NDA/NA SOLVED PAPER 2024-II

MATHEMATICS

1. Let X be a matrix of order 3 × 3, Y be a matrix of order 2 × 3 and Z be a matrix of order 3 × 2. Which of the following statements are correct?
   A. (ZY)X is defined and is a square matrix of order 3.
   B. Y(XZ) is defined and is a square matrix of order 2.
   C. X(YZ) is not defined.
   Select the answer using the code given below.
   (a) A and B only
   (b) B and C only
   (c) A and C only
   (d) A, B and C

2. Consider the following statements :
   A. The set of all irrational numbers between $\sqrt{12}$ and $\sqrt{15}$ is an infinite set.
   B. The set of all odd integers less than 1000 is a finite set.
   Which of the statements given above is/are correct?
   (a) A only
   (b) B only
   (c) Both A and B
   (d) Neither A nor B

3. How many 4-digit numbers are there having all digits as odd?
   (a) 625
   (b) 400
   (c) 196
   (d) 120

4. If $\omega \neq 1$ is a cube root of unity, then what is $(1 + \omega - \omega^2)^{100} + (1 - \omega + \omega^2)^{100}$ equal to?
   (a) $2^{100}\omega^2$
   (b) $2^{100}\omega$
   (c) 2^{100}
   (d) -2^{100}

5. Let A and B be two square matrices of same order. If AB is a null matrix, then which one of the following is correct?
   (a) Both A and B are null matrices
   (b) Either A or B is a null matrix
   (c) B is a null matrix if A is a non-singular matrix
   (d) Both A and B are singular matrices

6. In the expansion of $(1 + x)^p (1 + x)^q$, if the coefficient of x^3 is 35, then what is the value of $(p + q)$?
   (a) 5
   (b) 6
   (c) 7
   (d) 8

7. If p times the pth term of an AP is equal to q times the qth term $(p \neq q)$, then what is the $(p + q)^{th}$ term equal to?
   (a) 0
   (b) $p + q$
   (c) pq
   (d) $pq(p + q)$

8. Let $p = \ln(x)$, $q = \ln(x^3)$ and $r = \ln(x^5)$, where $x > 1$. Which of the following statements is/are correct?
   A. p, q and r are in AP.
   B. p, q and r can never be in GP.
   Select the answer using the code given below:
   (a) A only
   (b) B only
   (c) Both A and B
   (d) Neither A nor B

9. If $Z = \dfrac{1}{3}\begin{vmatrix} i & 2i & 1 \\ 2i & 3i & 2 \\ 3 & 1 & 3 \end{vmatrix} = x + iy; i = \sqrt{-1}$
   then what is modulus of Z equal to?
   (a) 1
   (b) $\sqrt{2}$
   (c) 2
   (d) $\sqrt{3}$

10. What is the value of the sum $\displaystyle\sum_{n=1}^{20}(i^{n-1} + i^n + i^{n+1})$
    where $i = \sqrt{-1}$?
    (a) $-2i$
    (b) 0
    (c) 1
    (d) $2i$

11. Let $x > 1, y > 1, z > 1$ be in GP. Then $\dfrac{1}{1 + \ln x}, \dfrac{1}{1 + \ln y}, \dfrac{1}{1 + \ln z}$ are
    (a) in AP
    (b) in GP
    (c) in HP
    (d) neither in AP nor in GP nor in HP

12. If $\omega = -\dfrac{1}{2} + i\dfrac{\sqrt{3}}{2}$ then what is
    $\begin{vmatrix} 1+\omega & 1+\omega^2 & \omega+\omega^2 \\ 1 & \omega & \omega^2 \\ \dfrac{1}{\omega} & \dfrac{1}{\omega^2} & 1 \end{vmatrix}$ equal to?
    (a) 0
    (b) ω
    (c) ω^2
    (d) $1 - \omega^2$

13. If the sum of the first n terms of a series is $n(2n + 1)$, then what is the nth term?
    (a) $4n - 1$
    (b) $4n$
    (c) $4n + 1$
    (d) $4n + 3$

14. In how many ways can the letters of the word INDIA be permutated such that in each combination, vowels should occupy odd positions?
    (a) 3
    (b) 6
    (c) 9
    (d) 12

15. The letters of the word EQUATION are arranged in such a way that all vowels as well as consonants are together. How many such arrangements are there?
    (a) 240
    (b) 720
    (c) 1440
    (d) 1620

16. If n is a root of the equation $x^2 + px + m = 0$ and m is a root of the equation $x^2 + px + n = 0$, where $m \neq n$, then what is the value of $p + m + n$?
    (a) -1
    (b) 0
    (c) 1
    (d) 2

17. In how many ways can a student choose $(n-2)$ courses out of n courses if 2 courses are compulsory $(n > 4)$?
    (a) $(n-3)(n-4)$
    (b) $(n-1)(n-2)$
    (c) $\dfrac{(n-3)(n-4)}{2}$
    (d) $\dfrac{(n-2)(n-3)}{2}$

18. If $D_n = \begin{vmatrix} n & 20 & 30 \\ n^2 & 40 & 50 \\ n^3 & 60 & 70 \end{vmatrix}$ then what is the value of $\sum\limits_{n=1}^{4} D_n$?
    (a) -10000
    (b) -10
    (c) 10
    (d) 10000

19. Consider the following in respect of the matrices
    $$P = \begin{bmatrix} 0 & c & -b \\ -c & 0 & a \\ b & -a & 0 \end{bmatrix} \text{ and } Q = \begin{bmatrix} a^2 & ab & ac \\ ab & b^2 & bc \\ ac & bc & c^2 \end{bmatrix}$$
    A. PQ is null a matrix.
    B. QP is an identity matrix of order 3.
    C. PQ = QP
    which of the above is/are correct?
    (a) A only
    (b) B only
    (c) A and C
    (d) B and C

20. If P is a skew-symmetric matrix of order 3, then what is det(P) equal to?
    (a) -1
    (b) 0
    (c) 1
    (d) 3

21. If $4\sin^{-1} x + \cos^{-1} x = \pi$, then what is $\sin^{-1} x + 4 \cos^{-1} x$ equal to?
    (a) $\dfrac{\pi}{2}$
    (b) π
    (c) $\dfrac{3\pi}{2}$
    (d) 2π

22. What is $\cot^2(\sec^{-1} 2) + \tan^2 (\text{cosec}^{-1} 3)$ equal to?
    (a) $\dfrac{11}{12}$
    (b) $\dfrac{11}{24}$
    (c) $\dfrac{7}{24}$
    (d) $\dfrac{1}{24}$

23. In a triangle ABC, $\dfrac{a}{\cos A} = \dfrac{b}{\cos B} = \dfrac{c}{\cos C}$
    What is the area of the triangle if $a = 6$ cm?
    (a) $9\sqrt{3}$ square cm
    (b) 12 square cm
    (c) $18\sqrt{3}$ square cm
    (d) 24 square cm

24. The roots of the equation $7x^2 - 6x + 1 = 0$ are $\tan \alpha$ and $\tan \beta$, where 2α and 2β are the angles of a triangle. Which one of the following is correct?
    (a) The triangle is equilateral
    (b) The triangle is isosceles but not right-angled
    (c) The triangle is right-angled
    (d) The triangle is right-angled isosceles

25. In a triangle ABC, $\angle A = 75°$ and $\angle B = 45°$. What is $2a - b$ equal to?
    (a) c
    (b) $\sqrt{2}c$
    (c) $2c$
    (d) $2\sqrt{2}c$

26. What is the number of solutions of the equation $\cot 2x . \cot 3x = 1$ for $0 < x < \pi$?
    (a) Only one
    (b) Only two
    (c) Only five
    (d) More than five

27. What is the general solution of $\cos^{100} x - \sin^{100} x = 1$?
    (a) $n\pi$
    (b) $(2n + 1)\pi$
    (c) $2n\pi$
    (d) $(2n+1)\dfrac{\pi}{2}$
    where n is an integer.

28. In a triangle ABC, $\tan A + \tan B + \tan C = k$
    What is the value of $\cot A \cot B \cot C$?
    (a) 0.5k
    (b) $\dfrac{1}{k}$
    (c) $\dfrac{3}{k}$
    (d) $\dfrac{1}{k^3}$

29. What is $\sin 12° \sin 48°$ equal to?
    (a) $\dfrac{\sqrt{5}-1}{4}$
    (b) $\dfrac{\sqrt{5}+1}{4}$
    (c) $\dfrac{\sqrt{5}-1}{8}$
    (d) $\dfrac{\sqrt{5}+1}{8}$

30. What is $\dfrac{\cos 17° - \sin 17°}{\cos 17° + \sin 17°}$ equal to?
    (a) $\tan 34°$
    (b) $\cot 34°$
    (c) $\tan 62°$
    (d) $\cot 62°$

31. Consider the following numbers :
    A. $\tan 22.5°$
    B. $\cot 22.5°$
    C. $\tan 22.5° - \cot 22.5°$
    How many of the above are irrational numbers?
    (a) None
    (b) Only one
    (c) Only two
    (d) All three

32. If $\dfrac{x}{\cos \theta} = \dfrac{y}{\cos\left(\dfrac{2\pi}{3} - \theta\right)} = \dfrac{z}{\cos\left(\dfrac{2\pi}{3} + \theta\right)}$
    then what is $x + y + z$ equal to?
    (a) -1
    (b) 0
    (c) 1
    (d) 3

33. If $p \tan (\theta - 30°) = q \tan (\theta + 120°)$, then what is $\dfrac{(p+q)}{(p-q)}$ equal to?

(a) $\sin 2\theta$
(b) $\cos 2\theta$
(c) $2 \sin 2\theta$
(d) $2 \cos 2\theta$

34. Let P and Q be two non-void relations on a set A. Which of the following statements are correct?

A. P and Q are reflexive $\Rightarrow$ P $\cap$ Q is reflexive.
B. P and Q are symmetric $\Rightarrow$ P $\cup$ Q is symmetric.
C. P and Q are transitive $\Rightarrow$ P $\cap$ Q is transitive.

Select the answer using the code given below.

(a) A and B only
(b) B and C only
(c) A and C only
(d) A, B and C

35. If A and B are two non-empty sets having 10 elements in common, then how many elements do A $\times$ B and B $\times$ A have in common?

(a) 10
(b) 20
(c) 40
(d) 100

36. What is the remainder when $7^n - 6n$ is divided by 36 for $n = 100$?

(a) 0
(b) 1
(c) 2
(d) 6

37. What is the maximum number of possible points of intersection of four straight lines and a circle (intersection is between lines as well as circle and lines)?

(a) 6
(b) 10
(c) 14
(d) 16

38. In an AP, the ratio of the sum of the first p terms to the sum of the first q terms is $p^2 : q^2$. Which one of the following is correct?

(a) The first term is equal to the common difference
(b) The first term is equal to twice the common difference
(c) The common difference is equal to twice the first term
(d) The first term is equal to square of the common difference

39. What is the number of real roots of the equation $(x - 1)^2 + (x - 3)^2 + (x - 5)^2 = 0$?

(a) None
(b) Only one
(c) Only two
(d) Three

40. In a class of 240 students, 180 passed in English, 130 passed in Hindi and 150 passed in Sanskrit. Further, 60 passed in only one subject, 110 passed in only two subjects and 10 passed in none of the subjects. How many passed in all three subjects?

(a) 60
(b) 55
(c) 40
(d) 35

DIRECTIONS (Qs 41-42): *Consider the following for the two (02) items that follow :*

Let Z_1 and Z_2 be any two complex numbers such that

$$Z_1^2 + Z_2^2 + Z_1 Z_2 = 0$$

41. What is the value of $\left| \dfrac{Z_1}{Z_2} \right|$?

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

42. What is the value of $\dfrac{1}{2} + \mathrm{Re}\left(\dfrac{Z_1}{Z_2} \right)$?

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

DIRECTIONS (Qs. 43-44): *Consider the following for the two (02) items that follow :*

The product of 5 consecutive terms of an AP is 229635. The first, second and fifth terms are in GP.

43. What is the common difference?

(a) 3
(b) 4
(c) 5
(d) 6

44. What is the sum of all five terms?

(a) 60
(b) 65
(c) 75
(d) 80

DIRECTIONS (Qs. 45-46): *Consider the following for the two (02) items that follow :*

Let $(8 + 3\sqrt{7})^{20} = U + V$ and $(8 - 3\sqrt{7})^{20} = W$, where U is an integer and $0 < V < 1$.

45. What is V + W equal to?

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

46. What is the value of (U + V) W?

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

DIRECTIONS (Qs. 47-48): *Consider the following for the two (02) items that follow :*

The roots of the quadratic equation $a^2(b^2 - c^2)x^2 + b^2(c^2 - a^2)x + c^2(a^2 - b^2) = 0$ are equal $(a^2 \neq b^2 \neq c^2)$.

47. Which one of the following statements is correct?

(a) a^2, b^2, c^2 are in AP.
(b) a^2, b^2, c^2 are in GP.
(c) a^2, b^2, c^2 are in HP.
(d) a^2, b^2, c^2 are neither in AP nor in GP nor in HP.

48. Which one of the following is a root of the equation?

(a) $\dfrac{b^2(c^2 - a^2)}{a^2(c^2 - b^2)}$
(b) $\dfrac{b^2(c^2 - a^2)}{a^2(b^2 - c^2)}$
(c) $\dfrac{b^2(c^2 - a^2)}{2a^2(c^2 - b^2)}$
(d) $\dfrac{b^2(c^2 - a^2)}{2a^2(b^2 - c^2)}$

Let A = $\begin{bmatrix} 3 & -3 & 4 \\ 2 & -3 & 4 \\ 0 & -1 & 1 \end{bmatrix}$

49. What is A(adj A) equal to?

(a) $\begin{bmatrix} 5 & 0 & 0 \\ 0 & 5 & 0 \\ 0 & 0 & 5 \end{bmatrix}$ (b) $\begin{bmatrix} 2 & 0 & 0 \\ 0 & 2 & 0 \\ 0 & 0 & 2 \end{bmatrix}$

(c) $\begin{bmatrix} \frac{1}{2} & 0 & 0 \\ 0 & \frac{1}{2} & 0 \\ 0 & 0 & \frac{1}{2} \end{bmatrix}$ (d) $\begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix}$

50. What is A^{-1} equal to?

(a) $\begin{bmatrix} 1 & -1 & 0 \\ -2 & 3 & -4 \\ -2 & 3 & -3 \end{bmatrix}$ (b) $\begin{bmatrix} \frac{1}{2} & \frac{-1}{2} & 0 \\ -1 & \frac{3}{2} & -2 \\ -1 & \frac{3}{2} & \frac{-3}{2} \end{bmatrix}$

(c) $\begin{bmatrix} 2 & -2 & 0 \\ -4 & 6 & -8 \\ -4 & 6 & -6 \end{bmatrix}$ (d) $\begin{bmatrix} \frac{1}{5} & \frac{-1}{5} & 0 \\ \frac{-2}{5} & \frac{3}{5} & \frac{-4}{5} \\ \frac{-2}{5} & \frac{3}{5} & \frac{-3}{5} \end{bmatrix}$

51. What is $3\alpha+2\beta$ equal to if

$(2\hat{i}+6\hat{j}+27\hat{k})\times(\hat{i}+\alpha\hat{j}+\beta\hat{k})$

is a null vector?
(a) 36 (b) 33
(c) 30 (d) 27

52. For what value of the angle between the vectors $\vec{a}$ and $\vec{b}$ is the quantity $|\vec{a}\times\vec{b}|+\sqrt{3}\,|\vec{a}.\vec{b}|$ maximum?
(a) 0° (b) 30°
(c) 45° (d) 60°

53. Let θ be the angle between two unit vectors $\vec{a}$ and $\vec{b}$. If $\vec{a}+2\vec{b}$ is perpendicular to $5\vec{a}-4\vec{b}$, then what is cosθ + cos2θ equal to ?

(a) 0 (b) $\frac{1}{2}$

(c) 1 (d) $\frac{\sqrt{3}+1}{2}$

54. Let ABCDEF be a regular hexagon. If $\overrightarrow{AD}=m\overrightarrow{BC}$ and $\overrightarrow{CF}=n\overrightarrow{AB}$, then what is mn equal to?
(a) -4 (b) -2
(c) 2 (d) 4

55. The vectors $\vec{a},\vec{b}$ and $\vec{c}$ are of the same length. If taken pairwise, they form equal angles. If $\vec{a}=\hat{i}+\hat{j}$ and $\vec{b}=\hat{j}+\hat{k}$, then what can $\vec{c}$ be equal to?

A. $\hat{i}+\hat{k}$

B. $\frac{-\hat{i}+4\hat{j}-\hat{k}}{3}$

Select the correct answer using the code given below.
(a) A only (b) B only
(c) Both A and B (d) Neither A nor B

56. The diagonals of a quadrilateral ABCD are along the lines $x-2y=1$ and $4x+2y=3$. The quadrilateral ABCD may be a
(a) rectangle (b) cyclic quadrilateral
(c) parallelogram (d) rhombus

57. The foci of the ellipse $4x^2+9y^2=1$ are at Q and R. If P(x,y) is any point on the ellipse, then what is PQ + PR equal to?
(a) 2 (b) 1

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

58. If P(2, 4), Q(8, 12), R(10, 14) and S(x,y) are vertices of a parallelogram, then what is ($x+y$) equal to?
(a) 8 (b) 10
(c) 12 (d) 14

59. The equation of a circle is
$(x^2-4x+3)+(y^2-6y+8)=0$
Which of the following statements are correct?
A. The end points of a diameter of the circle are at (1, 2) and (3, 4).
B. The end points of a diameter of the circle are at (1, 4) and (3, 2).
C. The end points of a diameter of the circle are at (2, 4) and (4, 2).
Select the answer using the code given below.
(a) A and B only (b) B and C only
(c) A and C only (d) A, B and C

60. Consider the points P($4k,4k$) and Q($4k, -4k$) lying on the parabola $y^2=4kx$. If the vertex is A, then what is ∠PAQ equal to?
(a) 60° (b) 90°
(c) 120° (d) 135°

A triangle ABC is inscribed in the circle $x^2+y^2=100$. B and C have coordinates (6, 8) and (– 8, 6) respectively.

61. What is ∠ BAC equal to?

    (a) $\dfrac{\pi}{2}$ (b) $\dfrac{\pi}{3}$ or $\dfrac{2\pi}{3}$

    (c) $\dfrac{\pi}{4}$ or $\dfrac{3\pi}{4}$ (d) $\dfrac{\pi}{6}$ or $\dfrac{5\pi}{6}$

62. What are the coordinates of A?

    (a) $(-6, 8)$

    (b) $(-6, -8)$

    (c) $(5\sqrt{2}, 5\sqrt{2})$

    (d) Cannot be determined due to insufficient data

DIRECTIONS (Qs. 63-64): *Consider the following for the two (02) items that follow :*

ABCD is an isosceles trapezium and AB is parallel to DC. Let A(2, 3), B(4, 3), C(5, 1) be the vertices.

63. What are the coordinates of vertex D?

    (a) $(2, 1)$ (b) $(1, 2)$

    (c) $(1, 1)$ (a) $(3, 1)$

64. What is the point of intersection of the diagonals of the trapezium?

    (a) $\left(3, \dfrac{7}{2}\right)$ (b) $\left(3, \dfrac{7}{3}\right)$

    (c) $\left(\dfrac{7}{2}, 2\right)$ (a) $\left(\dfrac{5}{2}, 2\right)$

DIRECTIONS (Qs. 65-66): *Consider the following for the two (02) items that follow :*

Let $2x^2 + 2y^2 + 2z^2 + 3x + 3y + 3z - 6 = 0$ be a sphere.

65. What is the diameter of the sphere?

    (a) $\dfrac{5\sqrt{3}}{4}$ (b) $\dfrac{5\sqrt{3}}{2}$

    (c) $\dfrac{3\sqrt{5}}{4}$ (d) $\dfrac{3\sqrt{5}}{2}$

66. The centre of the sphere lies on the plane

    (a) $2x + 2y + 2z - 3 = 0$

    (b) $4x + 4y + 4z - 3 = 0$

    (c) $4x + 8y + 8z - 15 = 0$

    (d) $4x + 8y + 8z + 15 = 0$

DIRECTIONS (Qs. 67-68): *Consider the following for the two (02) items that follow :*

Let S be the line of intersection of two planes $x + y + z = 1$ and $2x + 3y - 4z = 8$.

67. Which of the following are the direction ratios of S?

    (a) $<-7, -6, 1>$ (b) $<-7, 6, 1>$

    (c) $<-6, 5, 1>$ (d) $<6, 5, 1>$

68. If (l, m, n) are direction cosines of S, then what is the value of $43 (l^2 - m^2 - n^2)$?

    (a) 6   (b) 5

    (c) 4   (d) 1

DIRECTIONS (Qs. 69-70): *Consider the following for the two (02) items that follow :*

Let $L : x + y + z + 4 = 0 = 2x - y - z + 8$ be a line and $P : x + 2y + 3z + 1 = 0$ be a plane

69. What are the direction ratios of the line?

    (a) $<2, 1, -1>$ (b) $<0, -1, 2>$

    (c) $<0, 1, -1>$ (d) $<2, 3, -3>$

70. What is the point of intersection of L and P?

    (a) $(4, 3, -3)$ (b) $(4, -3, 3)$

    (c) $(-4, -3, -3)$ (d) $(-4, -3, 3)$

71. Let $z = [y]$ and $y = [x] - x$, where [.] is the greatest integer function. If x is not an integer but positive, then what is the value of z?

    (a) -1 (b) 0

    (c) 1   (d) 2

72. If $f(x) = 4x + 1$ and $g(x) = kx + 2$ such that $f \circ g(x) = g \circ f(x)$, then what is the value of k?

    (a) 7   (b) 5

    (c) 4   (c) 3

73. What is the minimum value of the function $f(x) = \log_{10} (x^2 + 2x + 11)$?

    (a) 0   (b) 1

    (c) 2   (d) 10

74. Which one of the following is correct regarding $\displaystyle\lim_{x\to 3} \dfrac{|x-3|}{x-3}$?

    (a) Limits exists and is equal to 1

    (b) Limits exists and is equal to 0

    (c) Limits exists and is equal to -1

    (d) Limit does not exist

75. What is the maximum value of the $a \cos x + b \sin x + c$?

    (a) $\sqrt{a^2 + b^2} + c$ (b) $\sqrt{a^2 + b^2} + c$

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

76. If $f(2x) = 4x^2 + 1$, then for how many real values of x will $f(2x)$ be the GM of $f(x)$ and $f(4x)$?

    (a) Four   (b) Two

    (c) One   (d) None

77. If $f(x) = [x]^2 - 30[x] + 221 = 0$, where $[x]$ is the greatest integer function, then what is the sum of all integer solutions?

    (a) 13   (b) 17

    (c) 27   (d) 30

78. If $f(x) = 9x - 8\sqrt{x}$ such that $g(x) = f(x) - 1$, then which one of the following is correct?

    (a) $g(x) = 0$ has no real roots

    (b) $g(x) = 0$ has only one real root which is an integer

    (c) $g(x) = 0$ has two real roots which are integers

    (a) $g(x) = 0$ has only one real root which is not an integer

79. What is $\lim_{x \to \frac{\pi}{2}} (\sec\theta - \tan\theta)$ equal to?

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

80. Let $f(x)f(y) = f(xy)$ for all real x, y. If $f(2) = 4$, then what is the value of $f\left(\dfrac{1}{2}\right)$?

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

DIRECTIONS (Qs. 81-82): *Consider the following for the two (02) items that follow :*

Let $f \circ g(x) = \cos^2 \sqrt{x}$ and $g \circ f(x) = |\cos x|$.

81. Which one of the following is $f(x)$?

    (a) $\cos x$ (b) $\cos x^2$
    (c) $\cos^2 x$ (d) $\cos |x|$

82. Which one of the following is $g(x)$?

    (a) $\sqrt{x}$ (b) $|x|$
    (c) x^2 (d) $x|x|$

DIRECTIONS (Qs. 83-84): *Consider the following for the two (02) items that follow :*

Let $f(x) = [x]^2 - [x^2]$.

83. What is $f(0.999) + f(1.001)$ equal to?

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

84. Consider the following statements :

    A. $f(x)$ is continuous at $x = 0$.

    B. $f(x)$ is continuous at $x = 1$.

    Which of the statements given above is/are correct?

    (a) A only
    (b) B only
    (c) Both A and B
    (d) Neither A nor B

DIRECTIONS (Qs. 85-86): *Consider the following for the two (02) items that follow :*

Let $f(x) = \cos 2x + x$ on $\left[\dfrac{-\pi}{2}, \dfrac{\pi}{2}\right]$

85. What is the greatest value of $f(x)$?

    (a) $\dfrac{\sqrt{3}}{2} - \dfrac{\pi}{12}$ (b) $\dfrac{\sqrt{3}}{2} + \dfrac{\pi}{12}$

    (c) $\dfrac{\sqrt{3}}{2} + \dfrac{\pi}{9}$ (d) $\dfrac{\sqrt{3}}{2} + \dfrac{\pi}{6}$

86. What is the least value of $f(x)$?

    (a) $-\left(1 + \dfrac{\pi}{2}\right)$ (b) $-\left(\dfrac{1}{2} + \dfrac{\pi}{2}\right)$

    (c) $-\left(1 + \dfrac{\pi}{4}\right)$ (d) $-2\left(\dfrac{1}{2} - \dfrac{\pi}{4}\right)$

DIRECTIONS (Qs. 87-88): *Consider the following for the two (02) items that follow :*

The area bounded by the parabola $y^2 = kx$ and the line $x = k$, where $k > 0$, is $\dfrac{4}{3}$ square units.

87. What is the value of k?

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

88. What is the area of the parabola bounded by the latus rectum?

    (a) $\dfrac{1}{6}$ square unit   (b) $\dfrac{2}{3}$ square unit

    (c) 1 square unit   (d) $\dfrac{4}{3}$ square unit

DIRECTIONS (Qs. 89-90): *Consider the following for the two (02) items that follow :*

Let $y\,dx + (x - y^3)dy = 0$ be a differential equation.

89. What are the order and degree respectively of the differential equation?

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

90. What is the solution of the differential equation?

    (a) $y^4 + 2x = c$ (b) $y^4 + 3x = c$
    (c) $2xy^4 + x = c$ (d) $4xy - y^4 = c$

DIRECTIONS (Qs. 91-92): *Consider the following for the two (02) items that follow :*

Let $f(x) = |x^2 - x - 2|$.

91. What is $\int_0^2 f(x)\,dx$ equal to?

    (a) 0 (b) 1

    (c) $\dfrac{5}{3}$ (d) $\dfrac{10}{3}$

92. What is $\int_1^3 f(x)\,dx$ equal to?

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

DIRECTIONS (Qs. 93-94): *Consider the following for the two (02) items that follow :*

Let $f(t) = \ln\left(t + \sqrt{1 + t^2}\right)$ and $g(t) = \tan(f(t))$.

93. Consider the following statements :

    A. $f(t)$ is an odd function.

    B. $g(t)$ is an odd function.

    Which of the statements given above is/are correct?

    (a) A only   (b) B only
    (c) Both A and B   (d) Neither A nor B

94. What is $\int_{-\pi}^{\pi} g(t)\,dt$ equal to?

   (a) -1 (b) 0

   (c) $\dfrac{1}{2}$ (d) 1

DIRECTIONS (Qs. 95-96): *Consider the following for the two (02) items that follow:*

Let $f: (-1, 1) \to R$ be a differentiable function with $f(0) = -1$ and $f'(0) = 1$. Let $h(x) = f(2f(x) + 2)$ and $g(x) = (h(x))^2$.

95. What is $h'(0)$ equal to?

   (a) -2 (b) -1

   (c) 0 (d) 2

96. What is $g'(0)$ equal to?

   (a) -4 (b) -2

   (c) 0 (d) 4

DIRECTIONS (Qs. 97-98): *Consider the following for the two (02) items that follow :*

Let $I = \int_{0}^{\frac{\pi}{2}} \dfrac{f(x)}{g(x)}\,dx$, where $f(x) = \sin x$ and

$g(x) = \sin x + \cos x + 1$.

97. What is $\int_{0}^{\frac{\pi}{2}} \dfrac{dx}{g(x)}$ equal to ?

   (a) $\dfrac{\ln 2}{2}$ (b) $\dfrac{\ln 2}{4}$

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

98. What is I equal to?

   (a) $\dfrac{\pi}{4} + \ln 2$ (b) $\dfrac{\pi}{4} - \ln 2$

   (c) $\dfrac{\pi}{4} - \dfrac{\ln 2}{2}$ (d) $\dfrac{\pi}{4} + \dfrac{\ln 2}{2}$

DIRECTIONS (Qs. 99-100): *Consider the following for the two (02) items that follow :*

Let $2\int \dfrac{x^2 - 1}{\sqrt{x^2 + 1}}\,dx = U(x)\,V(x) - 3\ln\{U(x) + V(x)\} + c$

99. What is $|U^2(x) - V^2(x)|$ equal to?

   (a) 0 (b) 1

   (c) 2 (d) 3

100. What is $U(x)\,V(x)$ equal to?

   (a) $\sqrt{x^2 + x^4}$ (b) $\sqrt{x + x^3}$

   (c) $\dfrac{\sqrt{x^2 + x^4}}{2}$ (d) $2\sqrt{x^2 + x^4}$

101. Let $x - 3y + 4 = 0$ and $2x - 7y + 8 = 0$ be two lines of regression computed from some bivariate data. If b_{yx} and

b_{xy} are regression coefficients of lines of regression of y on x and x on y respectively, then what is the value of $b_{xy} + 7b_{yx}$?

   (a) -2 (b) 1

   (c) 2 (d) 5

102. The mean of n observations

   $1, 4, 9, 16, ..., n^2$ is 130. What is the value of n?

   (a) 18 (b) 19

   (c) 20 (d) 21

103. Three distinct natural numbers are chosen at random from 1 to 10. What is the probability that they are consecutive?

   (a) $\dfrac{1}{12}$ (b) $\dfrac{3}{40}$

   (c) $\dfrac{1}{15}$ (d) $\dfrac{7}{120}$

104. A, B, C are three mutually exclusive and exhaustive events associated with a random experiment. If $3P(B) = 4P(A)$ and $3P(C) = 2P(B)$, then what is $P(A)$ equal to?

   (a) $\dfrac{7}{29}$ (b) $\dfrac{8}{29}$

   (c) $\dfrac{9}{29}$ (d) $\dfrac{10}{29}$

105. A die has two faces with number 4, three faces with number 5 and one face with number 6. If the die is rolled once, then what is the probability of getting 4 or 5?

   (a) $-$ (b) $\dfrac{2}{3}$

   (c) $\dfrac{5}{6}$ (d) $\dfrac{1}{2}$

106. A box contains 2 black, 4 yellow and 6 white balls. Three balls are drawn in succession with replacement. What is the probability that all three are of the same colour?

   (a) $\dfrac{1}{6}$ (b) $\dfrac{1}{36}$

   (c) $\dfrac{1}{12}$ (d) $\dfrac{5}{12}$

107. A can hit a target 5 times in 6 shots, B can hit 4 times in 5 shots and C can hit 3 times in 4 shots. What is the probability that A and C may hit but B may lose?

   (a) $\dfrac{1}{8}$ (b) $\dfrac{1}{6}$

   (c) $\dfrac{1}{4}$ (d) $\dfrac{1}{3}$

108. The letters of the word ZOOLOGY are arranged in all possible ways. What is the probability that the consonants and vowels occur alternatively?

   (a) $\dfrac{6}{35}$ (b) $\dfrac{3}{35}$

   (c) $\dfrac{2}{35}$ (d) $\dfrac{1}{35}$

109. A natural number x is chosen at random from the first 100 natural numbers. What is the probability that $x^2 + x > 50$?

(a) $\dfrac{93}{100}$ (b) $\dfrac{47}{50}$

(c) $\dfrac{24}{25}$ (d) $\dfrac{23}{25}$

110. What is the mean deviation of the first 10 natural numbers?

(a) 2   (b) 2.5

(c) 3   (d) 3.5

111. Let $\sum\limits_{i=1}^{9} x_i^2 = 855$. If M is the mean and σ is the standard deviation of $x_1, x_2, \ldots x_9$, then what is the value of $M^2 + \sigma^2$?

(a) 100   (b) 95

(c) 90   (d) 85

112. The mean of the series $x_1, x_2, \ldots, x_n$ is $\bar{x}$. If x_n is replaced by k, then what is the new mean?

(a) $\bar{x} - x_n + k$ (b) $\dfrac{n\bar{x} - \bar{x} + k}{n}$

(c) $\dfrac{\bar{x} - x_n - k}{n}$ (d) $\dfrac{n\bar{x} - x_n + k}{n}$

113. A fair coin is tossed till two heads occur in succession. What is the probability that the number of tosses required is less than 6?

(a) $\dfrac{5}{64}$ (b) $\dfrac{15}{32}$

(c) $\dfrac{31}{64}$ (d) $\dfrac{19}{32}$

114. Urn A contains 2 white and 2 black balls while urn B contains 3 white and 2 black balls. One ball is transferred from urn A to urn B and then a ball is drawn out of urn B. What is the probability that the ball is white?

(a) $\dfrac{11}{20}$ (b) $\dfrac{7}{12}$

(c) $-$ (d) 1

115. For two events A and B, $P(A) = P(A|B) = 0.25$ and $P(B|A) = 0.5$. Which of the following are correct?

A. A and B are independent.
B. $P(A^C \cup B^C) = 0.875$
C. $P(A^C \cap B^C) = 0.375$

Select the answer using the code given below.

(a) A and B only   (b) B and C only

(c) A and C only   (d) A, B and C

116. Two perfect dice are thrown. What is the probability that the sum of the numbers on the faces is neither 9 nor 10?

(a) $\dfrac{1}{36}$ (b) $\dfrac{5}{36}$

(c) $\dfrac{7}{36}$ (d) $\dfrac{29}{36}$

117. The occurrence of a disease in an industry is such that the workers have 20% chance of suffering from it. What is the probability that out of 6 workers chosen at random, 4 or more will suffer from the disease?

(a) $\dfrac{53}{3125}$ (b) $\dfrac{63}{3125}$

(c) $\dfrac{73}{3125}$ (d) $\dfrac{83}{3125}$

118. Three perfect dice are rolled. Under the condition that no two show the same face, what is the probability that one of the faces shown is an ace (one)?

(a) $\dfrac{5}{9}$ (b) $\dfrac{2}{3}$

(c) $\dfrac{1}{3}$ (d) $\dfrac{1}{2}$

119. Three perfect dice D_1, D_2 and D_3 are rolled. Let x, y and z represent the numbers on D_1, D_2 and D_3 respectively. What is the number of possible outcomes such that $x < y < z$?

(a) 20   (b) 18

(c) 14   (d) 10

120. In a binomial distribution, if the mean is 6 and the standard deviation is $\sqrt{2}$, then what are the values of the parameters n and p respectively?

(a) 18 and $\dfrac{1}{3}$ (b) 9 and $\dfrac{1}{3}$

(c) 18 and $\dfrac{2}{3}$ (d) 9 and $\dfrac{2}{3}$

GENERAL ABILITY

PART - A: ENGLISH

ANTONYMS

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

1. All human beings are <u>fallible</u>
   (a) Frail   (b) erring
   (c) mortal   (d) perfect

2. His words were <u>vague</u>
   (a) identical   (b) obscurc
   (c) precise   (d) imperceptible

3. She performed all her duties <u>conscientiously</u>
   (a) assiduously   (b) carelessly
   (c) painstakingly   (d) scrupulously

4. These risks are <u>incidental</u> to the work of a firefighter
   (a) essential   (b) adventitious
   (c) serendipitous   (d) subsidiary

5. She has always been <u>disdainful</u> of poor people
   - (a) reverential
   - (b) derisive
   - (c) supercilious
   - (d) insolent

Most of our food comes from agriculture, so we tend to believe that it is _____ of natural biota. This is not true. In nature, _____ plant and animals _____ to the rigours of natural selection. Only the fittest survive. _____ wild populations have numerous traits for competitiveness, resistance to parasites, _____ more like other to adverse conditions, _____ other aspects of vigour. In contrast, populations grown for many _____ more under the pampered conditions of agriculture tend to lose these traits, because they _____ more for production, not resilience. for example, a high-producing plant _____ lacks resistance to drought is _____ and the resistance to drought is ignored. Also, in the process of breeding plants for maximum production, all genetic variation is eliminated.

6.
   - (a) independent
   - (b) dependent
   - (c) relevant
   - (d) consequent

7.
   - (a) the
   - (b) both
   - (c) some
   - (d) among

8.
   - (a) had been continuously subjected
   - (b) will be continuously subject
   - (c) continuously subjected
   - (d) are continuously subjected

9.
   - (a) Consequently
   - (b) Inadvertenlty
   - (c) Although
   - (d) Since

10.
   - (a) withdrawal
   - (b) toleranc
   - (c) adaptable
   - (d) compliance

11.
   - (a) and
   - (b) with
   - (c) by
   - (d) upon

12.
   - (a) eras
   - (b) epochs
   - (c) periods
   - (d) generations

13.
   - (a) had selected
   - (b) have selected
   - (c) are selected
   - (d) might select

14.
   - (a) whichever
   - (b) whom
   - (c) that
   - (d) whenever

15.
   - (a) heated
   - (b) irrigatetd
   - (c) showered
   - (d) deserted

16. Preeti suggests
   - (a) that I ask to your advice
   - (b) that I had asked your advice
   - (c) that I can have asked your advice
   - (d) that I ask your advice

17. We saw
   - (a) the older of all monuments in the city
   - (b) the old of all monuments in the city
   - (c) the oldest monument in the city
   - (d) an oldest of all monuments in the city

18. Since you have been touring all day
   - (a) you must be tired
   - (b) you ought to have been tired
   - (c) you could had been tired
   - (d) you might not be tired

19. His condition in serious, but
   - (a) it should be worse
   - (b) it ought to be worse
   - (c) it could be worse
   - (d) it had been going to be worse

20. I hope the bus comes soon because
   - (a) we waited for half an hour
   - (b) we have been waiting for half an hour
   - (c) we waiting for half an hour
   - (d) we could have been waiting for half an hour

21. Someone
   - (a) had split juice on the sofa
   - (b) should have split juice on the sofa
   - (c) have split juice on the sofa
   - (d) would split juice on the sofa

22. What would you do
   - (a) if you found your lost toy?
   - (b) if you will have found your lost toy?
   - (c) if you would found your lost toy?
   - (d) if you have your lost toy?

23. If I were you
   - (a) I shouldn't buy that dress
   - (b) I wouldn't buy that dress
   - (c) I weren't buying that dress
   - (d) I mustn't buying that dress

24. I wish
   - (a) I could help you
   - (b) I ought to help you
   - (c) I did help you
   - (d) I must help you

25. The efforts of the security services have not been quite
   - (a) upto the incredibility
   - (b) up-take
   - (c) up-tight
   - (d) upto the mark

26. A white lie
   - (a) An offensive way of describing something
   - (b) To do something completely impossible
   - (c) A lie that is absolutely and universally true
   - (d) A lie that you tell to avoid hurting someone

27. Bad blood
    (a) Feelings of hatred between people
    (b) A situation which goes from bad to worse
    (c) A fatal accident
    (d) To accept the unpleasant situation
28. Count your blessings
    (a) to start to understand how badly something has affected you
    (b) an event which gradually becomes worse
    (c) to be grateful for good things in your life
    (d) something that you say in order to warn someone
29. Have the last laugh
    (a) to be worst example of something
    (b) to succeed when others thought that you would not
    (c) to solve all the problems of life
    (d) to laugh at someone secretly
30. Sit on the fence
    (a) to make someone suddenly notice you
    (b) to fail completely
    (c) to delay making a decision
    (d) to behave very badly

DIRECTIONS: *Each of the following items in this section consists of a sentence, the parts of which have been jumbled. These parts have been labelled P, Q, R and S. Given below each sentence have four sequences, namely (a), (b), (c) and (d). You are required to rearrange the jumbled parts of the sentences and mark your response accordingly.*

31. good quality elementary education conforming
                                            P
    as a fundamental right of all children
                                            Q
    the Right to Education Act (RTE) mandates
                                            R
    to the standards and norms specified in the Act
                                            S
    (a) Q S P R   (b) R P S Q
    (c) R Q S P   (d) S Q P R
32. the conflicts and disputes in their mind
                                            P
    music not only relieves the burden
                                            Q
    on children and the young
                R
    but also alleviates
                S
    (a) Q R S P   (b) P S R Q
    (c) Q P R S   (d) P Q R S
33. but is virtually covered by a dome-shaped
                                            P
    Antarctica is a continent
                Q
    nearly twice as large as Australia
                R

ice sheet nearly 2 miles thick
                S
    (a) Q R P S   (b) S P R Q
    (c) Q S P R   (d) S Q R P
34. the global economic weight from the advanced economies
                                            P
    that there was a major shift in
                                            Q
    and Central Bank Governors, in recognition of the fact
                                            R
    the G20 was formed in 1999, as a forum of Finance Ministers
                                            S
    (a) S P Q R   (b) P Q R S
    (c) Q R S P   (d) S R Q P
35. aquaculture nation in the world and
                                            P
    India's products are exported to many nations
                                            Q
    fish producing and the second largest
                                            R
    India is the third largest
                S
    (a) S R P Q   (b) Q P R S
    (c) R P Q S   (d) P Q R S

DIRECTION: *Each of the following sentences has word(s) under-lined. Read the sentence carefully and find which word class the class the underlined word(s) belong(s) to. Indicate your response on the answer sheet accordingly.*

36. Adders are the only poisonous snakes found across Britain
    (a) Noun   (b) Adjective
    (c) Adverb   (d) Determiner
37. She spoke to him once since he has been in town
    (a) Adjective   (b) Adverb
    (c) Conjunction   (d) Preposition
38. I don't really want to go. Besides, it's too late now
    (a) Adjective   (b) Adverb
    (c) Preposition   (d) Conjunction
39. Look at that man over there
    (a) Adverb   (b) Conjunction
    (c) Determiner   (d) Article
40. The plane is ready for take-off
    (a) Noun   (b) Conjunction
    (c) Verb   (d) Gerund

DIRECTIONS: *In this section, you have a short passage. After the passage, you will find some items based on the passage. Read the passage carefully and answer the items based on it. You are required to select your answer based on the contents of the passage and the opinion of author only.*

We live in a time when globalisation is rapidly encompassing travel, information, trade and investment. The internet ties people together in ways unimagined a few years ago. The globalisation of health, however, remains an elusive goal, similar to the

globalisation of economic well-being. Laurie Garrett, in *The Coming Plague,* describes an unwelcome form of globalisation: the globalisation of disease. Garrett examins the recent history of emerging diseases such as AIDS, Ebola, Hantavirus, Rift, Valley Fever, Legionnaires' disease, and others. She also explains the resurgence of familiar diseases like tuberculosis, cholera, and pneumonia as a consequence of the widespread and unwise use of antibiotics. Many of the new diseases are clearly linked to changes in land use, which brings humans into close contacts with rodents or other animals that harbour viruses previously unknown to medicine and often deadly to humans. Resurgent diseases, by contrast, are a creation of our medical practice. By treating people with antibiotics without restaint, we unknowinlgy select strains that are immune to the antibiotics and that pass on their resistant genes to unrelated bacteria by way of plasmid transfer. The heroes of her book are the women and men on the front lines of epidemiology. Garret makes a plea for a greater commitment from our universities, medical schools, and government agencies to train workers who will be capable of recognizing new diseases and who will be able to move about equally well in the laboratory, the hospital and the field in pursuit of knowledge and public-health intervention around the world.

41. What according to the passage is the 'unwelcome form of the globalization'?
    1. Globalization of the diseases
    2. Elusive goal of globalization
    3. History of fatal diseases
    4. Selective use of antibiotics
    Select the correct answer using the code given below:
    (a) 1 only
    (b) 2, 3 and 4
    (c) 3 only
    (d) 1 and 4

42. According to the passage, globalizatioin of health has become imperative due to
    (a) the globalization of diseases
    (b) public health intervention
    (c) the creation of new medical systems
    (d) the indiscriminate use of antibiotics

43. According to the passage, resurgent diseases are affected by:
    1. Medical practices
    2. Overuse of antibiotics
    3. Emergence of new strains
    Select the correct answer using the code given below:
    (a) 1 only
    (b) 2 only
    (c) 1 and 3 only
    (d) 1, 2 and 3

44. According to the passage, many new diseases are emerging due to change in land use because
    (a) humans are coming in contact with unfamiliar viruses
    (b) urbanisation makes pathogens proliferate
    (c) humans become adaptive and pass on their genes to related bacteria by way of plasmid transfer
    (d) humans are inadvertently releasing new viruses

45. What is the meaning of the word "epidemiology" in the passage?
    (a) The historical study of the spread of diseases
    (b) The scientific study of the spread and control of diseases
    (c) The scientific study of the invention and uses of drugs
    (d) The scientific study of the uses of drugs

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 on the answer sheet accordingly.*

46. Sages and seers have <u>cautioned</u> that the path towards enlightenment is full of illusory traps
    (a) reasoned
    (b) admitted
    (c) warned
    (d) refused

47. The officer reported the details of the mission in a <u>monotonous</u> manner
    (a) dull
    (b) happy
    (c) disturbed
    (d) enthusiastic

48. There are many <u>elusive</u> questions in philosophy
    (a) clear
    (b) baffling
    (c) paramount
    (d) truthful

49. Cleaning this mess is a <u>mammoth</u> task
    (a) huge
    (b) quick
    (c) easy
    (d) intelligent

50. The police department's image was tarnished after the high-profile murder case
    (a) enhanced
    (b) tainted
    (c) restored
    (d) assigned

PART- B: GENERAL KNOWLEDGE

51. Which one of the following statements about lysosomes is NOT correct?
    (a) They are waste disposal system of the cell
    (b) They breakdown all inorganic materials
    (c) These are also referred to as "suicidal bags"
    (d) Lysosomes stop entry of foreign materials

52. Which one of the following two cell organelles have their own genetic material?
    (a) Endoplasmic reticulum and plastids
    (b) Endoplasmic reticulum and mitochondria
    (c) Mitochondria and plastids
   (d) Lysosomes and Golgi apparatus

53. Which one among the following tissues help to connect two bones?
    (a) Tendons
    (b) Ligaments
   (c) Areolar tissue
    (d) Cartilage

54. Which one among the following is the source of energy in cell?
    (a) ADP
    (b) ATP
    (c) AMP
    (d) NAD

55. In which one among the following the vegetative propagation takes place through Eye Buds?
    - (a) Potato
    - (b) Ginger
    - (c) Onion
    - (d) Sugarcane

56. The intermixing of particles of two different types of matter on their own is called
    - (a) Osmosis
    - (b) Brownian motion
    - (c) Diffusion
    - (d) Conductance

57. Which one among the following separation techniques is used for blood tests in diagnostic laboratories?
    - (a) Filtration
    - (b) Chromatography
    - (c) Centrifugation
    - (d) Crystallization

58. Which one among the following elements is polyatomic?
    - (a) Phosphorus
    - (b) Sulphur
    - (c) Chlorine
    - (d) Aluminium

59. Which of the following anions has a valency of -3?
    - (a) Nitride
    - (b) Nitrate
    - (c) Sulphide
    - (d) Sulphate

60. The mass of 0.5 mole of N_2 gas is
    - (a) 7 g
    - (b) 14 g
    - (c) 21 g
    - (d) 28 g

61. The chemical reaction:
    $$2AgCl\ (s) \rightarrow 2Ag\ (s) + Cl_2\ (g)$$
    takes place
    - (a) in dark
    - (b) in sunlight
    - (c) on heating
    - (d) under high pressure

62. Which one among the following is commonly used as an 'anti-skinning agent' in paints?
    - (a) Gelatin
    - (b) N-methyl pyrrolidone
    - (c) Pyridine
    - (d) Polyhydroxy phenol

63. Two resistance of $5 \cdot 0\ \Omega$ and $7 \cdot 0\ \Omega$ are connected in series and the combination is connected in parallel with a resistance of $36 \cdot 0\ \Omega$. The equivalent resistance of the combination of three resistors is
    - (a) $24 \cdot 0\ \Omega$
    - (b) $12 \cdot 0\ \Omega$
    - (c) $9 \cdot 0\ \Omega$
    - (d) $6 \cdot 0\ \Omega$

64. Shown in the figure are two hollow cubes C_1 and C_2 of negligible mass partially filled (depicted by darkened area) with liquids of densities ρ_1 and ρ_2, respectively, floating in water (density ρ_w). The relationship between ρ_1, ρ_2 and ρ_w is
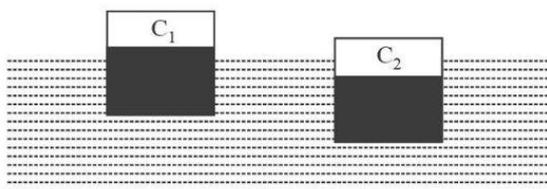

    - (a) $\rho_2 < \rho_w < \rho_1$
    - (b) $\rho_2 < \rho_1 < \rho_w$
    - (c) $\rho_1 < \rho_2 < \rho_w$
    - (d) $\rho_1 < \rho_w < \rho_2$

65. An astronaut whose weight on the Earth is 600 N experiences weightlessness on International Space Station orbiting around the Earth. It means that
    - (a) acceleration of the astronaut is zero
    - (b) normal reaction of the space-station floor on the astronaut is zero
    - (c) gravitational pull of earth on the astronaut is zero
    - (d) space station applies a centrifugal force on the astronaut

66. Which of the following statements give characteristics of contact forces?
    1. It appears between an object when it is in contact with some other object
    2. It satisfies the third law of motion
    3. It may appear between a pair of solid and fluid
    Select the answer using the code given below:
    - (a) 1 and 3 only
    - (b) 2 and 3 only
    - (c) 1 and 2 only
    - (d) 1, 2 and 3

67. Which one among the following figures correctly represents the ray diagram? (Consisder the lens to be thin)
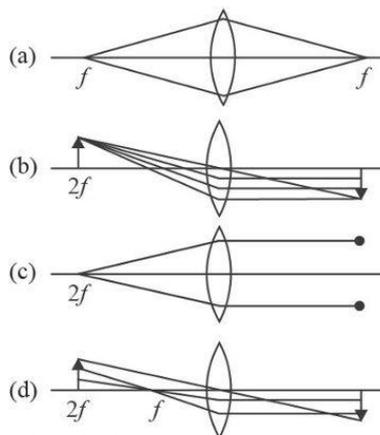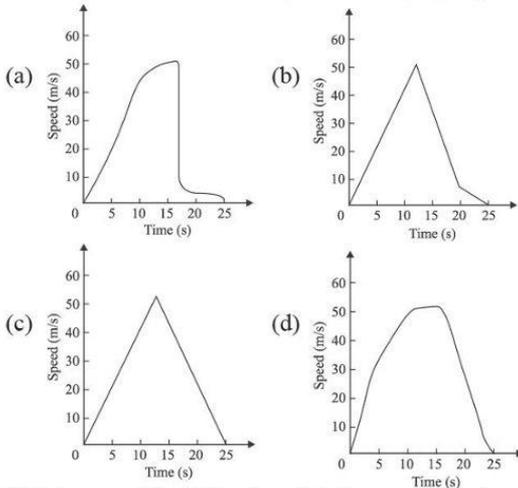

68. Lightning is due to
    - (a) The flow of charges between different parts of the cloud
    - (b) The short-circuiting of charges between the upper and lower surfaces of the cloud
    - (c) The collection of positively charged particles on the base and collection of negatively charged particles at the top of the cloud
    - (d) The induction of positive charge on the ground below the negative charge at the base of the cloud
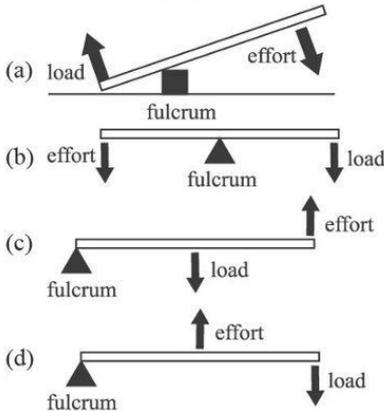
69. In which one among the following situations, the blub ⊗ would glow the most? (Consider all batteries are the same)

(a)

(b)

(c)

(d)
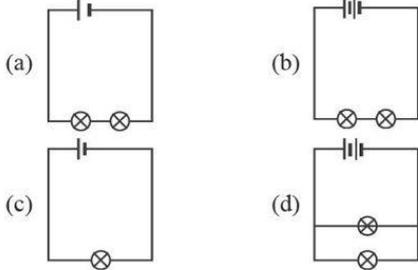
70. Which one among the following diagrams may correctly represent the motion of a skydiver during a jump?

(a)

(b)

(c)

(d)

71. Which one of the following sketches correctly describes a lever of second class?

(a) load, effort, fulcrum

(b) effort, fulcrum, load

(c) effort, load, fulcrum

(d) effort, fulcrum, load

72. For an electric circuit given below, the correct combination of voltage (V) and current (I) is
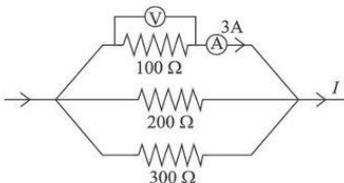
(a) $V = 900$ V; $I = 18$ A
(b) $V = 300$ V; $I = 5.5$ A
(c) $V = 600$ V; $I = 1$ A
(d) $V = 300$ V; $I = 2$ A

73. Taxila was the capital of which one among the following Mahajanapadas of ancient India?
(a) Kuru   (b) kasi
(c) Gandhar   (d) Avanti

74. Who among the following was the last Governor-General of India before the office was permanently abolished?
(a) Lord Mountbatten
(b) Chakravarti Rajagopalchari
(c) Lord Wavell
(d) Lord Linlithgow

75. Which among the following is/are the objective(s) of setting up of Planning Commission in the 1950s in India?
1. To increase production and offering opportunities to all for employment
2. To make assessment of all resources of the country
Select the answer using the code given below:
(a) 1 only   (b) 2 only
(c) Both 1 and 2   (d) Neither 1 nor 2

76. Which among the following statements with regard to Five Year Plans in India is/are correct?
1. The First and Ninth five year plans accorded high priority to agriculture
2. The Third Plan was based on the Harrod-Domar Model
3. Seventh Plan focused on food, work and productivity
4. The Ninth five year plan emphasized on massive investments in public sector
Select the answer using the code given below:
(a) 1 only   (b) 1 and 3
(c) 3 and 4   (d) 1, 2 and 4

77. Before the inception of the First Five year Plan, which among the following Plans were initiated in India?
1. Bombay Plan   2. Peoples Plan
3. Sarvoday a Plan 4. Gandhian Plan
Select the answer using the code given below:
(a) 1 and 2 only   (b) 1 and 3 only
(c) 3 and 4 only   (d) 1, 2, 3 and 4

78. Any land that is left fallow for more than five years is termed as
(a) Current fallow
(b) Fallow other than current fallow
(c) Culturable waste land
(d) Barren and waste land

79. Which statement is NOT correct with reference to Andaman and Nicobar Islands?
(a) Climate is humid, tropical coastal climate
(b) Maximum rainfall occurs between March and April
(c) Andaman and Nicobar islands are separated by 10 degree Channel which is 150 km wide
(d) Islands are inhabited by Negritotribes

80. Which one among the following local winds is NOT related to Mediterranean Sea?
    (a) Harmattan   (b) Khamsin
    (c) Sirocco   (d) Mistral
81. Which one among the following is a landlocked water body?
    (a) Mediterranean Sea (b) Black Sea
    (c) Red Sea   (d) Caspian Sea
82. Which one among the following statements with reference to Benguela current is NOT correct?
    (a) It influences the climate of the West coast of North Africa
    (b) It is a cold current
    (c) Its direction is from South to North
    (d) It flows in the Altantic Ocean
83. The lowest part of most bolsons is occupied by a landform called *playa*. Which category of landform formation does it represent?
    (a) Fluvial landforms
    (b) Arid landforms
    (c) Glacial landforms
    (d) Periglacial landforms
84. Which one among the following diseases is caused due to deficiency of Vitamin D in humans?
    (a) Beriberi   (b) Scurvy
    (c) Rickets   (d) Pneumonia
85. Which one among the following combinations most appropriately represent the components of balanced diet?
    (a) Carbohydrate, vitamins, proteins, fat, minerals, fibers and water
    (b) Carbohydrate, vitamins, proteins, fat and minerals
    (c) Carbohydrate, vitamins, proteins, minerals and water
    (d) vitamins, proteins, fat, minerals, fibers and water
86. In which part or organ of human body cartilage is NOT found?
    (a) Nose   (b) Trachea
    (c) Bronchiole   (d) Knee joint
87. Which part or nephron of the human kidney is responsible for filtration of blood for excretion?
    (a) Collecting duct   (b) Renal vein
    (c) Ureter   (d) Bowman's capsule
88. Organisms of which of the following phylum are called sponges?
    (a) Coelenterata   (b) Platyhelminthes
    (c) Porifera   (d) Echinodermata
89. A point object is placed at the centre of curvature of a spherical concave mirror. Which one among the following would be the correct location of image formed?
    (a) At infinity
    (b) At the centre of curvature
    (c) at the focal point
    (d) Between the focal point and the centre of curvature

90. Which one among the following is correct for a person suffering from myopia?
    (a) The person can see near objects clearly
    (b) The person can see distant objects clearly
    (c) The person cannot distinguish colours
    (d) The person cannot neither see near objects nor distant objects clearly
91. A vehicle starts moving along a straight line path from rest. In first t second it moves with an acceleration of 2 m/s^2 and then in next 10 seconds it moves with an acceleration of 5 m/s^2. The total distance travelled by the vehicle is 550m. The value of time t is
    (a) 10 s   (b) 13 s
    (c) 20 s   (d) 25 s
92. A pumkin weighs 7.5 N. On submerging it comletely in water, 3/4 L of water gets displaced. The acceleration due to gravity at the place where the pumpkin was weighed is 10 m/s^2. Which one of the following is the correct value of the density of the pumpkin?
    (a) 10 kg/m^3 (b) 100 kg/m^3
    (c) 1000 kg/m^3 (d) 1000 kg/m^3
93. An incandescent electric bulb converts 20% of its power consumption into light, and the remaining power is dissipated as heat. The bulb's filament has a resistance of $200 \, \Omega$ and 2 A current flows through it. If the bulb remains ON for 10h and the rate of electricity charge is rate ₹5/unit, then which among the following is the correct amount for the money spent on producing light?
    (a) ₹ 5   (b) ₹ 6
    (c) ₹ 7   (d) ₹ 8
94. Which one of the following statements best defines the concept of heat?
    (a) The transformation of energy from one form to another
    (b) The conversion of energy into mass and vice-versa due to temperature difference
    (c) The transfer of energy due to temperature difference
    (d) The change in volume of a substance with temperature
95. The masses of two planets are in the ratio of 1:7. The ratio between their diamenters is 2:1. The ratio of forces which they exert on each other is
    (a) 1 : 7   (b) 7 : 1
    (c) 1 : 1   (d) 2 : 1
96. A car weights 1000 kg. It is moving with a uniform velocity of 72 km/h towards a straight road. The driver suddenly presses the brakes. The car stops in 2.0s. The retarding force applied on the car to stop it is
    (a) 100 N   (b) 1000 N
    (c) 10 kN   (d) 100 kN
97. There is a ball of mass 320 g. It has 625 J potential energy when released freely from a height. The speed with which it will hit the ground is
    (a) 62.5 m/s   (b) 2.0 m/s
    (c) 50 m/s   (d) 40 m/s

98. Starting from rest a vehicle accelerates at the rate of 2m/s^2 towards east for 10s. It then stops suddenly. It then accelerates again at a rate of $4\sqrt{2}$ m/s^2 for next 10 s towards south and then again comes to rest. The net displacement of the vehicle from the starting point is

    (a) 100m   (b) 200m

    (c) 300m   (d) 400m

99. Which one of the following statements about the Industrial Revolution is correct?

    (a) Thomas Savery invented astrolabe

    (b) Thomas Newcomen invented chemical dyes

    (c) James Watt's invention converted the steam engine from being a mere pump into one which would provide energy to power machines in factories

    (d) Mathew Boulton discovered the technique of refinin gold of impurities

100. The first cotton mill in British India which began production in 1856 was set up by

    (a) Ghanshyam Das Birla

    (b) Jamnalal Bajaj

    (c) Ambalal Sarabhai

    (d) C. N. Davar

101. Consider the following statements about the Lingusitic Recorganization of the States:

    1. Gandhiji, in 1948, had argued for the recorganizatio of the reorganization of provinces on a linguistic basis

    2. The Constituent Assembly recomended it to be incorporated in the Constitution of India

    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

102. Inspired by the Dandi March by Mahatma Gandhi, in Tamilnadu, C Rajagolachari led a salt march from

    (a) Tirunelveli to Nagercoil

    (b) Kanchipuran to Mahabalipuram

    (c) Trichinopoly to Vedaranniyam on Tanjore coast

    (d) Chennai to Vellore

103. Acharya Vinoba Bhave received the first donation of land under the Bhoodan Movement at

    (a) Ramgarh   (b) Garhwa

    (c) Hyderabad   (d) Pochampally

104. Maize (makka) was introduced into India via

    (a) America and England (b) Africa and Spain

    (c) France and Italy   (d) Portugal and Italy

105. Which of the following pairs of Himalayan Passes and the Ranges in which they are located is/are correctly matched?

    1. Zoji La   — Great Himalayas

    2. Banihal Pass   — Pir Panjal Range

    3. Photo La   — Ladakh Range

    4. Khardung La   — Karakoram

Select the answer using the code given below:

    (a) 2 only

    (b) 4

    (c) 1 and 2 only

    (d) 1, 2 and 3

106. Which one among the following statements with reference to the black cotton soils of India is NOT correct?

    (a) The black cotton soils are also called 'Regur'

    (b) They are highly moisture retentive

    (c) They are rich in lime

    (d) These soils have less clay factor and hence can support a wide variety of crops and vegetables

107. Match List I with List II and select the correct answer using the code given below the lists:

List I (Hydroelectric Power Plant)	List II (State)
A. Doyang	1. Arunchal Pradesh
B. Gomuti	2. Assam
C. Kapili	3. Tripura
D. Ranganadi	4. Nagaland

Code:

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

108. Match List I with List II and select the correct answer using the code given below the lists:

List-I (Tropical Cyclone)	List-II (Country)
A. Hurricanes	1. China
B. Willy Willy	2. Philippines
C. Baguio	3. Australia
D. Typhones	4. USA

Code:

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

109. Consider the following facts of the rivers of the Indus system:

    1. The Satluj originates in Tibet where it is known as Langchen Khambab

    2. The Satluj is a classic example of an antecedent river

    3. The Jhelum is the largest tributary of the Indus System

Select the answer using the code given below:

(a) 2 only　　　　　　(b) 3 only

(c) 1 and 2　　　　　(d) 2 and 3

110. Which one of the following is an example of both an igneous as well as a metamorphic rock?

(a) Gabbro　　　　　(b) Geyserite

(c) Gneissoid　　　　(d) Granite

111. Which one of the following is correct?

(a) Pyroxene is commonly found in meteorites

(b) Amphiloles form about 20% of the Earth's crust

(c) Quartz is soluble in water

(d) The word 'sedimentary' is derived from the Latin word kelimentum

112. Which one among the following processes is NOT part of chemical weathering?

(a) Solution　　　　(b) Hydration

(c) Thawing　　　　(d) Reduction

113. What is the maximum number of electrons that can occupy the first shell of an atom?

(a) 2　　　　　　　(b) 4

(c) 8　　　　　　　(d) 16

114. At which temperature does liquid water show maximum density?

(a) 299 k　　　　　(b) 277 k

(c) 285 k　　　　　(d) 373 k

115. Which one among the following has valency of 3?

(a) Carbon　　　　(b) Oxygen

(c) Nitrogen　　　　(d) Sodium

116. Which one among the following is an example of oxidation reaction?

(a) Freezing of water

(b) Dissolving sugar in water

(c) Rusting of iron

(d) Boiling of petrol

117. Which one among the following fertilizers is a source of nitrogen?

(a) Superphoshate　　(b) Potassium sulfate

(c) Bone meal　　　　(d) Urea

118. For Aluminium (Al) (atomic number : 13, mass number : 27), which one among the following statement is NOT correct?

(a) Number os electrons present in Al is 13

(b) Number of protons present in Al is 13

(c) Number of neutrons present in Al is 14

(d) The valency of Al is 2

119. The elemental composition of diamond is

(a) Carbon and Hydrogen

(b) Carbon and Oxygen

(c) Pure Carbon

(d) Pure Silicon

120. Which one among the following is an example of chemical change?

(a) Sublimation of camphor

(b) Melting of ice

(c) Heating of an iron rod

(d) Mixing of NaOH and HCl

121. Which one among the following is the correct focal length of a combination of lenses of power 2.5 D and - 2.0 D?

(a) + 0.5 m　　　　(b) − 0.5 m

(c) + 2.0 m　　　　(d) − 2.0 m

122. The AC mains domestic supply current in India changes direction in every

(a) 50 s　　　　　　(b) $\dfrac{1}{50}$ s

(c) 100 s　　　　　(d) $\dfrac{1}{100}$ s

123. A block of mass 2.0 kg slides on a rough horizontal plane surface. Let the speed of the block at a particular instant is 10m/s. It comes to rest after travelling a distance of 20m. Which one of the following could be the magnitude of the frictional force?

(a) 10 N　　　　　(b) 20 N

(c) 40 N　　　　　(d) 50 N

124. Given below are the fuor cases in which certain heat transfer is taking place:

1. Ice is melting in a glass full of water

2. Water is boiling in an open container

3. A metal rod is heated in a furnace

4. A cup of coffee is allowed to cool on a table

In which of the above cases, the Newton's Law of Cooling is applicable?

(a) 1 only　　　　(b) 4 only

(c) 1 and 4 only　　(d) 1, 2 and 3

125. The figure given below shows the direction of the two forces P and Q acting on a skydiver:
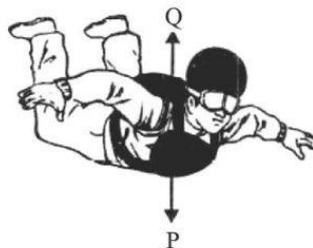
Which one among the following statements is correct about the two forces?

(a) Force P is caused by the gravity and force Q is caused by the friction

(b) When the force P is bigger than the force Q, the speed of the skydiver remains the same

(c) After the parachute opens, force P remains the same while force Q increases

(d) After the parachute opens, force P decreases while force Q increase

126. Vijayanagara rulers claimed that they were ruling on behalf of
(a) Lord Murugan
(b) Lord Venkateshwara
(c) Shri Virupasha
(d) Shri Vallabha

127. Domingo Paes describes a king in these words: 'of medium height, and of fair compexion and good figure, rather fat than thin; he has on his face sings of smallpox'. Identify the king from the options given below.
(a) Krishnadeva Raya
(b) Ram Raya
(c) Devaraya II
(d) Devaraya I

128. In which Schedule of the Consittution of India, provisions as to disqualification on grounds of defection are given?
(a) Ninth Schedule
(b) Tenth Schedule
(c) Eleventh Schedule
(d) Sixth Schedule

129. Consider the following statements:
1. The duties of the Attorney General of India are to give advice to the Government of India upon such legal matters, and to perform such other duties of a legal character, as may from time to time be referred to or assigned to him by the President of India
2. The Solicitor General of India is the secondary Law Officer of the country who assists the Attorney General,and is himself assisted by several Additional Solicitor Generals of India

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

130. Which of the following Committees does NOT consist of Members from the Upper House of the Parliament?
1. Public Accounts Committee
2. Estimates Committee
3. Committee on Public Undertakings

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

131. In the passing of a Money Bill, the Rajya Sabha has limited powers in that it shall return the Bill, with or without any recommendation, within the stipulated time of
(a) 12 days
(b) 21 days
(c) 14 days
(d) 30 days

132. Which of the following statements with regard to Article 19(1) of the Constitution of India is/are correct?
1. Freedoms under this Article are not absolute
2. Reasonable restrictions can be imposed on the exercise of freedoms under this Article

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

133. Which of the following is NOT a part of the five principles enshrined in the 'Panchsheel' agreement signed by India and China in 1954?
(a) Mutual non-aggression
(b) Mutual non-interference
(c) Peaceful coexistence
(d) Cultural cooperation

134. Freedom Fighter Kanaklata Barua sacrificed her life while participating in
(a) Rowlatt Satyagraha
(b) Non-Cooperation Movement
(c) Civil Disobedience Movement
(d) Quit India Movement

135. Where is the Coriolis Effect the largest?
(a) At the Equator
(b) At the tropic of Capricorn and Tropic of Cancer
(c) At the North Pole
(d) At 45 degree latitude in each hemisphere

136. In which among the following states in India, the Sun rays are never perpendicular?
1. Bihar
2. Chhattisharh
3. Manipur
4. Rajasthan

Select the answer using the code given below:
(a) 1 and 2
(b) 1 and 3
(c) 2 and 3
(d) 2 and 4

137. Which of the following is/are east flowing rivers in India?
1. Palar
2. Periyar
3. Pennar
4. Kalinadi

Select the answer using the code given below:
(a) 1 only
(b) 1 and 3
(c) 2 and 4
(d) 4 only

138. Which of the following tributaries is/are correctly matched with the Deccan Rivers?

	Tributary	River
1.	Bhavani	Krishna
2.	Kabini	Kaveri
3.	Manjra	Godavari
4.	Bhima	Mahanadi

Select the answer using the code given below:
(a) 1 and 2
(b) 2 and 3
(c) 1 and 3
(d) 3 and 4

139. Which of the following is found in appreciable amount in Laterite soil in India?
(a) Calcium
(b) Phosphate
(c) Potash
(d) Nitrogen

140. Consider the following statements regarding River Brahmaputra:
1. It rises in Tibet, near lake Manasrovar
2. It takes a "U" turn near Namcha Barwa and enters India through a gorge

Which of the statements given above is/are correct?

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

141. "Not me, but you" is the motto of which one of the following youth organizations/schemes?

(a) Rashtriya Yuva Sashaktikaran Karyakram
(b) National Service Scheme (NSS)
(c) National Young Leaders Programme
(d) National Discipline Scheme (NDS)

142. "Fitness ka dose, aadha ghanta roz" campaign, is associated with

(a) Khelo India
(b) Fit India Programme
(c) Mera Yuva Bharat
(d) Healthy Heart Programme

143. Consider the following statements:
1. Kozhikode has been included in UNESCO's creative cities network as the 'City of Music'
2. Garba of Gujarat has been declared by UNESCO as an intangible cultural heritage
3. Gwalior has been included in UNESCO's creative cities network as the 'City of Literature'

How many of the above statements is/are correct?

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

144. ASEAN -India Millet festival-2023, organized by Indian Mission to ASEAN, was held in which one of the following countries?

(a) India
(b) Indonesia
(c) Malaysia
(d) Thailand

145. Consider the following statements:
1. First Indian Military Heritage festival was inaugurated in October 2023 in Pune
2. First Green Hydrogen Fuel Cell Bus was flagged off in India in Bangalore
3. South Africa chaired the 15th BRICS Summit held in 2023

4. Viksit Bharat Sankalp Yatra was flagged off in 2023 from Jharkhand

How many of the above statements is/are correct?

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

146. Which of the following statements about 'ULLAS' scheme is/are NOT correct?
1. It's a Centrally Sponsored scheme which aims at securing childhood for street children
2. It's a scheme aligned with National Education Policy-2020 which aims at empowering adults aged 15 or above who could not get due schooling

Select the answer using the code givenbelow:

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

147. Which one of the following statements is NOT correct about NATO?

(a) It was formed out of the signing of the Washington Treaty
(b) Russia is not a member of this organization
(c) It derives its authority from the UN Charter
(d) Finland is its latest member

148. In January 2024, India has entered into a bilateral agreement through which it will provide grant assistance to a country to construct a 20 feet Bailey bridge. Identify the country.

(a) Nepal
(b) Bangladesh
(c) Bhutan
(d) Myanmar

149. Which one among the following Joint Military Exercises was NOT conducted between India and USA ?

(a) Yudhabhyas
(b) Vajra Prahar
(c) Malabar
(d) Varuna

150. Consider the following statements:
1. India has secured 10th rank in International Shipment category in World Bank's Logistics Performance Index Report-2023
2. Global Maritime India Summit-2023 was held in Vishakhapatnam
3. 'Maritime Amrit Kaal Vision 2047' was launched during Global Maritime India Summit-2023

How many ' of the above statements is/ are correct?

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

HINTS & SOLUTIONS

MATHEMATICS

1. (d) Since we know that matrix multiplication is only possible when column of first matrix is equal to row of the second matrix.

   $A_{m \times n} \cdot B_{n \times p} = (AB)_{m \times p}$

   Thus $[Z_{3 \times 2} \cdot Y_{2 \times 3}] X_{3 \times 3} = (zyx)_{3 \times 3}$

   and $Y_{2 \times 3} \cdot [X_{3 \times 3} \cdot Z_{3 \times 2}] = (yxz)_{2 \times 2}$

   and $x_{3 \times 3} [Y_{2 \times 3} \cdot Z_{3 \times 2}] = X_{3 \times 3} \cdot (YZ)_{2 \times 2}$

   $\because$ No. of columns in X $\neq$ no. of rows in (yz)

   Hence x(yz) is not defined.

2. (a) Since between any two irrational numbers, infinite number of irrational numbers are there. Hence, the set of all irrational numbers between $\sqrt{12}$ and $\sqrt{15}$ is having infinite number of elements.

   $\because$ Set of all odd integers less than 1000 is $\{...... -5, -3, 1, 3, ... 999\}$ which is an infinite set.

3. (a) Odd digits can be 1, 3, 5, 7, 9

   $5 \times 5 \times 5 \times 5$

   $\therefore$ All five odd digits can be filled at 4 places.

   Hence total required 4-digits numbers are $5 \times 5 \times 5 \times 5$ = 625.

4. (d) Let $I = (1 + \omega - \omega^2)^{100} + (1 - \omega + \omega^2)^{100}$

   $= (-\omega^2 - \omega^2)^{100} + (-\omega - \omega)^{100}$ $\{\because 1 + \omega + \omega^2 = 0\}$

   $= 2^{100} (\omega^{200} + \omega^{100})$

   $= 2^{100} (\omega^2 + \omega)$ $\{\because \omega^3 = 1\}$

   $= -2^{100}$.

5. (c) We have, AB = 0

   Let $A = \begin{bmatrix} a & b \\ c & d \end{bmatrix}$ and $B = \begin{bmatrix} p & q \\ r & s \end{bmatrix}$

   So, $AB = \begin{bmatrix} a & b \\ c & d \end{bmatrix} \begin{bmatrix} p & q \\ r & s \end{bmatrix} = \begin{bmatrix} 0 & 0 \\ 0 & 0 \end{bmatrix}$

   $\Rightarrow \begin{bmatrix} ap + br & aq + bs \\ cp + dr & cq + ds \end{bmatrix} = \begin{bmatrix} 0 & 0 \\ 0 & 0 \end{bmatrix}$

   Comparing both sides, we have

   $ap + br = 0$ ...(i)

   $aq + bs = 0$ ...(ii)

   $cp + dr = 0$ ...(iii)

   $cq + ds = 0$ ...(iv)

   Solving equation (i) and (iii), we get

   $(ad - bc) p = 0$ and $(ad - bc) r = 0$

   Solving equation (ii) amd (iv), we get

   $(ad - bc)q = 0$ and $(ad - bc)s = 0$

   Now, If A is non-singular $\Rightarrow ad - bc \neq 0$.

   So, we get, $p = q = r = s = 0$

   So, B is a null matrix.

6. (c) Here, $(1 + x)^p (1 + x)^q = (1 + x)^{p + q}$

   Given, Coeff. of x^3 in the expansion of $(1 + x)^{p + q} = 35$

   $\Rightarrow {}^{(p + q)}C_3 = 35 = {}^7C_3$

   $\Rightarrow p + q = 7$ (on comparison)

7. (a) Suppose 'a' and 'd' be the first term and common difference of AP respectively.

   $\because n^{th}$ term $= T_n = a + (n - 1) \cdot d$

   $\therefore (p + q)^{th}$ term $= T_{p+q} = a + (p + q - 1) d$ ...(i)

   Given, $p \cdot T_p = q \cdot T_q$

   $\Rightarrow p \cdot [a + (p - 1) d] = q \cdot [a + (q - 1)d]$

   $\Rightarrow (p - q) [a + (p + q - 1) d] = 0$

   $\Rightarrow [a + (p + q - 1) d] = 0$ $\{\because p \neq q\}$

   $\Rightarrow T_{p+q} = 0$ {from (i)}

8. (c) We have given, $p = \ell n\, x$, $q = \ell n\, x^3 = 3\ell n\, x$

   $r = \ell n\, x^5 = 5\, \ell n\, x$

   Clearly, $q - p = r - q = 2\, \ell nx$

   $\Rightarrow$ p, q and r are in A.P.

   Also, Since $\dfrac{q}{p} \neq \dfrac{r}{q} \Rightarrow$ p, q and r can never be in GP.

9. (b) We have given, $Z = \dfrac{1}{3} \begin{vmatrix} i & 2i & 1 \\ 2i & 3i & 2 \\ 3 & 1 & 3 \end{vmatrix}$

   $\Rightarrow Z = \dfrac{1}{3} [i(9i - 2) - 2i (6i - 6) + 1 (2i - 9i)]$

   $\Rightarrow Z = \dfrac{1}{3} (3 + 3i) = 1 + i$

   $\Rightarrow$ Modulus of $z = \sqrt{1^2 + 1^2} = \sqrt{2}$

10. (b) Suppose $A = \displaystyle\sum_{n=1}^{20} \left(i^{n-1} + i^n + i^{n+1} \right)$

    $\Rightarrow A = \displaystyle\sum_{n=1}^{20} i^n \cdot \left(\dfrac{1}{i} + 1 + i \right) = \displaystyle\sum_{n=1}^{20} i^n \left(-i + 1 + i \right)$

    $= \displaystyle\sum_{n=1}^{20} i^n = i^1 + i^2 + i^3 + i^4 .... + i^{20}$

    $= 5 \cdot (i + i^2 + i^3 + i^4)$

    $= 5 \cdot (0) = 0$ $\{\because i + i^2 + i^3 + i^4 = 0\}$

11. (c) Since, x, y, z are in G.P.

    $\Rightarrow y^2 = xz \Rightarrow 2 \ln y = \ln x + \ln z$

    $\Rightarrow \ln y - \ln x = \ln z - \ln y$

    $\Rightarrow \ln x, \ln y, \ln z$ are in AP.

    $\Rightarrow (1 + \ln x), (1 + \ln y), (1 + \ln z)$ are in AP

    $\Rightarrow \dfrac{1}{(1 + \ln x)}, \dfrac{1}{(1 + \ln y)}, \dfrac{1}{(1 + \ln z)}$ are in AP.

12. (a) Suppose $A = \begin{vmatrix} 1+\omega & 1+\omega^2 & \omega+\omega^2 \\ 1 & \omega & \omega^2 \\ \dfrac{1}{\omega} & \dfrac{1}{\omega^2} & 1 \end{vmatrix}$

Now $C_1 \rightarrow C_1 + C_2 + C_3$, we get

$\Rightarrow A = \begin{vmatrix} 2(1+\omega+\omega^2) & 1+\omega^2 & \omega+\omega^2 \\ (1+\omega+\omega^2) & \omega & \omega^2 \\ \dfrac{(1+\omega+\omega^2)}{\omega^2} & \dfrac{1}{\omega^2} & 1 \end{vmatrix}$

$\Rightarrow A = \begin{vmatrix} 2(0) & 1+\omega^2 & \omega+\omega^2 \\ 0 & \omega & \omega^2 \\ 0 & \dfrac{1}{\omega^2} & 1 \end{vmatrix} = 0$

$\{\because$ all element of C_1 is zero$\}$.

13. (a) Here, $S_n = n(2n+1) \Rightarrow s_{n-1} = (n-1)(2n-1)$
    n^{th} term $= T_n = S_n - S_{n-1}$
    $T_n = n(2n+1) - (n-1)(2n-1) = 4n-1$

14. (b) Here word 'INDIA' contains 3 vowels (I, I, A) and two consonants (N, D)
    Now, 3 vowels (I, I, A) can be arranged at odd position in
    $\dfrac{3!}{2!} = 3$ ways and 2 consonants (N, D) can be arranged in
    2! ways = 2 ways

odd	even	odd	even	odd

    Hence, required number of ways = (3)(2) = 6

15. (c) Here, word, 'EQUATION' contains 5 vowels (A, E, I, O, U) and 3 consonants (Q, T, N).
    Two cases are possible here
    Case (I):

N	Q	T	A	E	I	O	U

    Consonants   Vowels

    Number of ways for this arrangement = (3!) . (5!)
    Case(II):

A	E	I	O	U	N	Q	T

    Vowels   Consonants

    Number of ways for this arrangement = (3!) · (5!)
    Total required number of ways = (3!)(5!) + (3!)(5!)
    = 1440

16. (c) Given, n is a root of $x^2 + px + m = 0$
    $\Rightarrow n^2 + pn + m = 0$ ....(i)
    Given, m is a root of the equation $x^2 + px + n = 0$
    $\Rightarrow m^2 + pm + n = 0$ ...(ii)

Now subtracting Eq (ii) from Eq (i), we get
$(n^2 - m^2) + p(n-m) - (n-m) = 0$
$\Rightarrow (n-m)[(n+m)+p-1] = 0$
$\Rightarrow n+m+p-1 = 0$ {given, $n \neq m$}
$\Rightarrow n+m+p = 1$

17. (d) We have given that 2 courses are compulsory.
    Total remaining courses available for selection
    = n – 2 and total remaining courses that can be chosen
    from (n – 2) courses is (n – 2) – 2 = 0 (n – 4).
    Thus, required number of ways $= {}^{(n-2)}C_{(n-4)}$
    $= \dfrac{(n-2)(n-3)}{2}$

18. (a) Given,
    $D_n = \begin{vmatrix} n & 20 & 30 \\ n^2 & 40 & 50 \\ n^3 & 60 & 70 \end{vmatrix} = (20)(10)\begin{vmatrix} n & 1 & 3 \\ n^2 & 2 & 5 \\ n^3 & 3 & 7 \end{vmatrix}$

    $\Rightarrow D_n = 200[n(14-15) - 1(7n^2 - 5n^3) + 3(3n^2 - 2n^3)]$
    $\Rightarrow D_n = 200(-n + 2n^2 - n^3)$

    Now, $\displaystyle\sum_{n=1}^{4} D_n = 200\sum_{n=1}^{4}\left(-n + 2n^2 - n^3\right)$

    $\because \sum n = \dfrac{n(n+1)}{2}, \sum n^2 = \dfrac{n(n+1)(2n+1)}{6}$

    $\sum n^3 = \left[\dfrac{n(n+1)}{2}\right]^2$

    Hence,

    $\displaystyle\sum_{n=1}^{4} D_n = 200\left[-\dfrac{(4)(5)}{2} + 2 \cdot \dfrac{(4)(5)(9)}{6} - \left(\dfrac{(4)(5)}{2}\right)^2\right]$

    $= 200(-50) = -10000$

19. (c) We have given,

    $P = \begin{bmatrix} 0 & c & -b \\ -c & 0 & a \\ b & -a & 0 \end{bmatrix}, Q = \begin{bmatrix} a^2 & ab & ac \\ ab & b^2 & bc \\ ac & bc & c^2 \end{bmatrix}$

    $\Rightarrow PQ = \begin{bmatrix} 0 & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & 0 \end{bmatrix}$ and $QP = \begin{bmatrix} 0 & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & 0 \end{bmatrix}$

    $\Rightarrow PQ = QP \Rightarrow$ option (c) is correct.

20. (b) We know that, determinant of any skew symmetric matrix with odd order is always zero.
    Hence, determinant of skew symmetric matrix (3 × 3) will be zero.

21. (c) We have given, $4\sin^{-1}x + \cos^{-1}x = \pi$.

    $\Rightarrow 4\left(\dfrac{\pi}{2} - \cos^{-1}x\right) + \left(\dfrac{\pi}{2} - \sin^{-1}x\right) = \pi$

    $\left\{\sin^{-1}x + \cos^{-1}x = \dfrac{\pi}{2}\right\}$

$$\Rightarrow 2\pi - 4\cos^{-1}x + \frac{\pi}{2} - \sin^{-1}x = \pi$$

$$\Rightarrow 4\cos^{-1}x + \sin^{-1}x = \frac{3\pi}{2}$$

22. **(b)** Suppose $I = \cot^2(\sec^{-1}2) + \tan^2(\text{cosec}^{-1}3)$

$$\Rightarrow I = \cot^2(60°) + \tan^2 + \left(\cot^{-1}\sqrt{9-1}\right)$$

$$\left\{\because \text{cosec}^{-1}t = \cot^{-1}\sqrt{t^2-1}\right\}$$

$$\Rightarrow I = \frac{1}{3} + \tan^2\left(\tan^{-1}\frac{1}{\sqrt{8}}\right) = \frac{1}{3} + \frac{1}{8} = \frac{11}{24}$$

23. **(a)** We have given,

$$\frac{a}{\cos A} = \frac{b}{\cos B} = \frac{c}{\cos C}$$

$$\Rightarrow \frac{a}{\left(\frac{b^2+c^2-a^2}{2bc}\right)} = \frac{b}{\left(\frac{a^2+c^2-b^2}{2ac}\right)} = \frac{c}{\left(\frac{a^2+b^2-c^2}{2ab}\right)}$$

$$\Rightarrow b^2 + c^2 - a^2 = c^2 + a^2 - b^2 = a^2 + b^2 - c^2$$
$$\Rightarrow a^2 = b^2 = c^2 \Rightarrow a = b = c$$

Thus, ΔABC is an equilateral triangle

So, Area of $\Delta ABC = \frac{\sqrt{3}}{4}.a^2$ (Given, a = 6 cm)

$$= \frac{\sqrt{3}}{4}.(6)^2 = 9\sqrt{3}\text{cm}^2$$

24. **(c)** Since $\tan\alpha$, $\tan\beta$ are roots of $7x^2 - 6x + 1 = 0$

$$\therefore \quad \text{Sum of roots} = \tan\alpha + \tan\beta = \frac{6}{7} \quad ......(i)$$

$$\text{Product of roots} = \tan\alpha . \tan\beta = \frac{1}{7} \quad ......(ii)$$

$$\because \tan(\alpha+\beta) = \frac{\tan\alpha + \tan\beta}{1 - \tan\alpha.\tan\beta} = \frac{\left(\frac{6}{7}\right)}{1 - \frac{1}{7}} = 1$$

$$\Rightarrow \alpha + \beta = 45° \Rightarrow 2\alpha + 2\beta = 90°$$

Which means 3rd angle of triangle is 90°.
Hence, triangle is right-angled triangle.
Now consider,

$$(\tan\alpha - \tan\beta) = \sqrt{(\tan\alpha + \tan\beta)^2 - 4\tan\alpha.\tan\beta}$$

$$= \sqrt{\left(\frac{6}{7}\right)^2 - 4\left(\frac{1}{7}\right)} = \frac{2\sqrt{2}}{7}$$

Thus, $\tan(\alpha - \beta) = \dfrac{\tan\alpha - \tan\beta}{1 + \tan\alpha.\tan\beta} = \dfrac{1}{2\sqrt{2}}$

and $(\alpha - \beta) = \dfrac{2\tan(\alpha-\beta)}{1 - \tan^2(\alpha-\beta)} = \left(\dfrac{4\sqrt{2}}{7}\right)$

$\Rightarrow 2\alpha \neq 2\beta \Rightarrow$ triangle is not an isosceles triangles.

25. **(b)** Here, $\angle A = 75°$, $\angle B = 45° \Rightarrow \angle C = 60°$
We know that,

$$\frac{a}{\sin A} = \frac{b}{\sin B} = \frac{c}{\sin C} \Rightarrow \frac{a}{\sin 75°} = \frac{b}{\sin 45°} = \frac{c}{\sin 60°}$$

Hence,

$$a = \frac{\sin 75°}{\sin 60°}c = \frac{\left(\frac{\sqrt{3}+1}{2\sqrt{2}}\right)c}{\left(\frac{\sqrt{3}}{2}\right)} = \frac{(\sqrt{3}+1)c}{\sqrt{6}}$$

$$\text{and} \quad b = \frac{\sin 45°}{\sin 60°}.c = \frac{\left(\frac{1}{\sqrt{2}}\right)c}{\left(\frac{\sqrt{3}}{2}\right)} = \frac{2c}{\sqrt{6}}$$

Now,

$$2a - b = \frac{2\sqrt{3}}{\sqrt{6}}c = \sqrt{2}\,c$$

26. **(c)** We have given, $\cot 2x . \cot 3x = 1$ (given)
$$\Rightarrow \cos 2x . \cot 3x - \sin 2x . \sin 3x = 0$$
$$\Rightarrow \cos(2x + 3x) = \cos 5x = 0$$

Hence $5x = \dfrac{\pi}{2}, \dfrac{3\pi}{2}, \dfrac{5\pi}{2}, \dfrac{7\pi}{2}, \dfrac{9\pi}{2}, ...$

But $0 < x < \pi$

$$\Rightarrow x = \frac{\pi}{10}, \frac{3\pi}{10}, \frac{5\pi}{10}, \frac{7\pi}{10}, \frac{9\pi}{10}$$

Thus only five values of x are possible.

27. **(a)** Since, $\cos^2 x \in [0, 1] \Rightarrow \cos^{100}x \in [0, 1]$
and $\sin^2 x \in [0, 1] \Rightarrow \sin^{100}x \in [0, 1]$
Hence, $\cos^{100} x - \sin^{100} x = 1$ is only possible when $\cos^{100} x = 1$
$$\Rightarrow \cos^2 x = 1 \Rightarrow x = n\pi \pm 0 \Rightarrow x = n\pi$$

28. **(b)** In ΔABC, $A + B + C = \pi$
Taking tan both side, we get
$$\Rightarrow \tan(A + B + C) = \tan\pi = 0$$

$$\Rightarrow \frac{\tan A + \tan B + \tan C - \tan A\tan B\tan C}{1 - \tan A.\tan B - \tan B.\tan C - \tan C.\tan A} = 0$$

$$\Rightarrow \tan A . \tan B . \tan C = \tan A + \tan B + \tan C$$

$$\Rightarrow \cot A . \cot B . \cot C = \frac{1}{\tan A + \tan B + \tan C}$$

$$= \frac{1}{K}$$

29. **(c)** Let $I = \sin 12° . \sin 48° \Rightarrow I = \dfrac{2\sin 12° \sin 48°}{2}$

$$\Rightarrow I = \frac{1}{2}[\cos(36°) - \cos(60°)]$$

$$\Rightarrow I = \frac{1}{2}\left[\frac{\sqrt{5}+1}{4} - \frac{1}{2}\right] = \frac{\sqrt{5}-1}{8}$$

30. (d) Let $I = \dfrac{\cos 17^\circ - \sin 17^\circ}{\cos 17^\circ + \sin 17^\circ} = \dfrac{\cos 17^\circ \left(1 - \dfrac{\sin 17^\circ}{\cos 17^\circ}\right)}{\cos 17^\circ \left(1 + \dfrac{\sin 17^\circ}{\cos 17^\circ}\right)}$

$\Rightarrow I = \dfrac{\tan 45^\circ - \tan 17^\circ}{1 + \tan 45^\circ \cdot \tan 17^\circ}$

$= \tan(45^\circ - 17^\circ) = \tan 28^\circ$

$= \tan(90^\circ - 62^\circ) = \cot 62^\circ$

31. (b) Let $t = \tan 22.5^\circ = \tan \dfrac{45^\circ}{2}$

Now, $\tan 45^\circ = \tan\left(2 \times \dfrac{45}{2}\right)^\circ = \dfrac{2 \tan\left(\dfrac{45}{2}\right)^\circ}{1 - \tan^2\left(\dfrac{45}{2}\right)^\circ}$

$\Rightarrow 1 = \dfrac{2t}{1 - t^2} \Rightarrow t^2 + 2t - 1 = 0$

$\Rightarrow t = \dfrac{-2 \pm \sqrt{4+4}}{2} = -1 \pm \sqrt{2}$

$\Rightarrow \tan\left(\dfrac{45}{2}\right)^\circ = -1 \pm \sqrt{2} \Rightarrow \tan\left(\dfrac{45}{2}\right)^\circ = -1 + \left(\sqrt{2}\right)$

$\{\because$ In I^{st} quadrant tan is positive$\}$

(II) Now, $\cot 22.5^\circ = \dfrac{1}{\tan 22.5^\circ} = \dfrac{1}{-1 + \sqrt{2}} = 1 + \sqrt{2}$

which is also an irrational number.

(III) Since, $\tan 22.5^\circ - \cot 22.5^\circ = -1 + \sqrt{2} - \left(1 + \sqrt{2}\right) = -2$
which is not an irrational number.

32. (b)

33. (d) We have,

$p \tan(\theta - 30^\circ) = q \tan(\theta + 120^\circ)$

$\Rightarrow \dfrac{p}{q} = \dfrac{\tan(\theta + 120^\circ)}{\tan(\theta - 30^\circ)}$

$= \dfrac{\sin(\theta + 120^\circ)}{\cos(\theta + 120^\circ)} \dfrac{\cos(\theta - 30^\circ)}{\sin(\theta - 30^\circ)}$

Using componendo and dividendo rule,

$\Rightarrow \dfrac{p+q}{p-q} = \dfrac{\sin(\theta + 120^\circ)\cos(\theta - 30^\circ) + \cos(\theta + 120^\circ)\sin(\theta - 30^\circ)}{\sin(\theta + 120^\circ)\cos(\theta - 30^\circ) - \cos(\theta + 120^\circ)\sin(\theta - 30^\circ)}$

$\Rightarrow \dfrac{p+q}{p-q} = \dfrac{\sin\left[(\theta + 120^\circ) + (\theta - 30^\circ)\right]}{\sin\left[(\theta + 120^\circ) - (\theta - 30^\circ)\right]} = \dfrac{\sin(90^\circ + 2\theta)}{\sin(150^\circ)}$

$\Rightarrow \dfrac{p+q}{p-q} = \dfrac{\sin(90^\circ + 2\theta)}{\left(\dfrac{1}{2}\right)} = 2\cos 2\theta$

34. (d)

35. (d) We have,

$A \cap B = 10$

So, $(A \times B) \cap (B \times A) = 10 \times 10 = 100$.

36. (b) Suppose $p(n) = 7^n - 6n = (6+1)^n - 6n$

Using Binomial expansion, we get

$= 1 + 6n + {}^n c_2 \, 6^2 + {}^n c_3 \, 6^3 + \ldots + 6^n - 6n$

$= 1 + 6^2 \, ({}^n c_2 + {}^n c_2 \times 6 + \ldots + 6^{n-2})$

$= 1 + 36 \, ({}^{100} c_2 + {}^{100} c_2 \times 6 + \ldots + 6^{98}) \quad \{\because n = 100\}$

$= 1 + 36 \, m$ where $m = {}^{100} c_2 + {}^{100} c_2 \times 6 + \ldots + 6^{98}$

So, when $7^n - 6n$ is divided by 36, the remainder will be 1.

37. (c) There are 4 lines, then the maximum number of intersection points are ${}^4 c_2 = 6$

And maximum number of intersection of circle with 4 lines are $4 \times 2 = 8$.

Thus, the required intersection point $= 6 + 8 = 14$.

38. (c) We have,

$\dfrac{S_p}{S_q} = \dfrac{p^2}{q^2}$

$\Rightarrow \dfrac{\dfrac{p}{2}[2a + (p-1)d]}{\dfrac{q}{2}[2a + (q-1)d]} = \dfrac{p^2}{q^2} \quad \left\{\because S_n = \dfrac{n}{2}[2a + (n-1)d]\right\}$

$\Rightarrow \dfrac{2a + (p-1)d}{2a + (q-1)d} = \dfrac{p}{q}$

$\Rightarrow 2aq + q(p-1)d = 2ap + p(q-1)d$

$\Rightarrow 2a\,(q - p) = d(q - p)$

$\Rightarrow 2a = d$ or $d = 2a$

This, the common difference is equal to twice of the first term.

39. (a) Given that, $(x-1)^2 + (x-3)^2 + (x-5)^2 = 0$

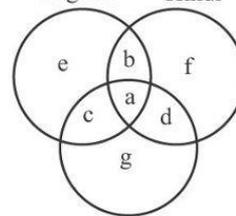$\Rightarrow x^2 - 2x + 1 + x^2 - 6x + 9 + x^2 - 10x + 25 = 0$

$\Rightarrow 3x^2 - 18x + 35 = 0$

Discriminant $D = (-18)^2 - 4 \times 3 \times 35 = -96 < 0$

$\because$ Discriminant is negative. So, the given equation does not have any real roots.

40. (a)

Given, total student = 240

Since, 10 student failed in every subject.

Hence, Remaining total = 230

Now, According to question,

$a + b + c + d + e + f + g = 230$ ...(i)

and $b + c + d = 110$ ...(ii)

and $e + f + g = 60$ ...(iii)

Using equation (ii) and (iii) in equation (i), we get

$\Rightarrow a = 230 - (110 + 60) = 60$

Sol. 41 to 42

Given that,

$Z_1^2 + Z_2^2 + Z_1 Z_2 = 0 \Rightarrow Z_1 = w$ and $Z_2 = w^2$

41. (a) $\left|\dfrac{Z_1}{Z_2}\right| = \left|\dfrac{\omega}{\omega^2}\right| = \left|\dfrac{1}{\omega}\right| = 1$

42. (b) Now,

$\dfrac{1}{2} + \text{Re}\left(\dfrac{Z_1}{Z_2}\right) = \dfrac{1}{2} + \text{Re}\left(\dfrac{\omega}{\omega^2}\right) = \dfrac{1}{2} + \text{Re}\left(\omega^2\right)$

$= \dfrac{1}{2} + \text{Re}\left(-\dfrac{1}{2} - \dfrac{\sqrt{3}}{2}i\right) = \dfrac{1}{2} + \left(-\dfrac{1}{2}\right) = 0$

$= 0$

43. (d) Let the required terms of the given AP are-

$a - 2d, a - d, a, a + d, a + 2d$.

According to the question,

$(a - 2d)(a - d) a (a + d)(a + 2d) = 229635$

$\Rightarrow a(a^2 - d^2)(a^2 - 4d^2) = 229635$ ...(i)

$\because a - 2d, a - d, a + 2d$ are in G.P.

$\therefore (a - d)^2 = (a - 2d)(a + 2d)$

$\Rightarrow (a - d)^2 = a^2 - 4d^2$

$\Rightarrow 5d^2 - 2ad = 0 \Rightarrow d(5d - 2a) = 0 \Rightarrow 5d = 2a$ ...(ii)

Solving equation (i) and (ii), we have,

$d = 6$.

44. (c) Using the value of d in equation (ii), we have,

$5 \times 6 = 2a \Rightarrow a = 15$

$\therefore$ The required terms of A.P. are 3, 9, 15, 21, 27.

So, required sum = $3 + 9 + 15 + 21 + 27 = 75$.

For. 45 and 46:

We have, $(8 + 3\sqrt{7})^{20} = U + V$ ...(i)

and $(8 - 3\sqrt{7})^{20} = W$ ...(ii)

Here, $o < W < 1$

Now, adding equation (i) & (ii), we have,

$U + V + W = (8 + 3\sqrt{7})^{20} + (8 - 3\sqrt{7})^{20}$

$= 2\left[{}^{20}C_0 \cdot 8^{20} + {}^{20}C_2\, 8^{18} \cdot (3\sqrt{7})^2 + ... + (3\sqrt{7})^{20}\right]$

R.H.S. is an even number.

Also, $o < V < 1$, $o < W < 1$ and U is an integer

$\Rightarrow V + W$ is an integer $\Rightarrow V + W = 1$

45. (d) So, $V + W = 1$

48. (b) $(U + V)W = (8 + 3\sqrt{7})^{20}(8 - 3\sqrt{7})^{20}$

$= \left[(8 + 3\sqrt{7})(8 - 3\sqrt{7})\right]^{20}$

$= (64 - 63)^{20} = 1^{20} = 1$

Sol. 47 and 48 :

The given equation is as follows,

$a^2 (b^2 - c^2) x^2 + b^2 (c^2 - a^2)x + c^2(a^2 - b^2) = 0$ ...(i)

Since, equation has equal roots $\Rightarrow D = 0$

$\Rightarrow [b^2 (c^2 - a^2)]^2 - 4a^2 c^2 (b^2 - c^2)(a^2 + b^2) = 0$

$\Rightarrow b^4(c^2 - a^2)^2 - 4a^2 c^2 (b^2 - c^2)(a^2 - b^2) = 0$

Solving above equation, we have,

$b^4 (c^2 + a^2) = 4a^4 c^4 \Rightarrow b^2 (a^2 + c^2)^2 = 2a^2 c^2$

$\Rightarrow \dfrac{2}{b^2} = \dfrac{1}{a^2} + \dfrac{1}{c^2}$

$\therefore a^2, b^2, c^2$ and in H.P.

47. (c) Option (c) is the correct option.

48. (c) Let α be the required root of the given equation.

Now, Sum of roots $= -\dfrac{B}{A} = -\dfrac{b^2(c^2 - a^2)}{a^2(b^2 - c^2)}$

$\Rightarrow \alpha + \alpha = \dfrac{-b^2(c^2 - a^2)}{a^2(b^2 - c^2)} \Rightarrow \alpha = \dfrac{b^2(c^2 - a^2)}{2a^2(c^2 - b^2)a}$

Sol. 49 and 50 :

We have : $A = \begin{bmatrix} 3 & -3 & 4 \\ 2 & -3 & 4 \\ 0 & -1 & 1 \end{bmatrix}$

So, Determinant

$|A| = 3(-3 + 4) - 2(-3 + 4) + 0 = 3 - 2 = 1$

$\because A (\text{adj } A) = |A| I = 1.I = I.$

49. (d) Option (d) is correct option.

50. (a) Now,

$\text{adj}(A) = \begin{bmatrix} 1 & -1 & 0 \\ -2 & 3 & -4 \\ -2 & 3 & -3 \end{bmatrix}$

So,

$A^{-1} = \dfrac{1}{|A|}\left(\text{Adj}(A)\right) = \dfrac{1}{1}\begin{bmatrix} 1 & -1 & 0 \\ -2 & 3 & -4 \\ -2 & 3 & -3 \end{bmatrix}$

$\Rightarrow A^{-1} = \begin{bmatrix} 1 & -1 & 0 \\ -2 & 3 & -4 \\ -2 & 3 & -3 \end{bmatrix}$

51. (a) Given that, $(2\hat{i} + 6\hat{j} + 27\hat{k}) \times (\hat{i} + \alpha\hat{j} + \beta\hat{k}) = 0$

$\Rightarrow \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 2 & 6 & 27 \\ 1 & \alpha & \beta \end{vmatrix} = 0$

$\Rightarrow \hat{i}(6\beta - 27\alpha) - \hat{j}(2\beta - 27) + \hat{k}(2\alpha - 6) = 0$

Comparing both sides of above equation, we get:-

$6\beta - 27\alpha = 0 \Rightarrow 2\beta = 9\alpha$

$2\beta - 27 = 0 \Rightarrow \beta = \dfrac{27}{2}$ and $2\alpha - 6 = 0 \Rightarrow \alpha = 3$

So, $3\alpha + 2\beta = 3 \times 3 + 2 \times \dfrac{27}{2} = 9 + 27 = 36$

52. (b) Let $m = |\vec{a} \times \vec{b}| + \sqrt{3}|\vec{a}.\vec{b}|$

$= |\vec{a}|.|\vec{b}||\sin\theta| + \sqrt{3}|\vec{a}||\vec{b}||\cos\theta|$

$= |\vec{a}||\vec{b}|\left[|\sin\theta| + \sqrt{3}|\cos\theta|\right]$

m will be max if $(\sin\theta + \sqrt{3}\cos\theta)$ is maximum

Now, for its maximum, $\dfrac{d}{d\theta}\left(\sin\theta + \sqrt{3}\cos\theta\right) = 0$

$\Rightarrow \cos\theta - \sqrt{3}\sin\theta = 0$
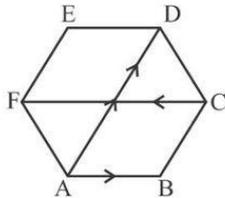
$\Rightarrow \tan\theta = \dfrac{1}{\sqrt{3}} \Rightarrow \theta = 30°$

53. (a) Since, $(\vec{a} + 2\vec{b}) \& (5\vec{a} - 4\vec{b})$ are perpendicular vectors.

$\Rightarrow (\vec{a} + 2\vec{b}).(5\vec{a} - 4\vec{b}) = 0$

$\Rightarrow 5|\vec{a}|^2 - 4\vec{a}.\vec{b} + 10\vec{a}.\vec{b} - 8|\vec{b}|^2 = 0$

$\Rightarrow 5 \times 1 + 6\vec{a}.\vec{b} - 8 = 0$ Since, $|\vec{a}| = |\vec{b}| = 1$

$\Rightarrow 6|\vec{a}||\vec{b}|\cos\theta = 3$

$\Rightarrow 1.1\cos\theta = \dfrac{1}{2} \Rightarrow \cos\theta = \dfrac{1}{2}$

So, $\cos2\theta = 2\cos^2\theta - 1 = 2 \times \dfrac{1}{4} - 1 = -\dfrac{1}{2}$

Now, $\cos\theta + \cos2\theta = \dfrac{1}{2} - \dfrac{1}{2} = 0$

54. (a)

In a regular hexagon,

$\overrightarrow{AB} = 2\overrightarrow{FC}$

$\Rightarrow \overrightarrow{AB} = -2\overrightarrow{CF}$

$\therefore$ n = −2

Also, $\overrightarrow{AD} = 2\overrightarrow{BC}$

$\therefore$ m = 2

Now, mn = 2 (−2) = − 4

55. (c) Given that,

$\vec{a} = \hat{i} + \hat{j}, \vec{b} = \hat{j} + \hat{k}$

Since, $\vec{a}, \vec{b}, \vec{c}$ has same length.

$\Rightarrow |\vec{a}| = |\vec{b}| = |\vec{c}| = \sqrt{1+1} = \sqrt{2}$

Let θ be the angle between the vectors.

$\therefore \cos\theta = \dfrac{\vec{a}.\vec{b}}{|\vec{a}||\vec{b}|} = \dfrac{0+1+0}{\sqrt{2} \times \sqrt{2}} = \dfrac{1}{2}$

(I) Take $\vec{c} = \hat{i} + \hat{k} \Rightarrow |\vec{c}| = \sqrt{1+1} = \sqrt{2}$

and $\cos\theta = \dfrac{\vec{a}.\vec{c}}{|\vec{a}||\vec{c}|} = \dfrac{1+0+0}{\sqrt{2}\sqrt{2}} = \dfrac{1}{2}$

All $\vec{c}$ the conditions are satisfied. So, it can be vector.

(II) Take $\vec{c} = \dfrac{\hat{i} + 4\hat{j} - \hat{k}}{3} \Rightarrow |\vec{c}| = \dfrac{1}{3}\sqrt{1+16+1} = \dfrac{3\sqrt{2}}{3} = \sqrt{2}$

and $\cos\theta = \dfrac{\vec{a}.\vec{c}}{|\vec{a}||\vec{c}|} = \dfrac{\dfrac{-1}{3} + \dfrac{4}{3}}{\sqrt{2}\sqrt{2}} = \dfrac{1}{2}$

$\therefore$ All the conditions are satisfied, so it can be vector $\vec{c}$

56. (d) The Slope of the diagonal along the line x − 2y = 1 is

$m_1 = \dfrac{1}{2}$

and the slope of the diagonal along the line 4x + 2y = 3 is $m_2 = -2$.

Now, $m_1 m_2 = \dfrac{1}{2}(-2) = -1 \Rightarrow m_1 m_2 = -1$

So, Diagonals are perpendicular to each others.

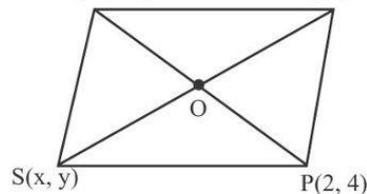$\Rightarrow$ The quadrilateral ABCD is a rhombus.

57. (b) Given equation of ellipse, $4x^2 + 9y^2 = 1$

Here, $a = \dfrac{1}{2}$ and $b = \dfrac{1}{3}$

Since, P(x, y) is any point on the ellipse.

So, PQ + PR = 2a = $2 \times \dfrac{1}{2} = 1$.

58. (b)

Let O is the intersection point of S(x, y)

So, O is mid point of P and R.

$\Rightarrow O \equiv \left(\dfrac{10+2}{2}, \dfrac{14+4}{2}\right) = (6,9)$

Also, O is mid point of S and Q.

$\therefore O \equiv \left(\dfrac{x+8}{2}, \dfrac{y+12}{2}\right)$

$\Rightarrow (6,9) = \left(\dfrac{x+8}{2}, \dfrac{y+12}{2}\right)$
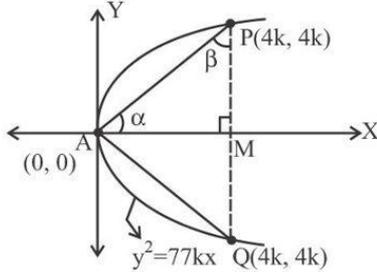
Comparing both sides, we have,

$\dfrac{x+8}{2} = 6 \Rightarrow x = 4$

and $\dfrac{y+12}{2} = 9 \Rightarrow y = 6$

Now, x + y = 4 + 6 = 10

59. (a) Given, $(x^2 - 4x + 3) + (y^2 - 6x + 8) = 0$

$\Rightarrow (x - 3)(x - 1) + (y - 4)(y - 2) = 0$

So, all the possible ends of the diameters of given circle are (3, 4), (3, 2), (1, 4) and (1, 4).

Also, Radius = $\sqrt{2}$ and center = (2, 3)

So, the required pair of ends of diameters are

(I) (1, 2) & (3, 4) and (II) (1, 4) and (3, 2).

60. (b)

Let $\angle PAM = \alpha$ and $\angle APM = \beta$

From figure, we have,

$\angle PAQ = \angle PAM + \angle QAM$

$= \alpha + \alpha = 2\alpha$

In right angled $\triangle AMP$,

$AM = PM = 4k \Rightarrow \alpha = \beta$

$\therefore \quad \alpha + \beta + 90 = 180 \Rightarrow 2\alpha = 90° \Rightarrow \alpha = 45°$
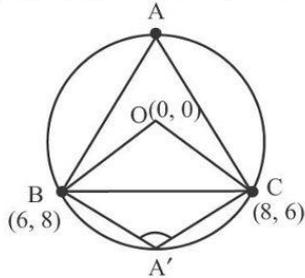
Hence, $\angle PAQ = 2\alpha = 90°$

Sol. 61 and 62

61. (c) Let O is centre of circle $x^2 + y^2 = 100$, radius = OB = OC = 10 units.

$BC = \sqrt{(6+8)^2 + (8-6)^2} = \sqrt{200} = 10\sqrt{2}$

$OB^2 + OC^2 = \sqrt{100 + 100} = \sqrt{200} = 10\sqrt{2}$

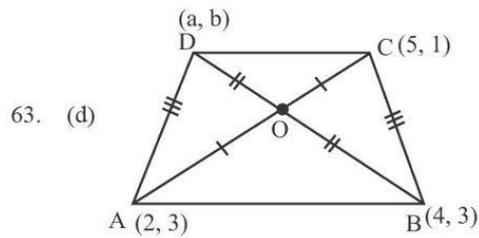In $\triangle BOC$, $OB^2 + OC^2 = BC^2 = \left(10\sqrt{2}\right)^2 = 200$

So $\angle BOC = 90°$ (By converse of Pythagoras theorem)

$\therefore \quad \angle BAC = 45°$ or $180° - 45° = \dfrac{3\pi}{4}$

(Angle subtended by a chord at centre is double than the angle at any point on circle)

Option (c) is correct.

62. (d) Since, the point A can be taken at any point on the circumference of circle which subtends $\dfrac{\pi}{4}$ to the chord so coordinates of A cannot be determined due to insufficient data.

63. (d)

We know,

In isosceles trapezium diagonal bisect each other. O is mid point of AC and BD.

$O \equiv \left(\dfrac{7}{2}, \dfrac{4}{2}\right) = \left(\dfrac{4+a}{2}, \dfrac{b+3}{2}\right)$

$a = 3, b = 1$ (equating x and y coordinates of O)

$D(a, b) \equiv (3, 1)$

64. (c) Since Diagonal of Isosceles trapezium bisect each other then let intersecting point of diagonal is O.

Coordinates of O is $\left(\dfrac{2+5}{2}, \dfrac{3+1}{2}\right)$ i.e $\left(\dfrac{7}{2}, 2\right)$

65. (b) Given sphere : $2x^2 + 2y^2 + 2z^2 + 3x + 3y + 3z - 6 = 0$ ...(i)

Divide equation (1) by (2)

$\Rightarrow x^2 + y^2 + z^2 + \dfrac{3}{2}x + \dfrac{3}{2}y + \dfrac{3}{2}z - 3 = 0$

radius of sphere $= \sqrt{\left(\dfrac{3}{4}\right)^2 + \left(\dfrac{3}{4}\right)^2 + \left(\dfrac{3}{4}\right)^2 + 3} = \sqrt{\dfrac{27}{16} + 3} = \dfrac{\sqrt{75}}{4}$

radius $= \dfrac{5\sqrt{3}}{4}$

Diameter of sphere $= \dfrac{5\sqrt{3}}{2}$

66. (d) Centre of sphere is $C\left(\dfrac{-3}{4}, \dfrac{-3}{4}, \dfrac{-3}{4}\right)$

$4x + 8y + 8z + 15 = 0$ is the only plane which satisfy the centre of sphere $- 3 + - 6 - 6 + 15 = 0 \Rightarrow 0 = 0$

Option (d) is correct.

Sol. 67 and 68

2 planes are $x + y + z = 1$ and $2x + 3y - 4z = 8$.

67. (b) Let a, b, c are dr's is of lines of formed by intersection of planes then the lines is perpendicular to normal of both planes.

$a + b + c = 0$ ...(i)

and $2a + 3b - 4c = 0$ ...(ii)

$\dfrac{a}{-4-3} = \dfrac{b}{2+a} = \dfrac{c}{3-2} = \lambda$ (Solving (i) and (ii))

$a = -7\lambda, b = 6\lambda, c = \lambda$

Dr's or $< -7, 6, 1 >$.

68. (a) DC's of line : S are l, m, n

$1 = \dfrac{-7}{\sqrt{86}}, m = \dfrac{6}{\sqrt{86}}, n = \dfrac{1}{\sqrt{86}}$

$43(l^2 - m^2 - n^2) = 43\left(\dfrac{49}{86} - \dfrac{36}{86} - \dfrac{1}{86}\right) = 43 \times \dfrac{12}{86} = 6$

Sol. for 69 to 70

We have

L : $x + y + z + 4 = 0 = 2x - y - z - 8$ and

P : $x + 2y + 3z + 1 = 0$ is a plane.

69. (c) Let Dr's of line < a, b, c >

Since, line L obtained by intersection of planes $x + y + z + 4 = 0$ and $2x - y - z - 8 = 0$

So, $a + b + c = 0$ ...(i)

$2a - b - c = 0$ ...(ii)

(line is perpendicular to normal of both plane)

$\dfrac{a}{-1+1} = \dfrac{b}{2+1} = \dfrac{c}{-1-2} = \lambda$ (solving (i) and (ii))

$\Rightarrow a = 0, b = 3\lambda, c = -3\lambda$

Dr's of line is < 0, 3, –3 > or < 0, 1, –1 >

70. (d) To find point of intersection of L and P.

The point must satisfy both line L and P.

From option (d) (–4, –3, 3), will satisfy both line L and plane P.

So, option (d) is correct answer.

71. (a) We know,

$\{x\} + [x] = x \Rightarrow x - [x] = \{x\}$ (where $\{x\}$ is fractional port of x.)

$0 \le x - [x] < 1$ $(\because 0 \le \{x\} < L)$

$-1 < [x] - x \le 0$

$-1 < y < 0$

$\therefore$ $[y] = -1$

72. (a) Given, f(x) = 4x + 1, g(x) = kx + 2

fog(x) = 4(kx + 2) + 1 = 4kx + 9

go f(x) = k(4x + 1) + 2 = 4kx + k + 2

fog(x) = g of (x) $\Rightarrow$ g = k + 2 $\Rightarrow$ k = 7

73. (b) Given, f(x) = $\log_{10}(x^2 + 2x + 11)$

For minimum and maximum

f'(x) = 0

$\dfrac{2x + 2}{x^2 + 2x + 11} = 0$ (sin, $x^2 + 2x + 11 > 0$)

At, x = –1, we get minimum value of f(x)

f(–1) = $\log_{10} 10 = I$

74. (d) Given,

$\lim\limits_{x \to 3} \dfrac{|x-3|}{x-3}$

Finding LRL and RHL at x = 3

$\text{LHL} = \lim\limits_{x \to 3^-} \dfrac{|x-3|}{x-3} = \dfrac{-(x-3)}{x-3} = -1$

$\text{LHL} = \lim\limits_{x \to 3^+} \dfrac{|x-3|}{x-3} = \dfrac{(x-3)}{x-3} = +1$

LHL ≠ RHL, limit does not exist.

75. (b) We know

Maximum value of a cos x + b sin x is $\sqrt{a^2 + b^2}$

So Maximum value of a cos x + b sin x + c is $\sqrt{a^2 + b^2} + c$

76. (c) Given

$f(2x) = 4x^2 + 1 \Rightarrow f(x) = x^2 + 1$

$f(4x) = 16x^2 + 1$

$(f(2x))^2 = f(x) \times f(4x)$

$(4x^2 + 1)^2 = (x^2 + 1) \times (16x^2 + 1)$

(f(2x) is GM of f(x) & f(4x))

$16x^4 + 1 + 8x^2 = 16x^2 + 16 x^2 + 1 + x^2$

$\Rightarrow 9x^2 = 0$

x = 0

$\therefore$ One real value of x is possible.

77. (d) We are given.

$f(x) = [x]^2 - 30[x] + 221 = 0$

$[x] = \dfrac{30 \pm \sqrt{900 - 884}}{2} = \dfrac{30 \pm 4}{2}$

[x] = 17 or 13.

Integral value of x and 17 and 13.

$\therefore$ Sum of integral solution of f(x) = 30.

78. (b) Given, f(x) = $9x - 8\sqrt{x}$, g(x) = $9x - 8\sqrt{x} - 1$

Lets take x = t^2,

$g(t^2) = 9t^2 - 8t - 1$

$t = \dfrac{8 \pm 10}{18} \Rightarrow t = \dfrac{18}{18}$ or $\dfrac{-1}{9}$

t = 1 or $\dfrac{-1}{9}$

$\Rightarrow$ x = 1, $\dfrac{1}{81}$

$\therefore$ g(x) = 0 has only one real root which is an integer.

79. (b) $\lim\limits_{\theta \to \frac{\pi}{2}} (\sec\theta - \tan\theta)$

$\lim\limits_{\theta \to \frac{\pi}{2}} (\sec\theta - \tan\theta) = \lim\limits_{\theta \to \frac{\pi}{2}} \dfrac{1 - \sin\theta}{\cos\theta} \left(\dfrac{0}{0}\text{ form}\right)$

$\lim\limits_{\theta \to \frac{\pi}{2}} \left(\dfrac{-\cos\theta}{-\sin\theta}\right) = 0$ (Using L Hospital Rule)

80. (a) Given f(x) = f(y)

Let f(x) = x^n and f(y) = y^n.

$f(xy) = (x y)^n$

$f(2) = 4 \Rightarrow 4 = (2)^n \Rightarrow n = 2$

$f(xy) = (xy)^2$

$f\left(\dfrac{1}{2}\right) = \left(\dfrac{1}{2}\right)^2 = \dfrac{1}{4}$

Sol. for 81 and 82

81. (c) Given $fog(x) = \cos^2\sqrt{x}$, go $f(x) = |\cos x|$
    If we take option (c)
    $f(x) = \cos^2 x$, then $g(x) = \sqrt{x}$
    $fog(x) = \cos^2\sqrt{x}$ and $gof(x) = \sqrt{\cos^2 x} = |\cos x|$
    $\therefore$ $f(x) = \cos^2 x$
    so option (c) is correct.

82. (a) If $f(x) = \cos^2 x$ then $g(x) = \sqrt{x}$,
    so that $fog(x) = \cos^2\sqrt{x}$

Sol. for Q.83 and Q.84

Given $f(x) = [x]^2 - [x^2]$

83. (b) According to the question
    $f(0.999) = [0.999]^2 - [(0.999)^2]$
    $= 0 - $ [value lies b/w 0 and 1]
    $f(0.999) = 0 - 0 = 0$ ...(i)
    $f(1.001) = [1.001]^2 - [(1.o001)^2] = 1 - 1 = $ ...(ii)
    Adding (i) and (ii)
    $f(0.999) + f(1.001) = 0 - 0 = 0$

84. (b) Given,
    $f(x) = [x]^2 - [x^2]$
    Let us check continuity of $f(x)$ at $x = 0$
    $LHL = \lim\limits_{x\to 0^-} = [0-h]^2 - [(0-h)^2] = (-1)^2 - 0 = 1$
    $RHL = \lim\limits_{x\to 1^+} = [0+h]^2 - [(0+h)^2] = 0 - 0 = 0$
    $LHL \neq RHL$, so $f(x)$ is not continous at $x = 0$
    Let us check continuity of $f(x)$ at $x = 1$
    $LHL = \lim\limits_{x\to 1^-} = [1-h]^2 - [(1-h)^2] = 0 - 0 = 0$
    $RHL = \lim\limits_{x\to 1^+} = [1+h]^2 - [(1+h)^2] = 1 - 1 = 0$
    $f(x)$ is continuous at $x = 1$ or $LHL = RHL$
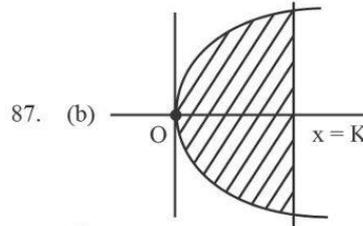
Sol. for 85 to 86

$f(x) = \cos 2x + x$ on $\left[-\dfrac{\pi}{2}, \dfrac{\pi}{2}\right]$

85. (b) $f'(x) = -2\sin 2x + 1$
    for maxima & minima $f'(x) = 0$
    $\sin 2x = \dfrac{1}{2}$
    $x = \dfrac{\pi}{12}$ or $\dfrac{5\pi}{12}$ (Not in interval) of $\left[\dfrac{-\pi}{2}, \dfrac{\pi}{2}\right]$
    So, maximum value of $f(x)$ occurs at $x = \dfrac{\pi}{12}$ ie
    $f\left(\dfrac{\pi}{12}\right) = \cos\dfrac{\pi}{6} + \dfrac{\pi}{12} = \dfrac{\sqrt{3}}{2} + \dfrac{\pi}{12}$

86. (a) Find the value of $f(x)$ at boundary of interval i.e at
    $x = \dfrac{-\pi}{2}$ and $x = \dfrac{\pi}{2}$

$f\left(\dfrac{-\pi}{2}\right) = -1 + \dfrac{-\pi}{2}$

$f\left(\dfrac{\pi}{2}\right) = -1 + \dfrac{\pi}{2}$

So, minimum value of $f(x)^2 = -\left(1 + \dfrac{\pi}{2}\right)$

Sol. for 87 and 88

87. (b)

Given,
Area bounded $= \dfrac{4}{3}$ squar

$0 = 2\int_0^k y\, dx$

$\dfrac{4}{3} = 2\int_0^k \sqrt{k}\sqrt{x}dx \Rightarrow \dfrac{4}{3} = 2\sqrt{k}\dfrac{2}{3}(k)^{\frac{3}{2}} \Rightarrow 1 = k^2$

$\Rightarrow$ $k = \pm 1$ (since $k > 0$)
$\Rightarrow$ $k = 1$

88. (a) So equation of parabola is $y^2 = x$ ($k = 1$)
    $4a = 1$, $a = \dfrac{1}{4}$
    Area of parabola $y^2 = x$ and latus rectum at $x = \dfrac{1}{4}$ is
    $= 2\int_0^{\frac{1}{4}} \sqrt{x}dx = 2 \times \dfrac{2}{3}\left(\dfrac{1}{4}\right)^{\frac{3}{2}} = \dfrac{4}{3} \times \dfrac{1}{8} = \dfrac{1}{6}$ sq. units

Sol. for 89 and 90

89. (a) Given differential equation is
    $ydx + \left(x - y^3\right)dy = 0 \Rightarrow \dfrac{dy}{dx} = \dfrac{y}{y^3 - x}$
    Order = 1, degree = 1

90. (d) Given differential equation is
    $y\dfrac{dx}{dy} + x = y^3 \Rightarrow \dfrac{dx}{dy} + x\dfrac{1}{y} = y^2$
    (Linear differential equation of form $\dfrac{dx}{dy} + px = \theta$)
    $If = e^{\int \frac{1}{y}dy} = y$
    $x\,(I.F) = \int (If)\, y^2\, dy \Rightarrow xy = \int y^3 dy \Rightarrow 4xy - y^4 + c$

91. (d) Given $f(x) = |x^2 - x - 2|$
    $\begin{cases} x^2 - x - 2; x \in (-\infty, -1] \cup [2, \infty) \\ -\left(x^2 - x - 2\right); x \in [-1, 2] \end{cases}$

Let $I = \int_0^2 f(x) = -\int_0^2 \left(x^2 - x - 2\right)dx = -\left[\dfrac{x^3}{3} - \dfrac{x^2}{2} - 2x\right]_0^2$

$= -\left(\dfrac{8}{3} - \dfrac{4}{2} - 4\right) + 0$

$= -\left(\dfrac{8-18}{3}\right) = \dfrac{10}{3}$

92. **(b)** $f(x) = |x^2 - x - 2|$

$= \begin{cases} x^2 - x - 2; x \in (-\infty, -1] \cup [2, \infty) \\ -\left(x^2 - x - 2\right); x \in [-1, 2] \end{cases}$

Let $I = \int_1^3 f(x)\,dn = -\int_1^2 \left(x^2 - x - 2\right)dx + \int_2^3 \left(x^2 - x - 2\right)dx$

$= -\left[\dfrac{x^3}{3} - \dfrac{x^2}{2} - 2x\right]_1^2 + \left[\dfrac{x^3}{3} - \dfrac{x^2}{2} - 2x\right]_2^3$

$= -\left[\dfrac{8}{3} - \dfrac{4}{2} - 4\right] + \left[\dfrac{1}{3} - \dfrac{1}{2} - 2\right] + \left[\dfrac{27}{3} - \dfrac{9}{2} - 6\right] - \left[\dfrac{8}{3} - \dfrac{4}{2} - 4\right]$

$= \dfrac{20}{6} - \dfrac{13}{6} - \dfrac{9}{6} + \dfrac{20}{6} = \dfrac{18}{6} = 3$

Sol. For 93 and 94

let $f(t) = \ln\left(t + \sqrt{1 + t^2}\right)$

Put $t = -t$ in $f(t)$

$f(-t) = \ln\left(\sqrt{1 + t^2} - t\right) = \ln\left(\dfrac{1}{t + \sqrt{1 + t^2}}\right)$

$= -\ln\left(t + \sqrt{1 + t^2}\right) = -f(t)$

$\Rightarrow f(-t) = -f(t)$

$\therefore$ f(t) is odd function and $g(l) = \tan f(t)$

Put $t = -t$ in $g(t)$

$\therefore g(-t) = \tan(f(-t)) = \tan(-f(t))$

[$\because$ f(t) is odd function]

$= -\tan(f(t)) = -g(t)$

So, g(t) is odd function.

93. **(c)** Both statements I and II are correct.

94. **(b)** we know that g(t) is odd function then $\int_{-\pi}^{\pi} g(t)\,dt = 0$

Sol. for 95 and 96

Let $f: (-1, 1) \to R$ be a differentiable function with $f(0) = -1$ and $f'(0) = 1$

95. **(d)** $h(x) = f(2f(n) + 2)$

Differentiate both side w.r.t x

$h'(x) = f'(2f(x) + 2)\, 2f'(x)$

$h'(0) = f'(2f(0) + 2) \cdot 2\, f'(0) = f'(-2 + 2) \cdot 2(1)$

$= f'(0) \cdot 2 = (1).2 = 2$ [$\because$ f(0) = -1 and f'(0) = 1]

96. **(a)** $g(n) = (h(x))^2$

Differentiate both side w.r.t x

$g'(x) = 2(h(x)) \cdot h'(x)$

$g'(0) = 2(h(0)) \cdot h'(0)$

[$\because h'(0) = 2$]

[$\because f'(0) = -1$]

$= 2f(2 + 10) + 2) \cdot 2$

$= 2f(2(-1) + 2) = 2\, f(0) \cdot 2 = (-2) \cdot 2 = -4.$

97. **(c)** Given that $g(x) = \sin x + \cos x + 1$

$\int_0^{\frac{\pi}{2}} \dfrac{dx}{g(x)} = \int_0^{\frac{\pi}{2}} \dfrac{1}{\sin x + \cos x + 1}dx$

$= \int_0^{\frac{\pi}{2}} \dfrac{1}{\dfrac{2\tan\frac{\pi}{2}}{1 + \tan^2\frac{\pi}{2}} + \dfrac{1 - \tan^2\frac{\pi}{2}}{1 + \tan^2\frac{\pi}{2}} + 1} dx$

$= \int_0^{\frac{\pi}{2}} \dfrac{1 + \tan^2\frac{x}{2}}{2\tan\frac{x}{2} + 1 - \tan^2\frac{x}{2} + 1 + \tan^2\frac{x}{2}} dx$

$= \int_0^{\frac{\pi}{2}} \dfrac{\sec^2\frac{x}{2}}{2\left(1 + \tan\frac{x}{2}\right)} dx$

let $1 + \tan\dfrac{x}{2} = t \Rightarrow \dfrac{1}{2}\sec^2\dfrac{x}{2}dx = dt$

when $x = \pi/2$ then $t = 2$, and when $x = 0$ then $t = 1$

$= \int_1^2 \dfrac{1}{t}dt = [\ln t]_1^2 = \ln 2 - \ln 1 = \ln 2$

98. **(c)** Given that $f(x) = \sin x$ and $g(x) \sin x + \cos x + 1$

Let $I = \int_0^{\frac{\pi}{2}} \dfrac{f(x)}{g(x)}dx = \int_0^{\frac{\pi}{2}} \dfrac{\sin x}{\sin x + \cos x + 1}dx$ ......(i)

$I = \int_0^{\frac{\pi}{2}} \dfrac{\sin\left(\frac{\pi}{2} - x\right)}{\sin\left(\frac{\pi}{2} - x\right) + \cos\left(\frac{\pi}{2} - x\right) + 1}dx$

$I = \int_0^{\frac{\pi}{2}} \dfrac{\cos x}{\cos x + \sin x + 1}dx$ ....(ii)

Adding equation (i) and (ii), we get

$2I = \int_0^{\frac{\pi}{2}} \dfrac{\sin x + \cos x}{\sin x + \cos x + 1}dx$

$= \int_0^{\frac{\pi}{2}} \left(1 - \dfrac{1}{\sin x + \cos x + 1}\right)dx$

$= \int_0^{\frac{\pi}{2}} 1\,dn - \int_0^{\frac{\pi}{2}} \dfrac{1}{\sin x + \cos x + 1}dx$

from solution of previous question

$2I = \int_0^{\frac{\pi}{2}} 1\,dx - \ln 2 = \dfrac{\pi}{2} - \ln 2$

$\therefore I = \dfrac{\pi}{4} - \dfrac{\ln 2}{2}$

Sol. for 99 and 100

$$I = 2\int \frac{x^2-1}{\sqrt{x^2+1}}\,dx = 2\int\left(\frac{x^2+1}{\sqrt{x^2+1}} - \frac{2}{\sqrt{x^2+1}}\right)dx$$

$$= 2\int\left(\sqrt{x^2+1} - \frac{2}{\sqrt{x^2+1}}\right)dx$$

$$= 2\left[\frac{x}{2}\sqrt{x^2+1} + \frac{1}{2}\ln\left(x+\sqrt{x^2+1}\right) - 2\ln\left(x+\sqrt{x^2+1}\right)\right] + c$$

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

$$= x\sqrt{x^2+1} - 3\ln\left(x+\sqrt{x^2+1}\right) + c$$

$$= U(x).\,V(x) - 3\ln\{U(x) + V(x)\} + c$$

$\therefore$ $U(x) = x$ and $V(x) = \sqrt{x^2+1}$

99. (b) Now, $|U^2(x) - V^2(x)|$
$= |x^2 - (x^2+1)| = |x^2 - x^2 - 1| = |-1| = 1$

100. (d) $\therefore U(x).V(x) = x\sqrt{x^2+1} = \sqrt{x^4+x^2} = \sqrt{x^2+x^4}$

101. (d) Line of regression of x on y
$x - 3y + 4 = 0$
$\Rightarrow x = 3y - 4$
$\Rightarrow b_{xy} = 3$
Line of regression of y on x
$2x - 7y + 8 = 0 \Rightarrow y = \frac{2}{7}x + \frac{8}{7}$

$\Rightarrow b_{yx} = \frac{2}{7}$

$\therefore b_{xy} + 7b_{yx} = 3 = 7 \cdot \frac{2}{7} = 3 + 2 = 5$

102. (b) Mean $= \dfrac{1 + 4 + 9 + \ldots\ldots + n^2}{n}$

$130 = \dfrac{n(n+1)(2n+1)}{6n}$

$\Rightarrow 780n = n(n+1)(2n+1)$
$\Rightarrow 780 = 2n^2 + 3n + 1$
$\Rightarrow 2n^2 + 3n - 779 = 0$
$\Rightarrow (2n + 41)(n - 19) = 0$

$\Rightarrow x = -\dfrac{41}{2}, 19$

$\Rightarrow n = 19$ ($\because n = -\dfrac{41}{2}$ not possible)

103. (c) Three distinct natural numbers are chosen from 1 to 10.
$n(s) = 10c_3$
Favourable outcomes = (1, 2, 3), (2, 3, 4), (3, 4, 5), (4, 5, 6), (5, 6, 7), (6, 7, 8), (7, 8, 9), (8, 9, 10)
$n(E) = 8$

$\therefore P(E) = \dfrac{n(E)}{n(S)} = \dfrac{8}{10_3} = \dfrac{8 \times 7! \times 3!}{10!} = \dfrac{8 \times 3 \times 2 \times 1}{10 \times 9 \times 8} = \dfrac{1}{15}$

104. (c) Given that A, B, C are mutually exclusive and exhaustive events
$\therefore P(A) + P(B) + P(C) = 1$ ...(i)

Given $3P(B) = 4P(A) \Rightarrow P(A) = \dfrac{3}{4}P(B)$ ...(ii)

and $3P(C) = 2P(B) \Rightarrow P(C) = \dfrac{2}{3}P(B)$ ...(iii)

Put (ii) and (iii) in (i), we get

$\dfrac{3}{4}P(B) + P(B) + \dfrac{2}{3}P(B) = 1$

$\Rightarrow \dfrac{9P(B) + 12P(B) + 8P(B)}{12} = 1$

$\Rightarrow \dfrac{29P(B)}{12} = 1 \Rightarrow P(B) = \dfrac{12}{29}$

Put the value of P(B) in (ii), we get

$P(A) = \dfrac{3}{4}P(B) = \dfrac{3}{4} \times \dfrac{12}{29} = \dfrac{9}{29}$

105. (c) Number on faces on die are 4, 4, 5, 5, 5, 6
$\therefore n(s) = 6$

P(getting 4 or 5) $= \dfrac{5}{6}$

106. (a)

> 2B, 4y
> 6w

To get all 3 balls of same colour, ball drawn must be either yellow or white with replacement.
Required probability

$= \dfrac{2}{12} \times \dfrac{2}{12} \times \dfrac{2}{12} + \dfrac{4}{12} \times \dfrac{4}{12} \times \dfrac{4}{12} + \dfrac{6}{12} \times \dfrac{6}{12} \times \dfrac{6}{12}$

$= \dfrac{8}{1728} + \dfrac{64}{1728} + \dfrac{216}{1728} = \dfrac{288}{1728} = \dfrac{1}{6}$

107. (a) Here A, B and C are independent events
$P(A) = \dfrac{5}{6}, P(B) = \dfrac{4}{5}, P(C) = \dfrac{3}{4}$

and $P(\bar{B}) = 1 - P(B) = 1 - \dfrac{4}{5} = \dfrac{1}{5}$

$\therefore P(A \cap \bar{B} \cap C) = P(A).P(\bar{B}).P(C) = \dfrac{5}{6} \times \dfrac{1}{5} \times \dfrac{3}{4} = \dfrac{1}{8}$

108. (a) Vowels = 0, 0, 0 and consonant = Z L G Y
Number of words form from letters of word ZOOLOGY
$= \dfrac{7!}{3!}$

$\therefore$ Number of words in which consonants and vowels occur alternatively $n(E)$
$= Z * L * G * Y = 4! \times 3!$

$\therefore P(E) = \dfrac{n(E)}{n(S)} = \dfrac{4! \times 3! \times 3!}{7!} = \dfrac{3 \times 2 \times 3 \times 2}{7 \times 6 \times 5} = \dfrac{6}{35}$

109. (b) First 100 natural numbers

$n(s) = 100$

Number from 7 to 100 satisfy

$x^2 + x > 50$

$\therefore \quad n(E) = 100 - 6 = 94$

$P(E) = \dfrac{n(E)}{n(S)} = \dfrac{94}{100} = \dfrac{47}{50}$

110. (b) Mean of 10 natural numbers

$\overline{x} = \dfrac{1 + 2 + 3 + \ldots + 10}{10} = \dfrac{10 \times 11}{2 \times 10} = 5.5$

Mean deviation $\dfrac{|1 - 5.5| + |2 - 5.5| + |3 - 5.5| + \ldots + |10 - 5.5|}{10}$

$= \dfrac{4.5 + 3.5 + 2.5 + 1.5 + 0.5 + 0.5 + 1.5 + 2.5 + 3.5 + 4.5}{10}$

$\dfrac{25}{10} = 2.5$

111. (b) Given that $\displaystyle\sum_{i=1}^{9} x_1^2 = 855$

We know that variance $(6^2) = \dfrac{\displaystyle\sum_{i=1}^{9} x_1^2 - (\text{Mean})^2}{N}$

$\Rightarrow \quad 6^2 = \dfrac{855}{9} - M^2$

$\Rightarrow \quad 6^2 + M^2 = \dfrac{855}{9} = 95$

112. (d) Given that, $\overline{x} = \dfrac{x_1 + x_2 + x_3 + \ldots + x_n}{n}$

$\Rightarrow \quad x_1 + x_2 + x_3 + \ldots + x_n = n\,\overline{x}$

Mean when x_n is replaced by k.

New mean $= \dfrac{x_1 + x_2 + x_3 \ldots + x_{n-1} + k}{n}$

$= \dfrac{x_1 + x_2 + x_3 + \ldots x_{n-1} + x_n - x_n + k}{n}$

$= \dfrac{n\overline{x} - x_n + k}{n}$

113. (b) $\because$ Fair coin is tossed till two heads occur in succession.

$\therefore$ P(the number of tosses required in less than 6)

$= P(HH) + P(THH) + P(TTHH) + P(TTTHH)$

$= \left(\dfrac{1}{2}\right)^2 + \left(\dfrac{1}{2}\right)^3 + \left(\dfrac{1}{2}\right)^4 + \left(\dfrac{1}{2}\right)^5$

$= \dfrac{\left(\dfrac{1}{2}\right)^2 \left[1 - \left(\dfrac{1}{2}\right)^4\right]}{1 - \dfrac{1}{2}} = \dfrac{\dfrac{1}{4}\left(1 - \dfrac{1}{16}\right)}{\dfrac{1}{2}} = \dfrac{1}{2}\left(\dfrac{15}{16}\right) = \dfrac{15}{32}$

114. (b) From the given information

White = 2		White = 3
Black = 2		Black = 2
A		B

E_1 = One white ball transferred from A to B then urn A contains White = 1, Black = 2 and urn B contains White = 4, Black = 2

E_2 = One Black ball transferred from A to B then urn A contains White = 2, Black = 1 and urn B contains White = 3, Black = 3

F = One white ball is drawn from urn B.

$\therefore \quad P(F) = P(E_1) \cdot P(F/E_1) + P(E_2) \cdot P(F/E_2)$

$= \dfrac{2}{4} \times \dfrac{4}{6} + \dfrac{2}{4} \times \dfrac{3}{6} = \dfrac{8}{24} + \dfrac{6}{24} = \dfrac{14}{24} = \dfrac{7}{12}$

115. (d)

116. (d) $n(s) = 6 \times 6 = 36$

Sum of the numbers on the faces 9 = (3, 6), (4, 5), (5, 4), (6, 3)

Sum of the numbers on the faces 10 : (4, 6), (5, 5), (6, 4)

P (sum 9 or 10) $= \dfrac{7}{36}$

$\therefore \quad$ P (sum is neither 9 nor 10) $= 1 - \dfrac{7}{36} = \dfrac{29}{36}$

117. (a) Here, n = 6

$p = P(\text{Suffering from disease}) = \dfrac{20}{100} = \dfrac{1}{9}$

$q = P(\text{Not suffering from disease}) = 1 - \dfrac{1}{5} = \dfrac{4}{5}$

$P(x \geq 4) = P(x = 4) + P(x = 5) + P(x = 6)$

$= {}^6 c_4 \left(\dfrac{1}{5}\right)^4 \left(\dfrac{4}{5}\right)^2 + {}^6 c_5 \left(\dfrac{1}{5}\right)^5 \left(\dfrac{4}{5}\right)^1 + {}^6 c_6 \left(\dfrac{1}{5}\right)^6$

$= \dfrac{6!}{4!2!} \times \dfrac{16}{5^6} + \dfrac{6!}{5!} \times \dfrac{4}{5^6} + \dfrac{1}{5^6}$

$= \dfrac{1}{(5)^6}\left[15 \times 16 + 6 \times 4 + 1\right]$

$= \dfrac{240 + 24 + 1}{15625} = \dfrac{26.5}{15625} = \dfrac{53}{3125}$

118. (d) When three dice rolled and no two show same faces

$n(s) = 6 \times 5 \times 4$

$n(E) = n(\text{one of the faces shown is an one}) = 3 \,(1 \times 5 \times 4)$

$= 3 \times 5 \times 4$

$P(E) = \dfrac{3 \times 5 \times 4}{6 \times 5 \times 4} = \dfrac{1}{2}$

119. (a) Let x, y, z are represent the numbers on three dice possible outcomes such that $n < y < z$

= (1, 2, 3) (1, 2, 4), (1, 2, 5), (1, 2, 6), (1, 3, 4), (1, 3, 5) (1, 3, 6), (1, 4, 5), (1, 4, 6), (1, 5, 6), (2, 3, 4), (2, 3, 5), (2, 3, 6), (2, 4, 5), (2, 4, 6), (2, 5, 6), (3, 4, 5), (3, 4, 6), (3, 5, 6), (4, 5, 6)

$\therefore \quad$ Total possible outcomes = 20

120. (d) Given that, mean $\bar{x} = np = 6$ ....(i)

and $S.D = \sqrt{npq} = \sqrt{2} \Rightarrow npq = 2$ ...(ii)

Divide (ii) by (i), we get

$$\frac{npq}{np} = \frac{2}{6} \Rightarrow q = \frac{1}{3}$$

We know that $p = 1 - q = 1 - \frac{1}{3} = \frac{2}{3}$

$\therefore \quad P = \frac{2}{3}$

Put the value of p in (i), we get

$n \times \frac{2}{3} = 6$

$n = 9$

GENERAL ABILITY

PART- A: ENGLISH

1. (d) The word, 'fallible' refers to making mistakes. On the other hand, the antonym of fallible is 'perfect' meaning that no errors or mistakes are made. The remaining words, frail, erring and mortal are synonyms of fallible.

2. (c) The word, 'vague' means not clear or definite. On the other hand, 'precise' means clear and accurate. From the remaining words, obscure is a synonym. Identical and imperceptible are not related in meaning to vague.

3. (b) The word, 'conscientiously' means in a careful way that involves a lot of effort. On the other hand, 'carelessly' refers to without taking or showing enough care and attention.

4. (a) The word, 'incidental' means happening as part of something more important. On the other hand, 'essential' refers to something completely necessary.

5. (a) The word, 'disdainful' refers to act mean and superior. On the other hand, its antonym, 'reverential' means full of respect and admiration.

6. (a) From the given options, independent will complete the sentence meaningfully and contextually. The complete sentence will be- "Most of our food comes from agriculture, so we tend to believe that it is independent of natural biota."

7. (b) From the given options, both will complete the sentence meaningfully and contextually. The complete sentence will be- "In nature, both plants and animals…" Since plants and animals are two entities and together they are part of nature.

8. (d) From the given options, 'are continuously subjected' will complete the sentence meaningfully and contextually. The complete sentence will be- "…are continuously subjected to the rigours of natural selection." Since the paragraph is in present continuous tense, hence option (d) will fit appropriately.

9. (d) From the given options, 'since' will begin the sentence meaningfully in order to end it well. The complete sentence will be- "Since wild populations have numerous traits for competitiveness, resistance to parasites,…" This implies a causal relationship.

10. (b) From the given options, 'tolerance' will fit in the blank appropriately in order to make the sentence grammatically and contextually correct. The complete sentence will be- "…tolerance to adverse conditions,…" This conveys that wild populations can withstand challenging environments.

11. (a) From the given options, 'and' will fit in the blank appropriately in order to make the sentence grammatically and contextually correct. The complete sentence will be- "…conditions, and other aspects of vigour."

12. (d) The complete sentence will be: "In contrast, populations grown for many **generations** under the pampered conditions of agriculture tend to lose their traits,…" This emphasizes the long-term effects of agricultural practices on these populations.

13. (c) The complete sentence will be: "…because they are selected for production, not resilience." The sentence is in present continuous tense, hence 'are selected' will appropriately complete the sentence.

14. (c) The complete sentence from the options given will be: "For example, a high producing plant that lacks resistance to drought is…"

15. (b) The complete sentence will be: "…irrigated and the resistance to drought is ignored. Also, in the process of breeding plants for maximum production, all genetic variation is eliminated." This suggests that the plant's drought resistance is overlooked because it is being watered artificially.

16. (a) The complete sentence will be: "Preeti suggests that I ask your advice." The sentence is in present continuous tense.

17. (c) The complete sentence will be: "We saw the oldest monument in the city." The sentence is in perfect past tense.

18. (a) The complete sentence will be: "Since you have been touring all day, you must be tired." The sentence is in past continuous tense.

19. (c) The complete sentence will be: "His condition is serious, but it could be worse." The sentence is in present perfect tense.

20. (b) The complete sentence will be: "I hope the bus comes soon because we have been waiting for half an hour." The sentence is in present continuous tense.

21. (a) The complete sentence will be: "Someone has spilt juice on the sofa." The sentence is in present continuous tense.

22. (a) The complete sentence will be: "What would you do if you found your lost toy?" The sentence is in past tense.

23. (b) The complete sentence will be: "If I were you, I wouldn't buy that dress." The sentence is in future tense.

24. (a) The complete sentence will be: "I wish I could help you." The sentence uses two different tense forms: it is more accurate to say that it is expressing a present wish using a past tense form.

25. (d) The complete sentence will be: "The efforts of the security services have not been quite upto the mark." The sentence is in present perfect tense.

26. (d) The idiom, 'white lie' is a lie that is not very harmful or serious, especially one that you tell because the truth would hurt somebody.

    For e.g., A young woman's little white lie leads to unforeseen complications.

27. (a) The idiom, 'bad blood' refers to feelings of hate between people because of arguments in the past.

    For e.g., There has been bad blood between the two families for years.

28. (c) The idiom, 'count your blessings' means to make a special effort to appreciate the good things in one's life.

    For e.g., I try to remember to count my blessings every day.

29. (b) The idiom, 'have the last laugh' means that you become successful at something so that people who criticize or oppose you look foolish.

    For e.g., But by keeping calm and carrying on, it is possible to have the last laugh, according to an expert.

30. (c) The idiom, 'sit on the fence' describes a person's lack of decisiveness to choose between two sides in an argument or a competition, or inability to decide due to lack of courage.

    For e.g., You can't sit on the fence any longer - you have to decide whose side you're on.

31. (b) The logical arrangement of the parts of this complete sentence will begin with R, followed by P, S and Q. The complete sentence will be: "The Right to Education Act (RTE) mandates good quality elementary education conforming to the standards and norms specified in the Act as a fundamental right of all children."

32. (a) The logical arrangement of the parts of this complete sentence will begin with Q, followed by R, S and P. The complete sentence will be: "Music not only relieves the burden on children and the young, but also alleviates the conflicts and disputes in their mind."

33. (a) The logical arrangement of the parts of this complete sentence will begin with Q, followed by R, P and S. The complete sentence will be: "Antarctica is a continent nearly twice as large as Australia, but it is virtually covered by a dome-shaped ice sheet nearly 2 miles thick."

34. (d) The logical arrangement of the parts of this complete sentence will begin with S, followed by R, Q and P. The complete sentence will be: "The G20 was formed in 1999 as a forum of Finance Ministers; in recognition of the fact that there was a major shift in the global economic weight from the advanced economies; and Central Bank Governors."

35. (a) The logical arrangement of the parts of this complete sentence will begin with S, followed by R, P and Q. The complete sentence will be: "India is the third largest fish producing and the second largest aquaculture nation in the world and India's products are exported to many nations."

36. (a) The word, 'adder' is the name of a small venomous Eurasian snake. Hence, it will be a **proper noun**.

37. (d) In the sentence: "She spoke to him once since he has been in town," the word 'since' is a **preposition**. It introduces a time frame that connects her speaking to him with the duration of his time in town.

38. (b) In the sentence: "I don't really want to go. Besides, it's too late now," the word "now" functions as an **adverb**. It indicates the present time, emphasizing that the situation has changed to the point where going is no longer feasible.

39. (c) In the sentence: "Look at that man over there," "that" is used as a **determiner**. It helps specify which man is being referred to.

40. (a) In the sentence: "The plane is ready for take-off," the word "take-off" is a **noun**. It refers to the action of the plane leaving the ground.

41. (a) From the passage, it can be inferred that an unwelcome form of globalization is the **globalization of disease**. According to Laurie Garrett, there is a resurgence of familiar diseases like tuberculosis, cholera, and pneumonia as a consequence of the widespread and unwise use of antibiotics.

42. (d) The **globalization of health** has become important because people are still being treated with antibodies. Selecting the strains that are immune to the antibodies, they pass on their resistant genes to unrelated bacteria by way of plasmid transfer.

43. (d) **Resurgent diseases** were created due to medical practice. When treating people with antibiotics, the medical practitioners unknowingly select strains that are immune to antibiotics and they pass on their resistant genes to unrelated bacteria by way of plasmid transfer.

44. (a) From the passage, it can be stated that 'many new diseases are clearly linked to changes in land use, which brings **humans into close contact** with rodents or other animals that harbor viruses previously unknown to medicine and often deadly to humans.

45. (b) In the passage, it mentions men and women are the heroes that serve mankind on the frontlines of **epidemiology**. It is important to train workers in order to prevent the spread of diseases as well as control them.

46. (c) The word, 'warned' is synonymous to cautioned, meaning to warn somebody not to do something.

47. (a) The word, 'dull' is synonymous to monotonous, meaning never changing and therefore boring.

48. (b) The word, 'baffling' is synonymous to elusive, meaning not easy to catch, find or remember.

49. (a) The word, 'huge' is synonymous to mammoth, meaning something very big.

50. (b) The word, 'tainted' is synonymous to tarnished, meaning to spoil something or give it an unpleasant quality.

PART- B: GENERAL KNOWLEDGE

51. (b) Lysosomes are organelles that contain hydrolytic enzymes that breakdown biological polymers, such as proteins, nucleic acids, carbohydrates, lipids, not inorganic materials.

52. (c) Mitochondria and plastids have their own DNA or genetic material and are known as semi-autonomous organelles.

53. (b) A ligament is the fibrous connective tissue that connect two bones together, especially at joints.

54. (b) Cells get energy from a variety of sources in the form of ATP.

55. (a) Vegetative propagation through eye buds is a type of asexual reproduction that occurs in plants like potatoes and Bryophyllum.

56. (c) Diffusion is the process of inter mixing two or more substance due to the motion of their particles in order to get a uniform mixture.

57. (c) Centrifugation is the primary technique used in diagnostic laboratories to separate blood components for testing.

58. (b) Sulphur is a polyatomic element. A polyatomic element is one that exists as a group of more than two atoms. Sulphur exists in nature as $S6$ and S_8.

59. (a) Nitride is an ion of Nitrogen. The configuration on of N will be $1s^2\, 2s^2\, 2p^3$. Nitride ion is formed when N-atom complete its octet by gaining three electrons, the ion is represented as N^{3-}. The oxidation state of nitride ion is -3 as well as its valency is -3.

60. (b) Atomic mass of Nitrogen = 14 g

Molar mass of N_2 = 28 g

Number of moles $(n) = \dfrac{\text{Given mass}}{\text{Molar mass}}$

$0.5\ \text{mol} = \dfrac{\text{Given mass}}{28\ \text{g mol}^{-1}}$

Given mass = $0.5 \times 28 = 14$ g

61. (b) The chemical reaction

$2AgCl(s) \longrightarrow 2Ag(s) + Cl_2(g)$

is called photochemical decomposition reaction. In this reaction silver chloride is exposed in the presence of sunlight, it decomposes into silver and chlorine gas (Cl_2).

62. (d) Polyhydroxy phenols are used in paint as anti-skinning agents. They prevent the formation of a skin or crust on the surface of the paint when exposed to air.
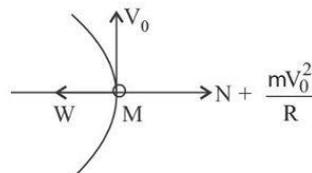
63. (c) The equivalent circuit diagram is
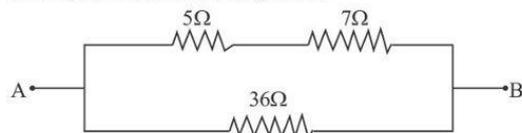
The equivalent resistance between points A and B is

$R_{AB} = (5 + 7)\ \|\ (36) = \dfrac{12 \times 36}{12 + 36} = 9\Omega$

64. (c)

65. (b) For astronaut : : orbiting around the earth

$W = N + \dfrac{mV_0^2}{R}$

$\Rightarrow 600 = N + \dfrac{m}{R}\left(\sqrt{\dfrac{G.M.}{R}}\right)^2$

$\Rightarrow 600 = N + m\left(\dfrac{GM}{R^2}\right) = N + mg = N + 600$

$\therefore\ N = 0 \Rightarrow$ This condition is called weight lessness

66. (d) There are following characteristics of contact forces:
   (i) It comes into picture when one body is in contact with another body.
   (ii) It is action - reaction pair. So, it satisfies Newton's third law of motion.
   (iii) It can appear between two bodies in contact like solid with solid, solid with liquid, liquid with liquid.

67. (d) (i) When a ray of light passing through f of a converse lens, then it becomes parallel to principal axis after refraction.
   (ii) When a ray of light passes through 2f of one side of a converse lens, then it also passes through 2f on the other side of the lens after refraction.

68. (d) Lightening is caused by electrostatic induction. In this process, there is an induction of positive charge on the ground just below the negative charge at the base of the cloud.

69. (d) The brightness of the bulb is given

$$\text{Brightness} \propto \text{Power} \propto \frac{V^2}{R}$$

As, $R_{parallel} < R_{indivisual} < R_{series}$

$\Rightarrow (\text{Brightness})_{parallel} (\text{Brightness})_{indivisual} >$
$(\text{Brightness})_{series}$

70. (d) When a skydriver jumps, then he first accelerated and after sometime it acquires terminal speed. At terminal speed, the sky driver opens parachute and again acquires second terminal speed after sometime followed by deceleration and finally reaches the ground. The speed-time graph of the skydriver during his jump is given below
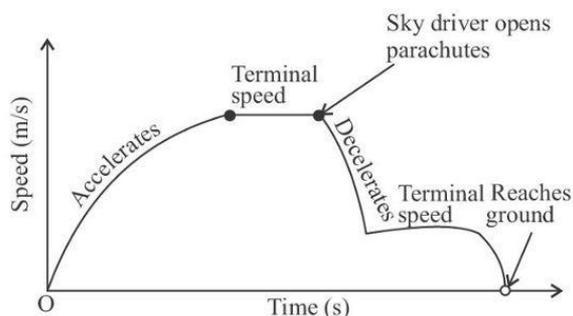
71. (c) A second class lever is a lever where the load is present between the fulcrum and the effort.

72. (b) For the given circuit,

$V = I_iR = 3 \times 100 = 300V$

Also, $I = I_1 + I_2 + I_3$

$= \dfrac{V}{R_1} + \dfrac{V}{R_2} + \dfrac{V}{R_3}$

$= \dfrac{300}{100} + \dfrac{300}{200} + \dfrac{300}{300} = 5.5A$

73. (c) Taxila was the capital of the ancient Mahajanapada known as **Gandhara**. This region was significant in ancient Indian history and was located in what is now parts of Pakistan and Afghanistan. Taxila itself was a renowned center of learning and trade in ancient times.

74. (b) Rajagopalachari was the last Governor-general of India from 1948 to 1950. An Indian statesman and activist, he became the only Indian and last Governor-general after India gained Independence.

75. (c) The Planning Commission of India focused on:
   1. **Balanced Economic Growth**: Reducing regional disparities and ensuring development for all.
   2. **Efficient Resource Allocation**: Optimizing resource use by prioritizing key sectors.
   3. **Employment Generation**: Promoting labor-intensive industries and job creation.

   4. **Poverty Alleviation**: Implementing targeted programs for inclusive growth and poverty reduction.
   5. **Infrastructure Development**: Developing roads, railways, and other critical infrastructure.

76. (b) The First Plan focused heavily on agriculture, and the Ninth Plan also prioritized agriculture to address rural development.
   - The First Plan was based on the Harrod-Domar Model, while the second Plan focused on self-reliance and heavy industries.
   - The Seventh Plan (1985-1990) focused on improving food, work (employment generation), and productivity.
   - The Ninth Plan aimed at increasing public investment in various sectors, especially agriculture and rural development.

77. (d) Plans Proposed before five years plan in India
   - **Bombay Plan** (1944-45) was proposed by industrialists;
   - **People's Plan** (1945) by M.N. Roy;
   - **Sarvodaya Plan** (1950) by Jaiprakash Narayan;
   - **Gandhian Plan** (1944) by S.N. Agarwal .

78. (c)

79. (b) • The climate of the Andaman and Nicobar Islands is indeed humid and tropical coastal,
   - The maximum rainfall in the Andaman and Nicobar Islands generally occurs during the southwest monsoon, which spans from May to September, not between March and April.
   - The Andaman and Nicobar Islands are separated by the 10 Degree Channel, which is 150 km wide.
   - The islands are inhabited by indigenous tribes, including the Negrito tribes, such as the Onge, Jarwa, and Great Andamanese.

80. (a)

81. (d) The landlocked seas around the world are Aral Sea, Caspian Sea, Dead Sea, Great Salt Lake, Salton Sea and Sea of Galilee. Landlocked seas may are also considered lakes as the definition of a lake is "a large body of freshwater surrounded by land". A land locked sea would be one with no access to the rest of the world's oceans.

82. (a) The Benguela Current is a cold ocean current that flows along the west coast of southern Africa in the South Atlantic Ocean. It's a branch of the South Atlantic Drift that flows northward, almost to the equator, before merging with the Atlantic South Equatorial Current.

83. (b) Playa are the Shallow, circular lakes formed by deposition in the middle of desert basins, filled with rainwater and transforming into lakes. Saline playas may be known by various names such as salt flats, salt marshes, salars, salt pans, alkali flats, or salinas.

84. (c) Vitamin D deficiency can lead to an array of problems, most notably rickets in children and osteoporosis in adults. It can lead to a loss of bone density.

85. (c) A balanced diet consists of six main nutrient groups : proteins, carbohydrates, lipids, vitamins, minerals and water.

86. (c) Bronchioles do not have cartilage, unlike large bronchi, which have C-shaped cartilaginous rings.

87. (d) The glomerulus is the network of capillaries in the Bowman's capsule. It filters blood, separating waste and water from proteins and blood cells, which remain in the glomerulus.

88. (c) Sponger belong to the phylum Porifera which means "pore-bearer" in latin.

89. (b) When a point object is placed at the centre of curvature of a spherical concave mirror, then the image formed is real, inverted and the same size of the object located at the centre of curvature also.

90. (a) A myopic eye can see near objects clearly. On the other hand, it cannot see distant object clearly.

91. (a) The velocity-time graph of moving vehicle is
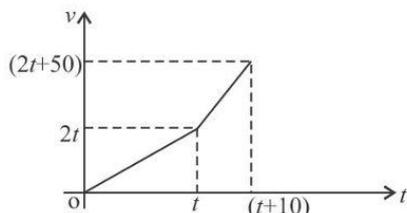
The distance travelled is given by

S = Area of $V - t$ graph

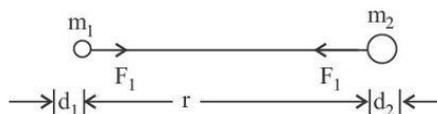$$\Rightarrow 550 = \frac{1}{2} \times t \times 2t + \frac{1}{2}(2t + 2t + 50) \times 10$$

$$\Rightarrow t^2 + 20t - 300 = 0$$

$$\Rightarrow (t - 10)(t + 30) = 0$$

$$\therefore t = 10_s$$

92. (c) For pumpkin,

W = mg = 7·5N $\Rightarrow$ m = 0.75 kg

$$V = \frac{3}{4}L = \frac{3}{4} \times 10^{-3} m^3$$

$$\therefore \text{Density, } \rho = \frac{m}{V} = \frac{0.75}{\frac{3}{4} \times 10^{-3}} = 1000 \text{ kg/m}^3$$

93. (d) For in candescent electric bulb,

$$P = 20\% \text{ of } I^2R = \frac{20}{100} \times 2 \times 2 \times 200 = 160W$$

$\Rightarrow$ Energy consumed, E = P.t

$$= \frac{160 \times 10 \times 3600}{3600 \times 1000} \text{ kWh}$$

= 1.6 kWh

$\therefore$ Amount of money spent = 1.6 × 5 = ₹ 8

94. (c) Heat transfer takes place due to temperature difference.

95. (c) For two planets.

The forces exerted on each other are

$$F_1 = F_2 = \frac{Cm_1m_2}{\left(\frac{d_1}{2} + r + \frac{d_2}{2}\right)}$$

$$\therefore F_1 : F_2 = 1 : 1$$

96. (d) For the moving car,

m = 1000 kg,

$$u = 72 \text{ km/h} = 72 \times \frac{5}{18} = 20 \text{ m/s}$$

The deceleration of the car is

$$a = \frac{u}{t} = \frac{20}{0.2} = 100 \text{ m/s}^2$$

$\therefore$ Retarding force,

F = ma = 1000 × 100 = 100 kN

97. (a)

98. (c) The displacement in east direction is

$$S_1 = \frac{1}{2}a_1t_1^2 = \frac{1}{2} \times 2 \times 10 \times 10 = 100 \text{ m}$$

The displacement in south direction is

$$S_2 = \frac{1}{2}a_2t_2^2 = \frac{1}{2} \times 4\sqrt{2} \times 10 \times 10 = 200\sqrt{2} \text{ m}$$

$\therefore$ The net displacement,

$$S = \sqrt{S_1^2 + S_2^2} = \sqrt{(100)^2 + (200\sqrt{2})^2} = 300 \text{ m}$$

99. (c)

• Thomas Savery did not invent the astrolabe; he is credited with inventing the first practical steam pump.

• Thomas Newcomen did not invent chemical dyes; he improved upon Savery's steam engine by creating the atmospheric engine.

• James Watt's invention converted the steam engine from being a mere pump into one that could provide energy to power machines in factories.

• Mathew Boulton did not discover the technique of refining gold; he was an entrepreneur and partner of James Watt, helping to commercialize the steam engine.

100. (d) The first cotton mill was established near Kolkata in 1818 at first Gloster but was a failure and was closed. Thus, the first successful cotton mill was established in Bombay by Cowasjee Nanabhai Davar and his associates on 7th July 1854 at Tardeo.

101. (a) • Mahatma Gandhi was a strong advocate for the linguistic reorganization of India, believing that language was a basis for identity. He said that India could only cohere as a free nation if it accepted moral government. He also believed that people should not be provincial, but instead think of themselves as Indians.

- The Constituent Assembly of India did not recommend linguistic reorganization to be included in the Constitution. However, the government did establish commissions to study the issue. In 1948, the Constituent Assembly appointed a commission headed by Justice S.K. Dhar. This commission ultimately rejected the idea of reorganizing states based on language.

102. (c) • A close disciple of Mahatma Gandhi C.Rajagopalachari, he led the march as a prolongation of the Dandi March to protest against the Salt tax imposed by the British on Indians.

- A group of 150 volunteers, mostly members of the Indian National Congress accompanied him from Trichinopoly to Vedaranyam in Tamil Nadu. They collected the salt directly from the sea as a part of the protest.

103. (d) Vinoba Bhave received his first donation of land for his Bhoodan Movement in Pochampally, Telangana on April 18, 1951. The donation came from Vedire Ramachandra Reddy, a local landlord who gave 100 acres of his land to Bhave.

104. (b) The exact date and route of maize's introduction to India remain a mystery, though some suggest it was brought by the Portuguese in the 16th century. Initially cultivated in the western regions of the country, maize is believed to have come from Spain and Africa. Over time, it has become the third-largest food crop in India, contributing 9% to the nation's food basket.

105. (c)
	Pass	Range
1.	Zoji La	Great Himalayas
2.	Banihal Pass	Pir Panjal Range
3.	Photu La	Zaskar Range
4.	Khardung La	Ladhak Range

106. (d) Black Cotton Soil

- Black soil is also known as "Regur Soil" or the "Black Cotton Soil".
- It covers about 15% of the total land area of the country.
- The colour of these soils varies from deep black to grey.
- The black soils are generally clayey, deep and impermeable. They swell greatly and become sticky when wet in the rainy season. In the dry season, the moisture evaporates; the soil shrinks and develops wide cracks.

- Black soils are rich in iron, lime, aluminium, magnesium and also contain potassium. However, these soils are deficient in nitrogen, phosphorus and organic matter.
- Cotton, pulses, millets, castor, tobacco, sugarcane, citrus fruits, linseed, etc. are mainly cultivated in black soil.

107. (a)
List I (Hydroelectric Power Plant)	List II (State)
A. Doyang	4. Nagaland
B. Gomuti	3. Tripura
C. Kapili	2. Assam
D. Ranganadi	1. Arunachal Pradesh

108. (a)
List I (Tropical Cyclone)	List II (Country)
A. Hurricanes	4. USA
B. Willy Willy	3. Australia
C. Baguio	2. Philippines
D. Typhoons	1. China

109 (a) Satluj River is the longest of the five tributaries of the Indus River.

- Satluj River is also known as "Satadree".
- Satluj River rises on the north slope of the Himalayas in Lake Rakshastal in southwestern Tibet at an elevation above 15,000 feet (4,600 metres).
- The Sutlej River is primarily located to the north of the Vindhya Range, east of the Pakistani Central Makran Range and south of the Hindu Kush region.
- Satluj is the example of Antecedent River.
- The Chenab is the largest tributary of the Indus. It is formed by two streams, the Chandra and the Bhaga, which join at Tandi near Keylong in Himachal Pradesh.

110. (d) Granite can form as an igneous rock through the cooling and solidification of magma or lava. However, it can also undergo metamorphism under certain conditions, resulting in a rock known as metamorphic granite or meta-granite.

111. (b) Amphiboles are primarily found in metamorphic and igneous rocks. They occur in many metamorphic rocks, especially those derived from mafic igneous rocks (which contain dark-colored ferromagnesian minerals) and siliceous dolomites. Amphiboles are also important constituents of various plutonic and volcanic igneous rocks, ranging in composition from granitic to gabbroic. They form approximately 20% of the Earth's crust.

112. (d) Chemical weathering is the process in which rocks and minearals break down due to chemical reaction with water gases. Thawing is a type of physical weathering not chemical weathering.

113. (a) The general formula for the maximum number of electron in a shell is $2n^2$, where n is the principal quantum number.

For the first shell of an atom $n = 1$

$2n^2 = 2 \times (1)^2 = 2$

114. (b) Liquid water show maximum density at 277 K because the water molecules are closest togther at this temperature. So, decrease in volume and increase in the density will be observed.

115. (c) Nitrogen atom needs to gain 3 electron in its outermost orbit to complete octet. So, nitrogen has, valency of 3.

116. (c) When iron is exposed to oxygen and water, it combines with oxygen forms a compound called iron oxide or rust. This process is an oxidation reaction.

117. (d) Urea is a source of nitrogen act as fertilizer. Urea has high nitrogen content around 46%.

118. (d) The valency of Al is 3.

119. (c) The element composition of a diamond is 100% carbon or pure carbon.

120. (d) Mixing of NaOH and HCl is an example of chemical change were a neutralization reaction occur, forming water and a salt.

121. (c) The equivalent focal length of combination of lens is

$P_e = P_1 + P_2 = 2.5 - 2.0 = 0.5$ D

∴ Focal length,

$$f_e = \frac{1}{P_e} = \frac{1}{0.5} = 2m$$

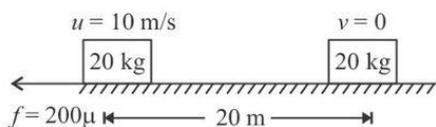122. (d) For domestic AC supply, frequency, $f = 50$ Hz

∴ Time period, $T = \dfrac{1}{f} = \dfrac{1}{50}s$

∴ The time after which AC changes its direction is

$t = \dfrac{T}{2} = \dfrac{1}{100}s$

123. (d) The motion of the block on the rough surface is

Applying work – energy theorem

$F_{friction} = \Delta K$

$$\Rightarrow -(200\mu)(20) = 0 - \frac{1}{2} \times 20 \times 10 \times 10$$

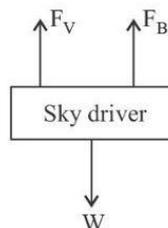$$\therefore \mu = \frac{1}{4}$$

∴ Frictional force,

$$f = 200\mu = 200 \times \frac{1}{4} = 50N$$

124. (b) Newton's law of cooling is a physical law which describes the rate of heat loss of an object to its surrounding without the phase change of object.

125. (c) During jump of sky driver, the forces acting on him are given by

∴ P = Weight = W

$Q = F_V + F_B$

When parachute opens,

P = constant, F_V increases ⇒ Q increases.

126. (c) Vijayanagara (1336-1647) AD

- In 1336, Vijayanagar kingdom was established by Harihara and Bukka, who were two brothers and served in the army of Muhammad-bin-Tughlaq. They broke away from the Delhi Sultanate and established an independent state in Karnataka and established the capital city Vijayanagar on the banks of river Tungabhadra in 1336.

- Harihara and Bukka were helped and inspired by contemporary scholar and a saint Vidyaranya for the establishment of their kingdom.

- The Vijayanagara rulers claimed to rule on behalf of Shri Virupaksha. The rulers considered themselves to be divine representatives on earth and saw a close relationship between their rule and the religious beliefs of the empire.

127. (a) Domingo Paes was a Portuguese trader, writer, and explorer who visited India between 1520 and 1522 AD and provided the most complete account of the ancient city of Hampi under the reign of King Krishnadeva Raya of the Vijayanagara Empire above all previous historic accounts. He defined krishnadeva Raya as the prominent ruler of the Vijayanagara Empire, is often recognized for his stature and the physical characteristics noted by Paes, including the signs of smallpox on his face.

128. (b) The Tenth Schedule of the Indian Constitution deals with the anti-defection law, which includes provisions for disqualifying Members of Parliament (MPs) and Members of State Legislatures (MLAs) for defection. The 52nd Amendment Act of 1985 added the Tenth Schedule to the Constitution

129. (c) **Attorney General's Duties and Functions:**
- To provide legal advice to the Government of India (GoI) on matters referred to them by the President.
- To perform other legal duties as assigned by the President.
- To appear on behalf of the GoI in all cases before the Supreme Court or any High Court where the GoI is involved.
- To represent the GoI in references made by the President to the Supreme Court under Article 143 (Power of the President to consult the Supreme Court) of the Constitution.
- To discharge functions conferred upon them by the Constitution or any other law.

Solicitor General:
- Unlike the Attorney General, the Solicitor General's duties and functions are not specified in the Constitution of India.
- The Solicitor General is the second-highest law officer of India, assisting the Attorney General in their responsibilities.
- As per the Conditions of Service Rules, the Solicitor General, along with other Law Officers, is appointed for a term of 3 years, with the possibility of re-appointment.

130. (c) Estimates Committee.
- The Estimates Committee has 30 members and all these members are from Lok Sabha (Lower House).
- There is no representation from Rajya Sabha (Upper House).
- It is constituted for the purpose of scrutinizing the functioning of Government Ministries and departments in terms of allocation of Funds.
- All the recommendations made by the committee are advisory in nature and stand non- binding for the Parliament.

131. (c) **Power of Rajya Sabha in relation to Money Bills**
- The Rajya Sabha has limited powers with regard to money bills and can only make recommendations and cannot reject or amend the bill.
- The Rajya Sabha must return the bill to the Lok Sabha within 14 days, with or without recommendations. The Lok Sabha can accept or reject any recommendations made by the Rajya Sabha.
- If the Lok Sabha accepts any recommendations, the bill is deemed to have been passed by both Houses in the modified form.
- If the Lok Sabha does not accept any recommendations, the bill is deemed to have passed by both Houses in the form originally passed by the Lok Sabha without any change.
- If the Rajya Sabha does not return the bill to the Lok Sabha within 14 days, the bill is deemed to have been passed by both Houses in the form originally passed by the Lok Sabha.
- The Lok Sabha has more powers than the Rajya Sabha with regard to money bills.

132. (c) **Article 19(2)**
Nothing in sub-clause 19 (1)(a) shall affect the operation of any existing law, or prevent the State from making any law, in so far as such law imposes reasonable restrictions on the exercise of the right conferred by the said sub-clause in the interests of the sovereignty and integrity of India, the security of the State, friendly relations with Foreign States, public order, decency or morality or in relation to contempt of court, defamation or incitement to an offence.

133. (d) The Panchsheel principles are five guiding principles of mutual respect and peaceful coexistence between two countries:
1) Mutual respect for each other's territorial integrity and sovereignty;
2) Mutual non-aggression;
3) Mutual non-interference;
4) Equality and mutual benefit;
5) Peaceful co-existence.

134. (d) **Kanaklata Barua.**
1. She was a teenage freedom fighter from Assam who participated in the Indian Freedom Movement.
2. She was born on December 22, 1924, and died on September 20, 1942, at the age of 17.
3. She was also known as Birbala and given the title Shaheed (martyr).
4. Barua was an Indian independence activist and AISF leader.
5. During the Quit India Movement of 1942, she joined the Mrityu Bahini, a youth group from the Gohpur subdivision of Assam.
6. On September 20, 1942, she led a procession of unarmed villagers to hoist the national flag at the local police station and she was shot dead in the procession.

135. (c) The Coriolis force is created by the Earth spinning on its axis, and it affects the direction of the wind. This force changes based on how far you are from the equator. In the southern hemisphere, the wind is pushed to the left, while in the northern hemisphere, it is pushed to the right.
The Coriolis force is strongest at the poles and is absent at the equator. The Coriolis force is a force that deflects the movement of wind and atmosphere patterns due to the Earth's rotation.

136. (b) Since Manipur and Bihar is located outside the region between the Tropic of Cancer and the Tropic of Capricorn, it does not experience the sun being directly overhead at any time of the year. This is because the sun's rays fall perpendicularly only in areas between these two tropics. Therefore, sunlight will never strike Bihar at a 90-degree angle.

137. (b) Sabarmati, Mahi, Bharathapuzha, Periyar, kalinadi, Narmada, and Tapi are west flowing rivers while Mahanadi, Godavari, Krishna, Kaveri, Palar and Pennar are east flowing rivers. Generally, west flowing rivers empty into the Arabian Sea and east flowing rivers empty into the Bay of Bengal.

138. (b)

Tributary	River
Bhavani	Kaveri
Kabini	Kaveri
Manjra	Godavari
Bhima	Krishna

139. (c) **Laterite Soil**
- The name has been derived from the Latin word "later" which means brick.
- It accounts for about 3.7% of the total area of the country.
- These are typical soils of the monsoon climate which is characterised by seasonal rainfall. With rain, lime and silica are leached away, and soil rich in iron oxide and aluminium are left leading to the formation of laterite soil.
- Laterite soil is deficient in organic matter, nitrogen, phosphate and calcium, however, iron oxide and potash are in abundance.
- Laterite soils are found in Karnataka, Tamil Nadu, Kerala, Madhya Pradesh and hilly regions of Assam and Odisha.
- Red laterite soil in Kerala, Tamil Nadu and Andhra Pradesh are well suited for tree crop cultivation like cashew nuts.

140. (*) **Brahmaputra**
- The Brahmaputra, one of the world's greatest rivers, rises from the Kailash range's Chemayungdung glacier near Mansarovar Lake
- The Tsangpo, which means 'purifier,' then continues eastward longitudinally for almost 1,200 kilometres through southern Tibet's dry and flat region, known as the Tsangpo
- The Rango Tsangpo is the river's main right-bank tributary in Tibet
- The Central Himalayas at Namcha Barwa making sharp U turn emerges by cutting out a steep gorge (7,755 m)
- Brahmaputra enters into Bangladesh near Dhubri and flows southward.

141. (b) **National Service Scheme**
- It was launched during 1969, the birth centenary year of Mahatma Gandhi.
- It is a Central Sector Scheme of the Government of India.
- It provides an opportunity to the student youth of the 11th & 12th Class of schools at +2 Board level and student youth of Technical Institution, Graduate & Post Graduate at colleges and University level of India to take part in various Government led community service activities & programmes.
- Motto: The motto of National Service Scheme is NOT ME BUT YOU

142. (b)
- On the occasion of the Fit India Movement's first anniversary, PM Shri Narendra Modi said Fitness Ki Dose, Aadha Ghanta Roz.
- It means to devote half an hour daily to fitness.
- The event is celebrated on 29 August on the birth anniversary of Major Dhyan Chand.
- It is also known as National sports day. On this occasion honored the eminent athletes from various sports with the prestigious Khel Ratna, Dronacharya Awards, Arjuna Awards, and Dhyan Chand Award by President of India.

143. (a)
- Kozhikode is the first city in India to receive the prestigious title of 'City of Literature' by UNESCO.
- Gwalior is the second city in India to be designated as the 'City of Music' by UNESCO, after Varanasi in 2015.
- The United Nations Educational, Scientific and Cultural Organization (UNESCO), during its 18th session of the Intergovernmental Committee in Botswana, officially added Gujarat's iconic Garba dance to its esteemed Representative List of Intangible Cultural Heritage(ICH) of Humanity.

144. (b) The Indian Mission to ASEAN in collaboration with Ministry of Agriculture and Farmers' Welfare is organizing the ASEAN-India Millet Festival 2023, in Indonesia from 22nd November to 26th November 2023.

145. (d)
- The first Indian Military Heritage Festival was inaugurated in October 2023, with the event taking place on October 21-22 at the Manekshaw Centre in New Delhi, and was inaugurated by Defence Minister Rajnath Singh.
- The launch of the first set of two fuel cell buses from India Gate on September 25, 2023, marks a significant milestone in this endeavour.
- Cyril Ramaphosa was the chair of the 15th BRICS summit, which was held in Johannesburg, South Africa from August 22–24, 2023.
- The Viksit Bharat Sankalp Yatra was flagged off by Prime Minister Narendra Modi on November 15, 2023 from Khunti, Jharkhand with multiple Information, Education and Communication (IEC) vans launched simultaneously from various locations across the country.

146. (c) **ULLAS**
- The Understanding Lifelong Learning for All in Society (ULLAS) is a centrally sponsored scheme implemented from 2022-2027.

- The scheme aligns with the recommendations of the National Education Policy (NEP) 2020.
- It aims to empower those adults aged 15 years and above from all backgrounds who could not get due schooling and mainstream them with society to be able to contribute more to the growth story of the country.
- The scheme consists of five components
  - Foundational Literacy and Numeracy,
  - Critical Life Skills,
  - Basic Education,
  - Vocational Skills, and
  - Continuing Education.
- The ULLAS app can be used for registration of learners and volunteers either through self-registration or by surveyors.
- It will serve as a digital gateway for learners to engage in diverse learning resources through the DIKSHA portal of NCERT.

147. (a) NATO was founded on April 4, 1949, with the signing of the North Atlantic Treaty.
- It enforces collective defense, where members agree to mutual defense against external attacks.
- Headquarters are in Brussels, Belgium, under the Supreme Allied Commander.
- the North Atlantic Treaty Organization (NATO) derives its authority from Article 51 of the United Nations Charter

- NATO was created to protect Western Europe's security amid rising Cold War tensions between the U.S. and the Soviet Union.
- The U.S. viewed the Soviet Union's spread of communism as a threat, leading to NATO's formation.
- Currently, NATO has 31 members, with Finland joining in 2023.

148. (a)

149. (d) Yudhabhyas: This is an annual joint military exercise conducted between the Indian and US armies.
- Vajra Prahar: This is also a joint special forces exercise between India and the United States.
- Malabar: This is a multilateral naval exercise involving India, the United States, and other nations (such as Japan and Australia in recent years).
- Varuna: This is actually a joint naval exercise conducted between India and France, not the USA.

150. (d) • According to the World Bank's Logistics Performance Index Report 2023, India ranks 38th out of 139 countries.
- The 3rd Global Maritime India Summit 2023 held from 17th to 19th October at MMRDA Grounds, BKC, Mumbai.
- The Maritime Amrit Kaal Vision 2047 was launched at the Global Maritime India Summit (GMIS) 2023 in Mumbai. The summit was inaugurated by the Prime Minister of India.