NDA/NA SOLVED PAPER 2022-II

MATHEMATICS

1. How many four-digit natural numbers are there such that all of the digits are odd?
   (a) 625 (b) 400
   (c) 196 (d) 120

2. What is $\sum_{r=0}^{n} 2^r C(n,r)$ equal to?
   (a) 2^n (b) 3^n
   (c) 2^{2n} (d) 3^{2n}

3. If different permutations of the letters of the word 'MATHEMATICS' are listed as in a dictionary, how many words (with or without meaning) are there in the list before the first word that starts with C ?
   (a) 302400 (b) 403600
   (c) 907200 (d) 1814400

4. Consider the following statements :
   1. If f is the subset of $Z \times Z$ defined by $f = \{(xy, x-y); x, y \in Z\}$, then f is a function from Z to Z.
   2. If f is the subset of $N \times N$ defined by $f = \{(xy, x+y); x, y \in N\}$, then f is a function from N to N.

   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

5. Consider the determinant
$$\Delta = \begin{vmatrix} a_{11} & a_{12} & a_{13} \\ a_{21} & a_{22} & a_{23} \\ a_{31} & a_{32} & a_{33} \end{vmatrix}$$
   If $a_{13} = yz$, $a_{23} = zx$, $a_{33} = xy$ and the minors of a_{13}, a_{23}, a_{33} are respectively $(z-y)$, $(z-x)$, $(y-x)$ then what is the value of Δ ?
   (a) $(z-y)(z-x)(y-x)$
   (b) $(x-y)(y-z)(x-z)$
   (c) $(x-y)(z-x)(y-z)(x+y+z)$
   (d) $(xy+yz+zx)(x+y+z)$

6. If $A = \begin{pmatrix} 1 & 0 & 0 \\ 0 & \cos\theta & \sin\theta \\ 0 & \sin\theta & -\cos\theta \end{pmatrix}$, then which of the following are correct ?
   1. $A + adj\ A$ is a null matrix
   2. $A^{-1} + adj\ A$ is a null matrix
   3. $A - A^{-1}$ is a null matrix

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

7. If X is a matrix of order 3×3, Y is a matrix of order 2×3 and Z is a matrix of order 3×2, then which of the following are correct ?
   1. $(ZY)\ X$ is a square matrix having 9 entries.
   2. $Y\ (XZ)$ is a square matrix having 4 entries.
   3. $X\ (YZ)$ is not defined.

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

8. For how many quadratic equations, the sum of roots is equal to the product of roots?
   (a) 0 (b) 1
   (c) 2 (d) Infinitely many

9. Consider the following statements :
   1. The set of all irrational numbers between $\sqrt{2}$ and $\sqrt{5}$ is an infinite set.
   2. The set of all odd integers less than 100 is a finite set.

   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

10. Consider the following statements :
    1. $2 + 4 + 6 + \ldots + 2n = n^2 + n$
    2. The expression $n^2 + n + 41$ always gives a prime number for every natural number n

    Which of the above statements is/are correct?
    (a) 1 only (b) 2 only
    (c) Both 1 and 2 (d) Neither 1 nor 2

11. Let p, q $(p > q)$ be the roots of the quadratic equation $x^2 + bx + c = 0$ where $c > 0$. If $p^2 + q^2 - 11pq = 0$, then what is $p - q$ equal to?
    (a) $3\sqrt{c}$ (b) $3c$
    (c) $9\sqrt{c}$ (d) $9c$

12. What is the diameter of a circle inscribed in a regular polygon of 12 sides, each of length 1 cm ?
    (a) $1 + \sqrt{2}$ cm (b) $2 + \sqrt{2}$ cm
    (c) $2 + \sqrt{3}$ cm (d) $3 + \sqrt{3}$ cm

13. Let $A = \{7, 8, 9, 10, 11, 12, 13, 14, 15, 16\}$ and let $f : A \to N$ be defined by $f(x)$ = the highest prime factor of x.
    How many elements are there in the range of f?
    (a) 4 (b) 5
    (c) 6 (d) 7

14. Let R be a relation from N to N defined by $R = \{(x, y) : x, y \in N \text{ and } x^2 = y^3\}$. Which of the following are ***not*** correct?
1. $(x, x) \in R$ for all $x \in N$
2. $(x, y) \in R \Rightarrow (y, x) \in R$
3. $(x, y) \in R$ and $(y, z) \in R \Rightarrow (x, z) \in R$

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

15. Consider the following :
1. $A \cap B = A \cap C \Rightarrow B = C$
2. $A \cup B = A \cup C \Rightarrow B = C$

Which of the above is/are correct ?
(a) 1 only (b) 2 only
(c) Both l and 2 (d) Neither 1 nor 2

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

Let $z = \dfrac{1 + i\sin\theta}{1 - i\sin\theta}$ where $i = \sqrt{-1}$

16. What is the modulus of z ?
(a) 1 (b) $\sqrt{2}$
(c) $1 + \sin^2\theta$ (d) $\dfrac{1 + \sin^2\theta}{1 - \sin^2\theta}$

17. What is angle θ such that z is purely real?
(a) $\dfrac{n\pi}{2}$ (b) $\dfrac{(2n+1)\pi}{2}$
(c) $n\pi$ (d) $2n\pi$ only
where n is an integer

18. What is angle θ such that z is purely imaginary ?
(a) $\dfrac{n\pi}{2}$ (b) $\dfrac{(2n+1)\pi}{2}$
(c) $n\pi$ (d) $2n\pi$
where n is an integer

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

Let P be the sum of first n positive terms of an increasing arithmetic progression A. Let Q be the sum of first n positive terms of another increasing arithmetic progression B.
Let $P : Q = (5n + 4) : (9n + 6)$

19. What is the ratio of the first term of A to that of B ?
(a) $\dfrac{1}{3}$ (b) $\dfrac{2}{5}$
(c) $\dfrac{3}{4}$ (d) $\dfrac{3}{5}$

20. What is the ratio of their 10th terms ?
(a) $\dfrac{11}{29}$ (b) $\dfrac{22}{49}$
(c) $\dfrac{33}{59}$ (d) $\dfrac{44}{69}$

21. If d is the common difference of A, and D is the common difference of B, then which one of the following is always correct?
(a) $D > d$ (b) $D < d$
(c) $7D > 12d$ (d) None of the above

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

Consider the binomial expansion of $(p + qx)^9$:

22. What is the value of q if the coefficients of x^3 and x^6 are equal ?
(a) p (b) $9p$
(c) $\dfrac{1}{p}$ (d) p^2

23. What is the ratio of the coefficients of middle terms in the expansion (when expanded in ascending powers of x)?
(a) pq (b) $\dfrac{p}{q}$
(c) $\dfrac{4p}{5q}$ (d) $\dfrac{1}{(pq)}$

24. Under what condition the coefficients of x^2 and x^4 are equal ?
(a) $p : q = 7 : 2$
(b) $p^2 : q = 7 : 2$
(c) $p : q = 2 : 7$
(d) $p^2 : q^2 = 2 : 7$

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

Consider the word 'QUESTION' :

25. How many 4-letter words each of two vowels and two consonants with or without meaning, can be formed ?
(a) 36 (b) 144
(c) 576 (d) 864

26. How many 8-letter words with or without meaning, can be formed such that consonants and vowels occupy alternate positions?
(a) 288 (b) 576
(c) 1152 (d) 2304

27. How many 8-letter words with or without meaning, can be formed so that all consonants are together ?
(a) 5760 (b) 2880
(c) 1440 (d) 720

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

Let Δ be the determinant of a matrix A,

where $A = \begin{pmatrix} a_{11} & a_{12} & a_{13} \\ a_{21} & a_{22} & a_{23} \\ a_{31} & a_{32} & a_{33} \end{pmatrix}$ and C_{11}, C_{12}, C_{13} be the cofactors of a_{11}, a_{12}, a_{13} respectively.

28. What is the value of $a_{11}C_{11} + a_{12}C_{12} + a_{13}C_{13}$?
(a) 0 (b) 1
(c) Δ (d) $-\Delta$

29. What is the value of $a_{21}C_{11} + a_{22}C_{12} + a_{23}C_{13}$?
(a) 0 (b) 1
(c) Δ (d) $-\Delta$

30. What is the value of $\begin{vmatrix} a_{21} & a_{31} & a_{11} \\ a_{23} & a_{33} & a_{13} \\ a_{22} & a_{32} & a_{12} \end{vmatrix}$?

(a) 0 (b) 1
(c) Δ (d) $-\Delta$

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

Let $f(x)$ be a function satisfying $f(x+y) = f(x)f(y)$ for all $x, y \in N$ such that $f(1) = 2$:

31. If $\sum_{x=2}^{n} f(x) = 2044$, then what is the value of n ?

(a) 8 (b) 9
(c) 10 (d) 11

32. What is $\sum_{x=1}^{5} f(2x-1)$ equal to ?

(a) 341 (b) 682
(c) 1023 (d) 1364

33. What is $\sum_{x=1}^{6} 2^x f(x)$ equal to?

(a) 1365 (b) 2730
(c) 4024 (d) 5460

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

A university awarded medals in basket ball, football and volleyball. Only x students ($x < 6$) got medal in all the three sports and the medals went to a total of $15x$ students. It awarded $5x$ medals in basketball, $(4x + 15)$ medals in football and $(x + 25)$ medals in volleyball.

34. How many received medals in exactly two of the three sports ?

(a) $30 - 4x$ (b) $35 - 7x$
(c) $40 - 7x$ (d) $45 - 5x$

35. How many received medals in at least two of three sports ?

(a) $30 - 6x$ (b) $35 - 6x$
(c) $40 - 5x$ (d) $40 - 6x$

36. How many received medals in exactly one of three sports ?

(a) $21x - 40$ (b) $21x - 35$
(c) $20x - 35$ (d) $20x - 25$

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

Let $A = \begin{pmatrix} 0 & \sin^2\theta & \cos^2\theta \\ \cos^2\theta & 0 & \sin^2\theta \\ \sin^2\theta & \cos^2\theta & 0 \end{pmatrix}$ and $A = P + Q$ where P is symmetric matrix and Q is skew-symmetric matrix.

37. What is P equal to?

(a) $\begin{pmatrix} 0 & 1/2 & 1/2 \\ 1/2 & 0 & 1/2 \\ 1/2 & 1/2 & 0 \end{pmatrix}$

(b) $\begin{pmatrix} 0 & 1 & 1 \\ 1 & 0 & 1 \\ 1 & 1 & 0 \end{pmatrix}$

(c) $\cos 2\theta \begin{pmatrix} 0 & -1 & 1 \\ 1 & 0 & -1 \\ -1 & 1 & 0 \end{pmatrix}$

(d) $\cos 2\theta \begin{pmatrix} 0 & -1/2 & 1/2 \\ 1/2 & 0 & -1/2 \\ -1/2 & 1/2 & 0 \end{pmatrix}$

38. What is Q equal to ?

(a) $\begin{pmatrix} 0 & 1/2 & 1/2 \\ 1/2 & 0 & 1/2 \\ 1/2 & 1/2 & 0 \end{pmatrix}$

(b) $\begin{pmatrix} 0 & 1 & 1 \\ 1 & 0 & 1 \\ 1 & 1 & 0 \end{pmatrix}$

(c) $\cos 2\theta \begin{pmatrix} 0 & -1 & 1 \\ 1 & 0 & -1 \\ -1 & 1 & 0 \end{pmatrix}$

(d) $\cos 2\theta \begin{pmatrix} 0 & -1/2 & 1/2 \\ 1/2 & 0 & -1/2 \\ -1/2 & 1/2 & 0 \end{pmatrix}$

39. What is the minimum value of determinant of A ?

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

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

ABC is a triangular plot with AB = 16 m, BC = 10 m and CA = 10 m. A lamp post is situated at the middle point of the side AB. The lamp post subtends an angle 45° at the vertex B.

40. What is the height of the lamp post ?

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

41. What is $\frac{AB}{\sin C}$ equal to?

(a) 17 m (b) $\frac{50}{3}$ m
(c) $\frac{40}{3}$ m (d) 16 m

42. What is $\cos A + \cos B + \cos C$ equal to ?

(a) 1 (b) $\frac{41}{25}$

(c) $\frac{37}{25}$ (d) $\frac{33}{25}$

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

There are two points P and Q due south of a leaning tower, which leans towards north. P is at a distance x and Q is at a distance y from the foot of the tower ($x > y$). The angles of elevation of the top of the tower from P and Q are 15° and 75° respectively.

43. At what height is the top of the tower above the ground level ?

(a) $\frac{x-y}{2\sqrt{3}}$ (b) $\frac{x-y}{4\sqrt{3}}$

(c) $\frac{x-y}{4}$ (d) $\frac{x-y}{2}$

44. If θ is the inclination of the tower to the horizontal, then what is cotθ equal to?

(a) $2+\frac{\sqrt{3}(x-y)}{x+y}$ (b) $2-\frac{\sqrt{3}(x-y)}{x+y}$

(c) $2+\frac{\sqrt{3}(x+y)}{x-y}$ (d) $2-\frac{\sqrt{3}(x+y)}{x-y}$

45. What is the length of the tower ?

(a) $\frac{x-y}{2\sqrt{3}}\sqrt{1+\left\{2+\frac{\sqrt{3}(x+y)}{x-y}\right\}^2}$

(b) $\frac{x-y}{2\sqrt{3}}\sqrt{1+\left\{2-\frac{\sqrt{3}(x+y)}{x-y}\right\}^2}$

(c) $\frac{x-y}{4\sqrt{3}}\sqrt{1+\left\{2+\frac{\sqrt{3}(x+y)}{x-y}\right\}^2}$

(d) $\frac{x-y}{4\sqrt{3}}\sqrt{1+\left\{2-\frac{\sqrt{3}(x+y)}{x-y}\right\}^2}$

46. What is the value of $\text{cosec}\left(-\frac{73\pi}{3}\right)$?

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

(c) 2 (d) -2

47. What is the value of

$$\cos\left(\frac{5\pi}{17}\right)+\cos\left(\frac{7\pi}{17}\right)+2\cos\left(\frac{11\pi}{17}\right)\cos\left(\frac{\pi}{17}\right)?$$

(a) 0 (b) 1

(c) $4\cos\left(\frac{6\pi}{17}\right)\cos\left(\frac{\pi}{17}\right)$ (d) $4\cos\left(\frac{11\pi}{17}\right)\cos\left(\frac{\pi}{17}\right)$

48. What is the value of $\tan\left(\frac{3\pi}{8}\right)$?

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

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

49. What is $\tan^{-1}\cot(\text{cosec}^{-1}2)$ equal to?

(a) $\frac{\pi}{8}$ (b) $\frac{\pi}{6}$

(c) $\frac{\pi}{4}$ (d) $\frac{\pi}{3}$

50. In a triangle ABC, $a=4$, $b=3$, $c=2$. What is $\cos 3C$ equal to?

(a) $\frac{7}{128}$ (b) $\frac{11}{128}$

(c) $\frac{7}{64}$ (d) $\frac{11}{64}$

51. What is $\cos 36° - \cos 72°$ equal to?

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

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

52. If $\sec x = \frac{25}{24}$ and x lies in the fourth quadrant, then what is the value of $\tan x + \sin x$?

(a) $-\frac{625}{168}$ (b) $-\frac{343}{600}$

(c) $\frac{625}{168}$ (d) $\frac{343}{600}$

53. What is the value of $\tan^2 165° + \cot^2 165°$?

(a) 7 (b) 14

(c) $4\sqrt{3}$ (d) $8\sqrt{3}$

54. What is the value of $\sin\left(2n\pi+\frac{5\pi}{6}\right)\sin\left(2n\pi-\frac{5\pi}{6}\right)$, where $n \in Z$?

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

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

55. If $1+2(\sin x+\cos x)(\sin x-\cos x)=0$ where $0<x<360°$, then how many values does x take?

(a) Only one value (b) Only two values

(c) Only three values (d) Four values

56. Consider the following statements in respect of the line passing through origin and inclining at an angle of 75° with the positive direction of x-axis :

1. The line passes through the point $\left(1,\frac{1}{2-\sqrt{3}}\right)$.
2. The line entirely lies in first and third quadrants.

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

57. If $P(3, 4)$ is the mid-point of a line segment between the axes, then what is the equation of the line ?
(a) $3x + 4y - 25 = 0$ (b) $4x + 3y - 24 = 0$
(c) $4x - 3y = 0$ (d) $3x - 4y + 7 = 0$

58. The base AB of an equilateral triangle ABC with side 8 cm lies along the y-axis such that the mid-point of AB is at the origin and B lies above the origin. What is the equation of line passing through (8, 0) and parallel to the side AC?
(a) $x - \sqrt{3}\,y - 8 = 0$ (b) $x + \sqrt{3}\,y - 8 = 0$
(c) $\sqrt{3}\,x + y - 8\sqrt{3} = 0$ (d) $\sqrt{3}\,x - y - 8\sqrt{3} = 0$

59. The centre of the circle passing through origin and making positive intercepts 4 and 6 on the coordinate axes, lies on the line
(a) $2x - y + 1 = 0$ (b) $3x - 2y - 1 = 0$
(c) $3x - 4y + 6 = 0$ (d) $2x + 3y - 26 = 0$

60. The centre of an ellipse is at (0, 0), major axis is on the y-axis. If the ellipse passes through (3, 2) and (1, 6), then what is its eccentricity ?
(a) $\frac{\sqrt{3}}{2}$ (b) $\sqrt{3}$
(c) $\frac{\sqrt{5}}{2}$ (d) $\sqrt{5}$

61. An equilateral triangle is inscribed in a parabola $x^2 = \sqrt{3}\,y$ where one vertex of the triangle is at the vertex of the parabola. If p is the length of side of the triangle and q is the length of the latus rectum, then which one of the following is correct ?
(a) $p = q$ (b) $p = \sqrt{3}\,q$
(c) $p = 2\sqrt{3}\,q$ (d) $2\sqrt{3}\,p = q$

62. Consider the points $A(2, 4, 6)$, $B(-2, -4, -2)$, $C(4, 6, 4)$ and $D(8, 14, 12)$. Which of the following statements is/are correct?
1. The points are the vertices of a rectangle $ABCD$.
2. The mid-point of AC is the same as that of BD.
Select the correct answer using the code given below :
(a) 1 only (b) 2 only
(c) Both 1 and 2 (d) Neither 1 nor 2

63. Consider the equation of a sphere $x^2 + y^2 + z^2 - 4x - 6y - 8z - 16 = 0$.
Which of the following statements is/are correct ?
1. z-axis is tangent to the sphere.
2. The centre of the sphere lies on the plane $x + y + z - 9 = 0$.
Select the correct answer using the code given below :
(a) 1 only (b) 2 only
(c) Both 1 and 2 (d) Neither 1 nor 21.

64. A plane cuts intercepts 2, 2, 1 on the coordinate axes. What are the direction cosines of the normal to the plane ?
(a) < 2/3, 2/3, 1/3 > (b) < 1/3, 2/3, 2/3 >
(c) $\langle \frac{1}{\sqrt{6}}, \frac{1}{\sqrt{6}}, \frac{2}{\sqrt{6}} \rangle$ (d) $\langle \frac{2}{\sqrt{6}}, \frac{1}{\sqrt{6}}, \frac{1}{\sqrt{6}} \rangle$

65. Consider the following statements :
1. The direction ratios of y-axis can be < 0, 4, 0 >
2. The direction ratios of a line perpendicular to z-axis can be < 5, 6, 0 >
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

66. $PQRS$ is a parallelogram. If $\overrightarrow{PR} = \vec{a}$ and $\overrightarrow{QS} = \vec{b}$, then what is $\overrightarrow{PQ}$ equal to?
(a) $\vec{a} + \vec{b}$ (b) $\vec{a} - \vec{b}$
(c) $\frac{\vec{a} + \vec{b}}{2}$ (d) $\frac{\vec{a} - \vec{b}}{2}$

67. Let $\vec{a}$ and $\vec{b}$ are two unit vectors such that $\vec{a} + 2\vec{b}$ and $5\vec{a} - 4\vec{b}$ are perpendicular. What is the angle between $\vec{a}$ and $\vec{b}$?
(a) $\frac{\pi}{6}$ (b) $\frac{\pi}{4}$
(c) $\frac{\pi}{3}$ (d) $\frac{\pi}{2}$

68. Let $\vec{a}$, $\vec{b}$ and $\vec{c}$ be unit vectors lying on the same plane. What is $\left\{\left(3\vec{a} + 2\vec{b}\right) \times \left(5\vec{a} - 4\vec{c}\right)\right\} . \left(\vec{b} + 2\vec{c}\right)$ equal to?
(a) -8 (b) -32
(c) 8 (d) 0

69. What are the values of x for which the angle between the vectors $2x^2\hat{i} + 3x\hat{j} + \hat{k}$ and $\hat{i} - 2\hat{j} + x^2\hat{k}$ is obtuse?
(a) $0 < x < 2$ (b) $x < 0$
(c) $x > 2$ (d) $0 \le x \le 2$

70. The position vectors of vertices A, B and C of triangle ABC are respectively $\hat{j} + \hat{k}, 3\hat{i} + \hat{j} + 5\hat{k}$ and $3\hat{j} + 3\hat{k}$. What is angle C equal to ?
(a) $\frac{\pi}{6}$ (b) $\frac{\pi}{4}$
(c) $\frac{\pi}{3}$ (d) $\frac{\pi}{2}$

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 $fog(x) = gof(x)$, then what is the value of k ?
(a) 7 (b) 5
(c) 4 (d) 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. What is $\int (x^x)^2(1 + lnx)dx$ equal to?

(a) $x^{2x} + c$ (b) $\frac{1}{2}x^{2x} + c$

(c) $2x^{2x} + c$ (d) $\frac{1}{2}x^x + c$

75. What is $\int e^x (1 + lnx + xlnx)dx$ equal to?

(a) $xe^x lnx + c$ (b) $x^2e^x lnx + c$

(c) $x + e^x lnx + c$ (d) $xe^x + lnx + c$

76. What is $\int \frac{(\cos x)^{1.5} - (\sin x)^{1.5}}{\sqrt{\sin x.\cos x}}dx$ equal to?

(a) $\sqrt{\sin x} - \sqrt{\cos x} + c$

(b) $\sqrt{\sin x} + \sqrt{\cos x} + c$

(c) $2\sqrt{\sin x} + 2\sqrt{\cos x} + c$

(d) $\frac{1}{2}\sqrt{\sin x} + \frac{1}{2}\sqrt{\cos x} + c$

77. If $y = \frac{x\sqrt{x^2 - 16}}{2} - 8\ln\left|x + \sqrt{x^2 - 16}\right|$, then what is $\frac{dy}{dx}$ equal to?

(a) $x\sqrt{x^2 - 16}$ (b) $x - \sqrt{x^2 - 16}$

(c) $\sqrt{x^2 - 16}$ (d) $4\sqrt{x^2 - 16}$

78. If $y = (x^x)^x$ then which one of the following is correct ?

(a) $\frac{dy}{dx} + xy(1 + 2lnx) = 0$

(b) $\frac{dy}{dx} - xy(1 + 2lnx) = 0$

(c) $\frac{dy}{dx} - 2xy(1 + 2lnx) = 0$

(d) $\frac{dy}{dx} - 2xy(1 + 2lnx) = 0$

79. What is the maximum value of $3(\sin x - \cos x) + 4(\cos^3 x - \sin^3 x)$?

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

(c) $\sqrt{3}$ (d) 2

80. What is the area of the region (in the first quadrant) bounded by $y = \sqrt{1 - x^2}$, $y = x$ and $y = 0$?

(a) $\frac{\pi}{4}$ (b) $\frac{\pi}{6}$

(c) $\frac{\pi}{8}$ (d) $\frac{\pi}{12}$

81. What is the area of the region bounded by $x - |y| = 0$ and $x - 2 = 0$?

(a) 1 (b) 2

(c) 4 (d) 8

82. If $f(\alpha) = \sqrt{\sec^2 \alpha - 1}$, then what is $\frac{f(\alpha) + f(\beta)}{1 - f(\alpha)f(\beta)}$ equal to?

(a) $f(\alpha - \beta)$ (b) $f(\alpha + \beta)$

(c) $f(\alpha)\, f(\beta)$ (d) $f(\alpha\beta)$

83. If $f(x) = \ln(x + \sqrt{1 + x^2})$, then which one of the following is correct ?

(a) $f(x) + f(-x) = 0$ (b) $f(x) - f(-x) = 0$

(c) $2f(x) = 2f(-x)$ (d) $f(x) = 2f(-x)$

84. What is $\lim_{x \to 0} \frac{x}{\sqrt{1 - \cos^4 x}}$ equal to?

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

(c) $\sqrt{2}$ (d) Limit does not exist

85. What is $\lim_{x \to \frac{\pi}{2}} \frac{4x - 2\pi}{\cos x}$ equal to?

(a) -4 (b) -2

(c) 2 (d) 4

86. If $f(x) = \frac{x2 + x + |x|}{x}$ then what is $\lim_{x \to 0} f(x)$ equal to?

(a) 0 (b) 1

(c) 2 (d) $\lim_{x \to 0} f(x)$ does not exist

87. What is $\lim_{h \to 0} \frac{\sin^2(x + h) - \sin^2 x}{h}$ equal to?

(a) $\sin^2 x$ (b) $\cos^2 x$

(c) $\sin 2x$ (d) $\cos 2x$

88. Let $f(x)$ be a function such that $f'(x) = g(x)$ and $f''(x) = -f(x)$. Let $h(x) = \{f(x)\}^2 + \{g(x)\}^2$. Then consider the following statements :

1. $h'(3) = 0$
2. $h(1) = h(2)$

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

89. In $y = \ln^2\left(\frac{x^2 - x + 1}{x^2 + x + 1}\right)$, then what is $\frac{dy}{dx}$ at $x = 0$ equal to?

(a) -2 (b) 0

(c) 1 (d) 2

90. If $\frac{d}{dx}\left(\frac{1 + x^4 + x^8}{1 - x^2 + x^4}\right) = ax + bx^3$, then which one of the following is correct ?

(a) $a = b$ (b) $a = 2b$

(c) $a + b = 0$ (d) $2a = b$

91. Under which one of the following conditions does the function $f(x) = (p \sec x)^2 + (q \operatorname{cosec} x)^2$ attain minimum value ?

(a) $\tan^2 x = \frac{q}{p}$ (b) $\cot^2 x = \frac{q}{p}$

(c) $\tan^2 x = pq$ (d) $\cot^2 x = pq$

92. Where does the function $f(x) = \sum_{j=1}^{7} (x - j)^2$ attain its minimum value ?

(a) $x = 3.5$ (b) $x = 4$

(c) $x = 4.5$ (d) $x = 4$

93. Consider the following statements in respect of the function

$$f(x) = \begin{cases} |x| + 1, & 0 < |x| \le 3 \\ 1, & x = 0 \end{cases}$$

1. The function attains maximum value only at $x = 3$
2. The function attains local minimum only at $x = 0$

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

94. What is $\int_0^1 \ln\left(\frac{1}{x} - 1\right) dx$ equal to?

(a) -1 (b) 0

(c) 1 (d) $ln2$

95. If $\int_0^{\pi/2} (\sin^4 x + \cos^4 x) dx = k$, then what is the value of $\int_0^{20\pi} (\sin^4 + \cos^4 x) dx$?

(a) k (b) $10\,k$

(c) $20\,k$ (d) $40\,k$

96. What is $\int_{-\pi/2}^{\pi/2} (e^{\cos x} \sin x + e^{\sin x} \cos x) dx$ equal to?

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

(c) $\frac{1 - e^2}{e}$ (d) 0

97. What is the area of the region enclosed in the first quadrant by $x^2 + y^2 = \pi^2$, $y = \sin x$ and $x = 0$?

(a) $\frac{\pi^3}{4} - 1$ (b) $\frac{\pi^3}{4} - 2$

(c) $\frac{\pi^3}{2} - 1$ (d) $\frac{\pi^2}{4} - 2$

98. Consider the following statements :

1. The degree of the differential $\frac{dy}{dx} + \cos\left(\frac{dy}{dx}\right) = 0$ is 1.
2. The order of the differential equation $\left(\frac{d^2y}{dx^2}\right)^3 + \cos\left(\frac{dy}{dx}\right) = 0$ is 2.

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

99. What is the differential equation of the family of parabolas having vertex at origin and axis along positive y-axis ?

(a) $x\frac{dy}{dx} + 2y = 0$ (b) $x\frac{dy}{dx} - 2y = 0$

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

100. What is the solution of the differential equation $(dy - dx) + \cos x(dy + dx) = 0$?

(a) $y = \tan\left(\frac{x}{2}\right) - x + c$ (b) $y = \frac{1}{2}\tan\left(\frac{x}{2}\right) - x + c$

(c) $y = 2\tan\left(\frac{x}{2}\right) - x + c$ (d) $y = \tan\left(\frac{x}{2}\right) - 2x + c$

101. Let x be the mean of squares of first n natural numbers and y be the square of mean of first n natural numbers.

If $\frac{x}{y} = \frac{55}{42}$, then what is the value of n ?

(a) 24 (b) 25

(c) 27 (d) 30

102. What is the probability of getting a composite number in the list of natural numbers from 1 to 50 ?

(a) $\frac{7}{10}$ (b) $\frac{17}{25}$

(c) $\frac{18}{25}$ (d) $\frac{33}{50}$

103. If $n > 7$, then what is the probability that $C(n, 7)$ is a multiple of 7 ?

(a) 0 (b) $\frac{1}{7}$

(c) – (d) 1

104. Two numbers x and y are chosen at random from a set of first 10 natural numbers. What is the probability that $(x + y)$ is divisible by 4 ?

(a) $\frac{1}{5}$ (b) $\frac{2}{9}$

(c) $\frac{8}{45}$ (d) $\frac{7}{45}$

105. A number x is chosen at random from first n natural numbers. What is the probability that the number chosen satisfies $x + \frac{1}{x} > 2$?

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

(c) $\frac{(n-1)}{n}$ (d) 1

106. Three fair dice are tossed once. What is the probability that they show different numbers that are in AP ?

(a) $\frac{1}{12}$ (b) $\frac{1}{18}$

(c) $\frac{1}{36}$ (d) $\frac{1}{72}$

107. If $P(A) = 0{\cdot}5$, $P(B) = 0{\cdot}7$ and $P(A \cap B) = 0{\cdot}3$, then what is the value of $P(A' \cap B') + P(A' \cap B) + P(A \cap B')$?

(a) 0.6 (b) 0.7

(c) 0.8 (d) 0.9

108. Five coins are tossed once. What is the probability of getting at most four tails?

(a) $\frac{31}{32}$ (b) $\frac{15}{16}$

(c) $\frac{29}{32}$ (d) $\frac{7}{8}$

109. Three fair dice are thrown. What is the probability of getting a total greater than or equal to 15 ?

(a) $\frac{19}{216}$ (b) $\frac{1}{12}$

(c) $\frac{17}{216}$ (d) $\frac{5}{54}$

110. The probability that a person hits a target is 0·5. What is the probability of at least one hit in 4 shots ?

(a) $\frac{1}{8}$ (b) $\frac{1}{16}$

(c) $\frac{15}{16}$ (d) $\frac{7}{8}$

111. A box contains 2 white balls, 3 black balls and 4 red balls. What is the number of ways of drawing 3 balls from the box with at least one black ball ?

(a) 84 (b) 72

(c) 64 (d) 48

112. During war one ship out of 5 was sunk on an average in making a certain voyage. What is the probability that exactly 3 out of 5 ships would arrive safely?

(a) $\frac{16}{625}$ (b) $\frac{32}{625}$

(c) $\frac{64}{625}$ (d) $\frac{128}{625}$

113. A card is drawn from a pack of 52 cards. A gambler bets that it is either a spade or an ace. The odds against his winning are

(a) 9 : 4 (b) 35 : 17

(c) 17 : 35 (d) 4 : 9

114. The coefficient of correlation between ages of husband and wife at the time of marriage for a given set of 100 couples was noted to be 0·7. Assume that all these couples survive to celebrate the silver jubilee of their marriage. The coefficient of correlation at that point of time will be

(a) 1 (b) 0.9

(c) 0.7 (d) 0.3

115. The completion of a construction job may be delayed due to strike. The probability of strike is 0·6. The probability that the construction job gets completed on time if there is no strike is 0·85 and the probability that the construction job gets completed on time if there is a strike is 0·35. What is the probability that the construction job will not be completed on time ?

(a) 0.35 (b) 0.45

(c) 0.55 (d) 0.65

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

The mean and standard deviation (SD) of marks obtained by 50 students of a class in 4 subjects are given below:

Subject	Mathematics	Physics	Chemistry	Biology
Mean Marks	40	28	38	36
SD	15	12	14	16

116. Which one of the following subjects shows highest variability of marks ?

(a) Mathematics (b) Physics

(c) Chemistry (d) Biology

117. What is the coefficient of variation marks in Mathematics?

(a) 37.5% (b) 38.0%

(c) 38.5% (d) 39.0%

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

Consider the following grouped frequency distribution :

Class	0-10	10-20	20-30	30-40	40-50	50-60
Frequency	1	2	4	6	4	3

118. What is the median of the distribution?

(a) 34 (b) 34.5

(c) 35 (d) 35.5

119. What is mean deviation about the median?

(a) 11.4 (b) 11.1

(c) 10.8 (d) 10.5

120. What is the mean deviation about the mean?

(a) 10.15 (b) 10.65

(c) 11.15 (d) 11.65

GENERAL ABILITY

PART - A: ENGLISH

ANTONYMS

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

1. Human craving for comfort leads to anxiety.
   (a) like (b) dislike
   (c) discomfort (d) complacency
2. His writings on the subject are obscure.
   (a) murky (b) vague
   (c) obvious (d) uncertain
3. The achievements of the team have been monumental in the last ten years.
   (a) enormous (b) memorable
   (c) striking (d) unimpressive
4. His frail appearance was considered a merit.
   (a) weak (b) delicate
   (c) sturdy (d) big
5. The novel depicts the hapless status of certain sections of society.
   (a) wretched (b) miserable
   (c) rural (d) fortunate
6. Her ideas have always been eccentric.
   (a) special (b) strange
   (c) normal (d) local
7. The land appears to be parched.
   (a) dry (b) desiccated
   (c) wet (d) scorched
8. The newly made road was smooth.
   (a) rutted (b) dangerous
   (c) winding (d) silken
9. Plenitude is one major cause for environmental degradation.
   (a) abundance (b) insufficiency
   (c) ample (d) plethora
10. The scholar quoted irrefutable evidence for her thesis.
    (a) overwhelming (b) undeniable
    (c) certain (d) questionable

SYNONYMS

DIRECTIONS : *Each item in this section consists of a sentence with an underlined word followed by four words/group of words (a), (b), (c) and (d). Select the option that is nearest in meaning to the underlined word and mark your response in the Answer Sheet accordingly.*

11. Ravi told his friend that he had no intention to malign him.
    (a) benign (b) slander
    (c) praise (d) greet
12. Sheela appeared to be vexed.
    (a) clear (b) calm
    (c) displeased (d) uncomplicated
13. Do not hold any preconception about people.
    (a) notion (b) experiment
    (c) great idea (d) conceit
14. All mortal elements are impermanent.
    (a) temporal (b) immortal
    (c) never-ending (d) divinely
15. The itinerary of the group's visit to the hills was given to everyone.
    (a) invitation (b) information
    (c) schedule (d) names
16. The effort was to harness the power of nature.
    (a) abuse (b) benefit
    (c) apply (d) control
17. The fickle nature of humans is at times the cause of great innovations.
    (a) vacillating (b) consistent
    (c) strong (d) wily
18. The flood situation during the monsoon this year was calamitous.
    (a) abundance (b) catastrophic
    (c) encouraging (d) welcome
19. He was appointed as the honorary member of the team.
    (a) paid (b) invited
    (c) accepted (d) unpaid
20. The church decided to excommunicate him for his actions.
    (a) admit (b) reward
    (c) expel (d) promote

ORDERING OF WORDS IN A SENTENCE

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

21. to be successful (P) what it is (Q) as a human being (R) have you ever considered (S)
    (a) SQPR (c) QRSP
    (b) RQPS (d) PRSQ
22. there is in all instance a single, (P) surrender to the idea that (Q) authoritative truth to be discovered and defended (R) many people today are willing to (S)
    (a) RPSQ (c) RPQS
    (b) SPRQ (d) SQPR

23. for yourself the implications of death, (P)
from one preacher to another (R)
if you do not reflect and understand (Q)
you will go endlessly (S)
(a) SRPQ (c) RSPQ
(b) QPSR (d) QRSP

24. a way of understanding the world, (P)
a language represents (Q)
and relating them to one another (R)
differentiating between things (S)
(a) PSRQ (c) RSPQ
(b) SRPQ (d) QPSR

25. for India's future (P)
mathematics and mathematical thinking (Q)
will be very important (R) it is recognized that (S)
(a) QRPS (b) RPSQ
(c) QRSP (d) SQRP

26. in agriculture and veterinary sciences through (P)
will be enhanced sharply (Q)
programmes integrated with general education (R)
the preparation of professionals (S)
(a) SRPQ (c) SPRQ
(b) RQPS (d) PQRS

27. and should shift the way (P)
are certainly very important, (R)
we think about politics (Q)
the issues raised by feminists and multiculturalists (S)
(a) RPQS (c) SPQR
(b) RSPQ (d) SQPR

28. by which the genetic material of a plant is altered, (P)
pests and enhance its nutritional value (R)
perhaps to make it more resistant to (Q)
genetic modification (GM) is the science (S)
(a) QRPS (b) SPRQ
(c) RSPQ (d) RPQS

29. a much wider array of perspectives (P)
the editors of the present work (R)
the history of social reforms from (Q)
argue the need to understand (S)
(a) QSRP (b) QPRS
(c) RSQP (d) SQRP

30. for which she fought till the end (P)
as a champion of women's rights, (R)
Pandita Ramabai was truly remarkable (Q)
as a pioneer in women's education and (S)
(a) SRQP (b) QPRS
(c) RSQP (d) PQRS

SPOTTING ERRORS

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

31. Our greatest glory is (a) not in never falling but in (b)
raising every time we fall (c) No error (d)

32. Rahim was one of that (a) selected for (b)
the award (c) No error (d)

33. Sujini has met her old friend (a) Guru before she shifted (b)
to Hyderabad two years ago (c) No error (d)

34. This monument happens (a) to be one of the old monument (b)
in the city. (c) No error (d)

35. Amit told to Divya (a) that he would come (b)
with a reward for her (c) No error (d)

36. If you have asked me (a) for the truth I would have told (b)
you at that time. (c) No error (d)

37. If I will be the millionaire (a) I would eradicate (b)
poverty from the country. (c) No error (d)

38. A bird in hand (a) is better than (b)
two in the bush. (c) No error (d)

39. The opportunity to attain foundational literacy (a)
and pursue a honest livelihood (b)
must be viewed as basic right of every citizen. (c)
No error (d)

40. Though there is progress (a) for different directions, (b)
why is there no brotherhood? (c) No error (d)

IDIOMS AND PHRASES

DIRECTIONS : *Given below are some idioms/phrases followed by four alternative meanings for each. Choose the most appropriate answer from among the options (a), (b), (c) and (d).*

41. A queer fish
(a) A strange person (b) A good person
(c) An unlucky person (d) A lucky person

42. Eat like a bird
(a) Eat very quickly (b) Eat a lot
(c) Eat continuously (d) Eat very little

43. Lock horns
(a) Be like a bull (b) Argue about something
(c) Agree with someone (d) Think about the horns

44. Early bird
(a) Low flying (b) Latest
(c) Ancient avian (d) First arrival

45. Be in the pink
(a) To be very healthy (b) To be very colourful
(c) To be very sad (d) To be very rich

46. Be in the running
(a) In a very bad state to speak
(b) In a powerful position
(c) In a good position to win
(d) In a losing position

47. A sea change
(a) Change in the sea tides
(b) A complete change
(c) Change like sea
(d) Changed sea with pollution

48. A pearl of wisdom
(a) An important event in one's life
(b) An important person of wisdom
(c) An important piece of advice
(d) An important thing in one's life

49. Be in seventh heaven
(a) To be extremely sorry
(b) To be extremely wise
(c) To be extremely sad
(d) To be extremely happy

50. Be in the red
(a) To owe money to a bank
(b) To get money from one's family
(c) To be in danger of being caught
(d) To be in favour of needy people

PART- B: GENERAL KNOWLEDGE

51. Which one of the following was composed by Harishena?
(a) Nashik Inscription of Gautami Balashri
(b) Prayaga Prashasti of Samudragupta
(c) Deopara Prashasti of Vijayasena Inscription of
(d) Hathigumpha Kharavela

52. Consider the following events :
1. Establishment of the Planning Commission
2. Formation of the National Development Council (NDC)
3. Approval of the First Five-Year Plan by the NDC Constitution of the National
4. Planning Committee

Which one of the following is the correct sequence of the above events?
(a) 1-2-3-4 (b) 2-1-3-4
(c) 4-1-2-3 (d) 1-4-2-3

53. Which one of the following battles could be seen as laying the formal foundation of the British Raj in India?
(a) Third Battle of Panipat
(b) Battle of Plassey
(c) Battle of Buxar
(d) Revolt of 1857

54. Where in South India did the British East India Company construct a trading post in 1639?
(a) Cuddalore (b) Madraspatam
(c) Kalahasti (d) Karwar

55. Which of the following statements is/are correct?
1. The Dutch East India Company was formed after the formation of the British East India Company.
2. Vasco da Gama reached Calicut in 1498.

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

56. In India, a cultivable land which is left uncultivated for more than a year but less than five years is labelled as
(a) cultivable wasteland
(b) current fallow
(c) fallow other than current fallow
(d) barren and wasteland

57. The major portion of the Great Artesian Basin in Australia is located in
(a) Western Australia (b) Victoria
(c) Queensland (d) Northern Territory

58. Which of the following statements is/are correct?
1. India has one of the longest navigable inland water networks in the world.
2. Inland waterways presently help in transporting about 25 percent of the total cargo movement.
3. About 111 inland waterways have been declared as National Waterways under the National Waterways Act, 2016.

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

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

List-I (Railway Zone)	**List-II (Headquarters)**
A. East Central	1. Gorakhpur
B. North Central	2. Jaipur
C. Northeast Frontier	3. Hajipur
D. East Central	4. Maligaon

Code :

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

60. Which one of the following statements about earthquake waves is not correct?
(a) P waves move faster and are the first to arrive at the surface.
(b) P waves can travel through gaseous, liquid and solid materials.
(c) Seismographs located beyond 145° from epicentre can record the arrival of P waves.
(d) P waves have maximum area covered under its shadow zone.

61. The commercial unit of electrical energy is kilowatt-hour (kWh), which is equal to
(a) 3.6×10^6 J (b) 3.6×10^3 J
(c) 10^3 J (d) 1 J

62. Which one of the following statements regarding a current-carrying solenoid is not correct?
(a) The magnetic field inside the solenoid is uniform.
(b) The current-carrying solenoid behaves like a bar magnet.
(c) The magnetic field inside the solenoid increases with increase in current.
(d) If a soft iron bar is inserted inside the solenoid, the magnetic field remains the same.

63. An object is made of two equal parts by volume; one part has density p0 and the other part has density 2p 0. What is the average density of the object?
(a) $3\rho_0$ (b) $\frac{3}{2}\rho_0$
(c) ρ_0 (d) $\frac{1}{2}\rho_0$

64. A pressure cooker cooks food faster by
(a) increasing the boiling point of water
(b) decreasing the boiling point of water
(c) increasing the melting point of water
(d) decreasing the melting point of water

65. Which one of the following wavelengths corresponds to the wavelength of X-rays?
(a) 500 nm (b) 5000 nm
(c) 100 nm (d) 1 nm

66. An electric bulb is connected to 220 V generator. The current drawn is 600 mA. What is the power of the bulb?
(a) 132 W (b) 13-2 W
(c) 1320 W (d) 13200 W

67. When the pitch of sound increases, which one of the following increases?
(a) Intensity (b) Loudness
(c) Wavelength (d) Frequency

68. Which one of the following is the correct reactivity series with water?
(a) Zinc > Iron > Lead > Copper
(b) Copper > Lead > Zinc > Iron
(c) Copper > Zinc > Iron > Lead
(d) Zinc > Copper > Iron > Lead

69. Which one of the following metals floats in cold water?
(a) Magnesium (b) Calcium
(c) Potassium (d) Copper

70. Which one of the following solutions is not capable of conducting electricity?
(a) Copper sulphate (b) Sodium chloride
(c) Sugar (d) Sodium hydroxide

71. To help deep-sea divers breathe, they carry cylinders of oxygen mixed with
(a) chlorine (b) helium
(c) nitrogen (d) ozone

72. Which of the following compounds undergoes/undergo thermal decom-position?
(a) Zinc oxide (b) Silver oxide and zinc oxide
(c) Silver oxide (d) Magnesium oxide

73. The transfer of electrical signals by nerve cells in human body is enabled by
(a) sodium (b) potassium
(c) iron (d) sodium and potassium

74. Silver artefacts get tarnished in air due to the formation of
(a) silver chloride (b) silver oxide
(c) silver sulphide (d) silver sulphate

75. Human eye can see objects at different distances with contrasting illuminations. This is due to
(a) far-sightedness
(b) near-sightedness
(c) far-sightedness sightedness
(d) accommodation of eye

76. Which one of the following hormones increases the heartbeat in mammals?
(a) Insulin (b) Melatonin
(c) Thyroxine (d) Adrenaline

77. The digestion of fat in human intestine is performed by
(a) trypsin (b) bile and lipase
(c) bile and amylase (d) bile and pepsin

78. Which one of the following statements about animal cells and plant cells is correct?
(a) Animal cells have only cell membrane not cell wall, whereas plant cells have only cell wall not cell membrane.
(b) Animal cells have only cell membrane not cell wall, but plant cells have both.
(c) Both animal and plant cells have cell membrane and cell wall.
(d) Only some cells of animals have cell wall and all plant cells have cell membrane.

79. Lymph is a tissue fluid present in intercellular spaces. It resembles to
(a) digestive juice (b) cytoplasmic fluid
(c) urine (d) plasma

80. The breakdown of glucose in cytoplasm results in the formation of
(a) pyruvate and energy
(b) pyruvate and carbon dioxide
(c) pyruvate and oxygen
(d) pyruvate and nitrogen

81. Rafael Nadal defeated whom among the following to win the French Open Tennis Tournament, 2022?
(a) Austin Krajicek (b) Ivan Dodig
(c) Casper Ruud (d) Joran Vliegen

82. eSanjeevani, the free telemedicine service of the Government of India, was recently integrated with the
(a) Ayushman Bharat Digital Mission
(b) Aam Aadmi Bima Yojana
(c) Pradhan Mantri Suraksha Bima Yojana
(d) Universal Health Insurance Scheme

83. Which of the following statements about 'SHRESHTA' scheme, launched recently by the Government of India, is/are correct?
1. This scheme is for residential education for students in high school in targeted areas.
2. It provides for high quality education for meritorious but poor Scheduled Caste students.
Select the correct answer using the code given below.
(a) 1 only (b) 2 only
(c) Both 1 and 2 (d) Neither 1 nor 2

84. In a recent judgement, the Supreme Court of India directed that every protected forest, national park and wildlife sanctuary across the country should have a mandatory eco-sensitive zone (ESZ) of a minimum of
(a) 1 km starting from their demarcated boundaries
(b) 2 km starting from their demarcated boundaries
(c) 3 km starting from their demarcated boundaries
(d) 5 km starting from their demarcated boundaries

85. Who among the following is the author of the book, Tomb of Sand ?
(a) Arundhati Roy (b) Geetanjali Shree
(c) Chetan Bhagat (d) Jhumpa Lahiri

86. Who among the following invented the flying shuttle?
(a) James Hargreaves (b) John Kay
(c) Richard Arkwright (d) Humphry Davy

87. Where did Netaji Subhas Chandra Bose announce the formation of the Government of Free India in 1943?
(a) Singapore (b) Shanghai
(c) Berlin (d) Mandalay

88. Who among the following introduced the 'Objective Resolution' in the Constituent Assembly on 13th December, 1946?
(a) Jawaharlal Nehru (b) Rajendra Prasad
(c) B. R. Ambedkar (d) Alladi Krishnaswami Aiyar

89. Consider the following historical events :
1. Gandhi-Irwin Pact
2. Second Round Table Conference
3. Peasant Movement in Bardoli
4. Peasant Movement in Kheda
Which one of the following is the correct chronological order (starting from the earliest) of the above events?
(a) 4-1-3-2 (b) 4-3-1-2
(c) 3-1-2-4 (d) 1-2-4-3

90. Which of the following statements about the Unionist Party is/are correct?
    1. It was a political party representing the interests of landholders in Punjab.
    2. It was opposed to the idea of the partition of India as India and Pakistan.

    Select the correct answer using the code given below.
    (a) 1 only (b) 2 only
    (c) Both 1 and 2 (d) Neither 1 nor 2
91. Which one of the following statements about metamorphic rocks is not correct?
    (a) Due to segregation of minerals into wavy bands or platy surfaces, some metamorphic rocks develop foliations.
    (b) Where the foliations develop into broad mineral bands, the metamorphic rock is extremely hard.
    (c) Where the foliations are moderately thin, the metamorphic rock tends to flake apart.
    (d) Rocks that originally were composed of one dominant mineral are often foliated by metamorphism.
92. Which one of the following 'discontinuities' separates the Earth's crust from the mantle?
    (a) Gutenberg (b) Mohorovicic
    (c) Conrad (d) Repetti
93. Which one of the following cities of the world would represent the greatest linear velocity of rotation of the Earth?
    (a) Kampala, Uganda (b) St. Petersburg, Russia
    (c) Madrid, Spain (d) Stockholm, Sweden
94. What will happen if you are flying east across the International Date Line?
    (a) You will lose 12 hours (b) You will gain 12 hours
    (c) You will gain 24 hours (d) You will lose 24 hours
95. The Prime Meridian does not pass through which one of the following African countries?
    (a) Morocco (b) Algeria
    (c) Mali (d) Ghana
96. Piecing together the puzzle of geologic time to create and analyze historical maps of the Earth is known as
    (a) paleoclimatology (b) paleogeomorphology
    (c) paleolithology (d) paleogeography
97. What is the nature of velocity-time graph for a car moving with uniform acceleration?
    (a) Parabola (b) Logarithmic
    (c) Straight line (d) Exponential
98. The amplitude of sound waves is measured in the units of
    (a) pressure (b) distance
    (c) time (d) speed
99. A current of 0-6 A is drawn by an electric bulb for 10 minutes. Which one of the following is the amount of electric charge that flows through the circuit?
    (a) 6 C (b) 0-6 C
    (c) 360 C (d) 36 C
100. A DC generator works on the principle of
    (a) Ohm's law
    (b) Joule's law of heating
    (c) Faraday's laws of electromagnetic induction
    (d) None of the above
101. The presence of magnetic field can be determined using which one of the following instruments?
    (a) Ammeter (b) Voltmeter
    (c) Magnetic needle (d) Motor
102. Which one of the following statements about speed and velocity is correct?
    (a) Speed and velocity both are vector quantities.
    (b) Speed and velocity both are scalar quantities.
    (c) Speed is vector quantity and velocity is scalar quantity.
    (d) Speed is scalar quantity and velocity is vector quantity.
103. Bronze is an alloy of
    (a) Cu and Zn (b) Cu and Sn
    (c) Zn and Mg (d) Fe and Cu
104. Which one of the following salts does not possess water of crystallization?
    (a) Potassium permanganate
    (b) Blue vitriol
    (c) Washing soda
    (d) Mohr's salt
105. Bee sting leaves an acid which causes pain and irritation. The acid released is
    (a) tartaric acid (b) citric acid
    (c) ethanoic acid (d) methanoic acid
106. Liquid vegetable oils are converted to solid margarine by the use of
    (a) hydrogen gas (b) chlorine gas
    (c) carbon dioxide gas (d) oxygen gas
107. The number of structural isomers of pentane is
    (a) 5 (b) 4
    (c) 2 (d) 3
108. Vapours of sulphur escaping from a volcano often form a crust on the rocks. The process involved is an example of
    (a) condensation (b) precipitation
    (c) deposition (d) evaporation
109. Dry ice is used on a performing stage to produce mist in air. The process involved is an example of
    (a) sublimation (b) evaporation
    (c) condensation (d) precipitation
110. C_4H_8 belongs to the homologous series of
    (a) alkanes (b) alkenes
    (c) alkynes (d) cycloalkanes
111. The protein-digesting enzyme secreted by the stomach wall in case of mammals is called
    (a) chitinase (b) amylase
    (c) pepsin (d) trypsin

112. Which one of the following will be resulted when an animal cell is surrounded by a medium with lower concentration of water?
(a) Cell will lose water
(b) No change in movement of water
(c) Cell will gain water
(d) Cell will swell up

113. The digestive enzymes are present in
(a) mitochondria (b) vacuoles
(c) lysosomes (d) ribosomes

114. After fertilization, the fruit and the seed are produced by
(a) ovule and ovary, respectively
(b) ovary and ovule, respectively
(c) ovary, no ovule required
(d) ovule, no ovary required

115. Which among the following has initiated a nationwide flagship campaign 'Puneet Sagar Abhiyan' to clean seashores/ beaches and other water bodies of plastic and other waste materials?
(a) Indian Coast Guard
(b) National Cadet Corps (NCC)
(c) Indian Navy
(d) Swachh Bharat Mission

116. Which among the following was the host country of the United Nations World Environment Day, 2022?
(a) Canada (b) Sweden
(c) South Africa (d) Brazil

117. Which of the following Indian Naval Ships 120. Who among the following laid the were decommissioned in June 2022?
(a) INS Ganga and INS Nipat
(b) INS Nishank and INS Akshay
(c) INS Khukri and INS Sandhayak
(d) INS Gomati and INS Ranjit

118. India signed a deal with which one of the following countries to supply MH-60R helicopters to the Indian Navy?
(a) Israel (b) France
(c) Russia (d) USA

119. With reference to India's defence, the 122- Who among the following initiated the terms 'Surat' and OJdaygiri' refer to Bhoodan Movement?
(a) coast guard patrol boats
(b) cargo helicopters
(c) maritime patrol aircrafts
(d) warships

120. Who among the following laid the foundation of the Vijayanagara Empire?
(a) Harihara and Bukka (b) Krishnadeva Raya
(c) Rama Raya (d) Virupaksha Raya

121. The book, Kalila wa Dimna is an Arabic translation of the
(a) Hitopadesha (b) Panckatantra
(c) Suryasiddhanta (d) Kathasaritsagar

122. Who among the following initiated the Bhoodan Movement?
(a) Ram Prasad Bismil (b) Vinoba Bhave
(c) Mahatma Gandhi (d) Kanhu Murmu

123. Which one of the following rivers in India was not crossed by Alexander and his army?
(a) Hyphasis (b) Acesines
(c) Hydraotes (d) Hydaspes

124. Who among the following has described the medieval Indian postal system as of two kinds—the horse-post called TJluq' and the foot-post called 'Dawa?
(a) Al-Biruni (b) Duarte Barbosa
(c) Ibn Battuta (d) Seydi Ali Reis

125. At which among the following Harappan sites are fire altars found?
(a) Kalibangan (b) Harappa
(c) Mohenjo-daro (d) Rakhi Garhi

126. Consider the following statements on computation of density :
1. Physiological density can be computed by dividing the total population by the net cultivable area.
2. Agricultural density can be computed by dividing the total agricultural population by the net cultivable area.
3. Population density can be computed by dividing the total population by the total area.

How many of the above statements is/are correct?
(a) 1 (b) 2
(c) 3 (d) None

127. The formation of tors' on small rocky hills is associated with which among the following?
(a) Granite (b) Limestone
(c) Alluvial (d) Dolomite

128. Consider the following statements about anticyclones :
1. Anticyclones are high pressure systems.
2. Air in the centre of the system must be subsiding.
3. Anticyclones are characterized by converging winds.

How many of the above statements is/are correct?
(a) 1 (b) 2
(c) 3 (d) None

129. Which of the following statements is/are correct?
1. The Earth's crust is brittle in nature.
2. The mean thickness of the oceanic crust is 15 km, whereas that of the continental crust is around 30 km.

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

130. In January 2020, the administration of which of the following Union Territories has been merged together?
(a) Daman and Diu and Puducherry
(b) Puducherry and Dadra and Nagar Haveli
(c) Puducherry and Nicobar Islands Haveli and
(d) Dadra and Nagar Haveli and Daman and Diu

131. Two convex lenses have focal lengths of 50 cm and 25 cm, respectively. If these two lenses are placed in contact, then the net power of this combination will be equal to
(a) +2 dioptre (b) +6 dioptre
(c) -6 dioptre (d) +3 dioptre

132. Which one of the following terms cannot represent electrical power in a circuit?
(a) VI (b) I^2/R
(c) I^2R (d) V^2/R

133. The refractive indes of crown glass is close to 3/2. If the speed of light in air is c, then the speed of light in the crown glass will be close to
(a) (3/2)c (b) (4/9)c
(c) (2/3)c (d) (9/4)c

134. The volume of a sealed packet is 1 litre and its mass is 800 g. The packet is first put inside water with density 1 g cm and then in another liquid B with density 1.5 g cm^{-3}. Then which one of the following statements holds true?
(a) The packet will float in both water and liquid B.
(b) The packet will sink in both water and liquid B.
(c) The packet will sink in water but will float in liquid B.
(d) The packet will float in water and sink in liquid B.

135. A simple pendulum having bob of mass m and length of string / has time period of T. If the mass of the bob is doubled and the length of the string is halved, then the time period of this pendulum will be
(a) T (b) T/J2
(c) 2T (d) V2T

136. In which one of the following devices, the light energy is converted into the electrical energy?
(a) Light-emitting diode (b) Laser diode
(c) Solar cell (d) Transistor

137. Which one of the following is not a power of Panchayats under Article 243G?
(a) Land improvement
(b) Implementation of land reforms
(c) Land consolidation and soil conservation
(d) Regulation of land revenue

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

List-I (Mahamatta)	**List-II (Function)**
A. Anta-mahamatta	1. Women's welfare
B. Ithijhakha-mahamatta	2. Spread of Dhamma
C. Dhamma-mahamatta	3. Associated with city administration
D. Nagalaviyohalaka-mahamatta	4. In-charge of frontier areas

Code :

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

139. Who among the following is the author of the Hastyayurveda?
(a) Palakapya (b) Vagbhata
(c) Sushruta (d) Charaka

140. Which one of the following areas was acquired by the British under the Treaty of Deogaon, 1803?
(a) Cuttack (b) Murshidabad
(c) Surat (d) Calicut

141. Consider the following statements :
1. Maharashtra State has the maximum share of national highways (length in kilometres).
2. The nature of terrain and the level of economic development is one of the reasons for the maximum share of national highways in Maharashtra.
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

142. The activities or services focussed on creation, rearrangement and inter-pretation of new and existing ideas are referred to as
(a) quaternary activities (b) quinary activities
(c) tertiary activities (d) secondary activities

143. Consider the following statements about OJde Desh ka Aam Nagrik (UDAN)' scheme :
1. It is an innovative scheme to develop the regional aviation market.
2. It creates affordability yet economically viable and profitable flight on regional routes.
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

144. Consider the following statements :
1. The Sharavati river creates Jog Falls.
2. The Brahmani river is formed by the confluence of the Kosi and Sankh rivers.
3. The Tamraparni is a river of Tirunelveli district of Tamil Nadu.
How many of the above statements is/are correct?
(a) 1 (b) 2
(c) 3 (d) None

145. SONAR is a device that is used to measure the distance of underwater objects by a ship. Which of the following types of waves does it use for this purpose?
(a) Infrasonic waves
(b) Sound waves in audible range for human beings
(c) Ultrasonic waves
(d) All of the above

146. Which one of the following statements about the speed of sound waves is not correct?
(a) The speed of sound waves in steel is higher than that in water.
(b) The speed of sound waves in air decreases with increase in temperature.
(c) The speed of sound waves in air increases with increase in temperature.
(d) The speed of sound waves in water is higher than that in air.

147. The part of the human ear that converts the pressure variations associated with audible sound waves to electrical signals is
(a) auditory nerve (b) cochlea
(c) eardrum (d) eustachian tube

148. Which one of the following metals is most commonly used for making filament of incandescent electric bulbs?
(a) Aluminium (b) Silver
(c) Copper (d) Tungsten

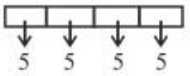
149. A bullet of mass 10 g is horizontally fired with velocity 300 m s^{-1} from a pistol of mass 1 kg. What is the recoil velocity of the pistol?
(a) 0.3 m s^{-1} (b) 3 m s^{-1}
(c) –3 m s^{-1} (d) –0.3 m s^{-1}

150. A microphone converts
(a) electrical signals to sound waves
(b) sound waves to electrical signals
(c) microwaves to sound waves
(d) sound waves to microwaves

HINTS & SOLUTIONS

MATHEMATICS

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



Number of four digits number with all odd digits
$= 5 \times 5 \times 5 \times 5 = 625$

2. (b) $\sum_{r=0}^{n} 2^r \ {}^nCr = {}^nC_0 2^0 + {}^nC_1 2^1 + {}^nC_2 2^2 + ... + {}^nC_2 2^n$

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

3. (c) Given word 'MATHEMATICS'

No. of words start with $A = \frac{10!}{2!2!}$

$\therefore$ No. of words before the first word that start with

$c = \frac{10!}{2!2!} = 907200$

4. (d) For statement 1:

Let $xy = 6 = 1.6 \quad \Rightarrow \quad x - y = 1 - 6 = -5$

and $xy = 6 = 2.3 \quad \Rightarrow \quad x - y = 2 - 3 = -1$

$\therefore$ 6 related to both – 5 and – 1

So f is not a function from Z to Z.

For statement 2:

Let $xy = 6 = 1.6 \quad \Rightarrow \quad x + y = 1 + 6 = 7$

and $xy = 6 = 2.3 \quad \Rightarrow \quad x + y = 2 + 3 = 5$

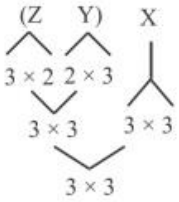
$\therefore$ 6 related to both 7 and 5

So f is not a function from N to N.

5. (a)

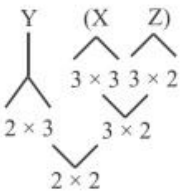
6. (d)

7. (d) 1.



Total entries = 9

2.



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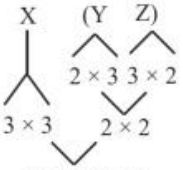
3.



Not defined

8. (d) Sum of roots = product of roots

$\frac{-b}{a} = \frac{c}{a} \Rightarrow b = -c$ $\therefore$ Quadratic equation is

$ax^2 - cx + c = 0$

So, roots of quadratic equation depend on $a, c \in R$.

Hence, infinitely many quadratic equations.

9. (a) There are infinitely many irrational numbers lies between $\sqrt{2}$ and $\sqrt{5}$.

Odd integers less than 100

$= ... - 5, -4, -3, -2, -1, 1, 2, 3, ... 99$

Which is infinite.

10. (a) Let $S = 2 + 4 + 6 + ... + 2n$

$= 2\,(1 + 2 + 3 + ... + n) = 2.\frac{n(n+1)}{2} = n^2 + n$

$\therefore$ Statement 1 is true.

Putting $n = 41$ in $n^2 + n + 41$

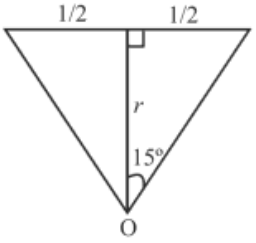
$= 41^2 + 41 + 41 = 41.(41 + 2) = 41.43$

Which is not prime.

So, expression not always prime for n $\in$ N

11. (a) Given that roots of $x^2 + bx + c = 0$ are p and q.
$\therefore \quad p + q = -b$ and $pq = c$
Given that
$p^2 + q^2 - 11pq = 0$
$\Rightarrow \quad (p+q)^2 - 13pq = 0$
$\Rightarrow \quad b^2 - 13c = 0$
$\Rightarrow \quad b^2 - 13c$ ...(i)
Now $(p-q)^2 = (p+q)^2 - 4pq$
$= b^2 - 4c = 13c - 4c = 9c$ [from (i)]
$p - q = 3\sqrt{c}$

12. (c) Central angle subtend by side $= \frac{360}{12} = 30°$



$\tan 15° = \frac{1/2}{r}$

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

$\Rightarrow 2r = \frac{\sqrt{3}+1}{\sqrt{3}-1} = \frac{4+2\sqrt{3}}{2}$

$\Rightarrow \quad d = 2 + \sqrt{3}$ cm

13. (c) $\therefore \quad f(x)$ = the highest prime factor of x,
$\therefore \quad f(7) = 7, f(8) = 2, f(9) = 3, f(10) = 5, f(11) = 11,$
$f(12) = 3, f(14) = 7, f(15) = 5, f(16) = 2, f(13) = 13$
$\therefore \quad$ Range $= \{2, 3, 5, 7, 11, 13\}$

14. (d)

15. (d) Let $A = \{1, 2\}, B = \{2, 3\}, C = \{2, 4\}$
$\therefore \quad A \cap B = A \cap C = \{2\}$
But $B \neq C$
So, statement 1 is wrong
Let $A = \{1, 2\}, B = \{2, 3\}, C = \{1, 2, 3\}$
$\therefore \quad A \cup B = A \cup C = \{1, 2, 3\}$
But $B \neq C$.
So, statement 2 is wrong.

16. (a) $\because z = \frac{1 + i\sin\theta}{1 - i\sin\theta}$

$\therefore |z| = \frac{|1 + i\sin\theta|}{|1 - i\sin\theta|} = \frac{\sqrt{1+\sin^2\theta}}{\sqrt{1+\sin^2\theta}} = 1$

17. (c) $\because \quad z = \frac{1 + i\sin\theta}{1 - i\sin\theta} \times \frac{1 + i\sin\theta}{1 + i\sin\theta}$

$= \frac{1 - \sin^2\theta + 2i\sin\theta}{1 + \sin^2\theta}$

$= \frac{\cos^2\theta}{1+\sin^2\theta} + \frac{2\sin\theta}{1+\sin^2\theta}\hat{i}$

If z is purely real

$\therefore \frac{2\sin\theta}{1+\sin^2\theta} = 0 \quad \Rightarrow \quad \sin\theta = 0$

$\Rightarrow \quad \theta = n\pi$, where n is an integer.

18. (b) If z is purely imaginary.

$\therefore \frac{\cos^2\theta}{1+\sin^2\theta} = 0 \quad \Rightarrow \quad \cos^2\theta = 0$

$\Rightarrow \quad \cos\theta = 0 \quad \Rightarrow \quad \theta = (2n+1)\frac{\pi}{2}$

Where n is an integer.

19. (d) Given that $\frac{S_n}{S_n'} = \frac{5n+4}{9n+6}$

Put $n = 1$

$\frac{S_1}{S_1'} = \frac{5+4}{9+6} = \frac{a_1}{a_1'}$

$\Rightarrow \frac{a_1}{a_1'} = \frac{9}{15} = \frac{3}{5}$

20. (c) $\frac{S_n}{S_n'} = \frac{5n+4}{9n+6}$

$\Rightarrow \frac{2a + (n-1)d}{2a' + (n-1)d'} = \frac{5n+4}{9n+6}$

Put $n = 19$

$\Rightarrow \frac{2a + 18d}{2a' + 18d'} = \frac{95+4}{171+6}$

$\Rightarrow \frac{a + 9d}{a' + 9d'} = \frac{99}{177} \Rightarrow \frac{a_{10}}{a_{10}^1} = \frac{33}{59}$

21. (c)

22. (a) Given expansion is $(p + qx)^9$
$T^{r+1} = {}^9Cr\, p^{9-r}(qx)^r = {}^9Cr\, p^{q-r}q^r x^r$
$\because$ coefficient of x^3 = coefficient x^6
${}^9C_3 p^6 q^3 = {}^9C_6 p^3 q^6$
$\Rightarrow \quad p^3 = q^3$
$\Rightarrow \quad p = q$

23. (b) Middle terms
$T_5 = T_{4+1} = {}^9C_4 p^5 q^4 x^4$
$T_6 = T_{5+1} = {}^9C_5 p^4 q^5 x^5$

Ratio of coefficients $= \frac{{}^9C_5 p^5 q^4}{{}^9C_4 p^4 q^5} = \frac{p}{q}$

24. (b) coefficient of x^2 = coefficient of x^4
${}^9C_2 p^7 q^2 = {}^9C_4 p^5 q^4$

$\frac{9.8}{2.1} p^2 = \frac{9.8.7.6}{4.3.2.1} q^2$

$\frac{p^2}{q^2} = \frac{7}{2}$

25. (d) Number of words contains two vowels and two consonants $= {}^4C_2 . {}^4C_2 \times 4!$
$= 6.6.24 = 864$

26. (c) C V C V C V/ CV or VC VC VC VC
Number of 8 letter words such that vowels and consonants occupy alternate positions.
$= 2 \times 4!\ 4! = 2 \times 24 \times 24 = 1152$

27. (b) Number 8 letter words such that all consonants are together
$= 4!\ 5! = 2880$

28. (c) We know that
$a_{11}C_{11} + a_{12}C_{12} + a_{13}C_{13} = \Delta$

29. (a) We know that
$a_{21}C_{11} + a_{22}C_{12} + a_{23}C_{13} = O$

30. (d) $\Delta = \begin{vmatrix} a_{11} & a_{12} & a_{13} \\ a_{21} & a_{22} & a_{23} \\ a_{31} & a_{32} & a_{33} \end{vmatrix} = \begin{vmatrix} a_{11} & a_{21} & a_{31} \\ a_{12} & a_{22} & a_{32} \\ a_{13} & a_{23} & a_{33} \end{vmatrix}$
Apply $C_1 \longleftrightarrow C_3$ Apply $C_1 \longleftrightarrow C_2$
$= -\begin{vmatrix} a_{31} & a_{21} & a_{11} \\ a_{32} & a_{22} & a_{12} \\ a_{33} & a_{23} & a_{13} \end{vmatrix} = +\begin{vmatrix} a_{21} & a_{31} & a_{11} \\ a_{22} & a_{32} & a_{12} \\ a_{23} & a_{33} & a_{13} \end{vmatrix}$
Apply $R_2 \longleftrightarrow R_3$
$= -\begin{vmatrix} a_{21} & a_{31} & a_{11} \\ a_{23} & a_{33} & a_{13} \\ a_{22} & a_{32} & a_{12} \end{vmatrix}$

31. (c) Given that $f(x+y) = f(x)\ .\ f(y)$ and $f(1) = 2$
$\therefore\ f(2) = f(1+1) = f(1) f(1) = 2.2 = 4$
$f(3) = f(1+2) = f(1)\ .\ f(2) = 2.4 = 8$
$f(4) = f(1+3) = f(1)\ .\ f(3) = 2.8 = 16$, So on
Now, $\sum_{x=2}^{n} f(x) = 2044$
$f(2) + f(3) + f(4) + \ldots + f(n) = 2044$
$4 + 8 + 16 \ldots (n-1)$ terms $= 2044$
$\frac{4(2^{n-1}-1)}{2-1} = 2044 \Rightarrow 2^{n-1}{}_{-1} = 511$
$\Rightarrow\ 2^{n-1} = 512 = 2^9$
$\Rightarrow\ n = 10$

32. (b) $\sum_{x=1}^{5} f(2x-1) = f(1) + f(3) + f(5) + f(7) + f(9)$
$= 2 + 8 + 32 + \ldots$ 5 terms
$= \frac{2(4^5-1)}{4-1} = \frac{2 \times 1023}{3} = 682$

33. (d) $\sum_{x=1}^{6} 2^x f(x) = 2f(1) + 2^2 f(2) + 2^3 f(3) \ldots + 2^6 f(6)$
$= 2.(2) + 4.(4) + 8.(8) + \ldots 64.64$
$= 4 + 16 + 64 \ldots 6$ terms
$= \frac{4(4^6-1)}{4-1} = \frac{4 \times 4095}{3} = 5460$

34. (c)

35. (d) At least two of three sports
$= b + e + f + d = 40 - 7x + x = 40 - 6x$

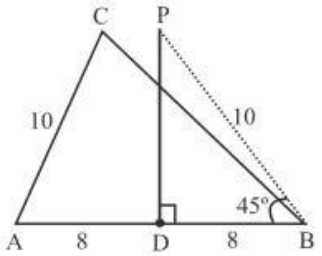
36. (a) Exactly one of three sports
$= a + c + g = 15x - (40 - 6x)$
$= 21x - 40$

37. (a) $\therefore A = \begin{bmatrix} 0 & \sin^2\theta & \cos^2\theta \\ \cos^2\theta & 0 & \sin^2\theta \\ \sin^2\theta & \cos^2\theta & 0 \end{bmatrix}$
$A^T = \begin{bmatrix} 0 & \cos^2\theta & \sin^2\theta \\ \sin^2\theta & 0 & \cos^2\theta \\ \cos^2\theta & \sin^2\theta & 0 \end{bmatrix}$
$P = \frac{1}{2}(A + A^T) = \begin{bmatrix} 0 & 1/2 & 1/2 \\ 1/2 & 0 & 1/2 \\ 1/2 & 1/2 & 0 \end{bmatrix}$

38. (d) $Q = \frac{1}{2}(A - A^T) = \frac{1}{2}\begin{bmatrix} 0 & -\cos 2\theta & \cos 2\theta \\ \cos 2\theta & 0 & -\cos 2\theta \\ -\cos 2\theta & \cos 2\theta & 0 \end{bmatrix}$
$= \cos 2\theta \begin{bmatrix} 0 & -1/2 & 1/2 \\ 1/2 & 0 & -1/2 \\ -1/2 & 1/2 & 0 \end{bmatrix}$

39. (a) $|A| = \begin{bmatrix} 0 & \sin^2\theta & \cos^2\theta \\ \cos^2\theta & 0 & \sin^2\theta \\ \sin^2\theta & \cos^2\theta & 0 \end{bmatrix}$
$= 0 - \sin^2\theta\,(0 - \sin^4\theta) + \cos^2\theta\,(\cos^4\theta)$
$= \sin^6\theta + \cos^6\theta$
$= (\sin^2\theta + \cos^2\theta)(\sin^4\theta + \cos^4\theta - \sin^2\theta.\cos^2\theta)$
$= (\sin^2\theta + \cos^2\theta)^2 - 3\sin^2\theta\cos^2\theta$
$= 1 - \frac{3}{4}\sin^2 2\theta = \frac{1}{4}\left[4 - 3\frac{(1-\cos 4\theta)}{2}\right]$
$= \frac{1}{8}\ [5 + 3\cos 4\theta]$
Minimum value of $\cos 4\theta$ is -1.
$\therefore\ |A|_{\min} = \frac{1}{8}[5-3] = \frac{2}{8} = \frac{1}{4}$

40. (c)



In ΔPDB,

$\tan 45° = \frac{PD}{BD} \Rightarrow PD = BD = 8$

$\therefore$ Height of the lamp post = 8 m

41. (b) $\cos C = \frac{a^2+b^2-c^2}{2ab} = \frac{100+100-256}{200} = \frac{-56}{200} = \frac{-7}{25}$

$\sin C = \sqrt{1-\cos^2 C} = \sqrt{1-\frac{49}{625}} = \frac{24}{25}$

$\therefore \frac{AB}{\sin C} = \frac{16\times 25}{24} = \frac{50}{3}$ m

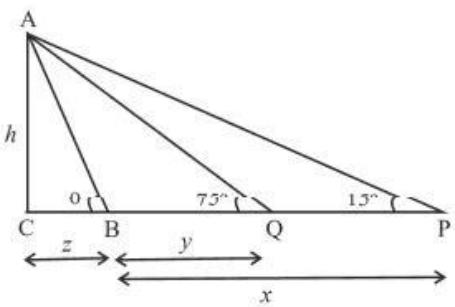
42. (d) $\cos A + \cos B + \cos C$

$\frac{b^2+c^2-a^2}{2bc} + \frac{a^2+c^2-b^2}{2ac} + \frac{a^2+b^2-c^2}{2ab}$

$= \frac{100+256-100}{2\times 160} + \frac{100+256-100}{2\times 160} + \frac{100+100-256}{200}$

$= \frac{256}{160} - \frac{56}{200} = \frac{1280-224}{800} = \frac{1056}{800} = \frac{33}{25}$

43. (a)



In ΔACQ $\tan 75° = \frac{h}{z+y}$

$\Rightarrow z = \frac{h}{\tan 75°} - y$ ...(i)

In ΔACP $\tan 15° = \frac{h}{z+x}$

$\Rightarrow z = \frac{h}{\tan 15°} - x$ ...(ii)

From (i) and (ii)

$\frac{h}{\tan 15°} - \frac{h}{\tan 75°} = x - y$

$\Rightarrow h\left(\frac{\sqrt{3}+1}{\sqrt{3}-1} - \frac{\sqrt{3}-1}{\sqrt{3}+1}\right) = x - y$

$\left[\because \tan 75° = \frac{\sqrt{3}-1}{\sqrt{3}+1}, \tan 75° = \frac{\sqrt{3}+1}{\sqrt{3}-1}\right]$

$\Rightarrow h\left(\frac{3+1+2\sqrt{3}-3-1+2\sqrt{3}}{3-1}\right) = x - y$

$\Rightarrow h(2\sqrt{3}) = x - y \Rightarrow h = \frac{x-y}{2\sqrt{3}}$

44. (d) $\therefore z = \frac{h}{\tan 75°} - y = \frac{x-y}{2\sqrt{3}} \cdot \frac{\sqrt{3}-1}{\sqrt{3}+1} - y$

$= \frac{(x-y)}{2}\left[\frac{\sqrt{3}-1}{3+\sqrt{3}} \times \frac{3-\sqrt{3}}{3-\sqrt{3}}\right] - y$

$= \frac{x-y}{2}\left[\frac{3\sqrt{3}-3-3+\sqrt{3}}{9-3}\right] - y$

$= (x-y)\frac{[2\sqrt{3}-3]}{6} - y = \frac{2\sqrt{3}(x-y)-3(x+y)}{6}$

$\cot\theta = \frac{z}{h} = \frac{2\sqrt{3}(x-y)-3(x+y)}{6} \times \frac{2\sqrt{3}}{x-y}$

$= 2 - \frac{\sqrt{3}(x+y)}{x-y}$

45. (b) Length of the tower, $AB = \sqrt{h^2+z^2}$

$= \sqrt{\frac{(x-y)^2}{12} + \left(\frac{2\sqrt{3}(x-y)-3(x+y)}{6}\right)^2}$

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

46. (b) $\operatorname{cosec}\left(-\frac{73\pi}{3}\right) = -\operatorname{cosec}\left(\frac{73\pi}{3}\right)$

$= -\operatorname{cosec}\left(24\pi + \frac{\pi}{3}\right) = -\operatorname{cosec}\frac{\pi}{3} = -\frac{2}{\sqrt{3}}$

47. (a)

48. (b) $\because \tan\left(\frac{3\pi}{4}\right) = \tan\left(\pi - \frac{\pi}{4}\right) = -1$

Let $\frac{3\pi}{4} = \theta \Rightarrow \tan\theta = -1$

Now, $\tan\theta = \frac{2\tan\theta/2}{1-\tan^2\theta/2}$

Let $\tan\theta/2 = x$

$\therefore \quad -1 = \dfrac{2x}{1-x^2}$

$\Rightarrow \quad x^2 - 2x - 1 = 0 \quad \Rightarrow \quad x = 1 \pm \sqrt{2}$

$\therefore \quad \tan\dfrac{3\pi}{8} = 1+\sqrt{2} \qquad \left(\because 0 < \dfrac{3\pi}{8} < \dfrac{\pi}{2}\right)$

49. (d) $\tan^{-1}\cot(\text{cosec}^{-1}2)$

$= \tan^{-1}\left(\cot\dfrac{\pi}{6}\right) = \tan^{-1}\sqrt{3} = \dfrac{\pi}{3}$

50. (a) $\because \ a = 4, b = 3, c = 2$

$\therefore \cos C = \dfrac{a^2+b^2-c^2}{2ab} = \dfrac{16+9-4}{24} = \dfrac{21}{24}$

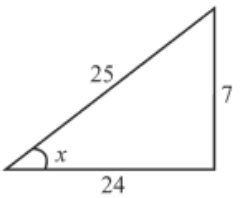
$\therefore \quad \cos 3C = 4\cos^3 C - 3\cos C$

$= 4\left(\dfrac{21}{24}\right)^3 - 3\left(\dfrac{21}{24}\right) = \dfrac{21}{24}\left(\dfrac{4\times441}{576} - 3\right) = \dfrac{7}{128}$

51. (c) $\cos 36° - \cos 72° = -2\sin 54°\,.\sin(-18°)$

$= 2\sin 54°.\sin 18° = 2\left(\dfrac{\sqrt{5}+1}{4}\right)\left(\dfrac{\sqrt{5}-1}{4}\right) = \dfrac{1}{2}$

52. (b)



$\sec x = \dfrac{25}{24} = \dfrac{h}{b}$

$P = \sqrt{(25)^2 - (24)^2} = 7$

$\therefore \tan x + \sin x = \left(-\dfrac{7}{24}\right) + \left(-\dfrac{7}{25}\right)$

$= -7\left[\dfrac{1}{24} + \dfrac{1}{25}\right] = \dfrac{-343}{600}$

53. (b)

54. (a) $\sin\left(2n\pi + \dfrac{5\pi}{6}\right)\sin\left(2n\pi - \dfrac{5\pi}{6}\right)$

$= -\sin\dfrac{5\pi}{6}.\sin\left(\dfrac{5\pi}{6}\right) = -\sin^2\left(\pi - \dfrac{\pi}{6}\right)$

$= -\sin^2\dfrac{\pi}{6} = -\dfrac{1}{4}$

55. (d) $1 + 2(\sin x + \cos x)(\sin x - \cos x) = 0$

$\Rightarrow \quad 1 + 2(\sin^2 x - \cos^2 x) = 0$

$\Rightarrow \quad 1 - 2\cos^2 2x = 0$

$\Rightarrow \quad \cos^2 2x = \dfrac{1}{2} \qquad \Rightarrow \quad \cos 2x = \dfrac{1}{\sqrt{2}}$

$\Rightarrow \quad x = n\pi \pm \dfrac{\pi}{8} \qquad \therefore \quad x = 0, \pi - \dfrac{\pi}{8},$

$\pi + \dfrac{\pi}{8}, 2\pi - \dfrac{\pi}{8}$. Four values.

56. (c) Given point (0, 0)

$m = \tan 75° = \dfrac{\sqrt{3}+1}{\sqrt{3}-1}$ ($\therefore$ Equation of straight line)

$y = \dfrac{\sqrt{3}+1}{\sqrt{3}-1}x$

Put $x = 1$ and $y = \dfrac{1}{2-\sqrt{3}}$

$\therefore \dfrac{1}{2-\sqrt{3}} = \dfrac{\sqrt{3}+1}{\sqrt{3}-1} \times \dfrac{\sqrt{3}-1}{\sqrt{3}-1} = \dfrac{3-1}{4-2\sqrt{3}} = \dfrac{1}{2-\sqrt{3}}$

Satisfy equation of straight line. So, statement 1 is correct.

Since $\dfrac{\sqrt{3}+1}{\sqrt{3}-1} > 0$

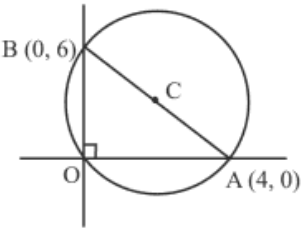
$\therefore$ Straight line passes through first and third quadrants.

So, statement 2 is also correct.

57. (b)

58. (a)

59. (c) Centre $C(x, y)$



$= \left(\dfrac{4+0}{2}, \dfrac{0+6}{2}\right) = (2, 3)$

Which satisfy the equation $3x - 4y + 6 = 0$

60. (a) Let equation of ellipse is $\dfrac{x^2}{b^2} + \dfrac{y^2}{a^2} = 1$

$\therefore$ It passes through (3, 2) and (1, 6)

$\therefore \dfrac{9}{b^2} + \dfrac{4}{a^2} = 1$ ...(i)

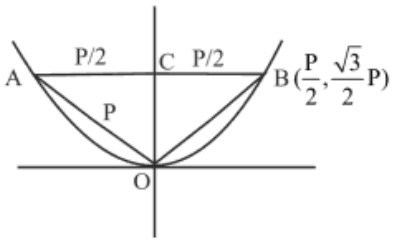
$\dfrac{1}{b^2} + \dfrac{36}{a^2} = 1$ ...(ii)

Solving equations (i) and (ii), we get

$a^2 = 40$ and $b^2 = 10$

Eccentricity of ellipse $= \sqrt{1 - \dfrac{b^2}{a^2}} = \sqrt{1 - \dfrac{10}{40}} = \dfrac{\sqrt{3}}{2}$

61. (c)



$$OC = \sqrt{P^2 - \frac{P^2}{4}} = \frac{\sqrt{3}}{2}P$$

$$\therefore BC\left(\frac{P}{2}, \frac{\sqrt{3}}{2}P\right)$$

Which lies on parabola

$x^2 = \sqrt{3}\,y$ i.e., $x^2 = qy$

[$\because$ Length of latus rectum = q]

$$\therefore \frac{P^2}{4} = q\frac{\sqrt{3}}{2}P \Rightarrow P = 2\sqrt{3}\,q$$

62. (b) $AC = \sqrt{(4-2)^2 + (6-4)^2 + (4-6)^2}$

$= \sqrt{4+4+4} = 2\sqrt{3}$

$BD = \sqrt{(8+2)^2 + (14+4)^2 + (12+2)^2}$

$= 2\sqrt{187}$

$\because AC \neq BD$ (i.e., Diagonals are not equal.)

So, statement is wrong.

Mid point of AC = (3, 5, 5) is equal to mid point of BD = (3, 5, 5)

So, statement 2 is correct

63. (b) $x^2 + y^2 + z^2 - 4x - 6y - 8z - 16 = 0$

$\Rightarrow (x^2 - 4x + 4) + (y^2 - 6y + 9) + (z^2 - 8z + 16)$

$= 16 + 4 + 9 + 16$

$\Rightarrow (x-2)^2 + (y-3)^2 + (z-4)^2 = (3\sqrt{5})^2$

$\therefore$ Centre of sphere = (2, 3, 4)

Radius = $3\sqrt{5}$

Since, radius $3\sqrt{5}$ is not equal to $\sqrt{2^2 + 3^2} = \sqrt{13}$

$\therefore$ Z-axis is not tangent to the sphere, so, statement 1 is wrong.

$\because 2 + 3 + 4 - 9 = 0$

$\therefore$ Centre of the sphere lies on the plane $x + y + z - 9 = 0$

So, statement 2 is correct.

64. (c) Equation plane is $\frac{x}{2} + \frac{y}{2} + \frac{z}{1} = 1$

$\Rightarrow x + y + 2z - 2 = 0$

$\therefore$ direction ratio's of normal are < 1, 1, 2 >

So, Direction cosines of normal are $< \frac{1}{\sqrt{6}}, \frac{1}{\sqrt{6}}, \frac{2}{\sqrt{6}} >$

65. (c) The direction cosines of y-axis are < 0, 1, 0 >

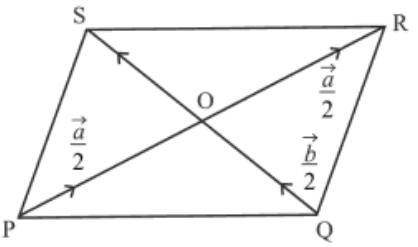
$\therefore$ The direction ratio of y-axis are in the form $< 0, a, 0 >, \forall a \in R$

So, statement 1 is correct.

We have direction ratio of a line perpendicular to Z-axis are in the form $< a, b, 0 >$

So, statement 2 is correct.

66. (d)



$\overrightarrow{PQ} = \overrightarrow{PO} - \overrightarrow{QO}$

$= \frac{\vec{a}}{2} - \frac{\vec{b}}{2} = \frac{1}{2}(\vec{a} - \vec{b})$

67. (c) According to question, $|\vec{a}| = |\vec{c}| = 1$

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

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

$\Rightarrow 5 + 6\vec{a}.\vec{c} - 8 = 0 \quad \Rightarrow \vec{a}.\vec{c} = \frac{1}{2}$

Now, $\cos\theta = \frac{\vec{a}.\vec{b}}{|\vec{a}||\vec{b}|} = \frac{1}{2}$

$\Rightarrow \cos\theta = \cos\frac{\pi}{3} \Rightarrow \theta = \frac{\pi}{3}$

68. (d) $\{(3\vec{a} + 2\vec{b}) \times (5\vec{a} - 4\vec{c})\}.(\vec{b} + 2\vec{c})$

$= \{0 - 12\vec{a} \times \vec{b} + 10\vec{b} \times \vec{a} - 8\vec{b} \times \vec{c}\}.(\vec{b} + 2\vec{c})$

$= -12[\vec{a}\ \vec{c}\ \vec{b}] + 10[\vec{b}\quad \vec{b}] - 8[\vec{b}\ \vec{c}\ \vec{b}]$

$\quad - 24[\vec{a}\ \vec{c}\ \vec{c}] + 20[\vec{b}\ \vec{a}\ \vec{c}] - 16[\vec{b}\ \vec{c}\ \vec{c}]$

$= 0$ [$\because \vec{a}, \vec{b}, \vec{c}$ are coplaner so, $[\vec{a}\ \vec{b}\ \vec{c} = 0]$ and $[\vec{b}\ \vec{a}\ \vec{c}], [\vec{b}\ \vec{c}\ \vec{b}]$ all are zero]

69. (a) Given that angle between vectors is obtuse

$\therefore \vec{a}.\vec{c} < 0$

$\Rightarrow 2x^2 - 6x + x^2 < 0 \Rightarrow 3x^2 - 6x < 0$

$\Rightarrow 3x(x-2) < 0 \quad \Rightarrow 0 < x < 2$

70. (d) $\overrightarrow{CA} = (3\hat{j} + 3\hat{k}) - (\hat{j} + \hat{k}) = 2\hat{j} + 2\hat{k}$

$\overrightarrow{CB} = (3\hat{j} + 3\hat{k}) - (3\hat{i} + \hat{j} + 5\hat{k})$

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

$\overrightarrow{CA}.\overrightarrow{CB} = 0 + 4 - 4 = 0$

$\cos C = \frac{\overrightarrow{CA}.\overrightarrow{CB}}{|\overrightarrow{CA}||\overrightarrow{CB}|} = 0 \quad \Rightarrow C = \frac{\pi}{2}$

71. (a) We have $x = [x] + \{x\}$

$\therefore \quad y = [x] - x = -\{x\}$

Now, $z = [y] = [-\{x\}] \quad [\because 0 < \{x\} < 1] = -1$

72. (a) Given that $f(g(x)) = g(f(x))$

$\Rightarrow \quad (f(kx+2) = g(4x+1)$

$\Rightarrow \quad 4(kx+2)+1 = k(4x+1)+2$

$\Rightarrow \quad 4kx + 9 = 4kx + k + 2 \Rightarrow k = 7$

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

$$\therefore f'(x) = \frac{2x+2}{x^2+2x+11}\log_{10}^{e} = 0$$

$\Rightarrow \quad x = -1$ (critical point)

$$f''(x) = \frac{2(x^2+2x+11)-(2x+2)^2}{(x^2+2x+11)^2}.\log_{10}^{e}$$

$\because \quad f''(-1) > 0$

$\therefore \quad$ Minimum value of $f(x)$

$f(-1) = \log_{10} 10 = 1$

74. (b) $I = \int (x^x)^2 (1 + \int lnx) dx$

Let $x^x = t$

$\Rightarrow \quad ln\, t = x\, ln\, x \quad \Rightarrow \quad dt = x^x (1 + ln\, x)\, dx$

$$I = \int t\, dt = \frac{t^2}{2} + C = \frac{1}{2}(x^x)^2 + C$$

$$\frac{1}{2}x^{2x} + C$$

75. (a) $\because \dfrac{d(xlnx)}{dx} = 1 + lnx$

$$\therefore I = \int e^x \{1 + lnx + xlnx\}\, dx$$

$$= x\, ln\, x\, e^x + c \left[\because \int e^x (f(x) + f'(x) dx = e^x f(x) + c)\right]$$

76. (c) $I = \int \dfrac{\cos^{3/2} x - \sin^{3/2} x}{\sin^{1/2} x . \cos^{1/2} x} dx$

$$\int \left(\sin^{-1/2} x.\cos x - \cos^{-1/2} x.\sin x\right) dx$$

$$= 2.\sin^{1/2} x + 2.\cos^{1/2} x + C \quad = 2\sqrt{\sin x} + 2\sqrt{\cos x} + C$$

77. (c) We have

$$\int \sqrt{x^2 - a^2}\ dx = \frac{x}{2}\sqrt{x^2 - a^2} - \frac{a^2}{2} ln \left| x + \sqrt{x^2 - a^2} \right|$$

$$\therefore \frac{dy}{dx} = \sqrt{x^2 - 16}.$$

78. (b) $y = \left(x^x\right)^x = x^{x^2}$

Taking *ln* both sides, we get

$ln\, y = x^2 \ln x$

Differentiate w.r.t to x.

$$\frac{1}{y}\frac{dy}{dx} = 2xlnx + x^2.\frac{1}{x}$$

$$\Rightarrow \quad \frac{dy}{dx} = (x + 2x\, ln\, x) \qquad \Rightarrow \quad \frac{dy}{dx} = xy\,(1 + 2\, ln\, x)$$

$$\Rightarrow \quad \frac{dy}{dx} - xy\,(1 + 2\, ln\, x) = 0$$

79. (b) Let $f(x) = 3(\sin x - \cos x) + 4(\cos^3 x - \sin^3 x)$

$f'(x) = 3(\cos x + \sin x) - 12 \sin x \cos x (\cos x + \sin x)$

$= 3(\cos x + \sin x)(1 - 2\sin 2x) = 0$

$$\Rightarrow x = \frac{3\pi}{4}, \frac{\pi}{6}$$

$f''(x) = 3(-\sin x + \cos x)(1 - 2\sin 2x)$

$\qquad - 3(\cos x + \sin x)(-4 \cos 2x)$

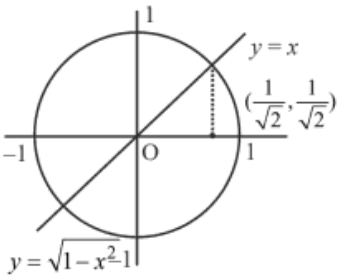
$$f''\left(\frac{3\pi}{4}\right) < 0 \text{ and } f''\left(\frac{\pi}{6}\right) > 0$$

$$\therefore \quad f(x) \text{ is maximum at } x = \frac{3\pi}{4}$$

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

$$= 3\sqrt{2} - 2\sqrt{2} = \sqrt{2}$$

80. (c)



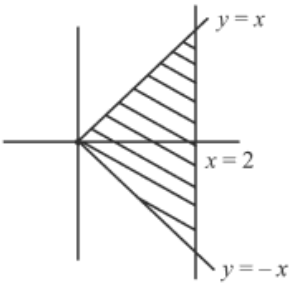
$\Rightarrow \quad x^2 + y^2 = 1$

Required area

$$\int_0^{1/\sqrt{2}} x\, dx + \int_{1/\sqrt{2}}^{1} \sqrt{1 - x^2}\, dx$$

$$= \left[\frac{x^2}{2}\right]_0^{1/\sqrt{2}} + \left[\frac{x}{2}\sqrt{1-x^2} + \frac{1}{2}\sin^{-1} x\right]_{1/\sqrt{2}}^{1} = \frac{\pi}{8}$$

81. (c)



$x = |y|$

Required area $= 2\int_0^2 x\, dx = 2\left[\dfrac{x^2}{2}\right]_0^2 = 2 \times 2 = 4$

82. (b) $f(\alpha)=\sqrt{\sec^2\alpha-1}=\tan\alpha$

$\therefore \dfrac{f(\alpha)+f(\beta)}{1-f(\alpha).f(\beta)}=\dfrac{\tan\alpha+\tan\beta}{1-\tan\alpha.\tan\beta}$

$=\tan(\alpha+\beta)=f(\alpha+\beta)$

83. (a) $\because \quad f(x)=ln\left(x+\sqrt{1+x^2}\right)$ ...(i)

$f(-x)=ln\left(-x+\sqrt{1+x^2}\right)$ ...(ii)

Adding equations (i) and (ii)

$f(x)+f(-x)=ln(\sqrt{1+x^2}+x)+ln(\sqrt{1+x^2}-x)$

$=ln1=0$

84. (d) $\lim\limits_{x\to0}\dfrac{x}{\sqrt{1-\cos4x}}=\lim\limits_{x\to0}\dfrac{2x}{\sqrt{2}|\sin2x|}\times\dfrac{1}{2}$

L.H.L $=-\dfrac{1}{2\sqrt{2}}$ and R.H.L. $=\dfrac{1}{2\sqrt{2}}$

$\because$ L.H.L $\neq$ R.H.L.

So, $\lim\limits_{x\to0}f(x)$ is not exist.

85. (a) $\lim\limits_{x\to\frac{\pi}{2}}\dfrac{4x-2\pi}{\cos x}$

Apply L' Hospital rule.

$\lim\limits_{x\to\frac{\pi}{2}}\dfrac{4}{-\sin x}=-4$

86. (d) L.H.L. $=\lim\limits_{x\to0^-}f(x)=\lim\limits_{x\to0^-}=\dfrac{x^2+x-x}{x}=\lim\limits_{x\to0^-}x=0$

R.H.L. $=\lim\limits_{x\to0^+}f(x)=\lim\limits_{x\to0^+}\dfrac{x^2+2x}{x}=\lim\limits_{x\to0^-}x+2=2$

$\because$ L.H.L $\neq$ R.H.L.

$\therefore \quad \lim\limits_{x\to0}f(x)$ does not exist.

87. (c) $\lim\limits_{h\to0}\dfrac{\sin^2(x+h)-\sin^2x}{h}$

Apply L' Hospital rule

$\lim\limits_{h\to0}2\sin(x+h).\cos(x+h)$

$=2\sin x.\cos x$ [Take x as constant]

$=\sin2x$

88. (c) $h(x)=\{f(x)\}^2+\{g(x)\}^2$

$=\{f(x)\}^2+\{f'(x)\}^2$

$h'(x)=2f(x).f'(x)+2f'(x)f''(x)$

$=2f(x)f'(x)-2f(x)f'(x)=0$

$\because$ h'$(x)=0$

$\therefore \quad h'(3)=0$

Statement 1 is correct.

$h'(x)=0 \Rightarrow h(x)=$ constant function

$\therefore \quad h(1)=f(2)$

Statement 2 is correct.

89. (b) $y=\left[ln\left(\dfrac{x^2-x+1}{x^2+x+1}\right)\right]^2$

$\dfrac{dy}{dx}=2ln\left(\dfrac{x^2-x+1}{x^2+x+1}\right)\times\dfrac{x^2+x+1}{x^2-x+1}$

$\times\dfrac{(2x-1)(x^2+x+1)-(2x+1)(x^2-x+1)}{(x^2+x-1)^2}$

Put $x=0$

$\dfrac{dy}{dx}=0$

90. (d) Let $f(x)=\dfrac{x^8+x^4+1}{x^4-x^2+1}$

$=\dfrac{x^8+2x^4+1-x^4}{x^4-x^2+1}=\dfrac{(x^4+1)^2-(x^2)^2}{(x^4-x^2+1)}$

$=\dfrac{(x^4-x^2+1)(x^4+x^2+1)}{x^4-x^2+1}$

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

$f'(x)=4x^3+2x=ax+bx^3$

$\Rightarrow \quad a=2, b=4 \quad \Rightarrow \quad b=2a$

91. (a) $f(x)=(P\sec x)^2+(q\ \text{cosec}\ x)^2$

$f'(x)=2P^2\sec^2x\tan x-2q^2\ \text{cosec}^2x.\cot x=0$

$\Rightarrow\dfrac{p^2}{q^2}=\dfrac{\text{cosec}^2x.\cot x}{\sec^2x.\tan x}=\cot^4x$

$\Rightarrow \quad \cot^2x=\dfrac{p}{q}\Rightarrow\tan^2x=\dfrac{q}{p}$

$f'(x)=2p^2(\tan x+\tan^3x)-2q^2(\cot x+\cot^3x)$

$f''(x)=2p^2\sec^2x(1+3\tan^2x)+2q^2\ \text{cosec}^2x(1+3\cot^2x)$

For $\tan^2x=\dfrac{q}{p}$

$f''(x)>0$

$\therefore \quad f(x)$ is minimum when $\tan^2x=\dfrac{q}{p}$

92. (b) $f(x)=\sum\limits_{j=1}^{7}(x-j)^2=\sum\limits_{j=1}^{7}(x^2-2xj+j^2)$

$x^2\sum\limits_{j=1}^{7}1-2x\sum\limits_{j=1}^{7}j+\sum\limits_{j=1}^{7}j^2$

$=7x^2-2x\dfrac{7(7+1)}{2}+\dfrac{7(7+1)(14+1)}{6}$

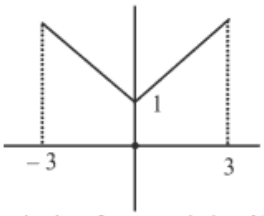
$=7x^2-56x+140$

$f'(x)=14x-56=0\Rightarrow x=4$

$f''(x)=14>0$

$\therefore \quad f(x)$ is minimum at $x=4$.

93. (b)



It is clear from graph that $f(x)$ is maximum at 3 and -3 and minimum at $x = 1$.

94. (b) $I = \int_0^1 ln\left(\frac{1}{x}-1\right)dx = \int_0^1 [ln(1-x) - lnx]dx$

$= \int_0^1 ln(1-x)dx - \int_0^1 lnx\ dx$

$= \int_0^1 ln(1-x)dx - \int_0^1 ln(1-x)\ dx = 0$

95. (d)

96. (a) $I = \int_{-\pi/2}^{\pi/2} (e^{\cos x}\sin x + e^{\sin x}\cos x)dx$

$= \int_{-\pi/2}^{\pi/2} e^{\cos x}.\sin x\ dx \pm \int_{-\pi/2}^{\pi/2} e^{\sin x}.\cos x\ dx$

$\because$ $e^{\cos x}.\sin x$ is odd function.

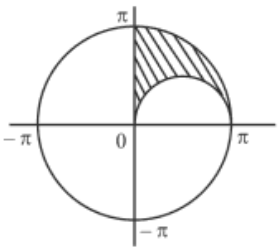
$\therefore \int_{-\pi/2}^{\pi/2} e^{\cos x}.\sin x\ dx = 0$

Let $\sin x = t$, $\cos x\ dx = dt$

when $x = \frac{-\pi}{2}$, $t = -1$, when $x = \frac{\pi}{2}$, $t = 1$

$\therefore$ $I = \int_{-1}^{1} e^t\ dt = e - e^{-1} = \frac{e^2-1}{e}$

97. (b)



Required area

$= \frac{1}{4}\pi(\pi)^2 - \int_0^{\pi} \sin x\ dx = \frac{\pi^3}{4} - [-\cos x]_0^{\pi} = \frac{\pi^3}{4} - 2$

98. (b) 1. $\frac{dy}{dx} + \cos\left(\frac{dy}{dx}\right) = 0$

Degree is not define, so, statement 1 is wrong.

2. Highest derivative is two therefore order is 2. So, statement 2 is correct.

99. (b) Let equation of parabola is

$x^2 = 4ay$ ...(i)

$\therefore$ $2x = 4a\frac{dy}{dx}$

$\Rightarrow 2x = \frac{x^2}{y}\frac{dy}{dx} \Rightarrow x\frac{dy}{dx} - 2y = 0$

100. (c) $(dy - dx) + \cos x\,(dy + dx) = 0$

$\Rightarrow$ $(1 + \cos x)dy = (1 - \cos x)dx$

$\Rightarrow \frac{dy}{dx} = \frac{1-\cos x}{1+\cos x} = \tan^2\frac{x}{2} = \sec^2\frac{x}{2} - 1$

$\int dy = \int\left(\sec^2\frac{x}{2} - 1\right)dx$

$\Rightarrow$ $y = 2\tan\frac{x}{2} - x + C$

101. (c) Mean of squares of first n natural number

$x = \frac{n(n+1)(2n+1)}{6n} = \frac{(n+1)(2n+1)}{6}$

Square of mean of first n natural numbers

$y = \left(\frac{n(n+1)}{2n}\right)^2 = \frac{(n+1)^2}{4}$

$\therefore \frac{x}{y} = \frac{2(2n+1)}{3(n+1)} = \frac{55}{42}$

$\Rightarrow$ $28\,(2n + 1) = 55(n + 1) \Rightarrow n = 27$

102. (b) Prime number between 1 to 50 are 2, 3, 5, 7, 11, 13, 17, 19, 23, 29, 31, 37, 41, 43, 47.

1 is not prime and composite number.

$\therefore$ Total number of composite number between

$= 50 - 16 = 34$

$\therefore$ Probability $= \frac{34}{50} = \frac{17}{25}$

103. (a) $\because$ ${}^nC_7 = \frac{n!}{(n-7)!7!}$

$= \frac{n(n-1)(n-2)(n-3)(n-4)(n-5)(n-6)}{7!}$

is not divisible by 7 for $n > 7$

$\therefore$ $n(E) = 0$ $\Rightarrow$ $P(E) = 0$

104. (b) $n(s) = 10 \times 9 = 90$

Sum of $x + y$ is divisible by 4 are

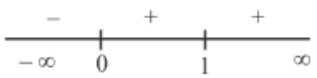
(1, 3), (1, 7), (2, 6), (2, 10), (3, 1), (3, 5), (3, 9), (4, 8), (5, 3), (5, 7), (6, 2), (6, 10), (7, 1), (7, 5), (7, 9), (8, 4), (9, 3), (9, 7), (10, 2), (10, 6)

$n(E) = 20$

$\therefore$ $P(E) = \frac{20}{90} = \frac{2}{9}$

105. (c) $x + \frac{1}{x} > 2 \Rightarrow \frac{x^2+1}{x} - 2 > 0$

$\Rightarrow \frac{x^2-2x+1}{x} > 0 \Rightarrow \frac{(x-1)^2}{x} > 0$



$x \in (0, \infty) - \{1\}$ and $x \in N$

$\therefore$ $n = \{2, 3, 4, ...n)$

$\therefore \quad n(E) = n - 1$

$$P(E) = \frac{n-1}{n}$$

106. (b) $n(s) = 6 \times 6 \times 6$

Different numbers that are in AP.

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

$n(E) = 12$

$$P(E) = \frac{12}{6 \times 6 \times 6} = \frac{1}{18}$$

107. (b) $P(A \cup B) = P(A) + P(B) - P(A \cap B)$

$= 0.5 + 0.7 - 0.3 = 0.9$

$\therefore \quad P(A' \cap B') + P(A' \cap B) + P(A \cap B')$

$= 1 - P(A \cup B) + P(B) - P(A \cap B) + P(A) - P(A \cap B)$

$= 1 - P(A \cap B) = 1 - 0.3 = 0.7$

108. (a) $n = 5$

$$P = P(T) = \frac{1}{2}, q = 1 - \frac{1}{2} = \frac{1}{2}$$

$P(x \le 4) = 1 - P(x = 5)$

$$= 1 - \left(\frac{1}{2}\right)^5 = 1 - \frac{1}{32} = \frac{31}{32}$$

109. (d) $n(s) = 6 \times 6 \times 6 = 216$

Sum greater than or equal to 15 i.e. 15, 16, 17, 18 are (4, 5, 6) → 6 ways;

(5, 5, 6) → 3ways; (5, 5, 5) → 1 way; (6, 6, 3) → 3 ways (6, 6, 4) → 3 ways; (6, 6, 5) → 3 ways; (6, 6, 6) → 1way

$\therefore \quad n(E) = 20$

$$P(E) = \frac{20}{216} = \frac{5}{54}$$

110. (c) $n = 4, P = 0.5, q = 1 - 0.5 = 0.5$

$P(x \ge 1) = 1 - P(x = 0) = 1 - (0.5)^4$

$$= 1 - \frac{1}{16} = \frac{15}{16}$$

111. (c) W = 2, B = 3, R = 4

Total balls = 2 + 3 + 4 = 9

$\therefore$ Number of ways of drawing 3 balls with at least one black ball

$= {}^3C_1 \cdot {}^6C_2 + {}^3C_2 \cdot {}^6C_1 + {}^3C_3$

$= 45 + 18 + 1 = 64$

112. (d) $n = 5, q = P(\text{sunk}) = \frac{1}{5}, P = 1 - \frac{1}{5} = \frac{4}{5}$

$$P(x = 3) = {}^5C_3 \left(\frac{4}{5}\right)^3 \left(\frac{1}{5}\right)^2 = \frac{128}{625}$$

113. (a) Number of favorable outcomes (either spade or ace) $= 13 + 3 = 16$

Number of unfavorable outcomes

$= 52 - 16 = 36$

$\therefore$ Odds against his winnings $= \dfrac{\text{No. of unfavorable}}{\text{No. of favorable}}$

$$= \frac{36}{16} = 9:4$$

114. (c) $\therefore r = \dfrac{\Sigma(x_i - \bar{x})(y_i - \bar{y})}{\sqrt{\Sigma(x_i - \bar{x})^2 \, \Sigma(y_i - \bar{y})^2}} = 0.7$

At time of silver jubilee new $\bar{x}$ and $\bar{y}$ increase 25 also each *xi* and *yi* increase with 25

Therefore, $(xi - \bar{x})$, $(yi - \bar{y})$ not change

So, coefficient of correlation remains same

Hence, new coefficient of correlation = 0.7

115. (b) Let E_1 = strike; E_2 = no strike

F = Job completed on time.

$\therefore \quad P(F) = P(F/E_1).P(E_1) + P(F/E_2).P(E_2)$

$= 0.35 \times 0.6 + 0.4 \times 0.85 = 0.55$

$P(\bar{F})$ = P (Job not completed on time)

$= 1 - 0.55 = 0.45$

116. (d) C.V. of Mathematics $= \dfrac{15}{40} \times 100 = 37.5\%$

C.V. of Physics $= \dfrac{12}{28} \times 100 = 42.86\%$

C.V. of Chemistry $= \dfrac{14}{38} \times 100 = 36.84\%$

C.V. of Biology $= \dfrac{16}{36} \times 100 = 44.44\%$

Since C.V. of Biology is greatest, therefore, Biology have more variability.

117. (a) C.V. of mathematics = 37.5%

118. (c)

Class	0-10	10-20	20-30	30-40	40-50	50-60
f i	1	2	4	6	4	3
C.F.	1	3	7	13	17	20

$$\frac{N}{2} = \frac{20}{2} = 10$$

$\therefore$ Median class = 30 – 40

$\therefore$ Median $= l + \dfrac{\frac{N}{2} - C}{f} \times h.$

$$\text{Me} = 30 + \frac{10 - 7}{6} \times 10$$

$= 30 + 5 = 35$

119. (d)

Class	0-10	10-20	20-30	30-40	40-50	50-60	Total
xi	5	15	25	35	45	55	
$\|xi-Me\|$	30	20	10	0	10	20	
fi	1	2	4	6	4	3	20
fi $\|xi-Me\|$	30	40	40	0	40	60	210

$$\text{Meadian} = \frac{\sum |x_i - M_e|}{\sum f_i} = \frac{210}{20} = 10.5$$

120. (b)

Class	0-10	10-20	20-30	30-40	40-50	50-60	Total
fi	1	2	4	6	4	3	20
xi	5	15	25	35	45	55	
$xi\,fi$	5	30	100	210	180	165	690
$\|xi-\bar{x}\|$	29.5	19.5	9.5	0.5	10.5	20.5	
$fi\|xi-\bar{x}\|$	29.5	39	38	3	42	61.5	213

$$\text{Mean} = \frac{\sum x_i f_i}{\sum f_i} = \frac{690}{20} = 34.5$$

Mean deviation about mean

$$= \frac{\sum |x_i - \bar{x}| f_i}{\sum} = \frac{213}{20} = 10.65$$

GENERAL ABILITY

PART- A: ENGLISH

1. (b) Craving means: strong desire for something. Antonyms of Craving: "dislike, indifference, aversion, disinterest etc".
2. (c) Obscure means: uncertain. Its antonyms: "obvious, bare, known etc".
3. (d) Monumental means: tremendous, enormous and memorable. Its antonyms: "insignificant, unimpressive".
4. (c) Frail means weak and delicate. Its antonyms: "sturdy and strong".
5. (d) Hapless means unfortunate. Its antonym will be: "fortunate and well-off".
6. (c) Eccentric means unconventional .Its antonyms: "ordinary and normal".
7. (c) Parched means: very hot and dry. Its antonyms: "Wet and soaking".
8. (a) Smooth means: glossy. Its antonyms: "rutted and rough".
9. (b) Plenitude means: an abundance and plethora. Its antonyms: "scarcity and insufficiency".
10. (d) Irrefutable means: undeniable and impregnable. Its antonyms: "questionable and doubtful".
11. (b) Malign means: "slander, malicious and harmful".
12. (c) Vexed means: "annoyed, irritated and displeased".
13. (a) Preconception: "idea or notion".
14. (a) Mortal means: "perishable and temporal".
15. (c) Itinerary means: "information and guidebook".
16. (d) Harness means: "control and yoke".
17. (a) fickle means : "inconstant and capricious".
18. (b) Calamitous means : "catastrophic and disastrous".
19. (d) honorary means : "unpaid and unsalaried" .
20 (c) Excommunicate: "ostracized, rejected and spurned".
21. (a) SQPR , **Correct sequence**: "Have you ever considered what it is to be successful as a human being"?
22. (d) SQPR, **Correct sequence** : "Many people today are willing to surrender to the idea that there is in all instance a single, authoritative truth to be discovered an defended".
23. (b) QPSR , **Correct sequence** : "If you do not reflect and understand for yourself the implications of death, you will go endlessly from one preacher to another".
24. (d) QPSR**,** Correct **sequence:** "A language represents a way of understanding the world ,differentiating between the things and relating them to one another".
25. (d) SQRP, **Correct sequence**: "It is recognized that mathematics and mathematical thinking will be very important for India's future".
26. (c) SPRQ**, Correct sequence**: "The preparation of professionals in agriculture and veterinary sciences, through programmes integrated with general education, will be enhanced sharply".
27. (d) SQPR, **Correct sequence** : "The issues raised by feminists and multiculturalists are certainly very important, and should shift the way we think about politics".
28. (b) SPRQ, **Correct sequence**: "Genetic modification(GM) is the science by which the genetic material of a plant is altered, perhaps to make it more resistant to pests and enhance its nutritional value".
29. (a) QSRP, , **Correct sequence**: "The editors of the present work argue the need to understand the history of social reforms from a much wider array of perspectives".
30. (c) RSQP, **Correct sequence**: "Pandita Ramabai was truly remarkable as a pioneer in women's education and as a champion of women's rights, for which she fought till the end".
31. (c) Raise means: to lift something up, whereas Rise means: to move upwards, to become higher, stronger or to increase**. Correct sentence**: "Our greatest glory is not in never falling but in (rising) every time we fall".
32. (a) The rule is that 'one of+ plural noun or pronoun **Correct statement**: "Rahim was one of (those) selected for the award".
33. (a) As the sentence refers to two incidents happening in the past , the earlier event will take "had+verb 3rdform" whereas later event will take past indefinite " verb 2nd form". **Correct statement**: "Sujini had met her old friend guru before she shifted to Hyderabad two years ago".
34. (b) "The" is always followed by superlative degree of adjective hence "oldest" will be used. **Correct sentence**: "This monument happens to be one of the oldest monuments in the city".

35. (a) You must use "said to" for direct speech and "told" for indirect speech. Correct sentence: "Amit told Divya that he would come with a reward for her" .
36. (a) Two past events are taking place hence in earlier past event past perfect (had + verb 3rd form) and in later event present perfect (have + verb 3rd form) will be used. **Correct statement** : "If you had asked me for the truth ,i would have told you at that time" .
37. (a) This is an imaginary sentence and in these sentences we use verb 'were' irrespective of the subject of the sentence .**Correct statement**: "If I were a millionaire, I would eradicate poverty from the country" .
38. (a) **Correct idiom**: A bird in the hand is worth two in the bush.
39. (b) The word 'honest' starts with a vowel sound, since the letter "h" is not pronounced in this situation. Some other examples: an herb,an hour and an honourable. **Correct Statement**: "The opportunity to attain foundational literacy and pursue 'an' honest livelihood must be viewed as basic right of every citizen".
40. (b) Error is in 'b' part because preposition 'in' will be used here.
Correct statement: "Though there is progress 'in' different directions, why is there no brotherhood"?
41. (a) A queer fish means: "**A strange person**".
42. (d) Eat like a bird refers to : "**eat very little**".
43. (b) Lock horns means: **"Argue about something or quarrel."**
44. (d) An early bird means **: "a person who rises, arrives, or acts before the usual or expected time".**
45. (a) Be in the pink means: **"To be very healthy"**
46. (c) Appropriate answer**: "In a good position to win".**
47. (b) Appropriate answer**: "Complete change".**
48. (c) Appropriate answer**: "An important piece of advice".**
49. (d) Appropriate answer**: "To be extremely happy".**
50. (a) Appropriate answer**: "To owe money to a bank".**

PART- B: GENERAL KNOWLEDGE

51. (b) Harishena was the 4th-century Sanskrit poet. He was an important figure in the court of Gupta emperor, Samudragupta. Prayag Prashasti, is attributed to the 4th century CE Gupta emperor Samudragupta. It is in excellent Sanskrit, written in the more refined Gupta script by the poet and minister, Harishena. The inscription is a panegyric praising Samudragupta and lists the political and military achievements of his reign including his expeditions to the south. It provides a unique snapshot of the Gupta Empire and its neighbours and is the source of much of what is known of the geopolitical landscape of that era.
52. (c)
53. (b) The Battle of Plassey laid the formal foundation of British raj in India. It was a decisive victory of the British East India Company over the Nawab of Bengal and his French allies on 23 June 1757.
54. (b) The East India company established trading posts at different locations in India. In 1639 the trading post was constructed in Madras. It was followed by more trading posts in the year inside Bombay (1668) and in Calcutta (1690).
55. (c) Vasco da Gama reached the coast of India at Calicut in May 1498 and was able to cross the Indian Ocean. The British East India Company was a private corporation formed in December 1600 to establish a British presence in the lucrative Indian spice trade. The Dutch East India Company established in 1602 when the States General of the Netherlands granted it a 21-year monopoly to carry out trade activities in Asia.
56. (c) The cultivable land which is left uncultivated for more than a year but less than five years is known as 'Fallow other than Current Fallow'. Following is a cultural practice adopted for giving the land rest. The land recoups the lost fertility through natural processes.
If the land is left uncultivated for more than five years, it would be categorised as culturable wasteland. This land which is left without cultivation for one or less than one agricultural year is known as Current Fallow.
57. (c)
58. (d) There are 111 officially notified Inland National Waterways (NWs) in India identified for the purposes of inland water transport, as per The National Waterways Act, 2016.
The total cargo moved by the inland waterway was just 0.1% of the *total* inland traffic in India and the country is lagging far behind in the navigable inland waterways.
59. (b) The headquarters of East Central Railway is Hajipur. Gorakhpur is the headquarter of North Eastern Railway. The headquarters of North Frontier Railway and North Western Railway is Maligaon, Gauhati and Jaipur respectively.
60. (d)
61. (a) One kilowatt-hour is equivalent to a power of 1 kW being used for 1 hour. Or, $1\ kWh = 1kW \times 1hour = 1000 \times 3600W.s$.
Or, $1kWh = 3.6 \times 10^6 J$. (Since, 1W = 1 J/s)
62. (d) The field lines inside the solenoid are in the form of parallel straight lines. This magnetic field is the same at all points inside the solenoid and therefore the field is uniform inside the solenoid. A *current carrying solenoid behaves* like a bar magnet. *The magnetic field inside a solenoid* is proportional to both the applied current and the number of turns per unit length. *The magnetic field inside a solenoid* is proportional to both the applied current and the number of turns per unit length.
When a soft iron core is inserted inside the solenoid then *the strength of the magnetic field becomes very large.*
63. (b) The average density of the object is given by
$\rho T = M/V$
Since the object is made up of two equal parts by volume
Hence volume of part 1 and part will be ½ V each
The density of part 1 is given by, **ρo** and the density of part 2 is, **$2\rho o$**

Le t the mass of part 1 is given by, $\mathbf{m}_1$ and the mass of part 2 is, m_2
then, $\rho o = m_1 / 0.5V$
and, $2\rho o = m_2 / 0.5V$
Here, ρT = Total density of the object, M = mass of object, and V = volume of object
$\rho T = M/V = (m1 + m_2)/ V$
$= (\rho o \times 0.5\ V) + (2\rho o \times 0.5\ V)/ V$
$= (3\ \rho o\ V/2\ )/ V = (3/2)\ \rho o$

64. (a) The Pressure cooker works like a sealed chamber. As steam builds inside this chamber pressure increases and raises the boiling point of water past 100°C, thereby speeding up the time it takes to boil or steam.
65. (d) X-rays are shorter in wavelength than UV rays and longer than gamma rays. X-rays have a wavelength in the range of **0.01–10 nm**.
66. (a) The formula for the power supplied is equal to current times the voltage, and shown as P=IV. Where P is the Power, I is the Current in Ampere and V is the Voltage in Volt,
Applying the formula, Power will be 0.6 A × 220 V =132 W
67. (d) Pitch is the sensation of the frequency of an emitted sound. Higher is the frequency higher is the pitch and similarly lower pitch corresponds to lower frequency.
68. (a) The correct sequence of reactivity with water is,
Zinc > Iron > Lead> Copper.
Water-reactive substances are those that spontaneously undergo a chemical reaction with water, as they are highly reducing in nature. Examples include alkali metals, lithium through caesium, and alkaline earth metals, magnesium through barium.
69. (c) Metals like **Calcium and Sodium** reacts with cold water. Calcium starts floating on water as the bubbles of hydrogen gas produced during the reaction stick to the surface of the metal and helps in floating.
70. (c) Sugar solution do not contain ions in significant numbers and these molecules do not break down into ions when dissolved. Therefore, these solutions cannot carry an electric current.
71. (b) Deep-Sea Divers breathe a Mixture of **Helium and Oxygen.** Helium is added to reduce the proportions of nitrogen and oxygen below those of air, to allow the gas mixture to be breathed safely on deep dives. A lower proportion of nitrogen is required to reduce nitrogen narcosis and other physiological effects of the gas at depth.
72. (c) Solid **silver oxide decomposes at temperatures greater than 280 °C**, yielding metallic silver and oxygen gas.
73. (d) Nerve cells generate electrical signals that transmit information. These electrical signals are **action potentials**, which transmit the information from one neuron to the other. An action potential is a rapid, temporary change in membrane potential and caused by **sodium (Na)** rushing to a neuron and **potassium (K)** rushing out.
74. (c) Silver articles turn black when exposed to the atmosphere for a few days due to the formation of silver sulphide. It is due to sulphur-containing gases in the air, it discolours and then darkens as it reacts with the gas to form a surface layer of sulphide of silver.
75. (d) Accommodation is the adjustment of the optics of the eye to keep an object in focus on the retina as its distance from the eye varies. This ability is mediated through the ciliary muscles of the eye and helps in change of the focal length of the lens by changing the curvature of lens.
76. (d) Adrenaline caused an increase in systolic blood pressure, a decrease in diastolic blood pressure, and **an increase in heart rate**. **Adrenaline** is a hormone also known as **epinephrine and** secreted by the medulla of the adrenal glands and functions primarily to increase cardiac output.
77. (b) Lipids are digested mainly in the small intestine by bile salts through the process of **emulsification**. This process helps in breaking lipids into fatty acids and mono-glycerides in the presence of lipases.
78. (b) **Animal cells have a cell membrane, but no cell wall**. On the other hand Plant cells have cell wall as well as a cell membrane. The cell wall surrounds the cell membrane and provides the plant cell its unique rectangular shape.
79. (d) Lymph is a fluid similar in composition to **blood plasma**. It is derived from blood plasma as fluids pass through capillary walls at the arterial end. Lymph is a clear to white fluid tissue which is composed of lymphocytes and white blood cells. Lymph is the part of the lymphatic system and is generally found in the lymphatic vessels and in the various cavities of the body.
80. (a) **The breakdown of glucose (**a 6-carbon compound) **in cytoplasm results in the formation of** two molecules of a 3-carbon compound called pyruvate through the process of Glycolysis. Pyruvate breaks further in mitochondria, forming **carbon dioxide and subsequent energy** is released.
81. (c)
82. (a) Telemedicine platform E-Sanjeevani integrated with the Ayushman Bharat Digital Mission. This integration will permit the pre-existing users of E-Sanjeevani to create their Ayushman Bharat Health Account (ABHA) with absolute ease. The E-Sanjeevani platform joined the 40 other digital health companies that have finished their Ayushman Bharat Digital Mission (ABDM) health integration.
83. (c) The purpose of SHRESHTA (Residential Education for Students in High Schools in Targeted Areas) is -providing seats for the meritorious SC boys and girls in the best private residential schools in the country. Every year, it is expected that about (3000) students would be selected for admission in Class 9 and Class 11 under the scheme.
84. (a) The Supreme Court on directed that every National Park and Wildlife Sanctuary in the country will have a mandatory eco-sensitive zone of at least 1 km starting from its demarcated boundaries. The decision was

made in response to a petition to protect forest lands in Tamil Nadu's Nilgiris district.

85. (b) *Geetanjali Shree's* 'Ret Samadhi' (2018), which was translated into English as 'T*omb of Sand'* is a novel written originally in Hindi. The novel won the 2022 International Booker Prize. The novel was translated in English by Daisy Rockwell.

86. (b) The *Flying shuttle* was created by an English inventor, John Kay. The flying shuttle was one of the key developments in the industrialization of weaving during the early industrial revolution. It allowed a single weaver to weave much wider fabrics, and it could be mechanized, allowing for automatic machine looms.

87. (a) Subhas Chandra Bose proclaimed the formation of the Provisional Government of Free India at Cathay Cinema Hall in Singapore on 21st October 1943. He was declared as the Head of State, Prime Minister and Minister of War. The Provisional Government not only enabled Bose to negotiate with the Japanese on an equal footing but also facilitated the mobilisation of Indians in East Asia to join and support the Indian National Army (INA).

88. (a) The historic Objectives Resolution was *moved by Jawahar Lal Nehru on 13 December 1946.* It was passed by Jawaharlal Nehru in the session of the constituent assembly. These resolutions were some guiding principles that helped our leaders in drafting the Constitution of India.

89. (b) The Kheda peasant was a peasant struggle. It was a satyagraha launched in March 1919 under the leadership of Gandhiji, Sardar Vallabhbhai Patel, Indulal Yajnik, N.M. Joshi, Shankerlal Pareekh and several others.
The Bardoli Satyagraha was a movement that began on 12 June 1928 for the peasants of Bardoli against arbitrary tax hikes.
The Gandhi-Irvin pact was *signed between Mahatma Gandhi and Lord Irwin the Viceroy of India on March 5, 1931.*
The *Second Round Table Conference* was held in London from 7 September 1931 to 1 December 1931.

90. (c) Unionist Party in Punjab *was founded by Fazli Husain, Chotu Ram and Sikandar Hayat*. It was formed in 1923 and basically represented the interests of Punjabi zamindars. The party was in opposition to the concept of Pakistan and formed a separate group of thirteen members in the Punjab Assembly when most Muslim Unionists joined the Muslim League. His death brought about the demise of the Unionist Party.

91. (d) In the process of metamorphism in some rocks grains or minerals get arranged in layers or lines. Such an arrangement of minerals or grains in metamorphic rocks is called foliation or lineation.

92. (b) The **Mohorovicic discontinuity** or the Moho separates the Earth's crust and the mantle.

93. (a) The greatest linear velocity of rotation of Earth is near the equator. Kampala, Uganda is near the equator and hence the linear velocity of rotation of Earth is greatest at this location.

94. (d) The International Date Line is located at *about 180° east or west*. It is halfway around the world from the prime meridian or 0° longitude. Crossing the line from the east to the west there is gain of a day (24 hours).

95. (a) The Greenwich pass through *England, France, Spain, Algeria, Mali, Burkina Faso, Togo, Ghana and Antarctica*. There is an international agreement that the meridian that runs through Greenwich, England, is considered as the official prime meridian.

96. (d) *Paleogeomorphology* is the study of historical physical geography or historical landforms. It is a branch of geomorphology that is concerned with the study of ancient topographic features now either concealed beneath the surface or removed by erosion.

97. (c) The velocity time-graph graph of a body moving with uniform acceleration represents **a** straight line.

98. (a) Amplitude is measured in metres; hence it is measured in the units of distance. The greater the amplitude of a wave then the more energy it is carrying.

99. (c) Current is the movement and flow of charge generally electrons.
Current can be calculated using the formula formula $I = Q/t$, where I represents the current, Q represents charge, and t represents time.
therefore, $Q = I\,t = 0.6\,A \times 10 \times 60\,s = 360\,C$
$= It = 0.6\,A \times 10 \times 60\,s =$ **360 C**

100. (c) A DC generator is a rotating machine that supplies an electrical output with unidirectional voltage and current. It operates on the principle of Faraday's laws of electromagnetic induction. Faraday's law *states that a current will be induced in a conductor which is exposed to a changing magnetic field*.

101. (c)

102. (d) *Speed is the distance covered by a body in unit time*, without considering any direction hence it is Scalar. Velocity is defined as the rate and direction of an object's movement or simply it is speed with direction and hence Vector.

103. (b) Bronze is an alloy tcomposed of **copper (Cu) and tin (Sn)**.Generrally it contains typically 88 percent copper and about 12 percent tin.

104. (a) Blue Vitriol are bright blue crystals containing five molecules of water ($CuSO_4 \cdot 5H_2O$) Mohr's salt also referred to as ammonium iron (II) sulphate with chemical formula is $(NH_4)_2Fe(SO_4)_2(H2O)_6$.
Washing soda is better known as sodium carbonate decahydrate with chemical formula $Na_2CO_3.10H_2O$. *Potassium permanganate* does not contain the water of crystallization as it is an inorganic compound with the chemical formula $KMnO_4$.

105. (d) Methanoic acid also known as formic acid, is released with bee stings and responsible for pain and irritation at the affected area. The formula of methanoic acid is HCOOH.

106. (a) Most of the margarine is made from hydrogenated oils or partial hydrogenation of vegetable oils. Fat

hydrogenation is process of combining vegetable oils with hydrogen, in order to make it more saturated to produce solid or semi-solid fats, such as margarine.

107. (d) **There are** three structural isomers for Pentane. These Structural isomers are n-pentane, Isopentane and Neopentane.
Structural isomers are molecules with the same chemical formula but different atomic arrangements and bonding patterns.

108. (c) **Different forms of sulphur like** sulphur dioxide **and other gases are escaped from the volcanoes and forms a crust** on the rocks involving the process of deposition.

109. (a) A block of dry ice has a surface temperature of -78.5 degrees. It contains a block of solid carbon dioxide. Mist is formed by Solid CO_2, once it gets temperature above this temperature as solid carbon dioxide bypasses the liquid state and goes directly into a gas in a process called **sublimation.**

110. (b) C_4H_8 is Isobutylene. It belongs to homologous series of alkene. Alkenes are defined as either branched or unbranched hydrocarbons that possess at least one carbon–carbon double bond (C=C) and have a general formula of $\mathbf{C_nH_{2n}}$.

111. (c) **Pepsin** is a stomach enzyme that serves to digest proteins found in ingested food. Gastric chief cells secrete pepsin as an inactive zymogen called pepsinogen. Parietal cells within the stomach lining secrete hydrochloric acid that lowers the pH of the stomach. In the small intestine, further digestion of protein is brought about by trypsin, chymotrypsin and carboxypeptidase.

112. (a) If an animal cell is surrounded by a medium with lower concentration of water it means it is placed in a hypertonic solution. As a result there will be a net flow of water out of the cell, and the cell will lose volume.

113. (c) Inside the cell, lysosome contains various enzymes. Lysosomes are membrane-enclosed compartments filled with hydrolytic enzymes that are used for the controlled intracellular digestion of macromolecules. These enzymes, include various nucleases, lipases, phospholipases, phosphatises, glycosidases, proteases etc.

114. (b) After fertilisation, the ovule is converted into seed and ovary into fruit. Fertilization occurs when one of the sperm cells fuses with the egg inside of an ovule.

115. (b)

116. (b) .Sweden was the host Country of World Environment Day 2022. The World Environment Day is celebrated by millions of people across the world on 5th June. The campaign slogan of World Environment Day 2022 is "Only One Earth".

117. (b) Indian Navy Ships **Nishank and Akshay** were decommissioned in June 2022. Both these naval ships were decommissioned after rendering 32 years of glorious service to the nation. INS Nishank and INS Akshay were part of the 22 Missile Vessel Squadron and 23 Patrol Vessel Squadron respectively under the operational control of Flag Officer Commanding, Maharashtra Naval Area.

118. (d) India signed a deal with United States to supply MH-60 R helicopter for Indian Navy. As a part of this deal, the Indian Navy received two MH-60 R multirole helicopters at Cochin International Airport .

119. (d) 'Surat' and 'Udaygiri' are indigenously built warships launched recently by the Defence Minister at the Mazagon Docks in Mumbai. Udaygiri is a frigate ship. And Surat is a Visakhapatnam Class guided-missile destroyer.

120. (a) The kingdom of Vijayanagar was founded by **Harihara and Bukka**. They are regarded as the founders of the Vijayanagar City in 1336 A.D. on the southern banks of Tungabhadra.

121. (b) Kalila wa Dimna is a book containing a collection of fables. It is based on the Sanskrit text Pañchatantra. The *Panchatantra* is a compilation of inter-woven series of tales in prose and poetry, mostly animal fables written around 200 BC by Pandit Vishnu Sharma.

122. (b) The **Bhoodan Movement was initiated by Acharya Vinoba Bhave.** The movement continued for thirteen years and Vinoba toured the length and breadth of the country, a total distance of 58741 Km.

123. (a) 124. (c)

125. (a) Evidences of fire altars are found in **Lothal and Kalibangan. These altars were found** towards the Late Harappan phase.

126. (c) The physiological density or real population density is the number of people per unit area of arable land. Agricultural density is found by dividing an area of farmland by the total population of farmers in the same area.
Population density or the number of individuals divided by the size of the area.

127. (a) Tors are landforms created by **the erosion and weathering of rock**. It is associated most commonly with granites. It also involves schists, dacites, dolerites, ignimbrites, coarse sandstones and others.

128. (b) The Pressure Condition Pattern of Wind Direction at the Centre in case of anticyclones are high and these are characterized by divergent wind circulation.

129. (a) **The Earth's crust is brittle** in nature and can break. The thickness of oceanic crust is **6–12 km** and it is basaltic in composition as compared to the continental crust which averages 30–40 km thick and has a roughly andesitic composition.

130. (d) The merger of Union Territories (UTs) took place by the Dadra and Nagar Haveli and Daman and Diu (Merger of Union Territories) Bill, 2019. This bill was passed by the Lok Sabha on November 27, 2019, and by Rajya Sabha on December 03, 2019.

131 (b) The focal length (F) of the combined convex lens is given by formula,
1/F=1/f1 + 1/f2 (where f1 and f2 are the foal lengths of individual lens)
Then the combined focal length will be Combined focal length (F): =f1f2/[f1 + f2]

$= 50 \times 25/ (50+25) = 1250/75 = 50/3$ cm$= 1/6$ metre
The power of the lens is calculated in Diopters (d) if the focal length is given in meters and written as P=1/F therefore the power of the combined lens will be + 6 D

132. (b) The electric power is given by P = VI, where V is the potential difference, I is the electric current and P is the electric power.
Since, V = IR
Therefore $P = IR \times I = I^2R$
Or, $I^2R = (V/R)^2 \times R = V^2/R$

133. (c) The relationship between refractive index and speed of light in the medium is,
n = Speed of light in vacuum /speed of light in medium
n = c/v
$3/2 = 3 \times 10^8$/speed of light in medium
Speed of light = $(3 \times 10^8) / (3/2)$
Where, n is the refractive index, = (2/3) C

134. (a) Volume of the sealed packet $V = 1000\ cm^3$
Mass of the sealed packet M = 800 g
The, Density of the packet $\rho = M/V = 800/1000$
$= 0.8\ g\ cm{-}3$
As the density of packet is less than that of water (density 1g cm−3) and liquid B density 1.5 g cm−3), it will float in water.

135. (b) Time period of the pendulum is given by, the time period of oscillation of simple pendulum $T, = 2\pi \sqrt{(l/g)}$
l = length of pendulum and
g= acceleration acting on pendulum.
If mass is doubled and the length is halved then the new time period
$(T2) = 2\pi \sqrt{(0.5l/g)} = T/\sqrt{2}$

136. (c) In a solar cell or photovoltaic cell, light energy from Sun is converted into **electrical energy.** This electrical energy is used by the various electrical appliances.

137. (d) **Article** 243G of the Constitution of India is related to the Powers, authority and responsibilities of Panchayats. According to this article Panchayats have the authority on matters related to Land improvement, implementation of land reforms, land consolidation and soil conservation, but not on regulation of land revenue.

138. (c) In Mauryan administration Anta-Mahamattas were the In-charge of frontier areas.
Ithijhakha-mahamattas were charged with superintendence of women including Women's Welfare.
The function of officials known as the *dhamma-mahamattas* was propagating the *dhamma*.
The Nagalaviyohalaka-mahamatas were associated with city administration as per the Asokan inscriptions.

139. (a) Palakabya wrote Hastayurveda during the period of Guptas. It is a complete treatise on both wild and pet elephants including the diseases and their cure.

140. (a) Treaty of Deogaon, was signed between Raghuji Bhonsle II—the Maratha raja of Berar—and the British East India Company. The Maratha raja gave up the province of Cuttack Odisha, Balasore Port, parts of Midnapore of West Bengal.

141. (c) Among the Indian States Maharashtra has the largest network of National Highways (NH). There are many factors like economic development, terrain plays an important role in contributing to the density of number of National Highways in any region and it is also responsible for the maximum share of NHs in Maharshtra.

142. (b) Quinary activities are the activities or services that focus on the creation, re-arrangement and interpretation of new and existing ideas. It also include data interpretation and the use and evaluation of new technologies.

143. (c) UDAN (Ude Desh ka Aam Nagrik) is the flagship Regional Connectivity Scheme of the Ministry of Civil Aviation. It is an innovative scheme to develop the regional aviation market and a market-based mechanism in which airlines bid for seat subsidies. This first-of-its-kind scheme globally will create affordable yet economically viable and profitable flights on regional routes so that flying becomes affordable to the common man even in small towns.

144. (b) The **Brahmani** is a major seasonal **river** in Odisha. The **river** is formed by the confluence of the Sankh and South Koel rivers.

145. (c)

146. (b) **The speed of sound is directly proportional to the temperature**. Therefore, as the temperature increases, the speed of sound increases. **The speed of the sound also depends on the density of the medium through which it travels**. In general, sound travels faster in liquids (like water) than in gases (like air) and quicker in solids (like steel) than in liquids.

147. (b) The structures of the cochlea vibrate in response to sound with a particular vibratory pattern and this vibratory pattern allows the inner hair cells and their connections to the auditory nerve to send signals to the brainstem and brain about the sound's vibration and its frequency content.

148. (d) Incandescent bulbs typically use a **tungsten filament** because of tungsten's high melting point. A tungsten filament inside a light bulb can reach temperatures as high as 4,500 degrees.

149. (c) When a bullet is fired by the gun and gun moves in backword direction with a particular speed known as recoil velocity of the gun.
Let m and M be the masses of bullet and gun, respectively. If v and V are the velocities of the bullet and gun, respectively after the firing then:-
0= mv+ MV
Therefore V=- (mv/M)
Putting the values, V=- (0.01kg X 300m/s) / (1Kg)
The recoil velocity of gun = **- 3 m/s**
The negative sign indicates that the gun moves in a direction to that of the bullet.

150. (b) A microphone **converts sound into electrical current**. The device is an acoustic-to-electric transducer. Sound is first converted to mechanical motion by means of a diaphragm, the motion of which is then converted to an electrical signal.