

2020-I

NDA/NA Solved Paper

Paper I: Mathematics

1. If matrix $A = \begin{bmatrix} 1-i & i \\ -i & 1-i \end{bmatrix}$ where $i = \sqrt{-1}$, then which one of the following is correct?

(a) A is hermitian (b) A is skew-hermitian
(c) $(A)^T + A$ is hermitian (d) $(A)^T + A$ is skew-hermitian

2. The term independent of x in the binomial expansion of $\left(\frac{2}{x^2} - \sqrt{x}\right)^{10}$ is equal to

(a) 180 (b) 120 (c) 90 (d) 72

3. If $(1 + 2x - x^2)^6 = a_0 + a_1x + a_2x^2 + \dots + a_{12}x^{12}$, then what is $a_0 - a_1 + a_2 - a_3 + a_4 - \dots + a_{12}$ equal to?

(a) 32 (b) 64 (c) 2048 (d) 4096

4. If $C(20, n+2) = C(20, n-2)$, then what is n equal to?

(a) 18 (b) 25 (c) 10 (d) 12

5. For how many values of k , is the matrix $\begin{bmatrix} 0 & k & 4 \\ -k & 0 & -5 \end{bmatrix}$ singular?

$$| \begin{bmatrix} -k & k & -1 \end{bmatrix} |$$

(a) Only one (b) Only two (c) Only four (d) Infinite

6. The number $(1101101 + 1011011)_2$ can be written in decimal system as

(a) $(198)_{10}$ (b) $(199)_{10}$ (c) $(201)_{10}$ (d) $(200)_{10}$

7. What is the value of $\frac{1}{10} \log_5 1024 - \log_5 10 + \frac{1}{5} \log_5 3125$?

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

8. If $x = \log_c(ab)$, $y = \log_a(bc)$, $z = \log_b(ca)$, then which of the following is correct?

(a) $xyz = 1$

(b) $x + y + z = 1$

(c) $(1+x)^{-1} + (1+y)^{-1} + (1+z)^{-1} = 1$

(d) $(1+x)^{-2} + (1+y)^{-2} + (1+z)^{-2} = 1$

9. Let $A = \begin{bmatrix} x+y & y \\ 2x & x-y \end{bmatrix}$, $B = \begin{bmatrix} 2 \\ -1 \end{bmatrix}$ and $C = \begin{bmatrix} 3 \\ 2 \end{bmatrix}$

If $AB = C$, then what is the value of the determinant of the matrix A ?

(a) -10 (b) -14 (c) -24 (d) -34

10. If $1.5 \leq x \leq 4.5$, then which one of the following is correct?

(a) $(2x-3)(2x-9) > 0$ (b) $(2x-3)(2x-9) < 0$

(c) $(2x-3)(2x-9) \geq 0$ (d) $(2x-3)(2x-9) \leq 0$

11. Let $S = \{1, 2, 3, \dots\}$. A relation R on $S \times S$ is defined by xRy if $\log_a x > \log_a y$ when $a = \frac{1}{2}$. Then the relation is

(a) reflexive only

(b) symmetric only

(c) transitive only

(d) both symmetric and transitive

12. What is the value of the determinant $\begin{vmatrix} i & i^2 & i^3 \\ i^4 & i^6 & i^8 \\ i^9 & i^{12} & i^{15} \end{vmatrix}$ where

$i = \sqrt{-1}$?

(a) 0 (b) -2 (c) $4i$ (d) $-4i$

13. Let $A = \begin{bmatrix} h & b & f \\ g & f & c \end{bmatrix}$ and $B = \begin{bmatrix} y \\ z \end{bmatrix}$, then what is AB equal to?

(a) $\begin{bmatrix} ax + hy + gz \\ y \\ z \end{bmatrix}$

(b) $\begin{bmatrix} ax + hy + gz \\ hx + by + fz \\ z \end{bmatrix}$

(c) $\begin{bmatrix} ax + hy + gz \\ hx + by + fz \\ gx + fy + cz \end{bmatrix}$

(d) $[ax + hy + gz \quad hx + by + fz \quad gz + fy + cz]$

14. What is the number of ways in which the letters of the word 'ABLE' can be arranged so that the vowels occupy even places?

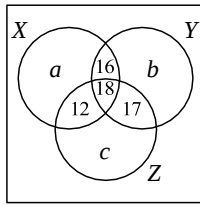
(a) 2 (b) 4 (c) 6 (d) 8

15. What is the maximum number of points of intersection of 5 non-overlapping circles?

(a) 10 (b) 15 (c) 20 (d) 25

Direction for the following three (03) items :

Consider the following Venn diagram, where X , Y and Z are three sets. Let the number of elements in Z be denoted by $n(Z)$ which is equal to 90.



16. If the number of elements in Y and Z are in the ratio 4 : 5, then what is the value of b ?
- (a) 18 (b) 19 (c) 21 (d) 23
17. What is the value of $n(X) + n(Y) + n(Z) - n(X \cap Y) - n(Y \cap Z) - n(X \cap Z) + n(X \cap Y \cap Z)$?
- (a) $a + b + 43$ (b) $a + b + 63$ (c) $a + b + 96$ (d) $a + b + 106$
18. If the number of elements belonging to neither X , nor Y , nor Z is equal to p , then what is the number of elements in the complement of X ?
- (a) $p + b + 60$ (b) $p + b + 40$ (c) $p + a + 60$ (d) $p + a + 40$

Direction for the following two (02) items:

Read the following information and answer the two items that follows:

Let $\frac{\tan 3A}{\tan A} = k$, where $A \neq 0$ and $k \neq \frac{1}{3}$

19. What is $\tan^2 A$ equal to?
- (a) $\frac{k+3}{3k-1}$ (b) $\frac{k-3}{3k-1}$ (c) $\frac{3k-3}{k-3}$ (d) $\frac{k+3}{3k+1}$
20. For real values of $\tan A$, k cannot lie between
- (a) $\frac{1}{3}$ and 3 (b) $\frac{1}{2}$ and 2 (c) $\frac{1}{5}$ and 5 (d) $\frac{1}{7}$ and 7

Direction for the following two (02) items:

Read the following information and answer the two items that follows:

$ABCD$ is a trapezium such that AB and CD are parallel and BC is perpendicular to them. Let $\angle ADB = \theta$, $\angle ABD = \alpha$, $BC = p$ and $CD = q$

21. Consider the following :
- (1) $AD \sin \theta = AB \sin \alpha$ (2) $BD \sin \theta = AB \sin (\theta + \alpha)$
- Which of the above is/are correct?
- (a) (1) only (b) (2) only
(c) Both (1) and (2) (d) Neither (1) nor (2)

22. What is AB equal to?

(a) $\frac{(p^2 + q^2) \sin \theta}{p \cos \theta + q \sin \theta}$ (b) $\frac{(p^2 - q^2) \cos \theta}{p \cos \theta + q \sin \theta}$

(c) $\frac{(p^2 + q^2) \sin \theta}{q \cos \theta + p \sin \theta}$ (d) $\frac{(p^2 - q^2) \cos \theta}{q \cos \theta + p \sin \theta}$

23. If $\tan \theta = \frac{\cos 17^\circ - \sin 17^\circ}{\cos 17^\circ + \sin 17^\circ}$, then what is the value of θ ?
- (a) 0° (b) 28° (c) 38° (d) 52°

24. A and B are positive acute angles such that $\cos 2B = 3 \sin^2 A$ and $3 \sin 2A = 2 \sin 2B$. What is the value of $(A + 2B)$?
- (a) $\frac{\pi}{6}$ (b) $\frac{\pi}{4}$ (c) $\frac{\pi}{3}$ (d) $\frac{\pi}{2}$

25. What is $\sin 3x + \cos 3x + 4 \sin^3 x - 3 \sin x + 3 \cos x - 4 \cos^3 x$ equal to?
- (a) 0 (b) 1 (c) $2 \sin 2x$ (d) $4 \cos 4x$
26. The value of ordinate of the graph of $y = 2 + \cos x$ lies in the interval
- (a) $[0, 1]$ (b) $[0, 3]$ (c) $[-1, 1]$ (d) $[1, 3]$
27. What is the value of $8 \cos 10^\circ \cdot \cos 20^\circ \cdot \cos 40^\circ$?
- (a) $\tan 10^\circ$ (b) $\cot 10^\circ$ (c) $\operatorname{cosec} 10^\circ$ (d) $\sec 10^\circ$
28. What is the value of $\cos 48^\circ - \cos 12^\circ$?
- (a) $\frac{\sqrt{5}-1}{4}$ (b) $\frac{1-\sqrt{5}}{4}$ (c) $\frac{\sqrt{5}+1}{2}$ (d) $\frac{1-\sqrt{5}}{8}$

29. Consider the following statements :

- (1) If ABC is a right-angled triangle, right-angled at A and if $\sin B = \frac{1}{3}$, then $\operatorname{cosec} C = 3$
- (2) If $b \cos B = c \cos C$ and if the triangle ABC is not right-angled, then ABC must be isosceles.

Which of the above statements is/are correct?

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

30. Consider the following statements :

- (1) If in a triangle ABC , $A = 2B$ and $b = c$, then it must be an obtuse-angled triangle.
- (2) There exists no triangle ABC with $A = 40^\circ$, $B = 65^\circ$ and $\frac{a}{c} = \sin 40^\circ \operatorname{cosec} 15^\circ$

Which of the above statements is/are correct?

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

Direction for the following three (03) items:

Read the following information and answer the three items that follows:

Let $a \sin^2 x + b \cos^2 x = c$; $b \sin^2 y + a \cos^2 y = d$ and $p \tan x = q \tan y$.

31. What is $\tan^2 x$ equal to?
- (a) $\frac{c-b}{a-c}$ (b) $\frac{a-c}{c-b}$ (c) $\frac{c-a}{c-b}$ (d) $\frac{c-b}{c-a}$
32. What is $\frac{d-a}{b-d}$ equal to?
- (a) $\sin^2 y$ (b) $\cos^2 y$ (c) $\tan^2 y$ (d) $\cot^2 y$
33. What is $\frac{p^2}{q^2}$ equal to?
- (a) $\frac{(b-c)(b-d)}{(a-d)(a-c)}$ (b) $\frac{(a-d)(c-a)}{(b-c)(d-b)}$
- (c) $\frac{(d-a)(c-a)}{(b-c)(d-b)}$ (d) $\frac{(b-c)(b-d)}{(c-a)(a-d)}$

Direction for the following two (03) items:

Read the following information and answer the two items that follows:

Let $t_n = \sin^n \theta + \cos^n \theta$.

34. What is $\frac{t_3 - t_5}{t_5 - t_7}$ equal to?
- (a) $\frac{t_1}{t_3}$ (b) $\frac{t_3}{t_5}$ (c) $\frac{t_5}{t_7}$ (d) $\frac{t_7}{t_1}$
35. What is $t_1^2 - t_2$ equal to?
- (a) $\cos 2\theta$ (b) $\sin 2\theta$ (c) $2 \cos \theta$ (d) $2 \sin \theta$

36. What is the value of t_{10} where $\theta = 45^\circ$?

- (a) 1 (b) $\frac{1}{4}$ (c) $\frac{1}{16}$ (d) $\frac{1}{32}$

Direction for the following three (03) items:

Read the following information and answer the three items that follows:

Let $\alpha = \beta = 15^\circ$

37. What is the value of $\sin\alpha + \cos\beta$?

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

38. What is the value of $\sin 7\alpha - \cos 7\beta$?

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

39. What is $\sin(\alpha + 1^\circ) + \cos(\beta + 1^\circ)$ equal to?

- (a) $\sqrt{3}\cos 1^\circ + \sin 1^\circ$ (b) $\sqrt{3}\cos 1^\circ - \frac{1}{2}\sin 1^\circ$
(c) $\frac{1}{\sqrt{2}}(\sqrt{3}\cos 1^\circ - \sin 1^\circ)$ (d) $\frac{1}{2}(\sqrt{3}\cos 1^\circ + \sin 1^\circ)$

40. If $\sin x + \sin y = \cos y - \cos x$, where $0 < y < x < \frac{\pi}{2}$, then what is

$\tan\left(\frac{x-y}{2}\right)$ equal to?

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

41. If A is a matrix of order 3×5 and B is a matrix of order 5×3 , then the order of AB and BA will respectively be

- (a) 3×3 and 3×3 (b) 3×5 and 5×3
(c) 3×3 and 5×5 (d) 5×3 and 3×5

42. If p^2 , q^2 and r^2 (where, $p, q, r > 0$) are in GP , then which of the following is/are correct?

- (1) p, q and r are in GP . (2) $\ln p, \ln q$ and $\ln r$ are in AP .

Select the correct answer using the code given below:

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

43. If $\cot\alpha$ and $\cot\beta$ are the roots of the equation $x^2 - 3x + 2 = 0$ then what is $\cot(\alpha + \beta)$ equal to?

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

44. The roots α and β of a quadratic equation satisfy the relations $\alpha + \beta = \alpha^2 + \beta^2$ and $\alpha\beta = \alpha^2\beta^2$. What is the number of such quadratic equations?

- (a) 0 (b) 2 (c) 3 (d) 4

45. What is the argument of the complex number $\frac{1-i\sqrt{3}}{1+i\sqrt{3}}$, where

$i = \sqrt{-1}$?

- (a) 240° (b) 210° (c) 120° (d) 60°

46. What is the modulus of the complex number $\frac{\cos\theta + i\sin\theta}{\cos\theta - i\sin\theta}$, where

$i = \sqrt{-1}$?

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

47. Consider the proper subsets of $\{1, 2, 3, 4\}$. How many of these proper subsets are superset of the set $\{3\}$?

- (a) 5 (b) 6 (c) 7 (d) 8

48. Let p, q and r be three distinct positive real numbers.

If $D = \begin{vmatrix} p & q & r \\ q & r & p \\ r & p & q \end{vmatrix}$, then which one of the following is correct?

- (a) $D < 0$ (b) $D \leq 0$ (c) $D > 0$ (d) $D \geq 0$

49. What is the sum of the last five coefficients in the expansion of $(1+x)^9$ when it is expanded in ascending powers of x ?

- (a) 256 (b) 512 (c) 1024 (d) 2048

50. Consider the following in respect of a non-singular matrix of order 3:

- (1) $A(\text{adj } A) = (\text{adj } A)A$ (2) $|\text{adj } A| = |A|$

Which of the above statements is/are correct?

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

51. The center of the circle, $(x-2a)(x-2b) + (y-2c)(y-2d) = 0$ is,

- (a) $(2a, 2c)$ (b) $(2b, 2d)$
(c) $(a+b, c+d)$ (d) $(a-b, c-d)$

52. The point $(1, -1)$ is one of the vertices of a square. If $3x + 2y = 5$ is the equation of one diagonal of the square, then what is the equation of the other diagonal?

- (a) $3x - 2y = 5$ (b) $2x - 3y = 1$
(c) $2x - 3y = 5$ (d) $2x + 3y = -1$

53. If $P(x, y)$ be any point on the ellipse $25x^2 + 16y^2 = 400$. If $Q(0, 3)$ and $R(0, -3)$ are two points, then what is $(PQ + PR)$ equal to?

- (a) 12 (b) 10 (c) 8 (d) 6

54. If the circumcentre of the triangle formed by the lines $x + 2 = 0$, $y + 2 = 0$ and $kx + y + 2 = 0$ is $(-1, -1)$, then what is the value of k ?

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

55. In the parabola, $y^2 = x$, what is the length of the chord passing through the vertex and inclined to the x -axis at an angle θ ?

- (a) $\sin\theta \cdot \sec^2\theta$ (b) $\cos\theta \cdot \csc^2\theta$
(c) $\cot\theta \cdot \sec^2\theta$ (d) $2\tan\theta \cdot \csc^2\theta$

56. Under which condition, are the points (a, b) , (c, d) and $(a-c, b-d)$ collinear?

- (a) $ab = cd$ (b) $ac = bd$ (c) $ad = bc$ (d) $abc = d$

57. Let ABC be a triangle. If $D(2, 5)$ and $E(5, 9)$ are the midpoints of the sides AB and AC respectively, then what is the length of the side BC ?

- (a) 8 (b) 10 (c) 12 (d) 14

58. If the foot of the perpendicular drawn from the point $(0, k)$ to the line $3x - 4y - 5 = 0$ is $(3, 1)$, then what is the value of k ?

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

59. What is the obtuse angle between the lines whose slopes are $2 - \sqrt{3}$ and $2 + \sqrt{3}$?

- (a) 105° (b) 120° (c) 135° (d) 150°

60. If $3x - 4y - 5 = 0$ and $3x - 4y + 15 = 0$ are the equations of a pair of opposite sides of a square, then what is the area of the square?

- (a) 4 square units (b) 9 square units
(c) 16 square units (d) 25 square units

61. What is the length of the diameter of the sphere whose center is at $(1, -2, 3)$ and which touches the plane $6x - 3y + 2z - 4 = 0$?
- (a) 1 unit (b) 2 units
(c) 3 units (d) 4 units
62. What is the perpendicular distance from the point $(2, 3, 4)$ to the line $\frac{x-0}{1} = \frac{y-0}{0} = \frac{z-0}{0}$?
- (a) 6 units (b) 5 units
(c) 3 units (d) 2 units
63. If a line has direction ratios $\langle a+b, b+c, c+a \rangle$, then what is the sum of the squares of its direction cosines?
- (a) $(a+b+c)^2$ (b) $2(a+b+c)$
(c) 3 (d) 1
64. Into how many compartments do the coordinate planes divide the space?
- (a) 2 (b) 4
(c) 8 (d) 16
65. What is the equation of the plane which cuts an intercept 5 units on the z-axis and is parallel to xy-plane?
- (a) $x+y=5$ (b) $z=5$
(c) $z=0$ (d) $x+y+z=5$
66. If $\hat{a}$ is a unit vector in the xy-plane making an angle 30° with the positive x-axis, then what is $\hat{a}$ equal to?
- (a) $\frac{\sqrt{3}\hat{i} + \hat{j}}{2}$ (b) $\frac{\sqrt{3}\hat{i} - \hat{j}}{2}$
(c) $\frac{\hat{i} + \sqrt{3}\hat{j}}{2}$ (d) $\frac{\hat{i} - \sqrt{3}\hat{j}}{2}$
67. Let A be a point in space such that $|\vec{OA}| = 12$, where O is the origin. If OA is inclined at angles 45° and 60° with x-axis and y-axis respectively, then what is OA equal to?
- (a) $6\hat{i} + 6\hat{j} \pm \sqrt{2}\hat{k}$ (b) $6\hat{i} + 6\sqrt{2}\hat{j} \pm 6\hat{k}$
(c) $6\sqrt{2}\hat{i} + 6\hat{j} \pm 6\hat{k}$ (d) $3\sqrt{2}\hat{i} + 3\hat{j} \pm 6\hat{k}$
68. Two adjacent sides of a parallelogram are $2\hat{i} - 4\hat{j} + 5\hat{k}$ and $\hat{i} - 2\hat{j} - 3\hat{k}$. What is the magnitude of the dot product of vectors which represent its diagonals?
- (a) 21 (b) 25
(c) 31 (d) 36
69. If $|\vec{a} \times \vec{b}|^2 + |\vec{a} \cdot \vec{b}|^2 = 144$ and $|\vec{a}| = 4$, then what is $|\vec{b}|$ equal to?
- (a) 3 (b) 4
(c) 6 (d) 8
70. If the vectors $\vec{a} = 2\hat{i} - 3\hat{j} + \hat{k}$, $\vec{b} = \hat{i} + 2\hat{j} - 3\hat{k}$ and $\vec{c} = \hat{j} + p\hat{k}$ are coplanar, then what is the value of p?
- (a) 1 (b) -1
(c) 5 (d) -5
71. What is $\lim_{x \rightarrow 1} \frac{x + x^2 + x^3 - 3}{x - 1}$ equal to?
- (a) 1 (b) 2
(c) 3 (d) 6
72. The radius of a circle is increasing at the rate of 0.7 cm/sec. What is the rate of increase of its circumference?
- (a) 4.4 cm/sec (b) 8.4 cm/sec
(c) 8.8 cm/sec (d) 15.4 cm/sec
73. If $\lim_{x \rightarrow 1} \frac{x^4 - 1}{x - 1} = \lim_{x \rightarrow k} \frac{x^3 - k^3}{x - k^2}$, where $k \neq 0$, then what is the value of k?
- (a) $\frac{2}{3}$ (b) $\frac{4}{3}$
(c) $\frac{8}{3}$ (d) 4
74. The order and degree of the differential equation $\frac{dy}{dx} = \int \left[1 + \left(\frac{dy}{dx} \right)^2 \right]^{\frac{3}{2}} dx$ are respectively
- (a) 1 and 1 (b) 2 and 3
(c) 2 and 4 (d) 1 and 4
75. What is $\lim_{x \rightarrow 0} \frac{\sin x \log(1-x)}{x^2}$ equal to?
- (a) -1 (b) Zero
(c) -e (d) $-\frac{1}{e}$
76. If $f(x) = 3x^2 - 5x + p$ and $f(0)$ and $f(1)$ are opposite in sign, then which of the following is correct?
- (a) $-2 < p < 0$ (b) $-2 < p < 2$
(c) $0 < p < 2$ (d) $3 < p < 5$
77. If $e^{\theta\phi} = c + 4\theta\phi$, where c is an arbitrary constant and ϕ is a function of θ , then what is $\phi d\theta$ equal to?
- (a) $\theta d\phi$ (b) $-\theta d\phi$
(c) $4\theta d\phi$ (d) $-4\theta d\phi$
78. If $p(x) = (4e)^{2x}$, then what is $\int p(x) dx$ equal to?
- (a) $\frac{p(x)}{1 + 2 \ln 2} + c$ (b) $\frac{p(x)}{2(1 + 2 \ln 2)} + c$
(c) $\frac{2p(x)}{1 + \ln 4} + c$ (d) $\frac{p(x)}{1 + \ln 2} + c$
79. What is the value of $\int_0^{\pi} (\tan^3 x + \tan x) dx$?
- (a) $\frac{1}{4}$ (b) $\frac{1}{2}$
(c) 1 (d) 2
80. Let $y = 3x^2 + 2$. If x changes from 10 to 10.1, then what is the total change in y?
- (a) 4.71 (b) 5.23
(c) 6.03 (d) 8.01
81. If $f(x) = \frac{\sin x}{x}$, where $x \in \mathbb{R}$, is to be continuous at $x = 0$, then the value of the function at $x = 0$
- (a) should be 0 (b) should be 1
(c) should be 2 (d) cannot be determined

82. The solution of the differential equation $dy = (1 + y^2)dx$ is

- (a) $y = \tan x + c$ (b) $y = \tan(x + c)$
(c) $\tan^{-1}(y + c) = x$ (d) $\tan^{-1}(y + c) = 2x$

83. What is $\int (e^{\log x} + \sin x) \cos x dx$ equal to?

- (a) $\sin x + x \cos x + \frac{\sin^2 x}{2} + c$ (b) $\sin x - x \cos x + \frac{\sin^2 x}{2} + c$
(c) $x \sin x + \cos x + \frac{\sin^2 x}{2} + c$ (d) $x \sin x - x \cos x + \frac{\sin^2 x}{2} + c$

84. What is the domain of the function $f(x) = \cos^{-1}(x - 2)$?

- (a) $[-1, 1]$ (b) $[1, 3]$
(c) $[0, 5]$ (d) $[-2, 1]$

85. What is the area of the region enclosed between the curve $y^2 = 2x$ and the straight line $y = x$?

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

86. If $f(x) = 2x - x^2$, then what is the value of $f(x + 2) + f(x - 2)$ when $x = 0$?

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

87. If $x^m y^n = a^{m+n}$, then what is $\frac{dy}{dx}$ equal to?

- (a) $\frac{my}{nx}$ (b) $-\frac{my}{nx}$
(c) $\frac{mx}{ny}$ (d) $-\frac{ny}{mx}$

88. What is $\int \frac{dx}{x(x^n + 1)}$ equal to?

- (a) $\frac{1}{n} \ln \left(\frac{x^n}{x^n + 1} \right) + c$ (b) $\ln \left(\frac{x^n + 1}{x^n} \right) + c$
(c) $\ln \left(\frac{x^n}{x^n + 1} \right) + c$ (d) $\frac{1}{n} \ln \left(\frac{x^n + 1}{x^n} \right) + c$

89. What is the minimum value of $|x - 1|$, where $x \in R$?

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

90. What is the value of k such that integration of $\frac{3x^2 + 8 - 4k}{x}$ with

respect to x , may be a rational function?

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

91. Consider the following statements for $f(x) = e^{-|x|}$

1. The function is continuous at $x = 0$:
2. The function is differentiable at $x = 0$.

Which of the above statements is/are correct?

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

92. What is the maximum value of $\sin x \cdot \cos x$?

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

93. What is $\lim_{x \rightarrow 0} \frac{3^x + 3^{-x} - 2}{x}$ equal to?

- (a) 0 (b) -1
(c) 1 (d) Limit does not exist

94. What is the derivative of $\tan^{-1} x$ with respect to $\cot^{-1} x$?

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

95. The function $u(x, y) = c$ which satisfies the differential equation $x(dx - dy) + y(dy - dx) = 0$, is

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

96. What is the minimum value of $\frac{3}{2} \cos \left(A + \frac{\pi}{3} \right)$ where $A \in R$?

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

97. Consider the following statements :

1. The function $f(x) = \ln x$ increases in the interval $(0, \infty)$.
2. The function $f(x) = \tan x$ increases in the interval $\left(-\frac{\pi}{2}, \frac{\pi}{2} \right)$

Which of the above statements is/are correct?

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

98. Which one of the following is correct in respect of the graph of

$$y = \frac{1}{x-1} ?$$

- (a) The domain is $\{x \in R | x \neq 1\}$ and the range is the set of reals.
(b) The domain is $\{x \in R | x \neq 1\}$, the range is $\{y \in R | y \neq 0\}$ and the graph intersects y -axis at $(0, -1)$.
(c) The domain is the set of reals and the range is the singleton set $\{0\}$
(d) The domain is $\{x \in R | x \neq 1\}$ and the range is the set of points on the y -axis.

99. What is the solution of the differential equation $\ln \left(\frac{dy}{dx} \right) = x$?

- (a) $y = e^x + c$ (b) $y = e^{-x} + c$
(c) $y = \ln x + c$ (d) $y = 2 \ln x + c$

100. Let l be the length and b be the breadth of a rectangle such that $l + b = k$. What is the maximum area of the rectangle?

- (a) $2k^2$ (b) k^2
(c) $\frac{k^2}{2}$ (d) $\frac{k^2}{4}$

101. The numbers 4 and 9 have frequencies x and $x-1$ respectively. If their arithmetic mean is 6, then what is the value of x ?

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

102. If three dice are rolled under the condition that no two dice show the same face, then what is the probability that one of the faces is having the number 6?

- (a) $\frac{5}{9}$ (b) $\frac{5}{9}$
(c) $\frac{1}{2}$ (d) $\frac{5}{12}$

103. If $P(A \cup B) = \frac{5}{6}$, $P(A \cap B) = \frac{1}{3}$ and $P(\text{not } A) = \frac{1}{2}$, then which one of the following is not correct?
- (a) $P(B) = \frac{2}{3}$
 (b) $P(A \cap B) = P(A)P(B)$
 (c) $P(A \cup B) > P(A) + P(B)$
 (d) $P(\text{not } A \text{ and not } B) = P(\text{not } A)P(\text{not } B)$
104. The sum of deviations of n number of observations measured from 2.5 is 50. The sum of deviations of the same set of observations measured from 3.5 is -50. What is the value of n ?
- (a) 50 (b) 60
 (c) 80 (d) 100
105. A data set of n observations has mean $2M$, while another data set of $2n$ observations has mean M . What is the mean of the combined data sets?
- (a) M (b) $\frac{3M}{2}$
 (c) $\frac{2M}{3}$ (d) $\frac{4M}{3}$

Direction for the following three (03) items:

Read the following information and answer the three items that follows:

Marks	Number of students	
	Physics	Mathematics
10-20	8	10
20-30	11	21
30-40	30	38
40-50	26	15
50-60	15	10
60-70	10	6

106. The difference between number of students under Physics and Mathematics is largest for the interval
- (a) 20 – 30 (b) 30 – 40
 (c) 40 – 50 (d) 50 – 60
107. Consider the following statements :
- Modal value of the marks in Physics lies in the interval 30-40.
 - Median of the marks in Physics is less than that of marks in Mathematics.
- Which of the above statements is/are correct ?
- (a) 1 only (b) 2 only
 (c) Both 1 and 2 (d) Neither 1 nor 2
108. What is the mean of marks in Physics ?
- (a) 38.4 (b) 39.4
 (c) 40.9 (d) 41.6
109. What is the standard deviation of the observations $-\sqrt{6}, -\sqrt{5}, -\sqrt{4}, -1, 1, \sqrt{4}, \sqrt{5}, \sqrt{6}$?
- (a) $\sqrt{2}$ (b) 2
 (c) $2\sqrt{2}$ (d) 4
110. If $\sum x_i = 20$, $\sum x_i^2 = 200$ and $n = 10$ for an observed variable x , then what is the coefficient of variation ?
- (a) 80 (b) 100
 (c) 150 (d) 200

111. What is the probability that February of a leap year selected at random, will have five Sundays ?
- (a) $\frac{1}{5}$ (b) $\frac{1}{7}$
 (c) $\frac{2}{7}$ (d) 1
112. The arithmetic mean of 100 observations is 40. Later, it was found that an observation '53' was wrongly read as '83'. What is the correct arithmetic mean ?
- (a) 39.8 (b) 39.7
 (c) 39.6 (d) 39.5
113. A husband and wife appear in an interview for two vacancies for the same post. The probability of the husband's selection is $\frac{1}{7}$ and that of the wife's selection is $\frac{1}{5}$. If the events are independent, then the probability of which one of the following is $\frac{11}{35}$?
- (a) At least one of them will be selected
 (b) Only one of them will be selected
 (c) None of them will be selected
 (d) Both of them will be selected
114. A dealer has a stock of 15 gold coins out of which 6 are counterfeits. A person randomly picks 4 of the 15 gold coins. What is the probability that all the coins picked will be counterfeits ?
- (a) $\frac{1}{91}$ (b) $\frac{4}{91}$
 (c) $\frac{6}{91}$ (d) $\frac{15}{91}$
115. A committee of 3 is to be formed from a group of 2 boys and 2 girls. What is the probability that the committee consists of 2 boys and 1 girl ?
- (a) $\frac{2}{3}$ (b) $\frac{1}{4}$
 (c) $\frac{3}{4}$ (d) $\frac{1}{2}$
116. In a lottery of 10 tickets numbered 1 to 10, two tickets are drawn simultaneously. What is the probability that both the tickets drawn have prime numbers ?
- (a) $\frac{1}{15}$ (b) $\frac{1}{2}$
 (c) $\frac{2}{15}$ (d) $\frac{1}{5}$
117. Let X and Y represent prices (in ₹) of a commodity in Kolkata and Mumbai respectively. It is given that $\bar{X} = 65$, $\bar{Y} = 67$, $\sigma_X = 2.5$, $\sigma_Y = 3.5$ and $r(X, Y) = 0.8$. What is the equation of regression of Y on X ?
- (a) $Y = 0.175X - 5$ (b) $Y = 1.12X - 5.8$
 (c) $Y = 1.12X - 5$ (d) $Y = 0.17X + 5.8$
118. Consider a random variable X which follows Binomial distribution with parameters $n = 10$ and $p = \frac{1}{5}$. Then $Y = 10 - X$ follows Binomial distribution with parameters n and p respectively given by
- (a) $5, \frac{1}{5}$ (b) $5, \frac{2}{5}$
 (c) $10, \frac{3}{5}$ (d) $10, \frac{4}{5}$

119. If A and B are two events such that $P(A) = 0.6, P(B) = 0.5$ and $P(A \cap B) = 0.4$, then consider the following statements :

1. $P(\overline{A} \cup B) = 0.9$.
2. $P(\overline{B} | \overline{A}) = 0.6$.

Which of the above statements is/are correct?

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

120. Three cooks X, Y and Z bake a special kind of cake, and with respective probabilities 0.02, 0.03 and 0.05, it fails to rise. In the restaurant where they work, X bakes 50%, Y bakes 30% and Z bakes 20% of cakes. What is the proportion of failures caused by X ?

- (a) $\frac{9}{29}$ (b) $\frac{10}{29}$
(c) $\frac{19}{29}$ (d) $\frac{28}{29}$

Paper II: General Ability

PART-A Antonyms

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

1. He nodded absently throughout the meeting.
(a) Capably (b) Alertly
(c) Agitatedly (d) Dreamily
2. I fully believe that the cornerstone of good policy is an electorate that is educated on the national issues.
(a) Cerebral (b) Enlightened
(c) Ignorant (d) Erudite
3. For important medical decisions, even finding a doctor you trust is not enough.
(a) Significant (b) Trivial (c) Basic (d) Probable
4. Planets move in their orbits.
(a) Push (b) Rotate (c) Stall (d) Flow
5. Temperature is a measure of internal energy of an object and is frequently expressed by physicists in units of Kelvin.
(a) Found (b) Told
(c) Distributed (d) Concealed
6. People argue about why Venus is so much warmer than the Earth.
(a) Friendlier (b) Colder
(c) Wilder (d) Heavier
7. Scientists are concerned whether the oceans and land biosphere will take up as much carbon in the future as they presently do.
(a) Worried (b) Indifferent
(c) Curious (d) Puzzled
8. The biggest debate among scientists today is about cloud feedback.
(a) Contend (b) Moot
(c) Wrangle (d) Agreement
9. The Earth's climate sensitivity is conventionally defined as the equilibrium temperature increase caused by a doubling of carbon dioxide.
(a) Imperviousness (b) Willingness
(c) Responsiveness (d) Closeness
10. The oceans carry a huge amount of heat from the tropics to the high latitudes.
(a) Significant (b) Major
(c) Tiny (d) Dormant

Ordering of Words in a Sentence

Directions: Each of the following items in this section consists of a sentence(s), the parts of which have been jumbled. These parts have been labeled as 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.

11. Several years ago,

P
course on climate change at Texas A&M University

Q
professor Andrew Dessler created an introductory

R
for freshmen and sophomores

S
(a) PRQS (b) QRPS (c) SQRP (d) PQRS

12. I realize that solving the climate change problem

P
than solving

Q
will be much harder

R
the ozone depletion problem

S
(a) PRQS (b) QRPS (c) SQRP (d) PQRS

13. Although the temperature of this layer of the

P
when directly comparing the satellite

Q
measurements of temperature

R
atmosphere should generally track the surface temperature, we must be careful

S
(a) PRQS (b) PSQR (c) SQRP (d) PQRS

14. The element heats up

P
eventually reaching high temperatures

Q
glowing like a dark orange that radiates

R
the visible range

S
(a) PQSR (b) QPSR (c) SQRP (d) PRSQ

15. two people argue about why Venus is so much warmer

P

to the Sun, so it absorbs more solar energy. The second argues

Q

that it is because Venus has a thick, greenhouse-gas-rich atmosphere

R

than the Earth. The first argues that it's because Venus is closer

S

(a) PSQR (b) QRPS (c) SQRP (d) PQRS

16. are now used by more than a thousand firms

P

and are growing in popularity

Q

in the United States and Europe

R

gain sharing-plans

S

(a) PRQS (b) QRPS (c) PRSQ (d) SPRQ

17. adversity without succumbing

P

to the clouds of doubt and jealousy

Q

between friends which is subjected to both prosperity and

R

the essay 'Of Friendship' by Francis Bacon celebrated the intimacy

S

(a) PRQS (b) QRPS (c) SRPQ (d) PQRS

18. friends without which the world is

P

make friends and a person will want to

Q

it is miserable solitude that compels a person to

R

nothing other than a place of wilderness

S

(a) PRQS (b) QRPS (c) RQPS (d) PQRS

19. takes the longest

P

the job

R

(a) PRQS (b) RQPS (c) SQRP (d) PQRS

20. to what you can create

P

control, shift your energy

Q

instead of worrying about

R

what you cannot

S

(a) PSQR (b) QRPS (c) SQRP (d) RSQP

Synonyms

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

21. She got the **divorce** within no time.

(a) Detachment (b) Breaking down
(c) Annulment (d) Punishment

22. He was known for his **gentle** disposition.

(a) Harmful (b) Amiable (c) Cunning (d) Adjusting

23. The harder we kick, the better the ball **bounces back**.

(a) Recoils (b) Deflates (c) Inflates (d) Ascends

24. I plan and **execute**.

(a) Desire (b) Debate
(c) Accomplish (d) Discard

25. He listened to me with **equanimity**.

(a) Carelessly (b) Excitedly
(c) Patiently (d) Half-heartedly

26. The whole thing was a **futile** exercise.

(a) Costly (b) Pointless
(c) Indecisive (d) Successful

27. He was too **cunning** for her.

(a) Capable (b) Fit
(c) Intelligent (d) Dodgy

28. This decision is **crucial** for me.

(a) Momentous (b) Natural
(c) Primitive (d) Inept

29. The media went into a **frenzy** about the case.

(a) Silent (b) Creative
(c) Berserk (d) Wrong

30. He has been **yearning** to go home.

(a) Declining (b) Demanding
(c) Begging (d) Hankering

Prepositions

Directions: Each item in this section has a sentence with a missing preposition. Select the correct **preposition** from the given options and mark your response on your Answer Sheet accordingly.

31. Simulations of the 20th century by climate models that exclude the observed increase, greenhouse gases fail to simulate the increase _____ temperature over the second half of the 20th century.

(a) Of (b) In (c) By (d) To

32. In extremely poor societies, children can be put to work _____ a young age and are therefore a source of income.

(a) In (b) On (c) By (d) At

33. People who are averse _____ hard work, generally do not succeed in life.

(a) To (b) About (c) At (d) On

34. I have known her _____ a long time.

(a) Since (b) For (c) At (d) Before

35. I accepted the offer _____ certain conditions.

(a) On (b) In (c) By (d) Within

36. She is a woman _____ humble origin.

(a) Off (b) Of (c) From (d) Within

37. There is no cure ____ the common cold.
(a) For (b) Of (c) To (d) On
38. I ran _____ John yesterday, and it was a pleasant surprise.
(a) By (b) Off (c) Beside (d) Into
39. My grandmother enjoyed boating ____ the lovely lake.
(a) In (b) On (c) Beside (d) Within
40. He visits the needy to relieve them ____ their sufferings and poverty.
(a) From (b) Off (c) Of (d) On

Spotting Errors

Directions: Each item in this section has a sentence with three underlined parts labeled as (a), (b) and (c). Read each sentence to find out whether there is any error in any underlined part and indicate your response on 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).

41. This building

(a)

comprises of six houses

(b)

three parking lots and one basement

(c)

No error

(d)

42. I look forward

(a)

you

(c)

to meet

(b)

No error

(d)

43. I cannot

(a)

with this pressure

(c)

cope up

(b)

No error

(d)

44. I came

(a)

by walk

(c)

to this place

(b)

No error

(d)

45. What is

(a)

in your watch?

(c)

the time

(b)

No error

(d)

46. The price of my dress

(a)

yours

(c)

is higher than that of

(b)

No error

(d)

47. My friend's

(a)

have come

(c)

daughter-in-laws

(b)

No error

(d)

48. I prefer seafood
(a) (b)
than Mediterranean food No error
(c) (d)

49. We were discussing about
(a) (b)
the issue No error
(c) (d)

50. Dispose off the garbage
(a) (b)
from the shelves No error
(c) (d)

PART-B

51. New Zealand is considered part of which one of the following island groups?

(a) Micronesia (b) Melanesia
(c) Polynesia (d) Hawaii Island chain

52. Which of the following statements with regard to Pradhan Mantri Krishi Sinchayee Yojana (PMKSY) is/are correct?

- PMKSY was launched during 2015-16
- The basic aim of PMKSY is to enhance physical access of water on farm
- One of the main objectives of PMKSY is to achieve convergence of investments in irrigation at the field level

Select the correct answer using the code given below:

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

53. According to Article 79 of the Constitution of India, which of the following is/are described as a part of Parliament of India?

- The House of the People
- The Council of States
- The President of India

Select the correct answer using the code given below:

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

54. The Five Year Plan was first launched in

(a) China (b) USSR (c) India (d) Bhutan

55. The call for Garibi Hatao was incorporated in

(a) Fourth Five Year Plan (b) Fifth Five Year Plan
(c) Sixth Five Year Plan (d) Seventh Five Year Plan

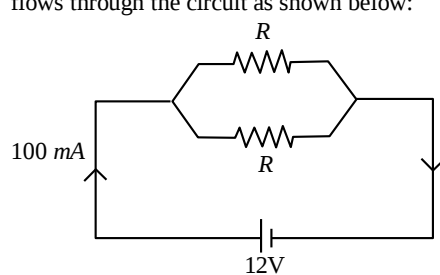
56. Match List-I with List-II and select the correct answer using the code given below the Lists:

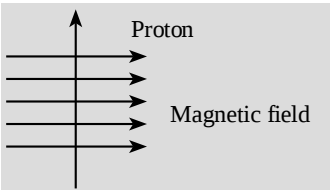
List-I (Major Objective)		List-II (Five Year Plan)	
A.	Faster and more inclusive growth	1.	First
B.	Faster, more inclusive and sustainable growth	2.	Fifth
C.	Correction of disequilibrium caused by Second World War	3.	Eleventh
D.	Attaining self-reliance	4.	Twelfth

- | | A | B | C | D |
|-----|---|---|---|---|
| (a) | 3 | 1 | 4 | 2 |
| (b) | 3 | 4 | 1 | 2 |
| (c) | 2 | 4 | 1 | 3 |
| (d) | 2 | 1 | 4 | 3 |
57. Which one of the following Directive Principles was inserted by the Constitution (42 nd Amendment) Act, 1976?
- (a) The State shall minimize inequalities in income
(b) Equal justice and free legal aid
(c) Promotion of co-operative societies
(d) Provision for early childhood care
58. A common High Court for two or more states can be established by
- (a) a law passed by the Parliament
(b) an order of the Supreme Court of India
(c) an order of the President of India
(d) an amendment to the Constitution of India
59. In the year 1928, a committee of Congress leaders drafted a Constitution for India. The Committee was headed by
- (a) Mahatma Gandhi (b) T. B. Saprū
(c) Motilal Nehru (d) Jawaharlal Nehru
60. Which one of the following statements about Jaipal Singh is NOT correct?
- (a) He was a member of the Constituent Assembly
(b) He founded the Adivasi Maha Sabha
(c) He was the captain of the first Indian national hockey team
(d) He campaigned for a separate state of Chhattisgarh
61. What is 'Tikki Mausi' in the context of Malnutrition?
- (a) A specially packaged food item
(b) A mascot
(c) Name of a scheme
(d) Name given to the healthcare providers
62. Which one of the following was the theme of the World Tourism Day, 2019?
- (a) Sustainable tourism
(b) Tourism and the digital transformation
(c) Tourism : responding to the challenge of climate change
(d) Tourism and jobs : a better future for all
63. Which one of the following countries has hosted the Army Exercise TSENTR, 2019?
- (a) Russia (b) China
(c) Kazakhstan (d) Kyrgyzstan
64. Which one of the following countries is called the 'country of winds'?
- (a) India (b) China
(c) Denmark (d) Germany
65. Which one of the following is the oldest scientific department of the Government of India?
- (a) Department of Biotechnology
(b) Survey of India
(c) India Meteorological Department
(d) DRDO
66. 'Naseem-Al-Bahr' is a bilateral naval exercise between India and
- (a) United Arab Emirates (b) Iran
(c) Saudi Arabia (d) Oman
67. Koneru Humpy excels in which one of the following sports ?
- (a) Boxing (b) Table Tennis
(c) Chess (d) Billiards
68. Which one of the following was the official mascot of Khelo India Youth Games, 2020 ?
- (a) Vijaya (b) Yaya
(c) Rongmon (d) Ammu
69. In January 2020 , a passenger aircraft crashed in Iran soon after taking off from Tehran's Imam Khomeini airport killing about 170 people onboard. The airplane belongs to
- (a) Qatar Airways
(b) Ukraine International Airlines
(c) Singapore Airlines?
(d) Cathay Pacific
70. MILAN, a multilateral naval exercise, 2020 was hosted by which one of the following cities ?
- (a) Port Blair (b) Kochi
(c) Visakhapatnam (d) Panaji
71. Chalk and marble are different forms of
- (a) Calcium hydrogen carbonate
(b) Calcium carbonate
(c) Calcium acetate
(d) Sodium carbonate
72. The number of maximum electrons in N Shell is
- (a) 2 (b) 8 (c) 18 (d) 32
73. Vinegar is also known as
- (a) ethanoic acid (b) nitric acid
(c) sulphuric acid (d) tartaric acid
74. A liquid is kept in a glass beaker. Which one of the following statements is correct regarding the pressure exerted by the liquid column at the base of the beaker ?
- (a) The pressure depends on the area of the base of the beaker
(b) The pressure depends on the height of liquid column
(c) The pressure does not depend on the density of the liquid
(d) The pressure neither depends on the area of the base of the beaker nor on the height of liquid column
75. Which of the following statements is NOT correct regarding the travel of sound waves?
- (a) Sound waves can travel through water
(b) Sound waves can travel through air
(c) Sound waves can travel through steel
(d) Sound waves can travel through vacuum
76. Deendayal Port is located at
- (a) Kerala (b) Gujarat
(c) Maharashtra (d) Goa
77. Which one of the following cities is associated with Biosafety Protocol to the Convention on Biological Diversity (2000)?
- (a) Geneva (b) Nairobi
(c) Cartagena (d) Rio de Janeiro

78. Krishna Raja Sagara Dam/Reservoir is developed on
 (a) river Krishna (b) river Tungabhadra
 (c) river Godavari (d) river Kavery
79. Which one of the following Indian states does NOT share international border with two or more countries ?
 (a) Arunachal Pradesh (b) Assam
 (c) Mizoram (d) Tripura
80. According to Census of India, 2011, which one among the following is the least populated state in India?
 (a) Maharashtra (b) Madhya Pradesh
 (c) Odisha (d) Punjab
81. The speakers of major Indian languages belong to how many language families ?
 (a) Two (b) Three (c) Four (d) Six
82. Where did Gandhiji initially forge the techniques of Satyagraha?
 (a) England (b) South Africa
 (c) North Africa (d) India
83. Who was the Viceroy of India at the time of Gandhiji's Dandi march?
 (a) Lord Irwin (b) Lord Linlithgow
 (c) Lord Reading (d) Lord Willingdon
84. Which one among the following American newsmagazines was highly sceptical of Gandhiji's Dandi march initially but within a week completely changed its opinion and saluted him as a Saint and Statesman ?
 (a) Saturday Evening Post (b) Readers Digest
 (c) Time (d) Life
85. In which of the following years were passenger trains introduced in England ?
 (a) 1823 (b) 1825 (c) 1848 (d) 1861
86. The correct relation between the radius of curvature R and focal length f of a spherical mirror is
 (a) $R = f$ (b) $R = 2f$ (c) $R = 3f$ (d) $R = 4f$
87. A lemon kept in water in a glass tumbler appears to be larger than its actual size. It is because of
 (a) reflection of light (b) scattering of light
 (c) refraction of light (d) polarization of light
88. Light enters the eye through a thin membrane called
 (a) retina (b) cornea (c) pupil (d) iris
89. Name the scientist who first used a glass prism to obtain the spectrum of sunlight
 (a) C. V. Raman (b) Lord Rayleigh
 (c) Isaac Newton (d) S. Chandrasekhar
90. The cost of energy to operate an industrial refrigerator that consumes 5 kW power working 10 hours per day for 30 days will be (Given that the charge per kW.h of energy = ₹ 4)
 (a) ₹ 600 (b) ₹ 6,000 (c) ₹ 1,200 (d) ₹ 1,500
91. Which one of the following statements regarding magnetic field is NOT correct?
 (a) Magnetic field is a quantity that has direction and magnitude
 (b) Magnetic field lines are closed curves
 (c) Magnetic field lines are open curves
 (d) No two magnetic field lines are found to cross each other
92. Which one of the following statements is NOT correct?
 (a) Buckminsterfullerene is an allotrope of carbon
 (b) Diamond is a good conductor of electricity
 (c) Graphite is a good conductor of electricity
 (d) In graphite, each carbon atom is linked to three other carbon atoms
93. How many covalent bonds are present in a Chloropropane molecule having molecular formula, C_3H_7Cl ?
 (a) 6 (b) 8 (c) 9 (d) 10
94. Which one of the following is the most fundamental characteristic of an element?
 (a) Melting point (b) Atomic number
 (c) Colour (d) Atomic weight
95. Neutrons were discovered by
 (a) James Chadwick (b) Ernest Rutherford
 (c) J. J. Thomson (d) John Dalton
96. Atomic mass of an element is equal to the sum of number of
 (a) electrons and protons only
 (b) protons and neutrons only
 (c) electrons and neutrons only
 (d) electrons, protons and neutrons
97. Which one of the following element's isotope is used in the treatment of cancer?
 (a) Uranium (b) Cobalt
 (c) Sodium (d) Iodine
98. Which one of the following cell organelles may play a role in expelling excess water and wastes in case of unicellular organisms?
 (a) Lysosome (b) Vacuole
 (c) Golgi body (d) Endoplasmic reticulum
99. Which one of the following terms describes the practice of growing two or more crops simultaneously on the same piece of land?
 (a) Crop rotation (b) Mixed cropping
 (c) Intercropping (d) Mixed farming
100. Which one of the following statements is correct about effects of antibiotics on viruses ?
 (a) Viruses are "non-living" entities but it can interact with antibiotics
 (b) Taking antibiotics cures viral infections
 (c) Viruses do not possess metabolic pathways on which antibiotics can function, whereas bacteria have such pathways
 (d) Viruses are resistant to antibiotics
101. The Panama Canal opened in 1914, links
 (a) Red Sea and Mediterranean Sea
 (b) Atlantic Ocean and Pacific Ocean
 (c) Indian Ocean and Pacific Ocean
 (d) Adriatic Sea and Black Sea
102. The United Nations Charter was signed by 51 original members of the United Nations in 1945 at the
 (a) Hague Conference (b) London Conference
 (c) San Francisco Conference (d) Berlin Conference
103. Land Revenue Records maintained in India have categorized land-use into
 (a) 6 categories (b) 9 categories
 (c) 15 categories (d) 21 categories

104. Dry land farming in India is largely confined to areas with rainfall less than
(a) 100 cm (b) 85 cm (c) 80 cm (d) 75 cm
105. For an area to be excluded from the drought-prone category, what percentage of its gross cropped area should be under irrigation ?
(a) 10 per cent or more (b) 20 per cent or more
(c) 25 per cent or more (d) 30 per cent or more
106. Which one of the following is NOT a current of Pacific Ocean ?
(a) Oyashio current (b) Alaska current
(c) Agulhas current (d) California current
107. The duration of monsoon in India extends for an average period of
(a) 80-140 days (b) 100-120 days
(c) 90-130 days (d) 100-140 days
108. Which one of the following is the natural vegetation of South east China?
(a) Subtropical broadleaf evergreen fores
(b) Tropical broadleaf evergreen forest
(c) Tropical deciduous forest
(d) Temperate evergreen forest
109. Which one of the following is a cold local wind?
(a) Santa Ana (b) Chinook
(c) Mistral (d) Loo
110. What was the consequence of Permanent Settlement on rural society in Bengal ?
(a) The zamindars invested capital and enterprise to improve agriculture along lines of British yeoman farmers
(b) A group of rich peasants known as jotedars succeeded in consolidating their position in the villages
(c) The ryots prospered as a result of fixed revenue levy imposed on them
(d) The system of Collectorate introduced by the Company for exercising supervisory control on zamindars failed to take off
111. What was Damin-i Koh in the Rajmahal area ?
(a) A large area of land demarcated and declared to be the land of the Santhals
(b) The land of the Paharias cultivated exclusively for paddy
(c) The British territory marked for their military camp
(d) The land earmarked for locating settled agriculturists
112. Which one of the following statements about the Revolt of 1857 is correct ?
(a) It was a revolt carefully organized and planned by the Rajas, Nawabs and Taluqdars
(b) Rumors and prophecies did not play any role in its outbreak and spread
(c) The rebel proclamations in 1857 repeatedly appealed to all sections of the population irrespective of their caste and creed
(d) The British succeeded in quickly and easily controlling the rebels
113. Which one among the following was NOT a Panch Sheel principle?
(a) Peaceful Co-existence
(b) Mutual respect for territorial integrity
(c) Nuclear deterrence
(d) Non-interference in internal affairs

114. Who among the following had organized, in 1904, a secret society of revolutionaries named. Abhinav Bharat?
(a) Khudiram Bose (b) Shyamji Krishna Verma
(c) Har Dayal (d) V D Savarkar
115. The principle that the framing of the new Constitution for independent India should be primarily (though not solely) the responsibility of Indians themselves, was for the first time conceded in the
(a) Government of India Act, 1935
(b) August Offer of Viceroy Linlithgow
(c) Cripps Proposals
(d) Cabinet Mission
116. Which one of the following is a major environmental issue in eastern Canada?
(a) Acid precipitation (b) Groundwater depletion
(c) Land degradation (d) Desertification
117. Which one of the following mountains lies in between Caspian Sea and Black Sea?
(a) Caucasus (b) Carpathians
(c) Apennine (d) Elburz
118. Bagalihar, Dulhasti and Salal hydro power projects have been developed on which of the following rivers ?
(a) Chenab and Jhelum (b) Chenab and Indus
(c) Ravi (d) Chenab only
119. Which of the following statements with regard to Biosphere Reserve is/are correct?
1. The idea of Biosphere Reserve was initiated by UNESCO in 1973-74
2. There are 18 designated Biosphere Reserves in India
3. All Biosphere Reserves in India have been included in world network of Biosphere Reserves of UNESCO
Select the correct answer using the code given below :
(a) 1 only (b) 2 only
(c) 1 and 2 only (d) 1,2 and 3
120. Which one of the following countries does NOT have direct access to the sea/ocean ?
(a) Syria (b) Jordan
(c) Azerbaijan (d) Armenia
121. In an incandescent electric bulb, the filament of the bulb is made up of which metal?
(a) Aluminium (b) Copper
(c) Tungsten (d) Silver
122. Two equal resistors R are connected in parallel, and a battery of 12 V is connected across this combination. A dc current of 100 mA flows through the circuit as shown below:
- 
- The value of R is
(a) 120 Ω (b) 240 Ω (c) 60 Ω (d) 100 Ω

123. Which one of the following is NOT the unit of energy?
 (a) Joule (b) Watt-hr
 (c) Newton-metre (d) kg-metre/sec²
124. Which one of the following statements is NOT correct?
 (a) Biomass is a renewable source of energy
 (b) Gobar gas is produced when cow dung, crop residues, vegetable waste, and sewage are allowed to decompose in the absence of oxygen
 (c) Biogas generation reduces soil and water pollution
 (d) Heating capacity of biogas is very low
125. In prokaryotic organisms, the nuclear region is not surrounded by a membrane. This undefined nuclear region is known as
 (a) Nucleic acid (b) Nucleoid
 (c) Nucleolus (d) Nucleosome
126. Which one of the following plant tissues has dead cells?
 (a) Epidermis (b) Parenchyma
 (c) Collenchyma (d) Sclerenchyma
127. Cartilage is NOT found in
 (a) larynx (b) nose
 (c) ear (d) urinary bladder
128. Two planets orbit the Sun in circular orbits, with their radius of orbit as $R_1 = R$ and $R_2 = 4R$. Ratio of their periods (T_1/T_2) around the Sun will be
 (a) $1/16$ (b) $1/8$ (c) $1/4$ (d) $1/2$
129. A metallic wire having a resistance of $20\ \Omega$ is cut into two equal parts in length. These parts are then connected in parallel. The resistance of this parallel combination is equal to
 (a) $20\ \Omega$ (b) $10\ \Omega$
 (c) $5\ \Omega$ (d) $15\ \Omega$
130. Light of uniform intensity impinges perpendicularly on a totally reflecting surface. If the area of the surface is halved, the radiation force on it will become
 (a) double (b) half
 (c) four times (d) one-fourth
131. The part of the human eye on which the image is formed is
 (a) pupil (b) cornea (c) retina (d) iris
132. Consider the following image:

- A proton enters a magnetic field at right angles to it, as shown above. The direction of force acting on the proton will be
 (a) to the right (b) to the left
 (c) out of the page (d) into the page
133. Which one of the following statements about sound is NOT correct?
 (a) Sound travels at a speed slower than the speed of light
 (b) Sound waves are transverse waves
 (c) Sound waves are longitudinal waves
 (d) Sound travels faster in moist air than in dry air
134. When the short circuit condition occurs, the current in the circuit
 (a) becomes zero
 (b) remains constant
 (c) increases substantially
 (d) keeps on changing randomly
135. Which one of the following is NOT a component of the human male reproductive system?
 (a) Cervix (b) Urethra
 (c) Seminal vesicle (d) Vas deferens
136. Which one of the following is NOT a reason for the decrease in biodiversity?
 (a) Large scale deforestation
 (b) Exploitation of forest produces
 (c) Maintaining sacred groves
 (d) Encroachment in forest areas
137. Which one of the following is NOT a cause of depletion in groundwater?
 (a) Afforestation
 (b) Loss of forests
 (c) Excessive pumping of groundwater
 (d) Construction of large scale concrete buildings
138. Which one of the following types of radiations has the smallest wavelength?
 (a) Microwaves (b) Infra-red
 (c) Visible light (d) X-rays
139. The instrument used for detecting the presence of electric current in a circuit is
 (a) Refractometer (b) Galvanometer
 (c) Viscometer (d) Diffractometer
140. Which one of the following is the largest composition in biogas?
 (a) Carbon dioxide (b) Methane
 (c) Hydrogen (d) Hydrogen sulphide
141. The Sun appears reddish during sunrise and sunset. The phenomenon in optics which is responsible for this appearance of the Sun is
 (a) Reflection (b) Total internal reflection
 (c) Scattering (d) Interference
142. A lens has a power of $+2.0$ Dioptre. Which one of the following statements about the lens is true?
 (a) The lens is concave and has a focal length of 0.5 metre
 (b) The lens is convex and has a focal length of 2.0 metre
 (c) The lens is convex and has a focal length of 0.5 metre
 (d) The lens is concave and has a focal length of 2.0 metre
143. At nearly 70°C , sodium bicarbonate shows the property of gradually decomposing, which makes it usable in bakery products. The product of decomposition responsible for this use of sodium bicarbonate is
 (a) Carbon dioxide (b) Hydrogen
 (c) Water vapour (d) Oxygen
144. Number of molecules of water of crystallization in copper sulphate, sodium carbonate and Gypsum are
 (a) $5, 10$ and 2 respectively (b) $10, 2$ and 5 respectively
 (c) $5, 2$ and 10 respectively (d) $2, 5$ and 10 respectively

145. Which one of the following is the correct sequence of change in colors when a turmeric stain on white clothes is scrubbed by soap and then washed with water?
- Yellow - pink - blue
 - Yellow - reddish brown - yellow
 - Yellow-reddish brown-blue
 - Yellow - blue - pink
146. Which one of the following statements regarding Bleaching powder and D.D.T. is correct ?
- Both are inorganic compounds
 - Both are organic compounds
 - Both contain chlorine
 - Both contain calcium
147. Which one of the following is the best example of desiccant?
- Silica gel
 - Polystyrene
 - Sodium chloride
 - Sodium carbonate
148. Which one of the following was the first mineral acid discovered?
- Sulphuric acid
 - Hydrochloric acid
 - Nitric acid
 - Phosphoric acid
149. The refractive index of fused quartz is 1.46 and that of sapphire is 1.77. If v_q is the speed of light in quartz and v_s is the speed of light in sapphire, then which one of the following relations is correct ?
- $v_q > v_s$
 - $v_s > v_q$
 - $v_s = v_q$
 - $v_s = \frac{v_q}{2}$
150. In case of a concave mirror, if an object is kept between principal focus F and pole P of the mirror, then which one of the following statements about the image is NOT correct?
- The image will be virtual
 - The image will be enlarged or magnified
 - The image will be formed at infinity
 - The image will be erect

ANSWER KEY

Paper I: Mathematics

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

Paper II: General Ability

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

EXPLANATION

Paper I: Mathematics

1. (c) The value is converted to

$$A = \begin{bmatrix} 1+i & -i \\ i & 1+i \end{bmatrix}$$

Now, it is converted to

$$(\bar{A})^T = \begin{bmatrix} 1+i & i \\ -i & 1+i \end{bmatrix}$$

Both the values are no added and we get:

$$(A) + (\bar{A})^T = \begin{bmatrix} 1-i & i \\ -i & 1-i \end{bmatrix} + \begin{bmatrix} 1+i & i \\ -i & 1+i \end{bmatrix} = \begin{bmatrix} 2 & 2i \\ -2i & 2 \end{bmatrix}$$

The diagonal elements are said to be real.

So, the value is $(\bar{A})^T + A$ is hermitian.

2. (a) General Term

$$= {}^{10}C_r (2x)^{-2-10-r} (-x^2)^{\frac{1}{2}r} \\ = {}^{10}C_r 2^{10-r} x^{-20+2r+\frac{r}{2}} \left(-\frac{1}{2}\right)^{\frac{r}{2}}$$

Now, for the independent term:

$$-20 + 2r + \frac{r}{2} = 0 \Rightarrow r = 8$$

The value of independent term is then obtained as:

$$= {}^{10}C_8 \times 2^{10-8} \times \left(-\frac{1}{2}\right)^{\frac{8}{2}} \\ = \frac{10 \times 9}{2} \times 4 = 180$$

3. (b) Putting the value of $x = -1$ in the given expression as:

$$(1 + 2x - x^2)^6 = 64$$

So, we get: $a_0 - a_1 + a_2 - a_3 + a_4 - \dots + a_{12} = 64$

4. (c) It is given that $C(20, n+2) = C(20, n-2)$.

It then can be written as:

$${}^{20}C_{(n+2)} = {}^{20}C_{(n-2)}$$

So, we get: $20 = (n+2) + (n-2)$
 $\Rightarrow n = 10$

5. (d) The matrix is in singular value when $|A| = 0$

$$\text{So, we get: } \begin{vmatrix} 0 & k & 4 \\ -k & 0 & -5 \\ -k & k & -1 \end{vmatrix} = 0$$

$$0 - k(k-5k) + 4(-k)(k) = 0$$

$$0 - k^2 + 5k^2 - 4k^2 = 0$$

$$4k - 4k = 0$$

As a result, we can choose any value for k such that the matrix is singular.

6. (d) The value of $(1101101)_2$ is obtained as: 109

The value of $(1011011)_2$ is obtained as: 91

The sum is then obtained as:

$$(1101101 + 1011011)_2$$

$$= (109 + 91)_{10} = (200)_{10}$$

$$\begin{aligned} 7. (a) & \frac{1}{10} \log_5 1024 - \log_5 10 + \frac{1}{5} \log_5 3125 \\ &= \frac{1}{10} \log_5 2^{10} - \log_5 (2 \times 5) + \frac{1}{5} \log_5 5^5 \\ &= \frac{1}{10} \times 10 \log_5 2 - \log_5 (2) - \log_5 5 + \frac{1}{5} \times 5 \log_5 5 \\ &= \log_5 2 - \log_5 2 - \log_5 5 + \log_5 5 = 0 \end{aligned}$$

$$8. (c) x = \frac{\log(ab)}{\log c}, y = \frac{\log(bc)}{\log a}$$

$$\text{and } z = \frac{\log(ca)}{\log b}$$

From this we get: $xyz \neq 1$ and $x + y + z \neq 1$

Now, let us consider that:

$$1 + x = 1 + \frac{\log(ab)}{\log c}$$

Using the logarithm property and we

$$\text{get: } 1 + x = \frac{\log c + \log(ab)}{\log c}$$

$$\frac{\log abc}{\log c}$$

$$1 + x = \frac{\log abc}{\log c} \quad \text{and} \quad \text{Similarly, we get: } 1 + y = \frac{\log abc}{\log a}$$

$$1 + z = \frac{\log abc}{\log b}$$

$$\text{So, no we get: } \frac{1}{1+x} + \frac{1}{1+y} + \frac{1}{1+z}$$

$$= \frac{\log c}{\log abc} + \frac{\log b}{\log abc} + \frac{\log a}{\log abc}$$

$$= \frac{\log c + \log b + \log a}{\log abc} = \frac{\log abc}{\log abc} = 1$$

9. (b) It is given that: $AB = C$

$$\text{Then, we get: } \begin{bmatrix} x+y & y \\ 2x & x-y \end{bmatrix} \begin{bmatrix} 2 \\ -1 \end{bmatrix} = \begin{bmatrix} 3 \\ 2 \end{bmatrix}$$

$$4x - x + y = 2$$

$$3x + y = 2 \quad \dots(i)$$

$$2x + 2y - y = 3$$

$$2x + y = 3 \quad \dots(ii)$$

On solving equation (i) from (ii), we get: $x = -1$ and $y = 5$

$$\text{The value of } A = \begin{bmatrix} 4 & 5 \\ -2 & -6 \end{bmatrix}$$

$$= -24 + 10 = -14$$

10. (d) It is given that: $1.5 \leq x \leq 4.5$

$$\text{So, the critical points will be: } x = 1.5 = \frac{3}{2}$$

$$\text{or } x = 4.5 = \frac{9}{2}$$

Further, we get: $2x - 3 = 0$ or $2x - 9 = 0$

Now, changing the inequality to equality form, we get:

$$\begin{array}{ccc} +ve & -ve & +ve \\ x = 3/2 & & x = 9/2 \end{array}$$

The wavy curve of the values $(2x - 3)$

$(2x - 9)$ are seen negative.

$$(2x - 3)(2x - 9) \leq 0$$

11. (c) Here it is given that: $xRy = \log_a x > \log_a y$ and $a = \frac{1}{2}$.

$$\text{Then, we get: } \frac{\log x}{\log \left(\frac{1}{2}\right)} > \frac{\log y}{\log \left(\frac{1}{2}\right)}$$

$$= \log x < \log y = x < y$$

The connection is not reflexive because, in the case of reflexive, $x > x$ is false.

In the case of symmetry, if $x < y$, then $y < x$ is like wise false.

If $x < y$ and $y < z$, then $x < z$, then the relation is transitive exclusively.

12. (d) When we have: $i = \sqrt{-1}$

Then, we get: $i^2 = -1$, $i^3 = -i$, $i^4 = 1$, $i^5 = i$, $i^6 = -1$, $i^7 = -i$, $i^8 = 1$ and $i^{12} = 1$

$$\text{So, it can be written as: } \begin{bmatrix} i & -1 & -i \\ 1 & i & 1 \\ i & 1 & -i \end{bmatrix}$$

$$\text{Then, we get: } i(i-1) + 1(-i-i) - i(1+i) = i^2 - i - 2i - i - i^2 = -4i$$

13. (c) The value of $AB = \begin{bmatrix} a & h & g \\ h & b & f \\ g & f & c \end{bmatrix} \begin{bmatrix} x \\ y \\ z \end{bmatrix}$

$$= \begin{bmatrix} ax + hy + gz \\ hx + by + fz \\ gx + fy + cz \end{bmatrix}$$

14. (b) There are two vowels and two consonants in the word ABLE.

There are 4 letters in all.

Total even position number: 2.

Two vowels need to go in two different places.

Number of ways are: ${}^2C_2 = 1$

The vowels can arrange among themselves in $2! = 2$ ways.

While the 2 consonants can fill the remaining 2 spaces in $2! = 2$ ways.

The total number of ways are: $1 \times 2 \times 2 = 4$ ways.

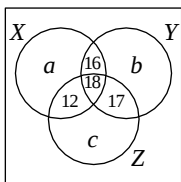
15. (c) The maximum number of points of intersection of

5 non-overlapping circles is obtained as:

$$2 \times {}^5C_2 = 2 \times \frac{5!}{3!2!}$$

$$= 2 \times \frac{5 \times 4}{2} = 20$$

16. (c) The diagram is given in the question as:



The value of $n(Y) = 16 + 18 + 17 + b$

The value of $n(Z) = 12 + 18 + 17 + c = 90$

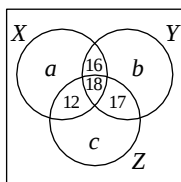
The value of b is then obtained as:

$$\frac{n(Y)}{n(Z)} = \frac{16 + 18 + 17 + b}{12 + 18 + 17 + c} = \frac{4}{5}$$

$$\frac{51 + b}{90} = \frac{4}{5}$$

$$\Rightarrow b = 21$$

17. (d) The diagram is given in the question as:



The values we have are:

$$n(X) = a + 46, n(Y) = 51 + b,$$

$$n(X \cap Y) = 16 + 18 = 34, n(Y \cap Z) = 17 + 18 = 35,$$

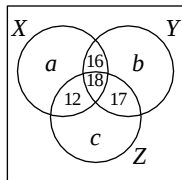
$$n(X \cap Z) = 12 + 18 = 30 \text{ and } n(X \cap Y \cap Z) = 18$$

The value is then evaluated as:

$$n(X) + n(Y) + n(Z) - n(X \cap Y) - n(Y \cap Z) - n(X \cap Z) + n(X \cap Y \cap Z) = a + 46 + 51 + b + 90 - 34 - 35 - 30 + 18$$

$$= a + b + 106$$

18. (a) The diagram is given in the question as:



As we have solved in the previous question, we can see:

$$n(X) + n(Y) + n(Z) - n(X \cap Y) - n(Y \cap Z) - n(X \cap Z) + n(X \cap Y \cap Z) = n(X \cup Y \cup Z)$$

Over here we have: $U - n(X \cup Y \cup Z) = p$

The value of U is a universal set.

$$\text{Then, we get: } U - (a + b + 106) = p$$

$$U = p + (a + b + 106)$$

The number of elements in the complement of X , $U - n(x)$ is:

$$p + (a + b + 106) - (a + 16 + 18 + 12) = p + b + 60$$

19. (b) It is given that: $\frac{\tan 3A}{\tan A} = k$

It can also be written as:

$$\tan 3A = \frac{3 \tan A - \tan^3 A}{1 - 3 \tan^2 A}$$

$$\frac{3 \tan A - \tan^3 A}{1 - 3 \tan^2 A} = k$$

$$\text{Then, we get: } \frac{3 \tan A - \tan^3 A}{\tan A} = k$$

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

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

$$3 - \tan^2 A = k(1 - 3 \tan^2 A)$$

$$(3 \tan^2 A)k - \tan^2 A = k - 3$$

$$\tan^2 A(3k - 1) = k - 3$$

$$\tan^2 A = \frac{k - 3}{3k - 1}$$

$$3k - 1$$

20. (a) It is evaluated in the previous question

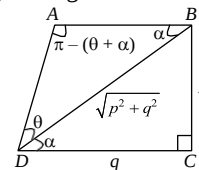
$$\text{that: } \tan^2 A = \frac{k - 3}{3k - 1}$$

Then, for the real values of $\tan^2 A$ we get:

$$\frac{k - 3}{3k - 1} > 0$$

So, for real values of $\tan A$, K cannot lie between $\frac{1}{3}$ and 3.

21. (c) A diagram can be drawn as:



The sine rule is used in the $\triangle ABD$ as:

$$\text{We get: } \frac{\sin \theta}{AB} = \frac{\sin \alpha}{AD}$$

$$AD \sin \theta = AB \sin \alpha$$

So, the first statement is correct.

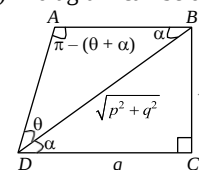
The sine rule is used in the $\triangle ABD$ as:

$$\text{We get: } \frac{\sin \theta}{AB} = \frac{\sin(180 - (\alpha + \theta))}{BD}$$

$$BD \sin \theta = AB \sin(\theta + \alpha)$$

So, the second statement is also correct.

22. (a) A diagram can be drawn as:



Let us take $\triangle BCD$, then we get:

$$\cos \alpha = \frac{q}{\sqrt{p^2 + q^2}} \text{ and } \sin \alpha = \frac{p}{\sqrt{p^2 + q^2}}$$

The sine rule is used in the $\triangle ABD$ as:

$$\frac{AB}{\sin \theta} = \frac{BD}{\sin(\theta + \alpha)}$$

Then, we get:

$$AB = \frac{\sqrt{p^2 + q^2} \sin \theta}{\sin \theta \cos \alpha + \cos \theta \sin \alpha}$$

$$= \frac{\sqrt{p^2 + q^2} \sin \theta}{\frac{\sin \theta \times q}{\sqrt{p^2 + q^2}} + \frac{\cos \theta \times p}{\sqrt{p^2 + q^2}}}$$

$$= \frac{(p^2 + q^2) \sin \theta}{p \cos \theta + q \sin \theta}$$

23. (b) It is given that: $\tan \theta = \frac{\cos 17^\circ - \sin 17^\circ}{\cos 17^\circ + \sin 17^\circ}$

The value is divided by $\cos 17^\circ$ and we get:

$$\tan \theta = \frac{\cos 17^\circ - \sin 17^\circ}{\cos 17^\circ + \sin 17^\circ}$$

$$= \frac{1 - \tan 17^\circ}{1 + \tan 17^\circ}$$

$$= \frac{\tan 45^\circ - \tan 17^\circ}{1 + \tan 45^\circ \times \tan 17^\circ}$$

$$= \frac{\tan 45^\circ - \tan 17^\circ}{1 + \tan 45^\circ \times \tan 17^\circ}$$

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

$$= \tan(28^\circ)$$

24. (d) The values given are:

$$\cos 2B = 3\sin^2 A \quad \dots(i)$$

$$3\sin 2A = 2\sin 2B \quad \dots(ii)$$

The equation (i) and (ii) are divided as:

$$\frac{\cos(2B)}{2\sin(2B)} = \frac{3\sin^2 A}{2\sin(2A)} \quad \dots(iii)$$

We know that: $\sin 2A = 2\sin A \times \cos A$

The third equation then becomes:

$$\frac{\cos(2B)}{2\sin(2B)} = \frac{\sin^2 A}{2\sin A \times \cos A}$$

$$\Rightarrow \frac{\cos(2B)}{\sin(2B)} = \frac{\sin A}{\cos A}$$

$$\cos(2B) \cos(A) = \sin(2B) \sin(A)$$

$$\Rightarrow \cos(2B) \cos(A) - \sin(2B) \sin(A) = 0$$

Now, with the help of above concept, we get:

$$\cos(A + 2B) = 0$$

$$\Rightarrow (A + 2B) = \cos^{-1}(0)$$

$$\Rightarrow (A + 2B) = \pi/2$$

25. (a) The value is obtained as:

$$\sin 3x + \cos 3x + 4\sin^3 x - 3\sin x + 3\cos x - 4\cos^3 x$$

$$= 3\sin x - 4\sin^3 x + 4\cos^3 x - 3\cos x + 4\sin^3 x - 3\sin x + 3\cos x - 4\cos^3 x = 0$$

26. (d) Over here we have: $y = 2 + \cos x$

We know that: $-1 \leq \cos x \leq 1$

Now, adding two, we get:

$$2 - 1 \leq 2 + \cos x \leq 2 + 1$$

$$1 \leq y \leq 3$$

The value of y - coordinate lies between: $y = 1$ to $y = 3$

27. (b) Let us assume that: $x = 8\cos 10^\circ \cdot \cos 20^\circ \cdot \cos 40^\circ$

Now, multiplying both the sides with $\sin 10^\circ$ and we get:

$$x \sin 10^\circ = 4 \times 2 \sin 10^\circ \cdot \cos 10^\circ \cdot \cos 20^\circ \cdot \cos 40^\circ$$

$$\cos 40^\circ$$

$$x \sin 10^\circ = 4\sin 20^\circ \cdot \cos 20^\circ \cdot \cos 40^\circ$$

$$x \sin 10^\circ = 2\sin 40^\circ \cdot \cos 40^\circ$$

$$x \sin 10^\circ = \sin 80^\circ$$

$$x \sin 10^\circ = \sin(90^\circ - 10^\circ) = \cos 10^\circ$$

$$x = \frac{\cos 10^\circ}{\sin 10^\circ}$$

$$x = \cot 10^\circ$$

28. (b) Applying the formula in the given equation as:

$$\cos 48^\circ - \cos 12^\circ = 2\sin\left(\frac{48^\circ + 12^\circ}{2}\right) \sin\left(\frac{12^\circ - 48^\circ}{2}\right)$$

$$= 2\sin\left(\frac{60^\circ}{2}\right)\sin\left(\frac{-36^\circ}{2}\right)$$

$$= 2\sin(30^\circ)\sin(-18^\circ)$$

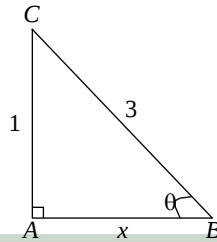
$$= 2 \times \frac{1}{2} \times \left(-\frac{\sqrt{5}-1}{4}\right)$$

$$= \frac{1-\sqrt{5}}{4}$$

29. (b) The value we have are:

$$\sin B = \frac{1}{3} = \frac{P}{H}$$

A right angle triangle can be drawn as:



The values we have are: $P = 1$, $H = 3$ and $B = x$

Pythagoras Theorem is used: $3^2 = 1^2 + x^2$

$$\Rightarrow x^2 = 8$$

$$\Rightarrow x = 2\sqrt{2}$$

$$\text{The value of } \csc C = \frac{3}{2\sqrt{2}}$$

Then, the first statement is incorrect.

It is given that: $b\cos B = c\cos C$

The sine rule is applied here and we get:

$$\frac{\sin A}{a} = \frac{\sin B}{b} = \frac{\sin C}{c} = \frac{1}{K}$$

$$b = K \sin B \text{ and } c = K \sin C$$

$$2 \sin B \cos B = 2 \sin C \cos C$$

$$\text{Now, assuming that: } K = 2$$

$$\text{Then, we get: } \sin 2B = \sin 2C$$

$$\sin 2B - \sin 2C = 0$$

$$2\cos(B+C)\sin(B-C) = 0$$

Firstly, we will take:

$$\cos(B+C) = 0$$

$$(B+C) = 90^\circ \quad \dots(i)$$

Then, we will take:

$$\sin(B-C) = 0$$

$$(B-C) = 0$$

$$B = C \quad \dots(ii)$$

Either Δ is right triangle or isosceles.

$$B = C = 45^\circ$$

So, the second statement is correct.

30. (d) It is given that: $A = 2B$ and $b = c$.

The sum of a triangle is:

$$A + B + C = 180^\circ$$

$$2B + B + B = 180^\circ$$

$$4B = 180^\circ$$

A triangle will be formed with sides:

$$A = 90^\circ, B = 45^\circ \text{ and } C = 45^\circ$$

So, the first statement is incorrect.

It is given that in a triangle: $A = 40^\circ$ and $B = 65^\circ$

So, the value of $C = 75^\circ$

$$\text{We know that: } \frac{a}{c} = \frac{\sin A}{\sin C} = \frac{\sin 40^\circ}{\sin 75^\circ}$$

It will become: $\sin 40^\circ \csc 75^\circ$

So, the second statement is incorrect.

31. (a) It is given that: $a\sin^2 x + b\cos^2 x = c$

Dividing it by $\cos^2 x$, we get:

$$a\tan^2 x + b = c\sec^2 x = c(1 + \tan^2 x)$$

$$a\tan^2 x - c\tan^2 x = c - b$$

$$\tan^2 x = \frac{c-b}{a-c}$$

32. (c) It is given that: $b\sin^2 y + a\cos^2 y = d$

Dividing it by $\cos^2 y$, we get:

$$b\tan^2 y + a = d(1 + \tan^2 y)$$

$$\tan^2 y(b-d) = d-a$$

$$\tan^2 y = \frac{d-a}{b-d}$$

33. (b) It is given that: $p\tan x = q\tan y$

The values for $\tan^2 x$ and $\tan^2 y$ are obtained in the previous questions.

$$\text{So, the value for } \frac{p^2}{q^2} = \frac{\tan^2 y}{\tan^2 x}$$

$$\frac{d-a}{c-b} = \frac{b-d}{a-c}$$

$$= \frac{d-a}{b-d} \times \frac{a-c}{c-b}$$

$$= \frac{(a-d)(c-a)}{(b-c)(d-b)}$$

34. (a) It is given that: $t_n = \sin^n \theta + \cos^n \theta$

The value of $\frac{t_3 - t_5}{t_5 - t_7}$ is obtained as:

$$\frac{t_3 - t_5}{t_5 - t_7} = \frac{\sin^3 \theta + \cos^3 \theta - \sin^5 \theta - \cos^5 \theta}{\sin^5 \theta + \cos^5 \theta - \sin^7 \theta - \cos^7 \theta}$$

$$= \frac{\sin^3 \theta \cos^2 \theta + \cos^3 \theta \sin^2 \theta}{\sin^5 \theta \cos^2 \theta + \cos^5 \theta \sin^2 \theta}$$

$$= \frac{\sin^2 \theta \cos^2 \theta (\sin \theta + \cos \theta)}{\sin^2 \theta \cos^2 \theta (\sin^3 \theta + \cos^3 \theta)} = \frac{t_1}{t_3}$$

35. (b) The value of $t_1^2 - t_2$ is obtained as:
- $$\frac{1}{2} t_1^2 - t_2 = \frac{(\sin^2 \theta + \cos^2 \theta)^2}{2} - (\sin^2 \theta + \cos^2 \theta)$$
- $$= \frac{\sin^2 \theta + \cos^2 \theta + 2\sin \theta \cos \theta}{2} - \sin^2 \theta - \cos^2 \theta = \sin 2\theta$$

36. (c) The value of $t_{10} = \sin^{10}\theta + \cos^{10}\theta$

It is given that: $\theta = 45^\circ$

Then, we get: $\sin^{10}45^\circ + \cos^{10}45^\circ$

$$= \left(\frac{1}{\sqrt{2}}\right)^{10} + \left(\frac{1}{\sqrt{2}}\right)^{10}$$

$$= \frac{1}{32} + \frac{1}{32} = \frac{1}{16}$$

37. (d) It is given that: $\alpha = \beta = 15^\circ$

So, the value of $\sin\alpha + \cos\beta$ is obtained as:

$$\sin\alpha + \cos\beta = \sin 15^\circ + \cos 15^\circ$$

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

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

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

38. (d) It is given that: $\alpha = \beta = 15^\circ$

So, the value of $\sin 7\alpha - \cos 7\beta$ is obtained as:

$$\sin 7\alpha - \cos 7\beta = \sin 105^\circ - \cos 105^\circ$$

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

$$= \cos 15^\circ + \sin 15^\circ$$

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

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

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

39. (d) The value is obtained as:

$$\sin(\alpha + 1^\circ) + \cos(\beta + 1^\circ)$$

$$= \sin(15^\circ + 1^\circ) + \cos(15^\circ + 1^\circ)$$

$$= \sin 15^\circ \cos 1^\circ + \cos 15^\circ \sin 1^\circ + \cos 15^\circ \cos 1^\circ - \sin 15^\circ \sin 1^\circ$$

$$= \cos 1^\circ (\sin 15^\circ + \cos 15^\circ) + \sin 1^\circ (\cos 15^\circ - \sin 15^\circ) \quad \dots(i)$$

The value of $\sin 15^\circ + \cos 15^\circ$ is $\frac{\sqrt{3}}{\sqrt{2}}$

Now, the value of $\cos 15^\circ - \sin 15^\circ$ is obtained as:

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

$$= \sin 75^\circ - \sin 15^\circ$$

$$= 2 \cos\left(\frac{75^\circ + 15^\circ}{2}\right) \sin\left(\frac{75^\circ - 15^\circ}{2}\right)$$

$$= 2 \cos(45^\circ) \sin(30^\circ)$$

$$= 2 \times \frac{1}{\sqrt{2}} \times \frac{1}{2} = \frac{1}{\sqrt{2}}$$

The first equation will then become:

$$\cos 1^\circ \left(\frac{\sqrt{3}}{\sqrt{2}}\right) + \sin 1^\circ \left(\frac{1}{\sqrt{2}}\right)$$

$$= \frac{1}{\sqrt{2}} (\sqrt{3} \cos 1^\circ + \sin 1^\circ)$$

40. (c) It is given that: $\sin x + \sin y = \cos y - \cos x$

Then, we get:

$$2 \sin\left(\frac{x+y}{2}\right) \cos\left(\frac{x-y}{2}\right)$$

$$= 2 \sin\left(\frac{x+y}{2}\right) \sin\left(\frac{x-y}{2}\right)$$

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

$$\Rightarrow \sin\left(\frac{x+y}{2}\right) = \sin\left(\frac{x+y}{2}\right) \times \tan\left(\frac{x-y}{2}\right)$$

$$\Rightarrow \tan\left(\frac{x-y}{2}\right) = 1$$

41. (c) For the value of A:

Number of rows: 3

Number of columns: 5

For the value of B:

Number of rows: 5

Number of columns: 3

The order of AB then will be: Number of rows of A Number of columns of B = 3×3 .

The order of BA then will be: Number of rows of B Number of columns of A = 5×5 .

42. (c) Let us assume the values to be:

$$p^2 = 4, q^2 = 12 \text{ and } r^2 = 36$$

Now, the value will be: $p = 2, q = 2\sqrt{3}$ and $r = 6$

The values are said to be in G.P when:

$$q^2 = p \times r$$

$$12 = 2 \times 6$$

$$12 = 12$$

So, the first statement is correct.

The values are said to be in AP when:

$$2 \times \log q = \log p + \log r$$

$$2 \log 2\sqrt{3} = \log 2 + \log 6$$

$$\log 12 = \log 12$$

So, the second statement is also correct.

43. (b) The quadratic equation is $x^2 - 3x + 2 = 0$

$$\text{Sum of roots} = \cot \alpha + \cot \beta = \frac{-(-3)}{1} = 3$$

$$\text{Product of roots} = \cot \alpha \cot \beta = \frac{2}{1} = 2$$

$$\cot(\alpha + \beta) = \frac{\cot \alpha \cot \beta - 1}{\cot \beta + \cot \alpha}$$

$$\cot(\alpha + \beta) = \frac{2 - 1}{3 + 3} = \frac{1}{6}$$

44. (b) $\alpha\beta = \alpha^2\beta^2$

$$\Rightarrow \alpha\beta - \alpha^2\beta^2 = 0$$

$$\Rightarrow \alpha\beta(1 - \alpha\beta) = 0$$

$$\Rightarrow \alpha\beta = 0, \alpha\beta = 1$$

So, $\alpha + \beta = \alpha^2 + \beta^2$

$$\alpha\beta = 1, \Rightarrow \alpha = \frac{1}{\beta}$$

$$\text{So, } \frac{1}{\beta} + \beta = \frac{1}{\beta^2} + \beta$$

$$\Rightarrow \beta - \beta = -\frac{1}{\beta^2} \Rightarrow \beta(\beta - 1) = \frac{\beta - 1}{\beta^2}$$

$$\Rightarrow (\beta - 1) \left(\beta - \frac{1}{\beta^2} \right) = 0$$

$$\Rightarrow (\beta - 1)(\beta^3 - 1) = 0$$

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

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

$$\Rightarrow \beta = 1, \beta = \frac{-1 \pm \sqrt{3}i}{2}$$

Now, put the value of β in $\alpha = \frac{1}{\beta}$

$$\alpha = 1, \alpha = \frac{-1 \mp \sqrt{3}i}{2}$$

Here two value of α and β takes place.

45. (a) $\frac{1-i\sqrt{3}}{1+i\sqrt{3}}$, where $i = \sqrt{-1}$

rationalize the complex number

$$\frac{(1-i\sqrt{3})^2}{(1)^2 - (\sqrt{3}i)^2} = \frac{1-3-2\sqrt{3}i}{1+4}$$

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

$$\tan \theta = \frac{\left| \frac{\sqrt{3}}{2} \right|}{\left| \frac{1}{2} \right|}$$

$$\tan \theta = \sqrt{3}$$

$$\theta = 60^\circ$$

Now argument of the complex number is $60^\circ + 180^\circ = 240^\circ$

46. (b) $\frac{\cos \theta + i \sin \theta}{\cos \theta - i \sin \theta} = Z$

$$\frac{\cos \theta + i \sin \theta}{\cos \theta - i \sin \theta} \times \frac{\cos \theta + i \sin \theta}{\cos \theta + i \sin \theta}$$

$$= \frac{(\cos \theta + i \sin \theta)^2}{\cos^2 \theta + \sin^2 \theta}$$

$$= \cos 2\theta + i \sin 2\theta = Z$$

$$\text{Modulus of } Z = \sqrt{\cos^2 2\theta + \sin^2 2\theta} = 1$$

47. (c) The number of proper set = $2^n - 1$

The proper set

$$= \{(1), (2), (3), (4), (1, 2), (1, 3), (1, 4), (2, 3),$$

$$(2, 4), (3, 4), (1, 2, 3), (1, 2, 4), (1, 3, 4), (2, 3, 4), \phi\}$$

The number of super set

$$\{3\} = \{(3), (1, 3), (2, 3), (3, 4), (1, 2, 3)$$

$$(1, 3, 4), (2, 3, 4)\}$$

The number of super set of $\{3\} = 7$

48. (a) $\begin{vmatrix} p & q & r \\ q & r & p \\ r & p & q \end{vmatrix}$
 $D = p(rq - p^2) + q(pr - q^2) + r(pq - r^2)$
 $= pqr - p^3 + pqr - q^3 + pqr - r^3$
 $= 3pqr - p^3 - q^3 - r^3$
 $D = -(p^3 + q^3 + r^3 - 3pqr)$
The value of D is always negative.
 $D < 0$
49. (a) $(1+x)^9 = {}^9C_0 + {}^9C_1x + {}^9C_2x^2 + {}^9C_3x^3 + {}^9C_4x^4 + {}^9C_5x^5 + {}^9C_6x^6 + {}^9C_7x^7 + {}^9C_8x^8 + {}^9C_9x^9$
Sum of last five coefficients $= {}^9C_5 + {}^9C_6 + {}^9C_7 + {}^9C_8 + {}^9C_9$
 $= 126 + 84 + 36 + 9 + 1 = 256$
50. (a) Checking statement 1
 $A(\text{adj } A) = (\text{adj } A)A$
By the property of the adjoint of the matrix the statement 1 is correct.
Checking statement 2.
 $|\text{adj } A| = |A|^{n-1}$
But we know that $|\text{adj } A| = |A|^{n-1}$
where n is the order of the matrix.
So, statement 2 is wrong.
51. (c) The equation of the center of the circle is
 $(x - 2a)(x - 2b) + (y - 2c)(y - 2d) = 0$
Center coordinates are
 $\left(\frac{2a+2b}{2}, \frac{2c+2d}{2} \right)$
Center coordinates are $(a + b, c + d)$
52. (c) The equation of the diagonal is $3x + 2y = 5$
The slope $m_1 = \frac{-3}{2}$
As the diagonals of the square bisect each other at right angles.
 $m_2 = \frac{2}{3}$
The equation of other diagonal passing through the point $(1, -1)$
 $y + 1 = \frac{2}{3}(x - 1)$
 $3y + 3 = 2x - 2$
 $2x - 3y = 5$
53. (b) The equation of ellipse is $25x^2 + 16y^2 = 400$
 $\frac{x^2}{16} + \frac{y^2}{25} = 1$
 $\frac{x^2}{4^2} + \frac{y^2}{5^2} = 1$
 $b = 5$
Length of major axis $= 2b = 10$
 $e = \sqrt{1 - \frac{a^2}{b^2}}$

$$e = \sqrt{\frac{25-16}{25}} = \frac{3}{5}$$

Foci of the ellipse $(0, \pm be) = (0, \pm 3)$

The sum of the distance from the two foci is equal to the length of the major axis.

Sum $= 10$

54. (c) The equation of two sides $x + 2 = 0$ and $y + 2 = 0$ intersect each other at right angles.

$kx + y + 2 = 0$ is satisfied by the point $(-1, -1)$

$$\Rightarrow -k - 1 + 2 = 0$$

$$\Rightarrow -k + 1 = 0$$

$$\Rightarrow k = 1$$

55. (b) The equation of parabola is $y^2 = x$ and the focus is $\left(\frac{1}{4}, 0 \right)$

And the vertex of the parabola is $(0, 0)$

The point lies on the parabola is $(at^2, 2at)$

$$\text{The point } O \left(\frac{t^2}{4}, \frac{t}{2} \right)$$

Slope $= \tan \theta$ (between $(0, 0)$ and O)

$$\frac{\frac{t}{2}}{\frac{t^2}{4}} = \tan \theta$$

$$t = 2 \cot \theta$$

$$O (\cot^2 \theta, \cot \theta)$$

Distance of O from $(0, 0)$

$$\sqrt{(\cot^2 \theta - 0)^2 + (\cot \theta - 0)^2}$$

$$= \cot \theta \sqrt{\cot^2 \theta + 1} \quad (1 \cot^2 \theta = \text{cosec}^2 \theta)$$

$$= \cot \theta \cdot \text{cosec} \theta$$

$$= \cos \theta \cdot \text{cosec}^2 \theta \left(\cot \theta = \frac{\cos \theta}{\sin \theta} \right)$$

56. (c) The three points are (a, b) , (c, d) and $(a - c, b - d)$

Slope of points (a, b) , (c, d)

$$\text{Slope } m_1 = \frac{d - b}{c - a}$$

Slope of points (c, d) and $(a - c, b - d)$

$$m_2 = \frac{b - d - d}{a - c - c}$$

As three points are collinear then, slope between two points is m_1 and slope between another two points is m_2 are equal
So, $m_1 = m_2$

$$\frac{b - d}{a - c} = \frac{d - b}{c - a}$$

$$bc - 2cd - ab + 2ad = ad - ab - 2cd + 2cb$$

$$bc + 2ad = ad + 2cb$$

$$ad = cb$$

57. (b) The coordinate of D and E are $(2, 5)$ and $(5, 9)$

The length of $BC = 2 DE$ (according to mid point theorem)

$$DE = \sqrt{(5-2)^2 + (9-5)^2}$$

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

$$DE = 5$$

Length of side $BC = 2DE$

Length of side $BC = 2 \times 5 = 10$ units.

58. (c) Equation of line is $3x - 4y - 5 = 0$

$$m = \frac{3}{4}$$

Slope of line perpendicular to line given

$$\text{line} = \frac{-4}{3}$$

The perpendicular passes through the point $(3, 1)$

Equation of perpendicular

$$(y - 1) = \frac{-4}{3}(x - 3)$$

$$\Rightarrow 3y - 3 = -4x + 12$$

The point $(0, k)$ also satisfy the equation

$$\Rightarrow 3k = 15 \Rightarrow k = 5$$

59. (b) The slope first $m_1 = 2 - \sqrt{3}$ and

$$m_2 = 2 + \sqrt{3}$$

The slope of two lines are

$$= \frac{2 - \sqrt{3} - 2 - \sqrt{3}}{1 + (2 - \sqrt{3})(2 + \sqrt{3})} = \tan \theta$$

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

$$\tan \theta = -\sqrt{3}$$

$$\theta = 120^\circ$$

The obtuse angle is 120° .

60. (c) The opposite sides of the square are $3x - 4y - 5 = 0$ and $3x - 4y + 15 = 0$

The side of the square is equal to the distance between two parallel lines.

$$d = \left| \frac{-5 - 15}{\sqrt{3^2 + 4^2}} \right|$$

$$d = 4 \text{ units}$$

Area of area of square $= a^2 = 16$ square units.

61. (d) The center of the sphere is $(1, -2, 3)$ and sphere is touching the plane $6x - 3y + 2z - 4 = 0$

The radius of the sphere is equal to the perpendicular distance between the plane and center.

$$r = \left| \frac{6(1) - 3(-2) + 2(3) - 4}{\sqrt{6^2 + 3^2 + 2^2}} \right|$$

$$\Rightarrow r = \frac{18 - 4}{7} \Rightarrow r = 2$$

Radius of sphere is $2r = 4$ units

62. (b) The equation of line is

$$\frac{x-0}{1} = \frac{y-0}{0} = \frac{z-0}{0} = \lambda$$

$$x = \lambda, y = 0, z = 0$$

The point is (2,3,4)

Direction ratio of perpendicular

$$= (\lambda - 2, 3, 4)$$

Direction ratio of given line = (1,0,0)

Now both lines are perpendicular to each other then

$$(\lambda - 2)1 + 3(0) + 4(0) = 0$$

$$\Rightarrow \lambda - 2 = 0$$

$$\Rightarrow \lambda = 2$$

$$x = 2, y = 0, z = 0$$

Now the distance between the points (2,0,0) and (2,3,4)

$$= \sqrt{0+9+16} = 5 \text{ units.}$$

63. (d) Sum of square of Direction cosines is always 1.

64. (c) In a plane, the two coordinate axes divide the plane into four quadrants.

Similarly on the space, the three coordinate axes divide the space into eight compartments called octants.

65. (b) Since the plane is parallel to XY-plane and cuts an intercept of 5 units on the axis

Equation of the plane: $z = 5$

66. (a) Since $\hat{a}$ is a unit vector in the XY-plane,

$$\hat{a} = \cos \theta \hat{i} + \sin \theta \hat{j}$$

$\theta = 30^\circ$, (Since it is in the positive x-axis)

$$\hat{a} = \cos 30^\circ \hat{i} + \sin 30^\circ \hat{j}$$

$$\hat{a} = \frac{\sqrt{3}}{2} \hat{i} + \frac{1}{2} \hat{j} = \frac{\sqrt{3}\hat{i} + \hat{j}}{2}$$

$$\left(\text{Since, } \cos 30^\circ = \frac{\sqrt{3}}{2} \text{ and } \sin 30^\circ = \frac{1}{2} \right)$$

67. (c) Given:- $|OA| = 12$

Let $\theta_x = 45^\circ = \alpha$ and $\theta_y = 60^\circ = \beta$

$$Q \cos^2 \alpha + \cos^2 \beta + \cos^2 \gamma = 1$$

$$\cos^2 45^\circ + \cos^2 60^\circ + \cos^2 \gamma = 1$$

$$\Rightarrow \frac{1}{2} + \frac{1}{4} + \cos^2 \gamma = 1$$

$$\Rightarrow \cos^2 \gamma = \frac{1}{2} \Rightarrow \gamma = \pm 60^\circ$$

$$\overline{OA} = |\overline{OA}| (\cos \alpha \hat{i} + \cos \beta \hat{j} + \cos \gamma \hat{k})$$

$$= 12 (\cos 45^\circ \hat{i} + \cos 60^\circ \hat{j} \pm \cos 60^\circ \hat{k})$$

$$= 12 \left(\frac{1}{\sqrt{2}} \hat{i} + \frac{1}{2} \hat{j} \pm \frac{1}{2} \hat{k} \right)$$

$$= 6\sqrt{2}\hat{i} + 6\hat{j} \pm 6\hat{k}$$

68. (c) Given:-

$$a = 2\hat{i} - 4\hat{j} + 5\hat{k} \quad b = \hat{i} - 2\hat{j} - 3\hat{k}$$

The first diagonal is obtained by the parallelogram law of vector addition,

$$c = a + b$$

$$c = 2\hat{i} - 4\hat{j} + 5\hat{k} + \hat{i} - 2\hat{j} - 3\hat{k}$$

$$c = 3\hat{i} - 6\hat{j} + 2\hat{k}$$

The second diagonal is obtained by the triangle law of vector addition,

$$a = d + b \Rightarrow d = a - b$$

→

$$d = 2\hat{i} - 4\hat{j} + 5\hat{k} - (\hat{i} - 2\hat{j} - 3\hat{k})$$

$$d = \hat{i} - 2\hat{j} + 8\hat{k}$$

The dot product of the diagonals:

$$(c \cdot d) = (3\hat{i} - 6\hat{j} + 2\hat{k}) \cdot (\hat{i} - 2\hat{j} + 8\hat{k})$$

$$= 3 + 12 + 16 = 31$$

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

$$\text{and } |\vec{a}| = 4$$

$$\cdot (\vec{a} \times \vec{b})^2 + (\vec{a} \cdot \vec{b})^2$$

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

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

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

$$\Rightarrow 4|\vec{b}|^2 = 144 \Rightarrow |\vec{b}| = 3$$

70. (b) Given:-

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

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

$$\vec{c} = \hat{j} + p\hat{k}$$

Since these three vectors are coplanar

$$\therefore \begin{vmatrix} 2 & -3 & 1 \\ 1 & 2 & -3 \\ 0 & 1 & p \end{vmatrix} = 0$$

$$\Rightarrow 2(2p+3) - (-3)(p-0) + 1(1-0) = 0$$

$$p = -1$$

71. (d) $\lim_{x \rightarrow 1} \frac{x + x^2 + x^3 - 3}{x - 1}$

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

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

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

$$= \lim_{x \rightarrow 1} 1 + (x+1) + (x^2+x+1) = 6$$

72. (a) Given: Rate of increase of radius

$$= \frac{dR}{dt} = 0.7 \text{ cm/sec}$$

$$\Rightarrow \frac{dC}{dt} = 2\pi \frac{dR}{dt}$$

$$\Rightarrow \frac{dC}{dt} = 2\pi(0.7)$$

$$\Rightarrow \frac{dC}{dt} = 4.4 \text{ cm/sec}$$

73. (c) Given:-

$$\lim_{x \rightarrow 1} \frac{x^4 - 1}{x - 1} = \lim_{x \rightarrow 1} \frac{x^3 - k^3}{x^2 - k^2}$$

First, we solve the left hand side part

$$\lim_{x \rightarrow 1} \frac{x^4 - 1}{x - 1} = \lim_{x \rightarrow 1} \frac{(x^2 - 1)(x^2 + 1)}{x - 1}$$

$$= \lim_{x \rightarrow 1} \frac{(x+1)(x^2 + 1)}{1} = 4$$

R.H.S

$$\lim_{x \rightarrow k} \frac{x^3 - k^3}{x^2 - k^2} = \lim_{x \rightarrow k} \frac{(x-k)(x^2 + xk + k^2)}{(x+k)(x-k)}$$

$$= \lim_{x \rightarrow k} \frac{(x^2 + xk + k^2)}{(x+k)}$$

$$= \frac{(k^2 + k^2 + k^2)}{(k+k)} = \frac{3k}{2}$$

Since, L.H.S = R.H.S

$$4 = \frac{3k}{2} \Rightarrow k = \frac{8}{3}$$

74. (b) Given:-

$$k \frac{dy}{dx} = \int \left[1 + \left(\frac{dy}{dx} \right)^2 \right]^{\frac{3}{2}} dx$$

Differentiating both sides w.r.t. x we get,

$$k \frac{d^2y}{dx^2} = \left[1 + \left(\frac{dy}{dx} \right)^2 \right]^{\frac{3}{2}}$$

$$\left(k \frac{d^2y}{dx^2} \right)^3 = \left[1 + \left(\frac{dy}{dx} \right)^2 \right]^{\frac{9}{2}}$$

$$\left(k \frac{d^2y}{dx^2} \right)^3 = \left[1 + \left(\frac{dy}{dx} \right)^2 \right]^{\frac{9}{2}} + 2 \left(\frac{dy}{dx} \right)^2 \left[1 + \left(\frac{dy}{dx} \right)^2 \right]^{\frac{7}{2}}$$

∴ order = 2 and degree = 3

75. (a) Given,

$$\lim_{x \rightarrow 0} \frac{\sin x \log(1-x)}{x^2}$$

$$= \lim_{x \rightarrow 0} \frac{\sin x}{x} \cdot \lim_{x \rightarrow 0} \frac{\log(1-x)}{x}$$

$$= 1 \cdot \lim_{x \rightarrow 0} \frac{\log(1-x)}{x}$$

$$= \lim_{x \rightarrow 0} \frac{\log(1-x)}{x}$$

Since on applying the limit, the value is undefined,

$$\lim_{x \rightarrow 0} \frac{f(x)}{g(x)} = \lim_{x \rightarrow 0} \frac{\log(1-x)}{x}$$

$$\lim_{x \rightarrow 0} \frac{f'(x)}{g'(x)} = \lim_{x \rightarrow 0} \frac{-\frac{1}{1-x}}{1} = -1$$

76. (c) Given: $f(x) = 3x^2 - 5x + p$

$$\therefore f(0) = 3(0)^2 - 5(0) + p = p$$

$$\text{Now, } f(1) = 3(1)^2 - 5(1) + p = -2 + p$$

Since the numbers are opposite in sign,

$$f(0) \times f(1) < 0$$

$$p \times (-2 + p) < 0$$

$$p \times (p - 2) < 0$$

$$\therefore p \in (0, 2)$$

77. (b) Given:-

$$e^{\theta\phi} = c + 4\theta\phi$$

Differentiate both sides w.r.t. θ

$$\frac{d}{d\theta} e^{\theta\phi} = \frac{d}{d\theta} (c + 4\theta\phi)$$

$$\Rightarrow (e^{\theta\phi} - 4) \left(\phi + \theta \frac{d\phi}{d\theta} \right) = 0$$

$$\Rightarrow \left(\phi + \theta \frac{d\phi}{d\theta} \right) = 0$$

$$\Rightarrow \phi d\theta + \theta d\phi = 0 \Rightarrow \phi d\theta = -\theta d\phi$$

78. (b) Given, $p(x) = (4e)^{2x}$

$$\Rightarrow \int p(x) dx = \int (4e)^{2x} dx$$

$$\text{put } 2x = t \Rightarrow dx = \frac{dt}{2}$$

$$\int p(x) dx = \frac{1}{2} \int (4e)^t dt$$

$$= \frac{1}{2} \cdot \frac{(4e)^t}{\ln 4e} + c$$

$$= \frac{p(x)}{2(1 + 2\ln 2)} + c$$

79. (b) Given:-

$$\int_0^{\pi} (\tan^3 x + \tan x) dx$$

$$= \int_0^{\pi} \sec^2 x \tan x dx$$

$$= \int_0^{\pi} \sec x (\sec x \tan x) dx$$

$$\text{Let } u = \sec x$$

$$du = \sec x \tan x dx$$

$$\therefore \int_1^2 u du = \frac{1}{2}$$

80. (c) Given:-

$$x = 10$$

$$\Delta x = 10.1 - 10 = 0.1$$

$$y = 3x^2 + 2$$

Differentiate w.r.t. x

$$\frac{dy}{dx} = 6x$$

$$\Delta y = \frac{dy}{dx} \Delta x$$

$$\Delta y = (6x) \Delta x$$

$$\Rightarrow \Delta y = 6 \times 10 \times 0.1 = 6$$

$$= 6.03$$

81. (b) Given:-

$$f(x) = \frac{\sin x}{x}$$

$$\lim_{x \rightarrow 0} \frac{\sin x}{x} = 1$$

Thus for the function to be continuous at $x = 0$,

the value of function at $x = 0$ should be 1

82. (b) Given:

$$dy = (1 + y^2) dx$$

$$\Rightarrow \frac{dy}{(1 + y^2)} = dx$$

Integrating on both sides we get,

$$\Rightarrow \tan^{-1} y = x + c$$

$$\Rightarrow y = \tan(x + c)$$

83. (c) Given -

$$\text{Let } I = \int (e^{\log x} + \sin x) \cos x dx$$

$$= \int (x \cos x + \sin x \cos x) dx$$

$$= \int x \cos x dx + \int \sin x \cos x dx$$

$$\text{Let } I = I_1 + I_2$$

$$\text{Here, } I_1 = \int x \cos x dx$$

$$\int x \cos x dx = \int \left(\frac{dx}{dx} \int \cos x dx \right) dx$$

$$= x \sin x + \cos x + c$$

$$\text{Now, } I_2 = \int \sin x \cos x dx$$

$$\text{Let } \sin x = t \Rightarrow \cos x dx = dt$$

Differentiating with respect to x -

$$I_2 = \int t dt = \frac{t^2}{2} + c$$

$$= \frac{\sin^2 x}{2} + c$$

$$\therefore I = x \sin x + \cos x + \frac{\sin^2 x}{2} + c$$

84. (b) Given -

$$f(x) = \cos^{-1}(x - 2)$$

Since domain of $\cos^{-1}x = [-1, 1]$,

$$\therefore -1 \leq (x - 2) \leq 1$$

$$\Rightarrow 1 \leq x \leq 3$$

Therefore, domain of $\cos^{-1}(x - 2)$ is $[1, 3]$.

85. (c) Given -

The curve and straight line expression is $y^2 = 2x$ and $y = x$ respectively.

$$A = \int_0^2 (\sqrt{2x} - x) dx$$

$$A = \frac{2}{3} \left[2^{3/2} - 0 \right] - \frac{1}{2} [4 - 0]$$

$$A = \frac{2}{3} \text{ units}^2$$

86. (a) Given -

The function is $f(x) = 2x - x^2$.

$$\therefore f(x + 2) = 2(x + 2) - (x + 2)^2 \text{ and}$$

$$f(x - 2) = 2(x - 2) - (x - 2)^2$$

The value of $f(x + 2) + f(x - 2)$ is -

$$2(x + 2) - (x + 2)^2 + 2(x - 2) - (x - 2)^2$$

Substitute $x = 0$, get

$$f(2) + f(-2)$$

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

$$\Rightarrow f(2) + f(-2) = 4 - 4 - 4 - 4$$

$$\Rightarrow f(2) + f(-2) = -8$$

87. (b) Given -

The expression is $x^m y^n = a^{m+n}$.

Differentiating with respect to x -

$$x^m \frac{dy^n}{dx} + y^n \frac{dx^m}{dx} = \frac{da^{m+n}}{dx}$$

$$x^m \times ny^{n-1} \frac{dy}{dx} + y^n \times mx^{m-1} = 0$$

$$\Rightarrow \frac{dy}{dx} = \frac{-y^n \times mx^{m-1}}{x^m \times ny^{n-1}}$$

$$\Rightarrow \frac{dy}{dx} = \frac{-my}{nx}$$

$$88. (a) \text{ Given, } \int \frac{dx}{x(x^n + 1)}$$

Multiplying and dividing the integral by (x^{n-1}) -

$$I = \int \frac{x^{n-1} dx}{x^n (x^n + 1)} \quad \dots(i)$$

$$\text{Let } x^n = t \Rightarrow x^{n-1} dx = \frac{dt}{n}$$

Equation (i) becomes -

$$I = \frac{1}{n} \int \frac{dt}{t(t+1)} \quad \dots(ii)$$

Now, consider

$$\frac{1}{t(t+1)} = \frac{A}{t} + \frac{B}{(t+1)} \quad \dots(iii)$$

$$\therefore \frac{1}{t(t+1)} = \frac{1}{t} - \frac{1}{(t+1)}$$

So, equation (ii) is

$$I = \frac{1}{n} \int \left(\frac{1}{t} - \frac{1}{(t+1)} \right) dt$$

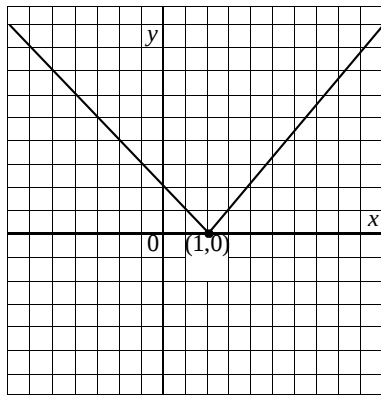
$$I = \frac{1}{n} \left[\log t - \log(t+1) \right] + c$$

Substitute the value of t -

$$I = \frac{1}{n} \left[\log \frac{x^n}{(x^n+1)} \right] + c$$

89. (a) Given, The expression is $|x-1|$.

Graph for the function is plotted -



The location where the graph's vertex is located at its lowest point is where a function's minimum value is found.

The vertex is $x = 1$ so the minimum value is $y = 0$.

Also, since the minimum value of a modulus function is 0.

Therefore, the minimum value of $|x-1|$ where $x \in R$ is 0.

90. (c) Given, The expression is $\frac{3x^2+8-4k}{x}$.

The first value is $k = 0$.
Integrate the expression with respect to x -

$$\Rightarrow \int f(x) dx = \int \frac{3x^2+8}{x} dx$$

$$\Rightarrow \int f(x) dx = \int \left(3x + \frac{8}{x} \right) dx$$

$$\int f(x) dx = \left(\frac{3x^2+16\log x}{2} \right) dx$$

Here, the numerator is not a polynomial.
Therefore, the function is not a rational function at $k = 0$.

The second value is $k = 1$.

Integrate the expression with respect to x -

$$\int f(x) dx = \int \frac{3x^2+4}{x} dx$$

$$\int f(x) dx = \left(\frac{3x^2+8\log x}{2} \right) dx$$

Here, the numerator is not a polynomial.

Therefore, the function is not a rational function at $k = 1$.

The third value is $k = 2$.

$$f(x) = \frac{3x^2+8-4(2)}{x}$$

Integrate the expression with respect to x -

$$\int f(x) dx = \int \frac{3x^2}{x} dx$$

$$\int f(x) dx = \int 3x dx$$

$$\int f(x) dx = \frac{3x^2}{2} = \frac{P(x)}{Q(x)}$$

Here, $p(x)$ and $Q(x)$ are polynomials with $Q(x) \neq 0$

Therefore, the function is a rational function at $k = 2$.

The fourth value is $k = -2$.

$$f(x) = \frac{3x^2+8-4(-2)}{x}$$

Integrate the expression with respect to x -

$$\int f(x) dx = \int \frac{3x^2+16}{x} dx$$

$$\int f(x) dx = \left(\frac{3x^2}{2} + 8\log x \right) dx$$

$$\int f(x) dx = \left(\frac{3x^2+16\log x}{2} \right) dx$$

Here, the numerator is not a polynomial.
Therefore, the function is not a rational function at $k = -2$.

91. (a)

92. (c) It is given that -

$f(x) = \sin x \cdot \cos x$
It can be written as -

$$= \frac{1}{2} (2\sin x \times \cos x) = \frac{1}{2} \sin 2x$$

Since, the maximum value of $\sin x$ is 1 so the maximum value of $\sin 2x$ is 1.

Therefore, the maximum value of

$$f(x) = \frac{1}{2} \times 1 = \frac{1}{2}$$

93. (a) It is given that -

$$\lim_{x \rightarrow 0} \frac{3^x + 3^{-x} - 2}{x}$$

Apply L'Hospital's rule -

$$= \lim_{x \rightarrow 0} \left(\frac{\ln(3) \cdot 3^x - \ln(3) \cdot 3^{(-x)}}{1} \right)$$

Substitute the value of $x = 0$.

$$= \frac{\ln(3) \cdot 3^0 - \ln(3) \cdot 3^{(-0)}}{1}$$

$$= 3^0 \ln(3) - 3^{-0} \ln(3)$$

$$= \ln(3) - \ln(3)$$

$$= 0$$

94. (a) It is given that -
 $u = \tan^{-1} x$ and $v = \cot^{-1} x$

Differentiating with respect to x , we get

$$\frac{du}{dx} = \frac{d(\tan^{-1} x)}{d(\cot^{-1} x)} = \frac{1}{1+x^2}$$

$$\frac{dv}{dx} = \frac{d(\cot^{-1} x)}{dx} = \frac{-1}{1+x^2}$$

Differentiate $\tan^{-1} x$ with respect to $\cot^{-1} x$

$$\frac{d(\tan^{-1} x)}{d(\cot^{-1} x)} = \frac{du}{dv}$$

$$\frac{du}{dv} = \frac{\frac{du}{dx}}{\frac{dv}{dx}} = \frac{\frac{1}{1+x^2}}{\frac{-1}{1+x^2}} = -1$$

95. (b) It is given that -

$$x(dx-dy) + y(dy-dx) = 0$$

It can be written as -

$$x dx - x dy + y dy - y dx = 0$$

Apply the integration -

$$\int x dx - \int x dy + \int y dy - \int y dx = 0$$

$$\frac{x^2}{2} - xy + \frac{y^2}{2} - xy + c = 0$$

$$x^2 + y^2 - 4xy + c = 0$$

96. (a) It is given that -

$$f(x) = \left(\frac{\pi}{3} \right) 3\cos \left(A + \frac{\pi}{3} \right)$$

It can be written as -

$$f(x) = 3 \times \left\{ \cos A \cos \left(\frac{\pi}{3} \right) - \sin A \sin \left(\frac{\pi}{3} \right) \right\}$$

$$f(x) = \frac{3}{2} \cos A - \frac{3\sqrt{3}}{2} \sin A$$

The range of the function is -

$$\left(-\sqrt{\left(\frac{3}{2}\right)^2 + \left(\frac{-3\sqrt{3}}{2}\right)^2}, \sqrt{\left(\frac{3}{2}\right)^2 + \left(\frac{-3\sqrt{3}}{2}\right)^2} \right)$$

$$= \left(-\sqrt{\frac{9}{4} + \frac{27}{4}}, \sqrt{\frac{9}{4} + \frac{27}{4}} \right)$$

$$= \left(-\sqrt{\frac{36}{4}}, \sqrt{\frac{36}{4}} \right)$$

$$= (-\sqrt{9}, \sqrt{9})$$

$$= [-3, 3]$$

Therefore, the minimum value of $f(x)$ is -3.

97. (c) $Q [2, 3] \in (0, \infty)$.

Here, $2 < 3 \Rightarrow \ln 2 < \ln 3$

Therefore, the function $f(x) = \ln x$ is increasing on the interval $(0, \infty)$.

$$Q \left[0, \frac{\pi}{4} \right] \in \left(-\frac{\pi}{2}, \frac{\pi}{2} \right)$$

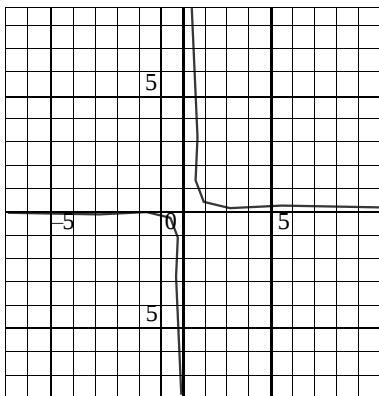
$$\text{Here, } 0 < \frac{\pi}{4} \Rightarrow \tan 0 < \tan \left(\frac{\pi}{4} \right)$$

Therefore, the function $f(x) = \tan x$ is increasing on the interval $\left(-\frac{\pi}{2}, \frac{\pi}{2} \right)$.

98. (b) It is given that -

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

The graph for the function is plotted -



Due to the substitution of $x-1$ for x , the rectangular parabola's position on the graph is displaced by 1 unit in the direction of the positive x -axis.

In the function put all real values of x except $x = 1$.

So, domain of $y = R - \{1\}$ or $\{x \in \mathbb{R} | x \neq 1\}$

The function can be written as -

$$x-1 = \frac{1}{y} \Rightarrow x = \frac{1}{y} + 1 \Rightarrow x = \frac{1+y}{y}$$

Therefore, the range will be the set of points on the y -axis excluding $y = 0$.

99. (a) It is given that -

$$\ln \left(\frac{dy}{dx} \right) = x$$

$$\frac{dy}{dx} = e^x$$

$$dy = e^x dx$$

Integrating both the sides, we get

$$\int dy = \int e^x dx$$

$$\Rightarrow y = e^x + c$$

100. (d) It is given that -

$$l + b = k$$

It can be written as -

$$l = k - b$$

$$\text{Area, } A = l \times b$$

$$= (k - b) \times b$$

$$= kb - b^2 \Rightarrow \frac{dA}{db} = k - 2b$$

$$\text{For maximum area } \frac{dA}{db} = 0$$

$$\Rightarrow k - 2b = 0 \Rightarrow b = \frac{k}{2}$$

The second derivative is -

$$\frac{d^2A}{db^2} = -2 < 0 \quad [\text{Maxima}]$$

So, maximum area will be at $b = k/2$.

Substitute the value in area formula -

$$\text{Area} = (k - b) \times b$$

$$= \left(k - \frac{k}{2} \right) \times \frac{k}{2}$$

$$= \left(\frac{k}{2} \right) \times \frac{k}{2} = \frac{k^2}{4}$$

$$101. (b) \text{ Arithmetic mean} = 6 = \frac{4x + 9(x-1)}{x + x-1}$$

$$6 = \frac{4x + 9x - 9}{2x - 1}$$

$$\Rightarrow 12x - 6 = 18x - 9$$

$$\Rightarrow x = 3$$

102. (c) The possible outcomes of dice are $\{1, 2, 3, 4, 5, 6\}$

The first dice will have six options.

Numbers can't be repeated so the second dice having options are 5.

For third dice, only 4 options are available.

The combinations available are

$$6 \times 5 \times 4 = 120$$

The probability of one of faces having number 6 are

$$5 \times 4 \times 3 = 60$$

$$\text{The probability is given as } \frac{60}{120} = \frac{1}{2}$$

103. (c) $P(A) + P(\bar{A}) = 1$

$$P(A) = 1 - \frac{1}{2} = \frac{1}{2}$$

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

$$\frac{5}{6} = \frac{1}{2} + P(B) - \frac{1}{3}$$

$$\frac{5}{6} = P(B) + \frac{1}{6}$$

$$P(B) = \frac{4}{6} = \frac{2}{3} \quad [\text{Correct}]$$

$$P(A)P(B) = \frac{1}{2} \times \frac{2}{3} = \frac{1}{3} = P(A \cap B),$$

which is correct

$$\text{Now, } P(A) + P(B) = \frac{7}{6} \text{ and}$$

$$P(A \cup B) = \frac{5}{6}$$

$\therefore P(A \cup B) > P(A) + P(B)$, which is not correct.

104. (d) Let the value be $a_1, a_2, \dots, a_n$.

$$\text{Then, } (a_1 - 2.5) + (a_2 - 2.5) \dots (a_n - 2.5) = 50$$

$$(a_1 + a_2 \dots a_n) - 2.5n = 50$$

For second statement,

$$(a_1 - 3.5) + (a_2 - 3.5) \dots (a_n - 3.5) = -50$$

$$(a_1 + a_2 \dots a_n) - 3.5n = -50$$

We can equate both statements,

$$50 + 2.5n = -50 + 3.5n$$

$$100 = 1n$$

$$n = 100$$

105. (d) Here, $n_1 = n$ and $n_2 = 2n$

$$\bar{x}_1 = 2M \text{ and } \bar{x}_2 = M$$

$$= \frac{n(2M) + 2n(M)}{n + 2n}$$

$$= \frac{4Mn}{3n}$$

$$= \frac{4M}{3}$$

106. (c) For the interval 10 - 20, difference between no. of student under math and physics is $10 - 8 = 2$

$$\text{For the interval } 20 - 30, 21 - 11 = 10$$

$$\text{For the interval } 30 - 40, 38 - 30 = 8$$

$$\text{For the interval } 40 - 50, 26 - 15 = 11$$

$$\text{For the interval } 50 - 60, 15 - 10 = 5$$

$$\text{For the interval } 60 - 70, 10 - 6 = 4$$

The largest difference is observed in class 40 - 50.

107. (a)

1. The maximum frequency in physics is 30, which lies in the interval 30 – 40. Hence, modal value lies in the interval 30-40. Hence, it is correct statement.

Marks	Number of students (Physics)	Cumulative frequency	Number of students (Maths)	Cumulative frequency
10-20	8	8	10	10
20-30	11	19	21	31
30-40	30	49	38	69
40-50	26	75	15	84
50-60	15	90	10	94
60-70	10	100	6	100

2. Cumulative frequency of physics

$$N_1 = 100$$

$$\therefore \frac{N_1}{2} = 50$$

Just greater than 50 is 75, which lies in the interval 40-50 Here $Cf_1 = 49$, $f_1 = 36$, $h = 10$, $l = 40$

$\therefore$ Median of physics (Md_1)

$$\begin{aligned} & \frac{N_1 - Cf_1}{f_1} \times h \\ &= l + \frac{2}{f_1} \times h \\ &= 40 + \frac{50 - 49}{26} \times 10 = 40.38 \end{aligned}$$

Cumulative frequency of mathematics is $N_2 = 100$

$$\therefore \frac{N_2}{2} = 50$$

Just greater than 50 is 69 which lies in the interval 30-40.

Here $Cf_2 = 31$, $f_2 = 38$, $h = 10$, $l = 30$

Median of mathematics (Md_2)

$$\begin{aligned} & \frac{N_2 - Cf_2}{f_2} \times h \\ &= l + \frac{2}{f_2} \times h \\ &= 30 + \frac{50 - 31}{38} \times 10 = 35 \end{aligned}$$

Here, $Md_1 > Md_2$

Hence, given statement 2 is not correct.

108. (c)

Marks	Number of Students in Physics (f_i)	Number of Students in Maths (f_i')	$x_i = \frac{\text{low} + \text{high}}{2}$	$f_i x_i$
10-20	8	10	15	120
20-30	11	21	25	275
30-40	30	38	35	1050
40-50	26	15	45	1170
50-60	15	10	55	825
60-70	10	6	65	650
	$\Sigma f_i = 100$			$\Sigma f_i x_i = 4090$

$$\begin{aligned} \text{Mean of marks in physics} &= \frac{\sum f_i x_i}{\sum f_i} \\ &= \frac{4090}{100} = 40.90 \end{aligned}$$

109. (b) Mean,

$$\mu = \frac{-\sqrt{6} - \sqrt{5} - \sqrt{4} - 1 + 1 + \sqrt{4} + \sqrt{5} + \sqrt{6}}{8} = 0$$

$$\begin{aligned} \sigma &= \sqrt{\frac{\sum (x_i - \mu)^2}{n}} \\ &= \sqrt{\frac{(-\sqrt{6})^2 + (-\sqrt{5})^2 + (-\sqrt{4})^2 + (-1)^2 + 1^2 + (\sqrt{4})^2 + (\sqrt{5})^2 + (\sqrt{6})^2}{8}} \end{aligned}$$

$$\sigma = \sqrt{\frac{6 + 5 + 4 + 1 + 1 + 4 + 5 + 6}{8}}$$

$$\sigma = \sqrt{\frac{32}{8}}$$

$$\sigma = 2$$

$$110. (d) \sigma = \sqrt{\left(\frac{\sum x_i^2}{n} \right) - \left(\frac{\sum x_i}{n} \right)^2}$$

$$\sigma = \sqrt{\left(\frac{200}{10} \right) - \left(\frac{20}{10} \right)^2}$$

$$\sigma = \sqrt{(20) - (4)}$$

$$\sigma = \sqrt{16} = 4$$

$$\mu = \frac{\sum x_i}{n} = \frac{20}{10} = 2$$

Q Coefficient of variation,

$$CV = \frac{\sigma}{\mu} \times 100$$

$$CV = \frac{4}{2} \times 100 = 200$$

111. (b) For a leap year, we have 366 days.

Number of days in February is 29.

The possible outcomes of days of week is 7.

Those are M, T, W, Th, F, Sa, S.

The number of weeks will be $29/7 = 4$ weeks and 1 day.

Required outcome is Sunday whose chance is 1.

So, the probability of getting Sundays in February is $1/7$.

112. (b)

$$\text{Arithmetic Mean} = \frac{\text{Sum of observations}}{\text{Total no. of observations}}$$

$$40 = \frac{\text{Sum}}{100}$$

Sum of observations = 4000.

$\therefore$ 53 was read as 83.

So, $4000 - 83 + 53 = 3970$

$\therefore$ Correction arithmetic mean

It is of 100 people, $= \frac{3970}{1000} = 39.70$

113. (a) Let the probability of Husband not getting selected is $P(H)$

$$Q P(H) + P(\bar{H}) = 1$$

$$P(\bar{H}) = 1 - P(H)$$

$$P(H) = 1 - \frac{1}{7} = \frac{6}{7}$$

Let the probability of wife not getting selected is $P(\bar{W})$.

$$P(W) + P(\bar{W}) = 1$$

$$P(\bar{W}) = 1 - P(W)$$

$$P(W) = 1 - \frac{1}{5} = \frac{4}{5}$$

$P(\text{none of them is selected})$

$$= P(H) \times P(W)$$

$$= \frac{4}{5} \times \frac{6}{7}$$

$$= \frac{24}{35}$$

The probability of at least one is selected is

$$1 - P(\text{none}) = 1 - \frac{24}{35} = \frac{11}{35}$$

114. (a) The possible combinations are

$${}^{15}C_4 = \frac{15!}{4!(11)!}$$

$$= \frac{15 \times 14 \times 13 \times 12}{4 \times 3 \times 2}$$

$$= \frac{15 \times 13 \times 7}{1}$$

The possible combinations of counterfeit coins are

$${}^6C_4 = \frac{6!}{4!(2)!}$$

$$= \frac{6 \times 5}{2}$$

$$= 15$$

The probability of counterfeit coins is

$$= \frac{15}{15 \times 13 \times 7} = \frac{1}{91}$$

115. (d) Let the boys be B1 and B2, and the girls be G1 and G2.

The possible combinations are (B1, B2, G1), (B1, B2, G2), (G1, G2, B1) and (G1, G2, B2).

The total combinations are four.

Out of which, The condition asked fulfilled in 2 sets.

So, the probability is $\frac{2}{4} = \frac{1}{2}$

116. (c) We know that prime numbers between 1 to 10 are 2, 3, 5, 7.

At a time, two tickets are drawn.

So, the total possible outcomes are $2 \times 3 = 10$.

The probability of getting prime number

$$\text{is } P(P_1) = \frac{4}{10}$$

For the second ticket, the numbers remaining are 9 and prime numbers are 3.

The probability of getting prime number on second ticket is $P(P_2) = \frac{3}{9}$

For Probability of getting prime numbers on both tickets,

$$= \frac{4}{10} \times \frac{3}{9} = \frac{2}{15}$$

117. (b) Equation of regression of y on x is

$$\frac{y - \bar{Y}}{\sigma_y} = r(x, y) \frac{x - \bar{X}}{\sigma_x}$$

$$\frac{y - 67}{3.5} = 0.8 \frac{x - 65}{2.5}$$

$$y - 67 = 3.5 \times 0.32 \times (x - 65)$$

$$y - 67 = 1.12x - 72.8$$

$$y = 1.12x - 72.8 + 67$$

$$y = 1.12x - 5.8$$

118. (d) Given, $B(X, n, p) = B\left(X, 10, \frac{1}{5}\right)$
 $Q B(X, n, p) = {}^nC_X p^X (1-p)^{n-X}$

$$\begin{aligned} & \left[\text{Put } p = \frac{1}{5} \right] \\ & \left[\text{Put } p = \frac{1}{5} \right] \\ & = {}^{10}C_X \left(\frac{1}{5}\right)^X \left(1 - \frac{1}{5}\right)^{10-X} \end{aligned}$$

$$\begin{aligned} & [Q {}^nC_r = {}^nC_{n-r}] \\ & = {}^{10}C_{10-X} \left(\frac{4}{5}\right)^{10-X} \left(\frac{1}{5}\right)^X \end{aligned}$$

$$\begin{aligned} & [Q y = 10 - X] \\ & = {}^{10}C_Y \left(\frac{4}{5}\right)^Y \left(\frac{1}{5}\right)^{10-Y} \end{aligned}$$

$$= B(Y, n, p) \text{ where } n = 10 \text{ and } p = \frac{4}{5}$$

119. (d) $P(A) + P(\bar{A}) = 1$

$$P(A) = 1 - P(A)$$

$$P(A) = 1 - 0.6 = 0.4$$

$$P(B) + P(\bar{B}) = 1$$

$$P(B) = 1 - P(B)$$

$$P(B) = 1 - 0.5 = 0.5$$

$$P(A \cap B) + P(\overline{A \cap B}) = 1$$

$$P(A \cap B) = 1 - P(\overline{A \cap B})$$

$$P(\overline{A \cap B}) = 1 - 0.6 = 0.4$$

$$\begin{aligned} P(\bar{A} \cap B) &= P(B) - P(A \cap B) \\ &= 0.5 - 0.4 = 0.1 \end{aligned}$$

$$\begin{aligned} P(\bar{A} \cap B) &= P(\bar{A}) + P(B) - P(\bar{A} \cap B) \\ &= 0.4 + 0.5 - 0.1 = 0.8 \end{aligned}$$

$$P(B|\bar{A}) = \frac{P(\bar{A} \cap B)}{P(\bar{A})}$$

$$\text{We know } P(\bar{A} \cap \bar{B}) = P(\overline{A \cup B})$$

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

$$= 1 - \{0.6 + 0.5 - 0.4\}$$

$$= 1 - 0.7 = 0.3$$

$$\text{Hence, } P(B/A) = \frac{0.3}{0.4} = 0.75$$

Both the statements are not correct.

120. (b) Using Baye's theorem

$$P\left(\frac{X}{F}\right) = \frac{\frac{50}{100}(0.02) + \frac{100}{100}(0.03) + \frac{20}{100}(0.05)}{\frac{50}{100}(0.02) + \frac{100}{100}(0.03) + \frac{20}{100}(0.05)}$$

$$P\left(\frac{X}{F}\right) = \frac{\frac{1}{100} + \frac{1}{100} + \frac{1}{100}}{\frac{1}{100} + \frac{1}{100} + \frac{1}{100}}$$

$$P\left(\frac{X}{F}\right) = \frac{\frac{1}{100}}{\frac{3}{100}} = \frac{10}{29}$$

Paper II: General Ability

- (b) In the given question, we have to find the antonym of 'absently'
Absently = with no attention
Capably = with having the ability to do something
Alertly = to be very attentive
Agitatedly = angrily or worrying manner
Dreamily = in dreams or not paying attention
 Clearly, 'Alertly' is the closest opposite meaning.
- (c) In the given question, we have to find the antonym of 'educated'
Educated = one who is well read and well informed
Cerebral = intelligently and seriously
Enlightened = with awareness
Ignorant = lacking knowledge or awareness
Erudite = having great knowledge or skills
 Clearly, 'Ignorant' is the nearest opposite meaning.

- (b) In the given question, we have to find the antonym of 'important'
Important = of great value or significance
Significant = that is crucial or important
Trivial = that is having very little importance
Basic = fundamental
Probable = that is likely to happen
 Clearly, 'trivial' is the nearest opposite meaning.
- (c) In the given question, we have to find the antonym of 'move'
Move = to go or change position
Push = to move forward
Rotate = to turn about axis or center
Stall = to be in a steady state or keep standing
Flow = to move continuously
 Clearly, 'Stall' is the nearest opposite meaning.
- (d) In the given question, we have to find the antonym of 'expressed'

- Express** = to convey a thought
Find = to discover something
Tell = to tell or convey something
Distribute = to share something
Conceal = to keep secret or hidden
 Clearly, 'Concealed' is the nearest opposite meaning.
- (b) In the given question, we have to find the antonym of 'warmer'
Warmer = that is comparatively hot
Friendlier = to be kind and pleasant
Colder = to be of low temperature
Wild = to lose one's control
Heavier = to have or constitute more weight
 Clearly, 'Colder' is the nearest opposite meaning.
 - (b) In the given question, we have to find the antonym of 'concerned'
Concern = to be disturbed or worried or anxious
Worry = to be tensed about something

Indifferent = to have no effect of anything

Curious = to be eager to know something

Puzzled = to be confused about something

Clearly, 'Indifferent' is the nearest opposite meaning.

8. (d) In the given question, we have to find the antonym of 'debate'

Debate = to oppose formally

Contend = to argue or keep holding your position

Moot = debateable or argueable

Wrangle = a dispute or argument

Agreement = to be in accordance with one's opinion

Clearly, 'Agreement' is the nearest opposite meaning.

9. (a) In the given question, we have to find the antonym of 'sensitivity'

Sensitivity = state of responsiveness

Imperviousness = not influenced or affected

Willingness = state of being ready to do something

Responsiveness = to react quickly

Closeness = to be close or in great affection

Clearly, 'Imperviousness' is the nearest opposite meaning.

10. (c) In the given question, we have to find the antonym of 'huge'

Huge = to be very large

Significant = that is of great importance

Major = that is big and crucial

Tiny = very small

Dormant = to fall asleep

Clearly, 'Tiny' is the nearest opposite meaning.

11. (a) Looking at the given parts, we figure out that 'Professor Andrew Dessler' is the subject. Part **R** contains the subject and the verb (created) but it cannot come first as it is not in the options. Thus, part **P** comes first which gives us the information about the time the action was done.

Part **R** follows part **P**. Part **Q** contains the object (course), thus, comes next. Part **S** gives the additional information and forms the remaining part of the sentence. Correct sequence: Several years ago, Professor Andrew Dessler created an introductory course on climate change at Texas A&M University for freshmen and sophomores.

12. (a) The correct answer for this question is **Option (a): PRQS- I realize that solving the climate change problem will be much harder than solving the ozone depletion problem.**

In the above question, we have to rearrange the parts in logical sentences.

P: I realize that solving the climate change problem

R: will be much harder

Q: than solving

S: the ozone depletion problem

The sentence is in the form of comparison and the correct sequence is P R Q S. The comparison is between solving the climate change problem and solving the ozone depletion problem. Therefore, Q follows R to complete the comparison and S follows Q to give the reference of the comparison.

13. (b) The correct answer for this question is **Option (b): PSQR- Although the temperature of this layer of the atmosphere should generally follow the surface temperature, we need to exercise caution when comparing satellite measurements of temperature directly.**

The sentence is in the form of a comparison, so we need to maintain the order of the comparison. The sentence starts with "although" which indicates a comparison, and the comparison is being made between the temperature of the atmosphere and the surface temperature. So, the correct sequence is P (although), S (the temperature of this layer of the atmosphere), Q (when directly comparing), and R (measurements of temperature). The other options have the comparison out of order and don't make grammatical sense.

14. (b) The correct answer for this question is **Option (b): QPSR- The element reaches high temperatures and begins to glow like a dark orange color that radiates in the visible range.**

In the above question, we have to rearrange the parts in logical sentences. Grammatically, the sentence describes the progression of events when an element heats up. It starts with a statement of the eventual outcome (Q), that the element reaches high temperatures, followed by a description of what happens when it reaches those high temperatures (P), it glows like a dark orange color. Finally, the sentence describes the effect of the glow (R), that it radiates in the visible range (S).

15. (a) Given that it is providing broad information about a "argument," sentence "P" can be read independently of all other sentences. P is hence the first component.

In the sentence "P," the comparative adjective "warmer" is connected to the

preposition "than" in the sentence "S." Thus, "S" comes after "P".

In the sentence "S," the adverb "Venus is closer" is connected to the noun "Sun" in the sentence "Q." Thus, "Q" comes after "S".

By mentioning the last argument, the sentence 'R' brings the sentence to a close. So, "R" completes the final sentence.

16. (d) The correct answer for this question is **Option (d): SPRQ- Gainsharing-plans are now used by more than a thousand firms in the United States and Europe and are growing in popularity.**

In the above question, we have to rearrange the parts in logical sentences.

"Gain sharing-plans": the topic of the sentence, which describes the type of plans being discussed.

"are now used by more than a thousand firms": mentions the current status of the gain sharing-plans, that they are being used by a large number of firms.

"in the United States and Europe": mentions the location where the plans are being used.

"and are growing in popularity": mentions that the plans are becoming more popular over time.

The other options are grammatically incorrect as the sentence does not flow smoothly and the phrases do not form a coherent thought in those arrangements.

17. (c) The correct answer for this question is **Option (c): SRPQ- The essay 'Of Friendship' by Francis Bacon celebrated the intimacy between friends which is subjected to both prosperity and adversity without succumbing to the clouds of doubt and jealousy.**

In the above question, we have to rearrange the parts in logical sentences.

The essay 'Of Friendship' by Francis Bacon": introduces the topic of the sentence, a famous essay by Francis Bacon.

"celebrated the intimacy": mentions the main focus of the essay, the celebration of intimacy.

"between friends": specifies the kind of intimacy being celebrated.

"which is subjected to both prosperity and adversity": describes the nature of the friendship being celebrated.

"without succumbing to the clouds of doubt and jealousy": mentions how the friendship endures despite adversity, not succumbing to negative emotions like doubt and jealousy.

The other options are grammatically incorrect as the sentence does not flow smoothly and the phrases do not form a coherent thought in those arrangements.

18. (c) The correct answer for this question is Option (c): RQPS - "It is miserable solitude that compels a person to make friends and want true friends, without which the world is nothing other than a place of wilderness."

In the above question, we have to rearrange the parts in logical sentences.

In this sentence, the subject "it" refers to "miserable solitude," and the verb "compels" refers to the action that the subject is taking on the person. The object of the verb "compels" is "a person." The phrase "to make friends and want true friends" is the infinitive phrase that acts as the purpose of the subject's action. The phrase "without which the world is nothing other than a place of wilderness" explains the importance of having true friends in the world.

19. (b) The correct answer for this question is **Option (b): RQPS- The job that never started takes the longest to finish.**

In the above question, we have to rearrange the parts in logical sentences.

The sentence describes a situation and provides advice. It begins by stating the problem (R), the job that never started. This is followed by a suggestion (Q) to focus on what can be created instead. The sentence then specifies the focus of creation (P), what one can create, and concludes with the intended outcome (S), to finish the job.

20. (d) The correct answer for this question is **Option (b): RQPS - Instead of worrying about what you cannot control, shift your focus and energy to what you can create.**

In the above question, we have to rearrange the parts in logical sentences.

Grammatically, the sentence presents advice on how to handle a situation. It begins by addressing a common problem (R), worrying about things that one cannot control. This is followed by a suggestion (S) to shift one's energy to what can be controlled, and an encouragement (Q) to create instead. Finally, the sentence specifies the focus of the creation (P), what one can create.

21. (a) In the given question, we have to find the **synonym** of 'divorce'

Divorce = to legally dissolve or get separated

Detachment = to stay away or in isolation

Breaking down = to break into small parts

Annulment = legal procedure that cancels marriage

Punishment = to penalize for an offence

22. (b) In the given question, we have to find the **synonym** of 'gentle'

Gentle = to show kind character

Harmful = that causes harm

Amiable = to display a friendly manner

Cunning = to be crafty or sharp (in a deceitful manner)

Adjusting = to change as per need

23. (a) In the given question, we have to find the **synonym** of 'bounces back'

Bounces back = to return to normal condition

Recoil = to rebound or jump back

Deflate = to puncture

Inflate = to fill with air

Ascend = to rise through the air

24. (c) In the given question, we have to find the **synonym** of 'execute'

Execute = to carry out properly

Desire = strong feeling to have something

Debate = to argue about something in a formal manner

Accomplish = to complete or achieve successfully

Discard = to throw away something

25. (c) In the given question, we have to find the **synonym** of 'equanimity'

Equanimity = to be in calmness

Carelessly = in a reckless or casual manner

Excitedly = in an enthusiastic manner

Patiently = with calmly and quietly

Half-heartedly = without enthusiasm or energy

26. (b) In the given question, we have to find the **synonym** of 'futile'

Futile = that is incapable of producing a result

Costly = that requires a good amount of money

Pointless = that is of no purpose

Indecisive = that is unable to provide a clear result

Successful = to achieve the desired aim

27. (c) In the given question, we have to find the **synonym** of 'cunning'

Cunning = to be sharp or intelligent

Capable = to have required skillset

Fit = to be of suitable quality

Intelligent = to have good mental power

Dodgy = unreliable or dishonest

28. (a) In the given question, we have to find the **synonym** of 'crucial'

Crucial = that is very important

Momentous = that is of great importance or significance

Natural = to be based on things of nature

Primitive = that relates to old period

Inept = that is having no skill

29. (c) In the given question, we have to find the **synonym** of 'frenzy'

Frenzy = uncontrolled excitement

Silent = to make no noise or remain quiet

Creative = work involving use of imagination

Berserk = out of control with excitement or anger

Wrong = to be not true or incorrect

30. (d) In the given question, we have to find the **synonym** of 'yearning'

Yearn = feeling of intense longing

Decline = to deny or disagree

Demand = a request made as a right

Beg = to ask humbly for something

Hanker = a strong desire to have something

31. (b) The correct answer is "in." In this sentence, the preposition "in" is used to indicate the direction or extent of the increase in temperature over the second half of the 20th century.

The other options are not as appropriate in this context because they do not accurately convey the intended meaning. "Of" would suggest a relationship of possession or composition, while "by" would suggest agency or a cause-and-effect relationship, and "to" would suggest a direction or goal.

32. (d) The correct answer is "at". The preposition "at" is used to describe a point in time or a specific age. In this sentence, "at a young age" indicates that the children are put to work at a specific point in their lives when they are young.

The other prepositions "in", "on", and "by" do not fit the context as well and do not accurately convey the intended meaning.

33. (a) The correct preposition for the sentence is "to". This is because the phrase "averse to" means "having a strong dislike or opposition to something", which fits in the context of the sentence.

The other prepositions "about", "at" and "on" are not appropriate for this sentence as they do not convey the meaning of dislike or opposition to hard work.

34. (b) The correct answer is “for”. In this sentence, the preposition “for” is used to express a duration of time, indicating that the speaker has known the person for a certain amount of time.

The other options do not fit grammatically in this context. “Since” is used to indicate a point in time, “at” is used to indicate a specific time or place, and “before” is used to indicate a time prior to a specific event. Thus, “for” is the most appropriate preposition in this sentence.

35. (a) The correct preposition here is “on”. It means that the speaker agreed to the offer only under certain conditions.

The other prepositions “in”, “by” and “within” don’t make sense in this context.

36. (b) The correct preposition is “of.” This sentence is using a prepositional phrase to describe the origin of the woman. “Of” shows possession here, (the women possessed humble origin).

“Of humble origin” means that the woman comes from a humble background.

“Off” and “within” are not appropriate prepositions in this context. “From” could also be used, but “of” is more commonly used in this expression.

37. (a) The correct preposition to use here is “for.” This is because “cure” is a noun and “for” is used to indicate that there is no solution or remedy for something.

The other options, “of,” “to,” and “on,” do not make grammatical sense in this context.

38. (d) The preposition “into” is correct.

Ran into is used to indicate a chance encounter or meeting.

The other options don’t fit the context of the sentence. For example, “by” means “near” or “past”, “off” means “away” or “not doing something anymore”, and “beside” means “next to”.

39. (b) The correct preposition here is “on” because it conveys the sense of being “on top of” or “on the surface of” the lake, which is appropriate in this context as the grandmother was enjoying boating on the lake.

The other options such as “in” and “within” do not convey the right sense here. “Beside” would suggest being near the lake but not necessarily on it, and “by” is not a preposition that fits well with boating.

40. (c) The preposition ‘from’ is used for indicating separation or removal.

The preposition “of” is used to show the relationship between two nouns,

where one noun is the source or cause of the other noun. In this sentence, “their sufferings and poverty” is the source of distress and the subject “He” is trying to relieve them of it. Hence, the preposition “of” is the correct one to use in this sentence.

Other options like “from,” “off,” and “on” don’t fit the meaning and context of the sentence, thus making them incorrect choices.

41. (b) Replace ‘comprises of six houses’ with ‘comprises six houses’

Comprises means ‘consist of’. Thus, the correct phrase is ‘comprises six houses’. Correct sentence: This building comprises six houses, three parking lots and one basement.

42. (b) Replace ‘meet’ with ‘meeting’.

The phrase “look forward to” is typically followed by a verb in the gerund form, which is a noun formed from a verb by adding “-ing”. In this sentence, the verb “meet” is in the infinitive form, which is not appropriate in this context.

The correct sentence: I look forward to meeting you.

43. (b) Replace ‘cope up’ with ‘cope with’.

The phrasal verb “cope up” is not commonly used in English, the correct phrasal verb to use in this sentence is “cope with”.

The correct sentence: I cannot cope with this pressure.

44. (c) Replace ‘by walk’ with by walking’.

The correct phrase to use here is ‘by walking’, correct sentence: I came to this place by walking.

45. (c) The sentence is grammatically incorrect. ‘By your watch’ has the idiomatic meaning of “according to.”

‘By your watch’ indicates shown/ displayed by.

46. (d) The sentence “The price of my dress is higher than that of yours” is grammatically correct and accurately compares the price of two dresses. The phrase “that of” is used correctly to make the comparison, and “yours” is a possessive pronoun that correctly refers to the other dress being compared.

47. (b) The error lies in part b.

‘Daughter-in-laws’ is erroneous.

The plural form of the noun “daughter-in-law” is “daughters-in-law”.

48. (c) The preposition ‘than’ should be replaced by the preposition ‘to’ in the part c).

In the sentence, the verb ‘prefer’ is used; preferring something implies a relationship between exactly two things:

one superior and one inferior. We cannot prefer something more “than” something else.

When comparing a noun to another noun, we use ‘prefer’ with the preposition ‘to’. It should be written as ‘I prefer seafood to Mediterranean food’.

49. (c) The error lies in part c.

The article “the” should be replaced by article “an”.

Because no specific issue is mentioned, the article “an” should be used.

50. (a) The first part of the sentence is incorrect. The phrase “Dispose off” should be replaced by “Dispose of”.

51. (c) 1. Due to its location in the centre and southern Pacific Ocean, New Zealand is regarded as a member of the Polynesia island chain.

2. Hawaii, Easter Island, Samoa, Tonga, the Society Islands, and New Zealand are all part of the Polynesian island chain.

52. (d) All the given statements are correct.

53. (d) According to Article 79, the Parliament of India consists of three parts i.e. the President, the Council of States and the House of the People.

54. (b) Joseph Stalin implemented the first Five-Year Plan in the Soviet Union in 1928 (1928-1932), concentrating on developing heavy industry and collectivizing agriculture.

55. (b) • Garibi Hatao Slogan was given by Indira Gandhi during 1971 elections.
• It was incorporated in fifth five year plan also.
• She did land reforms, removed privy purses, gave free food to poor under garibi hatao program.

56. (b) A-3, B-4, C-1, D-2

57. (b) The 42nd Amendment Act of 1976 added four new Directive Principles to the original list. They require the State:

1. To secure opportunities for healthy development of children (Article 39).
2. To promote equal justice and to provide free legal aid to the poor (Article 39 A).
3. To take steps to secure the participation of workers in the management of industries (Article 43 A).
4. To protect and improve the environment and to safeguard forests and wild life (Article 48 A).

58. (a) Parliament by law can create a common high court for more than two states. There are six common high court in our country which has jurisdiction over two states/ UT

59. (c) In 1928 a committee of All Indian Parties headed by Pt. Motilal Nehru drafted the constitution for India. It is also popular as Nehru report
60. (d) Jaipal Singh was the Indian politician, Freedom fighter and sports person. In 1938 he established Adivasi Maha Sabha to separate the Jharkhand from state of Bihar
61. (b) With an objective to create awareness about child and women's malnutrition, in collaboration with UNICEF, Women and Child Development and Mission Shakti Department unveiled a mascot named Tikki Mausi.
The Mascot has been named as 'Tikki Mausi' in reference to the second mother of a child.
62. (d) The United Nations World Tourism Organisation since 1980, started international observance of World Tourism Day on September 27.
The theme of 2019 World Tourism Day is Tourism and jobs: a better future for all.
63. (a) TSENTR is the military exercise hosted by Russia, aimed at evolving drills of the participating armies and practicing them in the fight against international terrorism and to ensure military security in the Central Asian region.
64. (c) Denmark is surrounded by sea on three sides and with its flat terrain, it was easy to wind up through. Because the sun can be seen quite often during the summer months, so Denmark is called the 'country of winds'.
65. (b) The National Survey and Mapping Organization of India, which is part of the Department of Science and Technology, is the oldest scientific department of the govt. of India.
It was founded in 1767 and has developed rich traditions over time.
66. (d) Naseem-Al-Bahr is a bilateral naval exercise held since 1993 between the Indian Navy and the Royal Navy of Oman.
67. (c) Humpy Koneru the current World Rapid Chess Champion and an Indian chess grandmaster.
She won the individual bronze at the women's World team Chess Championship 2015 held in Chengdu, China.
68. (a) Vijaya the Tiger and Jaya the Blackbuck were the mascots for the Khelo India Youth Games, 2020.
It was the third edition of the Khelo India Youth games, the first being in 2018.
69. (b) Ukraine International Airline Flight 752 was a scheduled international civilian passenger flight operated by Ukraine International Airlines from Tehran to Kyiv.
70. (c) Visakhapatnam Milan 2020: Due to the spread of Coronavirus, the Indian Navy's major multilateral exercise. Milan 2020, in which around 30 countries were to participate in Visakhapatnam, has been postponed.
71. (b) The calcium carbonate is the main constituent of chalk and marble. The chemical formula for calcium carbonate is CaCO_3 .
72. (d) The number of electron in the shell is given by Bohr's formula,
Number of electrons = $2n^2$, where n is shell number,
The shell number of the N shell is 4 (order of shell: K, L, M, N).
Number of electrons = $2(4)^2 = 32$
73. (a) The chemical formula of vinegar is CH_3COOH . The IUPAC name of CH_3COOH is ethanoic acid and commonly known as acetic acid.
74. (b) Pressure is defined as the force per unit area. Mathematically, it is expressed as follows:

$$\text{Pressure (P)} = \frac{\text{Force (F)}}{\text{Area (A)}}$$
 If the height of a liquid column is h and ' d ' is the density of the liquid then,

$$\text{Area (A)} = \frac{\text{Volume (V)}}{\text{Height (h)}}$$

$$[V = \text{volume}]$$
 Force acting on the liquid column $F = mg$
 $[m = \text{mass}, g = \text{acceleration due to gravity}]$
 Therefore, the pressure exerted by a liquid at depth h is given by

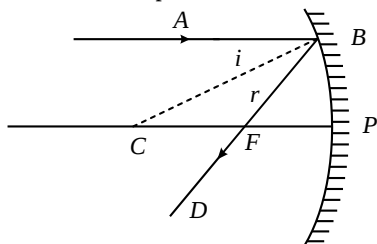
$$P = \frac{mg}{V}$$

$$d = \frac{m}{V}$$
 Hence, $P = dgh$
75. (d) A sound wave travels in the form of compressions and rarefactions which is the characteristic of longitudinal waves.
76. (b) Deendayal Port, sometimes referred to as Kandla Port, is a seaport in Gujarat, India's Kutch state. It is situated close to the community of Kandla on the Gulf of Kutch. It is one of the biggest ports in the nation, the port manages a sizable portion of India's foreign trade.
77. (c) 1. An international agreement called the Biosafety Protocol to the Convention on Biological Diversity attempts to secure the safe handling, use, and transportation of living modified organisms (LMOs) that might have a negative impact on biodiversity.
2. It was adopted in 2000, and it became effective in 2003.
3. Cartagena, Colombia hosted one of the crucial gatherings that resulted in the adoption of the Biosafety Protocol in 1999.
78. (d) In the Mandya district of the Indian state of Karnataka is the Krishna Raja Sagara Dam (KRS Dam). It is constructed across the river Kaveri, commonly known as Cauvery, which is an important interstate river in South India.
79. (a) Arunachal Pradesh is a state in northeastern India that borders the nations of China, Assam, Nagaland, and Sikkim in addition to other Indian states.
80. (d) Among the given options Punjab is the least populated state in India, Uttar Pradesh is the most populated state, according to 2011 census.
81. (c) 1. The four linguistic families that make up the major Indian languages are:
2. Indian languages, such as Bengali, Punjabi, and Hindi. Indo-Aryan languages
3. Tamil, Telugu, and Malayalam are Dravidian languages.
4. The Munda languages Santhali, Ho, and Mundari are among the Austroasiatic languages.
5. Tibetan, Lepcha, and Limbu are Sino-Tibetan languages.
82. (b) Gandhiji started using the technique of satyagraha in South Africa. He first used it in India in the year 1917 (Champaran satyagraha)
83. (a) Salt march was started on 12 March 1930
At that time Lord Irwin was the viceroy of India
Gandhi wrote a letter to Lord Irwin to inform him about the Salt March
The march lasted for 24 days ended on 6 April 1930
Hence the correct answer is Option (a)
84. (c) The American news magazine 'Time', initially highly skeptical of Gandhi's dandi march, completely changed its mind within a week, hailing him as a saint and a statesman.
The salt March also known as the Dandi March was led by Mahatma Gandhi on March 12, 1930.

85. (b) The passenger trains were introduced in England in the year 1825. The world's first steam locomotive passenger train, Locomotion No.1 started its journey on 27 September, 1825.

It was run by the first passenger railway, the Stockton and Darlington Railway in North East England.

86. (b) Given below is a simplified diagram for reflection in a spherical mirror.



Here

AB is the incident ray which is incident at point B at angle of incidence, $\angle i$. The reflected ray BF makes $\angle r$, angle of reflection and passes through focus, F.

Given: $CP = R$, $FP = f$ and $\angle BCF = \alpha$

According to the law of reflection,

$$\angle i = \angle r \quad \dots(i)$$

Since AB is parallel to CP and CB is transversal,

$$\angle i = \angle \alpha \quad \dots(ii)$$

From (i) and (ii) we can write,

$$\angle r = \angle \alpha$$

Thus, $\triangle CBF$ is an isosceles triangle, so $CF = FB$

For a mirror with small aperture, $FB = FP$

hence, $CF = FB$

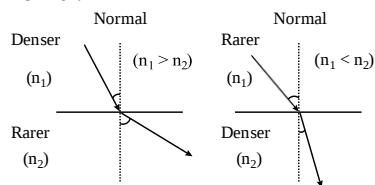
$$CP = FP + FP = 2FP$$

$$R = 2f$$

Hence, the correct option is (b) i.e. $R = 2f$

87. (c) A lemon kept in water in a glass tumbler appears larger than its actual size due to refraction of light.

When light rays travel from rarer to denser medium (air to water), the refracted ray bends towards the normal. On the other hand, when light ray passes from denser to rarer medium, the refracted ray bends away from the normal.



The difference in speed of light in the two media is responsible for the refraction of light while traveling from one medium to another. Larger the

difference in speed of light in two media, the greater will be the amount of refraction.

An optically rarer medium has a greater speed of light whereas an optically denser medium has lesser light speed.

In this case, light travels from water (denser) to air (rarer) medium. As a result, the refracted ray bends away from the normal to a point that the object being observed appears larger than its original size, thereby, projecting a larger image than the object.

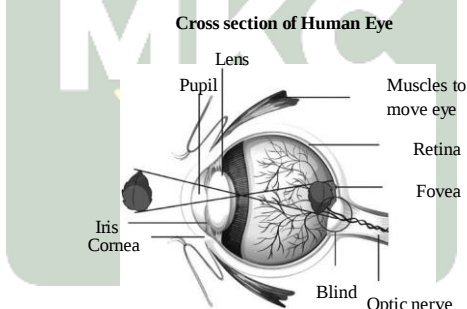
Hence, the correct option is (c) i.e. refraction of light.

88. (b) Cornea is the structure of human eye through which light enters.

Cornea is a dome-shaped structure that is non-vascular and convex anteriorly.

A thin transparent membrane known as the conjunctiva covers the cornea. This membrane is composed of stratified epithelium.

The curved surface of the cornea acts as a refracting surface that allows the light rays into the interior of the eye and bends them so that they can be brought to focus.



Hence, the correct option is (b) i.e. cornea.

89. (c) Sir Isaac Newton was the first to obtain the spectrum of sunlight by using a glass prism. He used a glass prism to split the white light into its constituent colors. He then tried to split the spectrum of white light even more by using another similar prism but didn't get any more colors. After that he repeated the experiment using the second prism in an inverted manner with respect to the first one and allowed to pass all the colors of the spectrum through the second prism. He observed that the band of seven colors of the spectra combines and white light emerged on the other side of the second prism.

Hence, the correct option is (c) i.e. Isaac Newton

90. (b) Given: Power = 5 kW, Time = 10 hours per day, Number of days = 30, Cost per unit = Rs 4 per kWh

$$\text{Total time } (t) = 10 \times 30 = 300 \text{ hrs}$$

The total energy consumed by the industrial refrigerator in 30 days is given by

$$\text{Energy } (E) = P \times t = 5 \text{ kW} \times 300 \text{ hrs} = 1500 \text{ kWh}$$

Total cost to operate the refrigerator for 30 days

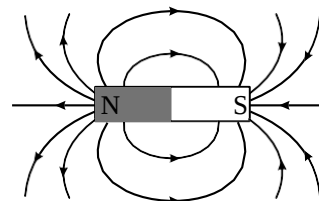
$$= \text{total energy} \times \text{cost per kWh}$$

$$= 1500 \times 4 = \text{Rs } 6000$$

Hence, the correct option is (b) i.e. Rs 6000

91. (c) The properties of magnetic field lines are as follows:

1. They form a continuous closed loop.
2. The field lines originate from the north pole of a magnet and move outward to terminate at the south pole.
3. There are magnetic field lines within a magnet. Inside a magnet, the field lines run from the south pole to the north pole.
4. Two field lines can never intersect each other. This is because if they do, there will be two different directions of the magnetic field at the same point, which is impossible.
5. At the neutral point, there are no magnetic field lines, hence magnetic field strength is zero.
6. Higher the density of field lines at any place, the greater will be the strength of the magnetic field.
7. The field lines are parallel straight lines and equally spaced in a uniform magnetic field.
8. Greater the pole strength of a magnet, the higher the number of field lines.
9. Magnetic field lines exhibit the property of longitudinal contraction and lateral repulsion.



Hence, the correct option is (c) i.e. Magnetic field lines are open curves.

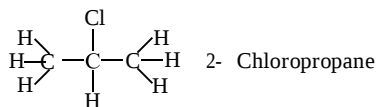
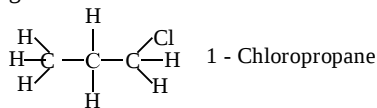
92. (b) Graphite act as a good conductor of heat and electricity.

It is a poor conductor of electricity.

Each carbon atom in diamond is bonded to four other carbon atoms.

93. (d) Chloropropane exists in two isomeric forms:

1-chloropropane (n-propyl chloride) and 2-chloropropane (isopropyl chloride). The structures of these two forms are given below:



From the structure of both forms of chloropropane, we can see that there are 10 covalent bonds that constitute 7 C-H bonds, 2 C-C bonds, and 1 C-Cl bond.

Therefore, 10 covalent bonds are present in a chloropropane molecule having molecular formula, $\text{C}_3\text{H}_7\text{Cl}$.

94. (b) In 1913, the English physicist, Henry Moseley observed some characteristic regularities in the X-ray spectra of the elements where the plot of $\sqrt{\nu}$ (ν = frequency of X-rays) against the atomic number gave a linear curve which is not observed by plotting $\sqrt{\nu}$ against the atomic mass. Thus, from his observations, he concluded that the atomic number is a more fundamental property than atomic mass.

According to the modern periodic law, “the physical and chemical properties of the elements are periodic functions of their atomic numbers”.

95. (a) Discovery of Neutron: James Chadwick is credited for the discovery of neutrons in 1932. He bombarded a thin sheet of beryllium (Be_4^9) by α -particles (He_2^4) which emitted electrically neutral particles having a mass slightly greater than that of a proton. He then named these electrically neutral particles neutrons.
96. (b) The atomic mass of an element is equal to the sum of the number of positively charged protons (p) and electrically neutral neutrons (n).
97. (b) Radioactive isotopes have extensive uses in the field of medical science. They are used as ‘tracers’ in medicines to detect any kind of medical abnormality such as tumors, blood clots, etc.

Cobalt-60 is used in tumor therapy to treat cancer.

98. (b) Vacuoles, especially the contractile vacuoles take part in osmoregulation and excretion in unicellular organisms. Vacuoles help to maintain the shape

and rigidity of the cell. They protect a cell from absorbing excess water and maintain the osmotic pressure of a cell. Vacuoles help in the removal of wastes such as ammonia from the cell. Ammonia which is soluble in water is excreted along with excess water.

Hence, the correct option is (b) i.e. Vacuole

99. (c) Polyculture, or the practise of growing two or more different crops in the same space, is a sort of intercropping.

Intercropping can be utilised for many things, including boosting crop output, enhancing soil health, lowering insect and disease pressure, and enhancing an agricultural system’s overall biodiversity.

By growing various crops that require different amounts of light and water, intercropping can also be used to maximise the use of natural resources like water and sunlight.

Planting wheat and clover together or maize and beans together are two typical examples of intercropping.

Hence, the correct answer will be (c) i.e. Intercropping.

100. (c) Viruses lack protoplasm, the living material of a cell that is the site for most of the metabolic activities in a cell.

Viruses lack a cell wall, instead they possess a protein coat called the capsid.

Antibiotics like penicillin are effective against bacteria having a cell wall because it works by destroying the cell wall of bacteria or inhibiting its growth machinery. But since viruses do not have cell walls antibiotics are ineffective against them.

Viruses take over the biosynthetic machinery of the host cell and replicate

to form copies of themselves.

Hence, the correct option is (c).

101. (b) The Panama Canal, which opened in 1914, connected the Atlantic and Pacific oceans.

It is an artificial 82 km waterway in Panama.

102. (c) On June 26 in 1945, representatives from the 50 countries attending the United Nations Conference on International Organization in San Francisco signed the UN Charter.

Poland, which was not represented at the time, later signed it and became one of the UN’s original 51 members.

103. (b) The Land Revenue Records kept in India have classified land-use into nine categories, as follows:

(i) Forests, (ii) barren and unculturable land, (iii) land put to non-agricultural uses, (iv) culturable wastes, (v) permanent pasture and other grazing land, (vi) Area under the Miscellaneous tree crop and grove (Not include is the net snow area) (vii) current fallows, (viii) Other fallow, and (ix) Net area sown.

104. (d) In India, dry land farming is mostly limited to regions with little annual rainfall—typically less than 75 cm.

105. (c) 1. The use of irrigation can lessen the impacts of drought and help to guarantee a steady supply of water for crops.

2. It can be inferred that an area is less susceptible to drought and can be categorised as less drought-prone if 25% or more of the gross cultivated area is irrigated.

106. (c) 1. The Agulhas current is not a Pacific Ocean current. A current can be found in the western Indian Ocean. Warm water current known as the Agulhas Current travels along Africa’s southeast coast.

107. (b) 1. The Intertropical Convergence Zone (ITCZ) seasonal shift and the thermal low pressure system over the continent are what bring about the monsoon in India.

2. A period of intense rainfall occurs from this, which normally lasts from June to September. The monsoon often lasts between 100 and 120 days.

Hence, the correct answer will be (b) i.e. 100-120 days

108. (b) 1. A subtropical climate with high annual temperatures and high relative humidity prevails in Southeast China.
2. Subtropical broadleaf evergreen forests, which are characterised by a variety of plant species, including evergreen trees and shrubs that can

resist the high temperatures and humidity of the region, grow best in this type of climate.

109. (c) The Rhône valley and the Gulf of Lion region of France are both affected by the Mistral, a powerful, chilly, and typically dry wind that comes from the north or northwest.

110. (b) 2. It resulted in the concentration of power among a handful of wealthy peasants known as zamindars, who were granted land ownership rights in exchange for paying the British a set annual revenue.

2. As a result of having to pay excessive rent to the zamindars and frequently being exploited, the status and way of life of the traditional farmers, known as ryots, declined.

111. (a) Damin-i-Koh is a range of hills located in the Rajmahal Hills area of Jharkhand, India. In 1855, the British colonial government demarcated and declared this land to be the homeland of the Santhal people, who are one of the largest indigenous communities in the region.

The British recognized the importance of preserving the rights of indigenous people and wanted to protect them from the exploitation and displacement that often accompanied colonial expansion.

As such, they declared Damin-i-Koh to be a "scheduled district," which meant that the land was set aside specifically for the Santhals and could not be sold or transferred to non-Santhal individuals or communities without government permission.

112. (c) The rebel proclamations in 1857 repeatedly appealed to all sections of the population irrespective of their caste and creed.

113. (c) The Panchsheel is a set of principles for conducting international relations, reflecting the aspirations of all nations to live and prosper together in peace and harmony.

The 5 principles of Panchsheel are:

Mutual respect for each other's territorial integrity and sovereignty

1. Mutual non-aggression
2. Mutual non-interference
3. Equality and mutual benefit
4. Peaceful co-existence.

114. (d) Vinayak Damodar Savarkar along with his brother Ganesh Damodar Savarkar established the Abhinav Bharat in 1904.

Abhinav Bharat society which was earlier known as Mitra Mela, was a kind of an independent secret society.

115. (b) The August Offer of Viceroy Linlithgow, also known as the Linlithgow Declaration, was a proposal made by the then Viceroy of India, Lord Linlithgow on August 8, 1940.

It was a proposal for constitutional reforms in India that aimed to increase Indian participation in the governance of the country.

116. (a) Acid Precipitation happens when sulphur dioxide and nitrogen oxides are released into the atmosphere, typically as a result of burning fossil fuels, acid precipitation is a significant environmental problem in eastern Canada.

117. (a) Between the Caspian Sea and the Black Sea, there is a vast chain of mountain ranges known as the Caucasus.

118. (d) 1. The Chenab river has been used to create the hydroelectric power projects Baglihar, Dulhasti, and Salal.

2. The Baglihar Dam, Dulhasti Dam, and Salal Dam are only a few of the hydroelectric power projects being built on the Chenab River by the Indian government.

119. (c) India has 18 officially recognised Biosphere Reserves that are dispersed around the nation and guard a variety of habitats, including tropical and subtropical forests, wetlands, grasslands, and coastal and marine areas under UNESCO.

120. (d) 1. The sea or ocean are inaccessible to Armenia directly.

2. It is a landlocked nation in Eurasia's Caucasus region, bordered to the north by Georgia, to the east and northeast by Russia, to the south by Turkey, and to the east and southwest by Azerbaijan.

121. (c) Tungsten is an ideal metal used to make filament of electric bulbs for the following reasons:

Tungsten has high resistivity and the highest melting point (3695 K) of any element. When it is glowing for a long time.

Tungsten has the highest tensile strength and is very resistant to corrosion.

122. (b) Given: Potential difference (V) = 12V, Current (I) = 100 mA = 0.1 A

Here both the resistors have resistances R and are connected in parallel combination. Therefore, the equivalent resistance is

$$R_{eq} = \frac{R \times R}{R + R} = \frac{R}{2}$$

Since in parallel combination, the potential difference remains constant, therefore according to the Ohm's law

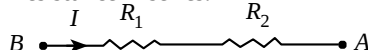
$$V = IR_{eq} \Rightarrow R = \frac{V}{I} = \frac{12}{0.1} = 120\Omega$$

$$\Rightarrow R = 240$$

The value of R is 240 ohm

Note-

Resistance in series:



In series combination, two or more resistors are connected one after another, hence same current flows through them.

The equivalent resistance of two resistors R_1 and R_2 connected in series combination is given by

$$R_{eq} = R_1 + R_2$$

Hence, the correct option is B i.e., 240

123. (d) There are different units of energy which are given below:

1. Joule (J) (SI unit)
2. Erg (erg) (CGS unit)
3. Electron-volt (eV)
4. Calorie (cal)
5. Watt-hour (Wh) or Kilowatt-hour (KWh)

1 Joule is defined as the work done by a force of 1 Newton (N) to displace the body by one meter. Thus, $1 J = 1 N \times 1 m = 1 N.m$

One watt-hour is defined as the energy equivalent to one-watt power consumed for one hour. Thus,

$$1 Wh = 1 W \times 1 hr$$

Watt (W) is the SI unit of power which is defined as one joule of work done in one second.

$$1 W = 1 J/s$$

The unit $Kg.m/s^2$ is the SI unit of force which is equivalent to 1 N. Thus,

$$1 N = 1 kg.m/s^2$$

Hence, the correct option is D i.e., $Kg - m/s^2$

Additional information-

1. $1 eV = 1.6 \times 10^{-19} J$
2. One calorie is defined as the amount of heat required to increase the temperature of 1 gram of water by 1 degree Celsius.
3. Horse-power (hp) is a unit of power to describe the output of automobiles, etc.
 $1 hp = 746 W$
4. One kilowatt-hour is the work done in 1 hour when the power is 1 kW.
 $1 kWh = 3.6 \times 10^6 J$

124. (d) Biogas is considered to be a renewable source of energy because its production and use cycle are continuous, and it generates no net carbon dioxide.

Biogas mainly consists of methane (75%), carbon dioxide (25%), and some other gases.

Methane gas has a high calorific value. That's why it has a high heating capacity. Hence, the Correct option is d.

125. (b) In prokaryotic cells, the nucleus is not defined properly because it is not surrounded by a nuclear membrane. Most of the genetic material is present in nucleoids. Hence, the Correct option is b i.e., nucleoid

126. (d) Long, narrow cells with thick, lignified cell walls make up sclerenchyma. They are usually dead and without protoplasts. It provides mechanical support to organs.

Parenchyma is generally isodiametric cells. They are living cells. Their cellulose-based walls are thin. The parenchyma plays a variety of roles, including secretion, storage, and photosynthesis.

Collenchyma occurs in layers below the epidermis of dicot plants. It consists of cells that are much thickened at the corner due to the deposition of cellulose, hemicellulose, and pectin.

Epidermis is the outermost layer of the plant tissues which protects it from infections and water loss. It also regulates gaseous exchange in plant cells.

Hence, the Correct option is d i.e. Sclerenchyma

127. (d) Cartilage is a type of specialized connective tissue. The intercellular material of cartilage is solid and pliable and resists compression.

Cartilage is present in the tip of the nose, outer ear joints, and between adjacent bones of the vertebral column, limbs, and hands in adults.

Most of the cartilage in vertebrate embryos is replaced by bones in adults. Cartilage is not found in the urinary bladder because it is made up of epithelial tissue. The urinary bladder stores the urine which comes from the kidneys.

Hence, the Correct option is d i.e. Urinary bladder

128. (b) From **Kepler's 3rd law**, we have $T^2 \propto R^3$ where T is the orbital period and R is the radius of the orbit.

Given that:

Radius of two orbits is $R_1 = R$ and $R_2 = 4R$

Orbital time period is T_1 and T_2

Ratio of orbital period

$$\Rightarrow \left(\frac{T_1}{T_2}\right)^2 = \left(\frac{R_1}{R_2}\right)^3$$

$$\left(\frac{T_1}{T_2}\right)^2 = \left(\frac{R}{4R}\right)^3$$

$$\left(\frac{T_1}{T_2}\right)^2 = (1/64)$$

$$\left(\frac{T_1}{T_2}\right) = \sqrt[3]{(1/64)} = 1/8.$$

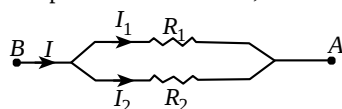
Hence, the Correct option is B i.e. 1/8

129. (c) Given that: Resistance of an original wire (R) = 20 Ω

The new resistance of any resistor is half of its original resistance when it is divided into two equal lengths i.e.,

$$\Rightarrow R_1 = R_2 = 20/2 = 10 \Omega$$

For parallel combinations,



We use, $1/R_{\text{net}} = 1/R_1 + 1/R_2$

Here both resistors R_1 and R_2 are in parallel combination, therefore the resultant resistance is

$$1/R_{\text{net}} = 1/R_1 + 1/R_2$$

$$1/R_{\text{net}} = 1/10 + 1/10 = 2/10 = 1/5$$

$$\text{So, } R_{\text{net}} = 5 \Omega$$

Hence, the Correct option is c i.e. 5 Ω

Total Energy

130. (a) $I = \frac{\text{Surface Area} \times \text{Time}}$

From the above-mentioned formula, the intensity is inversely proportional to the surface area.

Therefore, if the surface area is halved then the intensity will be doubled.

Hence, the Correct option is a i.e. doubled

131. (c) One way to think of the eye is as a living optical device. It consists of many different components like the outermost white part of the eye is called **the sclera** and one of its inner layers which is pigmented called **the choroid** keeps the eye essentially light tight.

The cornea, which is the clear part of the eye, serves as the first lens, focusing most of the light coming in from the outside.

Then an aperture called the **pupil** in a diaphragm called the **iris**—the colored part of the eye that controls the amount of light entering the eye.

A **light-sensitive** part of the eye called **the retina** where image fall and are processed. The optic nerve connects the retina to the brain.

Hence, the Correct option is c i.e. retina

132. (d) A proton enters a magnetic field at right angles to it as mentioned in the question.

Therefore, it will experience a force and the direction of force can be easily calculated by using Fleming's left-hand rule.

So, after applying this rule we are getting that the direction of force acting on the proton is into the page.

Hence, the Correct option is d i.e. into the page.

133. (b) As sound waves are longitudinal waves which means the air particles move to and fro in the direction of propagation of sound waves.

Sound waves consist of compression and rarefaction.

Hence, the Correct option is b i.e. Sound waves are transverse waves.

134. (c) When a short circuit condition occurs in the circuit, electrical current experiences little or no resistance because of this excess heat is produced in the circuit and that can damage the electrical appliances.

To prevent this situation, a fuse is used in the circuit so that it can break the circuit due to the excess heat produced.

Wire of lead and tin is preferred as a fuse because it has high resistivity and low melting points.

Hence, the Correct option is c i.e. increases substantially

135. (a) The male reproductive system is located in the pelvic region. It includes a pair of testes along with accessory ducts, glands, and the external genitalia.

Urethra originates from the urinary bladder and extends through the penis to its external opening called the urethral meatus.

The male accessory glands include paired seminal vesicles, a prostate, and paired bulbourethral glands. Their secretions constitute the seminal plasma which is rich in fructose, Calcium, and certain enzymes.

The epididymis leads to vas deferens that ascend to the abdominal and loop over the urinary bladder.

Cervix is the part of the female reproductive system which later forms the birth canal.

Hence, the Correct option is a i.e. Cervix

136. (c) There are some reasons for the Loss of Biodiversity: Habitat destruction, Invasive Species, Over-exploitation of Species, Global Warming and Climate Change.

137. (a) Most commonly pumping of groundwater causes depletion in groundwater. Plantation of trees known as afforestation that provides proper flow of rainwater into ground, which lead to increased groundwater level i.e. depletion in groundwater is not due to Afforestation.

138. (d) Increasing order of energy: Gamma ray < X-ray < visible < infra-red < microwave.

The radiation with high energy have high frequency and small wavelength.

139. (b) A galvanometer is used to detect the presence of electric current in a circuit, it shows both the direction as well as the magnitude of the current, whereas an ammeter shows only magnitude of the current. Unit of current is ampere.

Additional Information-

The refractometer used for measuring refractive index.

Viscosity of a fluid is measured by a viscometer.

For measuring diffraction, a diffractometer is used.

140. (b) Biogas production is an eco-friendly process, and is a renewable source of energy produced via organic waste. Biogas is a mixture of methane, carbon dioxide, nitrogen and hydrogen gas. It contains methane as a major component around 50-75%, 25-50% carbon dioxide and traces of other gases like nitrogen and hydrogen.

141. (c) According to Rayleigh's Law of scattering,

Intensity of scattered light is inversely proportional to the fourth power of wavelength i.e. shorter wavelength has maximum intensity.

At the time of sunrise and sunset, the rays from the sun have to travel a larger path of the atmosphere. As we know that the wavelength of blue color is less than the wavelength of red color ($\lambda_b < \lambda_r$) i.e. scattering of blue light will be more than red light and that less scattered red light enters our eyes and that is why the sun looks reddish during sunrise and sunset.

142. (c) Optical power of a lens measured in Dioptre, is equal to reciprocal of the focal length.

Power of lens given (P) = +2.0 Dioptre

$$P = \frac{1}{f}$$

$$\text{So, } f = \frac{1}{P}$$

$$f = \frac{1}{2} = 0.5\text{m}$$

Focal length is positive, which shows that the lens is convex.

Additional Information-

Negative sign of focal length shows that the lens is concave.

143. (a) Carbon dioxide is the responsible product, which makes sodium bicarbonate usable in bakery products at 70°C. Decomposition reaction of sodium bicarbonate is-
- $$2\text{NaHCO}_3(\text{s}) \rightarrow \text{Na}_2\text{CO}_3(\text{s}) + \text{CO}_2(\text{g}) + \text{H}_2\text{O}(\text{g})$$

144. (a) Molecular formula of copper sulphate is $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$ i.e. copper sulphate contain 5 molecules of water that's why crystal of copper sulphate appears blue in color.

sodium carbonate has molecular formula $\text{Na}_2\text{CO}_3 \cdot 10\text{H}_2\text{O}$ i.e. sodium carbonate contains 10 water molecules.

Molecular formula of gypsum $\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$ i.e. contain 2 water molecules.

145. (b) When turmeric stain on a white cloth comes in contact with soap it turns into a reddish color because soap is basic in nature and when the cloth is washed i.e. base is removed it again turns into yellow color.

146. (c) Dichloro Diphenyl Trichloroethane is used to make synthetic insecticides and Bleaching powder used as disinfectant. Molecular formula of DDT is $\text{C}_{14}\text{H}_9\text{Cl}_5$ and the molecular formula of bleaching powder is CaOCl_2 .

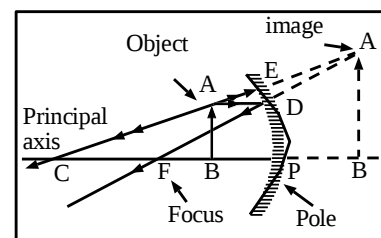
147. (a) Desiccant work on the process of adsorption, which is a surface phenomenon. Desiccant is used where the rate of evaporation is low due to

humidity in the environment. Silica gel is used as a desiccant.

148. (a) Sulfuric acid was the first mineral acid discovered by Johann Glauber. Molecular formula of sulfuric acid is H_2SO_4 .

149. (a) Refractive index of fused quartz is 1.46 and the refractive index of sapphire is 1.77. According to the formula we know that the refractive index is inversely proportional to the speed of light in a medium i.e. faster the speed of light in any medium lower will be its refractive index and vice-versa. The given refractive index of fused quartz is less than sapphire i.e. speed of light in fused quartz (v_q) will be more than sapphire (v_s).

150. (c) The size of the image produced by the concave mirror depends on the distance between the object and the mirror. It can form both a real and virtual image of the object.



If an object is kept between principal focus F and pole P of the mirror, the nature of the image will be virtual, erect and enlarged i.e. statement c is incorrect.