Oxygen is the product of photosynthesis whereas carbon dioxide, water, sunlight and chlorophyll are the required components.
The chemical equation of photosynthesis is

$$6\text{CO}_2 + 6\text{H}_2\text{O} \xrightarrow[\text{sunlight}]{\text{chlorophyll}} \text{C}_6\text{H}_{12}\text{O}_6 + 6\text{O}_2$$
94. (a)
95. (a) Correct sequence of events in sexual reproduction in angiosperms (flowering plants) egg (pollination) zygote (fertilization) embryo seed
96. (d)
97. (c)
98. (c) Sanchi was discovered by General Taylor in 1818 out of four gateways to the stupa in the southern was built first.
Animals represented a bull, a horse, an elephant and a lion and monkey is also present at some places at Sanchi.
99. (b)
100. (d)
101. (c) Vijayanagar empire was founded by two brothers Harihar and Bukka of Sangam dynasty on the southern bank of Tungabhadra river in 1336.
102. (a) Area wise state Rajasthan > Madhya Pradesh > Maharashtra > Uttar Pradesh > Gujarat.
103. (a) Favorable conditions for cotton :
Black soil or regur soil
Temperature $20-30^\circ\text{C}$
At least 210 days of frost free time.
Moderate rainfall between 50-75 cm
104. (a) The Central Institute of Buddhist Studies, formerly known as the School of Buddhist Philosophy, located in Leh (Ladakh) is a deemed university under Ministry of Culture. It was founded in 1959 and formerly affiliated to the Sampurnanand Sanskrit University in Varanasi. It also teaches Sanskrit, English, Hindi, Tibetan and Pali.
105. (c)
106. (c)
107. (b) Suez canal is an artificial canal that separates Africa from Asia and it connects the Mediterranean Sea (city of port said in north) and the Red Sea (city of Suez in south). Its total length is 193 km. It was opened in 1869 and nationalized by Egypt in 1956. It carries 12% of world trade, 7% of world's oil, 30% container - ship daily.
108. (b) Things float on the principle of Archimedes' principle
When an object floats on a liquid the buoyant force that acts on the object is equal to the weight of the object.
- If the weight of the object is less than the upthrust, then the object will float on the fluid.
 - If the weight of the object is greater than the upthrust, then the object will sink in the fluid.
 - If the weight of the object is equal to the upthrust, then the object will float with half of its body immersed.

109. (a) Equivalent resistance is always less than the smallest individual resistance.
110. (b) 111. (d) 112. (a)
113. (a) Metals which are less reactive than carbon can be extracted using carbon as reducing agent. Metal reduced by carbon reduction are zinc, Iron, Tin, Lead. Aluminum is more reactive than carbon so carbon cannot reduce it. Silver and Gold are reduced by Mac Arthur process.
114. (b) It is a heterogeneous mixture which consist of two phases, the dispersed phase as well as the dispersion medium. The size of colloidal particles is very small. Their particle size ranges between 1-1000 nanometers.
115. (c) Two miscible liquids having difference in boiling point like kerosene and petrol can be separated by the process of fractional distillation. Petrol having lower boiling point evaporates leaving behind kerosene.
116. (d)
117. (c) Carbon can form single, double and triple bond between carbon atoms but cannot form tetra bonds between carbon atoms. It is tetravalent which means it can form 4 bonds with different atoms.
118. (a)
119. (a) Edmund Cartwright invented the power loom which was firstly was designed in 1784 and built in 1785. It was one of the key developments in the industrialization which made it easier to weave any kind of materials.
120. (c) P.C. Mahalanobis known as the Architect of Indian Planning and considered as the father of modern statistics in India and founder of the Indian Statistical Institute. Second five year plan was based on Mahalanobis model.
121. (a) There are 33 inscriptions in all, which are broadly grouped as follows:
Major rock edicts (14), Minor rock edicts (15), Separate rock edicts, Major pillar edicts (7), Minor pillar edicts.
Maski edict was discovered by C. Beadon in 1915 in Raichur district of Karnataka in which he was named as 'Devanampriyaya Ashoka' whereas other edicts he is referred as Devanampriyam (beloved of God) and Priyadarshi (Loved by all)
122. (c)
123. (a) It is highest mountain Japan which is a stratovolcano where as Alps, Andes, Rockies and the Himalayas are folded mountains.
124. (b) 125. (d) 126. (d)
127. (b) Jamshedpur steel plant is located on the confluence of Swarnrekha and Kharkai rivers in Jharkhand. Jamshedpur is important iron and steel center in India.
128. (a) All pairs are correctly matched
129. (b) Western disturbances which arises from Mediterranean sea is responsible for causing rainfall in north western part of India in Haryana, Punjab, western U.P. etc. which impacts Rabi crops specially wheat.
130. (d)
- | City | Industry |
|------------|-------------------------|
| Saharanpur | Paper industry |
| Chanderi | Cotton textile industry |
| Bhadohi | Carpet industry |
| Rniganj | Coal mining industry |
131. (b) We know that 'u' = the initial velocity of a body 'v' = the final velocity of a body time interval 't'.
-
- As you can see in the figure
Then, acceleration 'a' of the body can be written as,
 $a = \text{Slope of the velocity-time graph}$
 $a = \frac{v-u}{t}$
$v = u + at$
132. (b) Sound is a mechanical wave because, sound can not propagate without medium and Sound waves are longitudinal because A longitudinal wave is one where all the particles of the medium (such as gas, liquid or solid) vibrate in the same direction as the wave.
133. (d)
134. (d) For a transverse wave the direction of motion is perpendicular to the direction in which the oscillation occurs. Polarization is the property of transverse wave because they confine its orientation to on specific direction. Longitudinal wave does not show polarization.
135. (d) The magnets are not stick to the good quality of stainless steel, its depends on the composition of stainless steel.
The stainless steel which has 10.5 % chromium, has minimum 8 % nickel and 8 % manganese, then this stainless will become non magnetic.
So, those stainless steel contain higher amount of nickel, do not stick with magnets.
Plastic, carbon and aluminium are non magnetic in nature.
136. (c) All three statement are correct.
137. (a) The council has 15 members: the five permanent members and 10 non-permanent members elected for 2 year terms.
- The five permanent members are the United States, the Russia, France, China and the United Kingdom.
 - India, for the eighth time, has entered the UNSC as a non-permanent member in 2021 and stayed on the council for two years i.e 2021-22.

Each year, the General Assembly elects five non-permanent members for a two-year term. The ten non-permanent seats are distributed on a regional basis.

The council's presidency is a capacity that rotates every month among its 15 members.

138. (a) The 74th Amendment of the Constitution have the provision to form District Planning

Committees (DPCs) under Article 243 ZD, which is a requirement for both Panchayats and Municipalities. The District Planning Committees will be in charge of integrated planning for the district's urban and rural areas. District Planning Committees must prepare a draft development plan that addresses critical issues of common interest such as water and natural resource sharing, among other things.

139. (c) Article 76, The Constitution of India has provided for the office of the Attorney General Of India.

- He is the highest law officer in the country.
- As a chief legal advisor to the government of India, he advises the union government on all legal matters.
- He is also the primary lawyer representing the Union Government in the Supreme Court and High Court of India NOT a counsel.

140. (d) The Land Boundary Agreement came into force on 6 June 2015 between India and Bangladesh. Implementation of the Land Boundary Agreement deals with three outstanding border issues, relating to:

- (i) Adverse possessions;
- (ii) Enclaves; and
- (iii) An undemarcated land boundary issues.

West Bengal, Assam and Tripura share the boundary with Bangladesh while Arunachal Pradesh did not share.

141. (c) It is located in Kalikot district, Karnali Province of Nepal.

The project will use the flow from the Karnali River for power generation and the generated power will be fed into integrated power system of Nepal.

142. (d) The Helmand River serves as a crucial water source for both Afghanistan and Iran, supporting agriculture, livelihoods, and ecosystems in the region. Originating near Kabul in the Hindu Kush mountain range, the river flows for approximately 1,150 kilometers (715 miles) before emptying into Lake Hamun, which straddles the Afghanistan-Iran border.

143. (b)

Bilateral Exercises	Participating Countries
A. Garud shakti	4. India and Indonesia
B. Nomadic elephant	3. India and Mongolia
C. Mitra shakti	2. India and Sri Lanka
D. Dharma Guardian	1. India and Japan

144. (a) Post-Independence, first three gallantry awards namely Param Vir Chakra, Maha Vir Chakra and Vir

Chakra were instituted by the government of India on 26th January, 1950 which were deemed to have effect from 15th August, 1947.

Thereafter, other three gallantry awards — the Ashoka Chakra Class-I, the Ashoka Chakra Class-II and the Ashoka Chakra Class-III — were instituted in 1952, which were deemed to have effect from 15th August, 1947.

These awards were renamed as Ashoka Chakra, Kirti Chakra and Shaurya Chakra respectively in January 1967.

145. (d) The Centralised Laboratory Network is the largest global group which has standardised methods and materials for testing. India is a member of CLN. CLN is a part of the coalition for epidemic preparedness Innovation (CEPI).

146. (b) It is India's own automatic protection system, which is in development since 2012, under the name Train Collision Avoidance System (TCAS), which got rechristened Kavach or "armour".

- It is a set of electronic devices and Radio Frequency Identification (RFID) devices installed in locomotives, in the signalling system as well as the tracks.
- They connect to each other using ultra high radio frequencies to control the brakes of trains and also alert drivers, all based on the logic programmed into them.

Kavach includes the key elements from already existing, and tried and tested systems like the European Train Protection and Warning System, and the indigenous Anti Collision Device.

It will also carry features of the high-tech European Train Control System Level-2 in future.

The current form of Kavach adheres to the highest level of safety and reliability standard called Safety Integrity Level (SIL)4.

147. (c) A huge Soviet-era dam on the Dnipro River in southern Ukraine, known as the Kakhovka Dam, recently breached, resulting in flooding across the war zone.

148. (b) Australia

149. (b) RBI launched a financial inclusion dashboard 'Antardrishti' aimed at monitoring and evaluating the progress of financial inclusion in India. The primary objective is to assess the current state of financial inclusion by analyzing key metrics and indicators, enabling policymakers and stakeholders to identify areas that require attention and implement targeted interventions.

150. (d) The Sengol is profound in meaning, derived from the Tamil word "Semmai", it means "Righteousness".

A Sengol sceptre was carried by emperors on ceremonial occasions, and used to represent their authority.

It is associated with the Chola Empire, one of the longest-ruling and most influential dynasties in South India.