AP/EAPCET Solved Paper 2020
Held on September 17

INSTRUCTIONS

1. This test will be a 3 hours Test.
2. Each question is of 1 mark.
3. There are three parts in the question paper consisting of Mathematics (80 Questions), Physics (40 Questions) and Chemistry (40 Questions).
4. Any textual, printed or written material, mobile phones, calculator etc. is not allowed for the students appearing for the test.
5. All calculations / written work should be done in the rough sheet provided .

MATHEMATICS

1. $\int \frac{x^3-1}{x^3+x}\,dx =$

(a) $x+\log|x|+\frac{1}{2}\log\left(x^2+1\right)+\sin^{-1}(x)+c$

(b) $x-\log|x|+\frac{1}{2}\log\left(x^2+1\right)-\sin^{-1}(x)+c$

(c) $x+\log|x|-\frac{1}{2}\log\left(x^2+1\right)+\tan^{-1}(x)+c$

(d) $x-\log|x|+\frac{1}{2}\log\left(x^2+1\right)-\tan^{-1}(x)+c$

2. The values of x at the stationary points of $f(x) = x^3 + 3x^2 - 2$ are

(a) 0, 2 (b) 1, 2 (c) 0, – 2 (d) 1, 1

3. The perimeter of ΔABC is 36 cm and its in radius is 8 cm. Then, the area of the triangle is

(a) 144 cm^2 (b) 124 cm^2 (c) 164 cm^2 (d) 104 cm^2

4. Find the domain of the real valued function $f(x) = ([x]^2 - [x] - 2)^{-1/2}$, where $[\cdot]$ is the greatest integer function.

(a) $R-(-1,3]$ (b) $R-[-1, 3)$ (c) $R-(-1,3)$ (d) $R-[-1, 3]$

5. Find the value of k, if the angle between the straight lines represented by $2x^2 + 5xy + 3y^2 + 6x + 7y + 4 = 0$ is $\tan^{-1}(k)$.

(a) $\left(\frac{1}{5}\right)$ only (b) $\left(\frac{-1}{5}\right)$ only

(c) $\pm\frac{1}{5}$ (d) 0

6. The roots of the equation $|x^2 - x - 6| = x + 2$ are

(a) –2, 1, 4 (b) 0, 2, 4 (c) 0, 1, 4 (d) –2, 2, 4

7. Let a, b, c be real numbers. A set formed with a, b, c whose order of occurrence is pre-assigned is called ....

(a) An ordered triad

(b) An ordered pair

(c) Both ordered triad and ordered pair

(d) None of these

8. If $3f(x)-2f\left(\frac{1}{x}\right)=x$, then $f'(2)$ is

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

9. $\int_1^{e^2}\frac{dx}{x(1+\log x)^2}=$

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

10. The constant term in the expansion of $\left(\frac{x}{2}+\frac{1}{x}+\sqrt{2}\right)^5$ is $\frac{a\sqrt{2}}{2}$, then $a =$

(a) 7 (b) 69 (c) 63 (d) 65

11. $\cos^2(x)+\cos^2\left(x+\frac{\pi}{3}\right)+\cos^2\left(x-\frac{\pi}{3}\right)=$

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

12. If one end of diameter of the circle $x^2 + y^2 - 4x - 6y + 11 = 0$ is (3, 4), then the other end of the diameter is

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

13. $\cos 48° \cdot \cos 12° =$

(a) $\frac{\left(3-\sqrt{5}\right)}{8}$ (b) $\frac{\left(3+\sqrt{5}\right)}{4}$

(c) $\frac{\left(3+\sqrt{5}\right)}{2}$ (d) $\frac{\left(3+\sqrt{5}\right)}{8}$

14. If $\sin(\theta) + \text{cosec}(\theta) = 2$, then $\sin^{2020}(\theta) + \text{cosec}^{2020}(\theta) =$ ......

(a) 2^{2020} (b) $2020^{2^{2019}}$ (c) 2^{2019} (d) 2

15. Assuming $|x|$ to be so small, that x^2 and higher powers of x can be neglected, then $\frac{\sqrt{1+x}+(1-x)^{3/2}}{(1+x)+\sqrt{1+x}} =$

(a) $1+\frac{5x}{4}$ (b) $1-\frac{5x}{4}$ (c) $1+\frac{4x}{5}$ (d) $1-\frac{4x}{5}$

16. How many bijections $f : Z \to Z$ are there such that $f(x+y) = f(x) + f(y)$ for all $x, y \in Z$?

(a) One (b) Two
(c) Three (d) Infinitely many

17. The matrix $A = \begin{bmatrix} \frac{1}{\sqrt{2}} & \frac{1}{\sqrt{2}} \\ \frac{-1}{\sqrt{2}} & \frac{-1}{\sqrt{2}} \end{bmatrix}$ is ....

(a) Unitary (b) Orthogonal
(c) Nilpotent (d) Involuntary

18. The length of the latus rectum of the parabola $169\{(x-1)^2 + (y-3)^2\} = (5x - 12y + 17)^2$ is

(a) $\frac{14}{13}$ (b) $\frac{12}{13}$ (c) $\frac{28}{13}$ (d) $\frac{56}{13}$

19. If $\tan h(x) = \frac{1}{3}$, then $\tan h\,(3x)$ is

(a) $\frac{8}{9}$ (b) $\frac{7}{9}$ (c) 1 (d) $\frac{2}{3}$

20. A square is formed by the lines $x = 0, y = 0, x = 1, y = 1$. Then, the equations of its diagonals will be

(a) $y = x, x + y = 2$ (b) $2y = x, x + y = \frac{1}{2}$
(c) $y = x, x + y = 1$ (d) $y = 2x, x + y = \frac{1}{4}$

21. The equation of a circle with centre (5, 4) and touch the Y-axis is

(a) $x^2 + y^2 - 10x - 8y - 16 = 0$
(b) $x^2 + y^2 - 10x - 8y - 16 = 0$
(c) $x^2 + y^2 + 10x + 8y + 16 = 0$
(d) $x^2 + y^2 - 10x - 8y + 16 = 0$

22. Let X be a random variable such that $X(x)$ is the number of heads is X for each $x \in S$, where S is the sample space of random experiment of tossing three fair coins simultaneously. Find the value of $\rho(X^{-1}(2))$.

(a) $\frac{3}{8}$ (b) $\frac{5}{8}$ (c) $\frac{1}{8}$ (d) $\frac{3}{4}$

23. If p and q are length of the perpendicular from origin to the lines $x \sec(\theta) + y \operatorname{cosec}(\theta) = k$ and $x \cos(\theta) - y \sin(\theta) = k \cos(2\theta)$ respectively, then

(a) $p^2 + 4q^2 = k^2$ (b) $4p^2 + q^2 = k^2$
(c) $p^2 + q^2 = 4k^2$ (d) $p^2 + q^2 = k^2$

24. If $x^2 + y^2 + 6x + 2ky + 25 = 0$ to touch Y-axis, then $k =$

(a) ± 20 (b) $-1, -5$ (c) ± 5 (d) 4

25. Find the number of ways of selecting 4 pens and 3 pencils from a packet of 8 pens and 5 pencils,

(a) 700 (b) ${}^8P_4 \times {}^5P_3$ (c) ${}^8P_4 + {}^5P_3$ (d) $700 \times {}^8P_4$

26. $\frac{x^4}{x^3 - 3x + 2}$ is a ....

(a) proper fraction (b) improper fraction
(c) mixed fraction (d) not a fraction

27. In how many ways one can send 6 new-year greeting cards to 4 people?

(a) 360 (b) 180 (c) 720 (d) 90

28. If $[a, b]$ is the range of the function $\frac{x+2}{2x^2 + 3x + 6}$ for $x \in \mathbf{R}$, then

(a) $a < 0, b < 0$ (b) $a < 0, b > 0$
(c) $a > 0, b > 0$ (d) $a < 0, b < 0$

29. The point on the circle $x^2 + y^2 = 4$ whose distance from the line $4x + 3y - 12 = 0$ is 4/5 units is equal to

(a) $\left(\frac{12}{25}, \frac{36}{25}\right)$ (b) (4, 0)
(c) (2, 0) (d) $\left(\frac{-14}{25}, \frac{48}{25}\right)$

30. Let a, b and c be the lengths of the sides of triangle with its opposite angles A, B and C respectively. If $\angle C = 60°$, then the value of $\frac{c(a+b) + (a^2 + b^2)}{(b+c)(c+a)}$ is

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

31. If $f(x)$ is a polynomial of the second degree in x such that $f(0) = f(1) = 3f(2) = -3$. Then $\int \frac{f(x)}{x^3 - 1}\,dx =$

(a) $\log\left(\frac{x^2+x+1}{|x-1|}\right) + \frac{1}{\sqrt{3}}\tan^{-1}\left(\frac{2x+1}{\sqrt{3}}\right) + c$

(b) $\log\left(\frac{x^2+x+1}{|x-1|}\right) - \frac{2}{\sqrt{3}}\tan^{-1}\left(\frac{2x+1}{\sqrt{3}}\right) + c$

(c) $\log\left(\frac{x^2+x+1}{|x-1|}\right) - \frac{1}{\sqrt{3}}\tan^{-1}\left(\frac{2x+1}{\sqrt{3}}\right) + c$

(d) $\log\left(\frac{x^2+x+1}{|x-1|}\right) + \frac{2}{\sqrt{3}}\tan^{-1}\left(\frac{2x+1}{\sqrt{3}}\right) + c$

32. If $x \in \mathbf{R}$, then one of the solutions of $\sqrt{x+1} - \left|\sqrt{x-1}\right| = \sqrt{4x-1}$ among the following is

(a) $x = \frac{5}{4}$ (b) $x = \frac{-5}{4}$ (c) $x = 0$ (d) $x = 1$

33. Let **p, q** and **r** be such that **r** $\neq$ **0**, **p** $\times$ **q** = **r**, **q** $\times$ **p**, then

(i) **p, q, r** are pair-wise orthogonal vectors
(ii) |**q**| = |**r**| = |**p**|

(a) (i) is correct, (ii) is incorrect
(b) (i) is incorrect, (ii) is correct
(c) Both (i) and (ii) are incorrect
(d) Both (i) and (ii) are correct

34. The domain of

$f(x) = \cos^{-1}\left(\frac{x-3}{2}\right) - \log_{10}(4-x)$ is

(a) (1, 4) (b) [1, 4) (c) (1, 4] (d) [1, 4]

35. $\int\left(1+\frac{x}{1!}+\frac{x^2}{2!}+\ldots\infty\right)dx =$

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

(c) e^x+c (d) $-e^{-x}+c$

36. Find $|\mathbf{a}\times\mathbf{b}|^2$, if $|\mathbf{a}| = 2$, $|\mathbf{b}| = 3$ and $(\mathbf{a}, \mathbf{b}) = \frac{\pi}{6}$

(a) –9 (b) 9 (c) 3 (d) –3

37. The general solution of $\cos(x) - \sin(x) = 0$ is

(a) $n\pi-\frac{\pi}{4}, n\in\mathbf{Z}$ (b) $2n\pi+\frac{\pi}{4}, n\in\mathbf{Z}$

(c) $n\pi+\frac{\pi}{4}, n\in\mathbf{Z}$ (d) $2n\pi-\frac{\pi}{4}, n\in\mathbf{Z}$

38. If 1, a, a^2, ..., a^{n-1} are the n^{th} roots of unity.

Then $\sum_{i=1}^{n-1}\frac{1}{2-a^i}$ is equal to

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

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

39. Find the solution of the differential equation

$(e^{y-x})\,dy = (e^x - e^y)\,dx$

(a) $e^y e^x = e^{2x} - e^{x^2} + c$

(b) $e^y e^x = e^x e^{e^x} - e^{e^x} + c$

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

(d) $e^{e^y} e^x = e^x e^{e^x} - e^{e^x} + c$

40. If $[x]$ denotes the greatest integer function on x, then the number of positive integral divisors of $\left[\left(2+\sqrt{3}\right)^5\right]$ is

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

41. If a line makes angles α, β, γ with the positive direction of *X, Y* and *Z*-axes respectively, then the value of $\sin^2\alpha + \sin^2\beta + \sin^2\gamma =$

(a) 1 (b) 2 (c) 3 (d) –1

42. If $f(x) = \begin{vmatrix} x-3 & 2x^2-18 & 3x^3-81 \\ x-5 & 2x^2-50 & 4x^3-500 \\ 1 & 2 & 3 \end{vmatrix}$, then

$f(1)f(3)+f(3)f(5)+f(5)f(1)$ is equal to

(a) $f(1)$ (b) $f(3)$

(c) $f(1)+f(3)$ (d) $f(1)+f(5)$

43. Foci of the ellipse $2x^2 + 3y^2 - 4x - 12y + 13 = 0$ are

(a) $\left(1+\frac{1}{\sqrt{6}}, 2\right)$ and $\left(1-\frac{1}{\sqrt{6}}, 2\right)$

(b) $\left(\frac{1}{\sqrt{6}}+1, 2\right)$ and $\left(\frac{1}{\sqrt{6}}-1, 2\right)$

(c) $\left(2, 1+\frac{1}{\sqrt{6}}\right)$ and $\left(2, 1-\frac{1}{\sqrt{6}}\right)$

(d) $\left(2, \frac{1}{\sqrt{6}}+1\right)$ and $\left(2, \frac{1}{\sqrt{6}}-1\right)$

44. $\frac{k^5}{5}+\frac{k^3}{3}+\frac{}{15}$ is............ if $k\in\mathbf{N}$

(a) a natural number (b) an integer

(c) a positive fraction (d) equal to zero

45. The equation of the circle passing through (0, 0) and which makes intercepts *a* and *b* on the coordinates axes is

(a) $x^2 + y^2 + ax + by = 0$ (b) $x^2 + y^2 + ax - by = 0$

(c) $x^2 + y^2 - ax + by = 0$ (d) $x^2 + y^2 - ax - by = 0$

46. If pairs of straight lines $x^2 - 2pxy - y^2 = 0$ and $x^2 - 2qxy - y^2 = 0$ be such that each pair bisects the angle between the other pair, then

(a) $pq = 1$ (b) $pq = 2$

(c) pq = – 2 (d) $pq = -1$

47. If *P* and *Q* are square matrices such that $P^{2006} = 0$ and $PQ = P + Q$, then det (Q) will be

(a) 0 (b) 1 only (c) –1 only (d) ± 1

48. $\int\frac{2\tan(x)}{1+2\tan^2(x)}dx =$

(a) $\log|\cos^2 x + \sin^2 x| + c$

(b) $\log\left|\frac{\cos^2 x}{2}+\sin^2 x\right|+c$

(c) $\log\left|\cos^2 x+\frac{\sin^2 x}{2}\right|+c$

(d) $\log\left|\frac{\cos^2 x}{2}+\frac{\sin^2 x}{2}\right|+c$

49. If $\theta\in\left[-\frac{\pi}{2}, \frac{\pi}{2}\right]$, then $\cos^{-1}(\sin\theta)$ is equal to

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

50. If $\mathbf{a} = \alpha\hat{\mathbf{i}}+3\hat{\mathbf{j}}-6\hat{\mathbf{k}}$ and $\mathbf{b} = 2\hat{\mathbf{i}}-\hat{\mathbf{j}}+\beta\hat{\mathbf{k}}$, then the value of α, β so that **a** and **b** may be collinear are

(a) (5, 3) (b) (6, 2) (c) (2, –6) (d) (–6, 2)

51. If $2\alpha = -1-i\sqrt{3}$ and $2\beta = -1+i\sqrt{3}$, then

$5\alpha^4 + 5\beta^4 + 7\alpha^{-1}\beta^{-1}$ is equal to

(a) –1 (b) –2 (c) 0 (d) 2

52. The direction cosines of the line which is perpendicular to the lines with direction cosines proportional to (1, –2, –2) and (0, 2, 1) is given by

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

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

53. The value of x that satisfies the equation

$\int_{\sqrt{2}}^{x}\frac{dt}{|t|\sqrt{t^2-1}}=\frac{\pi}{12}$ is

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

54. The angle between the lines $2x + 11y - 7 = 0$ and $x + 3y + 5 = 0$ is ....

(a) $\tan^{-1}\left(\frac{17}{13}\right)$ (b) $\tan^{-1}\left(\frac{4}{35}\right)$

(c) $\tan^{-1}\left(\frac{1}{7}\right)$ (d) $\tan^{-1}(7)$

55. The value of 'k' so that the line $y = 2x + k$ may touch the ellipse $3x^2 + 5y^2 = 15$ is

(a) $\pm\sqrt{23}$ (b) $\pm\sqrt{13}$ (c) $\pm\sqrt{33}$ (d) $\pm\sqrt{32}$

56. Let **a, b, c** be three vectors

(i) **(a × b) × c = (a · c) b – (b · c) a**

(ii) **(a) × (b × c) = (a · b) c – (a · c) b**

(a) (i) is incorrect, (ii) is correct

(b) (i) is correct, (ii) is incorrect

(c) Both (i) and (ii) are correct

(d) Both (i) and (ii) are incorrect

57. If $(1 - x + x^2)^{10} = a_0 + a_1x + a_2x^2 + ... + a_{20}x^{20}$, then $2a_2 + 3a_3 + 4a_4 + ... + 20a_{20} =$

(a) 0 (b) 10 (c) 20 (d) –20

58. If $y = \sin^{98}(x) \cdot \cos^{39}(x)$, then find $\frac{dy}{dx}$

(a) $(98\cos^{99}x \cdot \sin^{38}x) + (39\sin^{40}x \cdot \cos^{97}x)$

(b) $(99\cos^{98}x \cdot \sin^{39}x) - (40\sin^{39}x \cdot \cos^{98}x)$

(c) $(98\cos^{99}x \cdot \sin^{38}x) - (39\sin^{40}x \cdot \cos^{97}x)$

(d) $(99\cos^{98}x \cdot \sin^{39}x) + (39\sin^{40}x \cdot \cos^{97}x)$

59. The derivative of $\tan^{-1}\left[\frac{x}{1+\sqrt{1-x^2}}\right]$ with respect to $\sec^{-1}\left(\frac{1}{2x^2-1}\right)$ is

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

60. For a triangle with the sides of lengths 6, 5 and 9, then the radius of the circle is

(a) $\sqrt{3}$ (b) $\sqrt{2}$ (c) $\sqrt{5}$ (d) $\frac{\sqrt{3}}{\sqrt{2}}$

61. If $a+bi=\frac{i}{1-i}$, then $(a, b) =$

(a) $\left(\frac{-1}{2},\frac{-1}{2}\right)$ (b) $\left(\frac{1}{2},\frac{1}{2}\right)$

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

62. ABC is a right-angled triangle in which max $\{AB, BC, AC\} = BC$. If the position vectors of B and C are respectively $3\hat{\mathbf{i}}-2\hat{\mathbf{j}}+\hat{\mathbf{k}}$ and $5\hat{\mathbf{i}}+\hat{\mathbf{j}}-3\hat{\mathbf{k}}$, then **AB · AC + BA · BC + CA · CB =**

(a) 28 (b) 29 (c) 27 (d) 25

63. If the lines $3x + 4y - 5 = 0$, $2x + 3y - 4 = 0$ and $px + 4y - 6 = 0$ all meet at the same point, then p is equal to

(a) –2 (b) 0 (c) 1 (d) 2

64. If $a > 0$, $n \in \mathbf{R}$, then $\lim_{x\to a} x^n =$

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

65. $\int_{-\pi}^{\pi} x^2(\sin x)\,dx =$

(a) π^2 (b) $\frac{\pi^2}{2}$ (c) 0 (d) $2\pi^2$

66. Find the solution of the following differential equation

$$\left\{x\cos\left(\frac{y}{x}\right)+y\sin\left(\frac{y}{x}\right)\right\}ydx = \left\{y\sin\left(\frac{y}{x}\right)-x\cos\left(\frac{y}{x}\right)\right\}x\,dy$$

(a) $y\cos\left(\frac{x}{y}\right)=\pm e^{-c}$ (b) $x\cos\left(\frac{y}{x}\right)=\pm e^{-c}$

(c) $xy\cos\left(\frac{y}{x}\right)=\pm e^{-c}$ (d) $xy\sin\left(-\right)=\pm e$

67. The function $f(x) = (1/2)^x$ on R is

(a) Strictly decreasing

(b) Strictly increasing

(c) Decreasing

(d) Neither increasing nor decreasing

68. If the pair of straight lines $6x^2 - 5xy + y^2 = 0$ makes angles α and β with the X-axis, then $\tan(\alpha - \beta) =$

(a) 2 (b) $\frac{1}{7}$ (c) 3 (d) 7

69. The slope of the tangent of the curve

$\left(\frac{x}{31}\right)^n+\left(\frac{y}{1209}\right)^n=2$ at (31,1209)................

(a) – 39 (b) 39 (c) $\frac{1}{39}$ (d) $\frac{-1}{39}$

70. Tangents are drawn to the hyperbola $x^2 - 9y^2 = 9$ from point (3, 2). Then, the area of the triangle formed by the tangents and the chord of contact is .... sq. units.

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

71. If the standard deviation of the numbers 2, 3, $2x$ and 11 is 3.5. Find the possible values of x.

(a) $2, \frac{7}{2}$ (b) $3, \frac{5}{3}$ (c) $2, \frac{5}{2}$ (d) $3, \frac{7}{3}$

72. If $x^{2019} \cdot y^{2020} = (x + y)^{4039}$, then $\frac{dy}{dx} =$

(a) 0 (b) $\frac{x}{y}$ (c) $\frac{y}{x}$ (d) 1

73. A bag consists of 3 red balls, 5 blue balls and 8 green balls. A ball is selected at random. What is the probability of not getting a blue balls ?

(a) $\frac{11}{16}$ (b) $\frac{3}{16}$ (c) $\frac{1}{2}$ (d) $\frac{5}{16}$

74. If $y = 5x^2 + 6x + 6$, $x = 2$, $\Delta x = 0.001$, then value of dy is

(a) 0.026 (b) 0.0026 (c) 0.062 (d) 0.0062

75. Find the value of $m + n$, if the circumference of the circle $x^2 + y^2 + 8x + 8y - m = 0$ is bisected by the circle $x^2 + y^2 - 2x + 4y + n = 0$.

(a) – 56 (b) 56 (c) 50 (d) – 34

76. Find the transformed equation of $x \cos\theta + y \sin\theta = p$, when the axes are rotated through an angle θ.

(a) $x = p$ (b) $y = p$
(c) $x + y = p$ (d) $x - y = p$

77. If $f(x) \in \mathbf{Q}[x]$ be a non-zero polynomial such that all its roots are irrational, then the degree of $f(x)$ is

(a) an even number (b) an odd number
(c) 0 (d) can't determine

78. $\int \sin^3(x) \cdot \cos^3(x)\, dx =$

(a) $\sin^4(x) - \sin^6(x) + c$

(b) $\cos^4(x) - \cos^6(x) + c$

(c) $\frac{1}{4}\sin^4(x) - \frac{1}{6}\sin^6(x) + c$

(d) $\frac{1}{4}\cos^4(x) - \frac{1}{6}\cos^6(x) + c$

79. Find the number of different garlands that can be prepared using 5 different coloured flowers.

(a) 120 (b) 60 (c) 119 (d) 59

80. $\lim_{x \to 0} \frac{8}{\sin^8 x}$

$$\left\{1 - \cos\left(\frac{x^2}{2}\right) - \cos\left(\frac{x^2}{4}\right) + \cos\left(\frac{x^2}{2}\right)\cos\left(\frac{x^2}{4}\right)\right\} =$$

(a) $\frac{1}{16}$ (b) $\frac{1}{32}$ (c) $\frac{1}{64}$ (d) $\frac{1}{8}$

PHYSICS

81. Microwaves are used in

(a) TV (b) radio transmission
(c) Radar (d) atmospheric research

82. The lower half of a vessel of depth $2d$ cm is filled with a liquid of refractive index μ_1 and the upper half with a liquid of refractive index μ_2. The apparent depth of the vessel seen perpendicularly is

(a) $d\left(\frac{\mu_1\mu_2}{\mu_1 + \mu_2}\right)$ (b) $d\left(\frac{1}{\mu_1} + \frac{1}{\mu_2}\right)$

(c) $2d\left(\frac{1}{\mu_1} + \frac{1}{\mu_2}\right)$ (d) $2d\left(\frac{1}{\mu_1\mu_2}\right)$

83. The energy stored in a coil of inductance L carrying a steady current i is in the form

(a) magnetic
(b) electrical
(c) both magnetic and electrical
(d) heat

84. A resistor of resistance R is connected between the terminals of a cell of emf E and internal resistance r. If I is the current through the circuit. The terminal potential difference of the cell is given by

(a) IR (b) $E - Ir$ (c) $\frac{ER}{R + r}$ (d) $\frac{E - R}{r}$

85. When a body slides down on inclined plane with coefficient of friction μ, then its acceleration will be

(a) $g(\sin\theta - \mu\cos\theta)$ (b) $g(\sin\theta + \mu\sec\theta)$
(c) $g(\mu\sin\theta - \cos\theta)$ (d) $g\mu(\sin\theta - \cos\theta)$

86. The limit of resolution of an oil immersion objective microscope of numerical aperture 0.8 for light of wavelength 0.6 μm is

(a) $\frac{1.5}{8}\mu$m (b) $\frac{3}{8}\mu$m (c) $\frac{5}{8}\mu$m (d) $\frac{7}{8}\mu$m

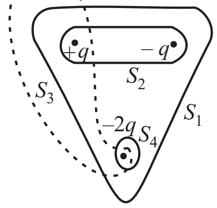
87. Four point masses, each of mass M are placed at the corners of a square of side L. The moment of inertia of the system about one of its diagonals is

(a) $2ML^2$ (b) ML^2 (c) $4ML^2$ (d) $6ML^2$

88. A flywheel starts from rest and rotates at a constant acceleration of 2 rad s^{-2}. The number of revolutions that it makes in first 10 s is

(a) 16 (b) 24 (c) 32 (d) 8

89. Four closed surfaces S_1, S_2, S_3 and S_4 together with charges $+q$, $-q$ and $-2q$ are shown. Through which one of the surfaces the net flux is zero?



(a) S_1 (b) S_2 (c) S_3 (d) S_4

90. On producing the waves of frequency 1000 Hz in a Kundt's tube, the total distance between 6 successive nodes is 85 cm. Then, the speed of sound in the gas filled in the tube is

(a) 330 ms^{-1} (b) 340 ms^{-1}
(c) 350 ms^{-1} (d) 300 ms^{-1}

91. 5 kg of water at 20°C is added to 10 kg of water at 60°C. Neglecting heat capacity of vessel and other losses, then resultant temperature will be nearly

(a) 35°C (b) 40°C (c) 47°C (d) 28°C

92. If ultraviolet radiation of 6.2 eV falls of an aluminium surface, then kinetic energy of the fastest emitted electron is (work-function = 4.2 eV)

(a) 3.2×10^{-19} J (b) 3.2×10^{-21} J
(c) 7×10^{-25} J (d) 9×10^{-31} J

93. In the nuclear reaction, ${}^{11}_{6}C \rightarrow {}^{11}_{5}B + \beta + X$, X stands for

(a) a neutron (b) an electron
(c) a neutrino (d) an anti-neutrino

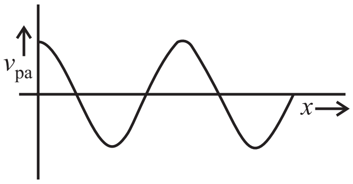
94. 1 kg of steam at 150°C is passed from a steam chamber is to a copper coil immersed in 20 L of water. The steam condenses in the coil and is returned to the steam chamber as water at 90°C. Latent heat of steam is 540 cal g^{-1}, specific heat of the steam is 1 cal $g^{-1}°C^{-1}$. Then, the rise in temperature of water is

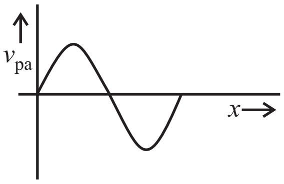
(a) 75°C (b) 60°C (c) 30°C (d) 20°C

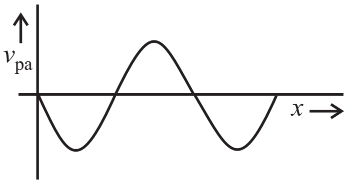
95. If a unit positive charge is taken from one point to another over an equipotential surface, then

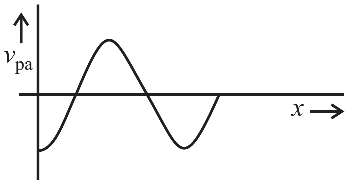
(a) work is done on the charge
(b) work is done by the charge
(c) work done is constant
(d) no work is done

96. A plane wave $y = a \sin (\omega t - kx)$ propagates through a stretched string. The particle velocity versus x graph at $t = 0$ is

(a)


(b)


(c)


(d)


97. An airplane flies 400 m north and 300 m south and flies 1200 m upward, then net displacement is

(a) 1400 m (b) 1500 m (c) 1200 m (d) 1100 m

98. A pure number which determines the types of flow of a liquid through a pipe is known as

(a) Reynold's number (b) Bernoulli's number
(c) Pascal's number (d) Torricelli's number

99. Work done

(a) can only be positive
(b) can only be negative
(c) can either be positive or negative
(d) cannot be assigned a sign

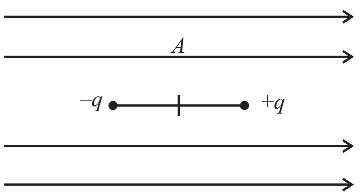
100. A gas volume 251 cm^3 at 20°C and pressure 78 cm of Hg. Find its volume at NTP.

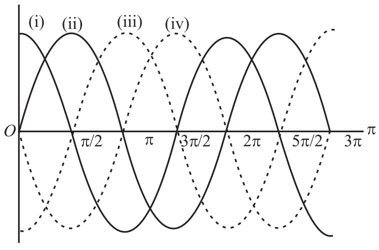
(a) 420 cm^3 (b) 440 cm^3 (c) 240 cm^3 (d) 100 cm^3

101. Frank and Hertz experiment proves that

(a) light move in the form of waves as well as particles
(b) the electron does not radiate energy, while moving in an orbit
(c) the energy states of an atom are quantised
(d) the whole of the positive charge of the atom is concentrated in the nucleus

102. An electric dipole is situated in an electric field as shown in figure. The dipole and electric field are both in the plane of paper. The dipole is rotated about an axis, perpendicular to the paper at point A in anti-clockwise direction. If the angle of rotation is measured with respect to the direction of the electric field, then the torque for different values of the angle of rotation θ is correctly represented by which graph among (i), (ii), (iii), (iv) given in Fig (B) ?

(A)


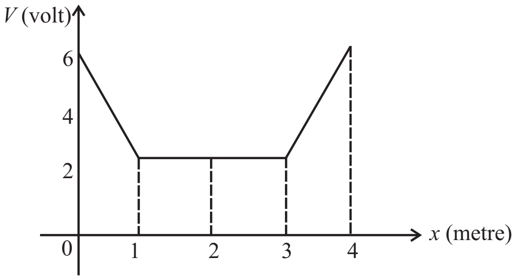
(B)


(a) (i) (b) (iii) (c) (ii) (d) (iv)

103. When 50 g of water at 10°C is mixed with 50 g of water at 100°C. The resultant temperature is

(a) 80°C (b) 55°C (c) 25°C (d) 45°C

104. The variation of electric potential with distance from a fixed point is shown in figure. What is the value of electric field at x = 2 m?



(a) 0 (b) 3 (c) 2 (d) 6

105. A calorimeter contains 0.5 kg of water at 30°C. When 0.3 kg of water at 60°C is added to it, the resulting temperature is found to be 40°C. The water equivalent of the calorimeter is
(a) 0.25 kg (b) 0.1 kg (c) 0.2 kg (d) 0.25 kg

106. If a vessel containing a fluid of density ρ upto height h is accelerated vertically downwards with acceleration a_0. Then, the pressure by fluid at the bottom of vessel is given by the equation .... (p_0 denotes the atmospheric pressure and g denotes the acceleration due to gravity).
(a) $p = p_0 + \rho gh + \rho ha_0$ (b) $p = p_0 + \rho gh$
(c) $p = p_0 + \rho h(g - a_0)$ (d) $p = p_0 - \rho gh$

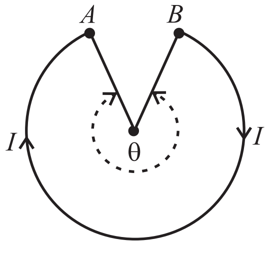
107. Weak nuclear force always operates between
(a) electrons and neutrino
(b) heavier elementary particles
(c) charged particles
(d) all the objects in the universe

108. A 3 m long steel wire is stretched to increase its length by 0.3 cm. Poisson's ratio for steel is 0.26. The lateral strain produced in the wire is
(a) 0.26×10^{-4} (b) 0.26×10^{-2}
(c) 0.26×10^{-3} (d) 0.26×10^{-1}

109. Why 220 V AC is more dangerous than 220 V DC?
(a) The DC attracts
(b) Peak voltage for AC is much larger
(c) The body offers less resistance to AC
(d) Due to some other reason

110. A body is moving with an initial velocity of $10\sqrt{2}$ ms^{-1} in the north-east direction. If it is subjected to an acceleration of 2 ms^{-2} directed towards the south, then velocity of the body after 5s is
(a) 10 ms^{-1}, towards east
(b) 10 ms^{-1}, towards north
(c) 10 ms^{-1}, towards south
(d) 10 ms^{-1}, towards north-east

111. A current I a flows in a circular arc of radius r subtending an angle θ as shown in the figure. Find the magnetic field at the centre O of the circle.



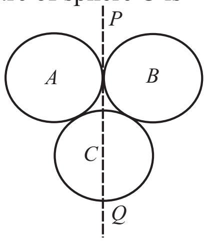
(a) $\dfrac{\mu_0 I\theta}{4\pi r}$ (b) $\dfrac{2\mu_0 I.\sin\theta}{4\pi r}$
(c) $\dfrac{2\mu_0 I\sin\theta}{2r}$ (d) $\dfrac{2\mu_0 I\sin\theta}{4r}$

112. The current in a coil changes from 3 A to 1 A in 0.1 s in coil of self-inductance 8 mH. The emf induced in the coil is
(a) 16 V (b) 1.6×10^{-2} V
(c) 16×10^{-2} V (d) 2 V

113. Acceleration due to gravity.
(a) increases with altitude
(b) decreases with altitude
(c) is independent of altitude
(d) first decrease and then increases with altitude

114. If mass, speed and radius of the circular path of the particle are increased by 100%, then the necessary force required to maintain the circular path will have to be increased by
(a) 100% (b) 250% (c) 300% (d) 400%

115. Three identical uniform solid spheres each of mass m and radius r are joined as shown in the figure, with centres lying in the same plane. The moment of inertia of the system about an axis lying in that plane and passing through the centre of sphere C is



(a) $\dfrac{16}{5}mr^2$ (b) $\dfrac{12}{5}mr^2$ (c) $4\,mr^2$ (d) $\dfrac{3}{5}mr^2$

116. Unit of pole strength of a magnet is
(a) Am^{-1} (b) Am^2 (c) Am^{-2} (d) Am

117. The ratio of the slopes of isothermal and adiabatic curves is
(a) 1 (b) γ (c) $\dfrac{1}{\gamma}$ (d) $\dfrac{3}{2}$

118. Kepler's second law (law of areas) is nothing but a statement of
(a) work-energy theory
(b) conservation of linear momentum
(c) conservation of angular momentum
(d) conservation of energy

119. In a potentiometer experiment the balancing length with a cell is 560 cm. When an external resistance of 10Ω is connected in parallel to the cell, then the balancing length changes by 60 cm. Find the internal resistance of the cell.
(a) 1 Ω (b) 2 Ω (c) 1.2 Ω (d) 2.1 Ω

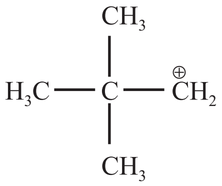
120. A particle is projected with a velocity v such that its range on the horizontal plane is twice the greatest height attained by it. The range of the projectile is
(g = acceleration due to gravity)
(a) $\dfrac{4v^2}{5g}$ (b) $\dfrac{4g}{5v^2}$ (c) $\dfrac{v^2}{g}$ (d) $\dfrac{4v^2}{\sqrt{5g}}$

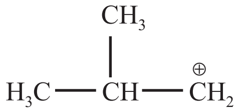
CHEMISTRY

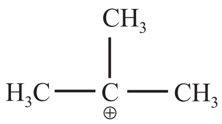
121. Choose the smallest ion from the following.
(a) Mg^{2+} (b) S^{2-} (c) Na^+ (d) Cl^-

122. Examples for bactericidal and bacteriostatic antibiotics, respectively are
(a) penicillin, ofloxacin
(b) erythromycin, tetracycline
(c) penicillin, chloramphenicol
(d) tetracycline, penicillin

123. Which of the following is most stable form for the given structure, after rearrangement?



(a) 

(b) 

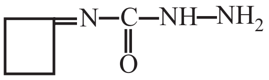
(c) $CH_3-\overset{}{\underset{\oplus}{C}}H-CH_2-CH_3$

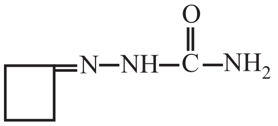
(d) $CH_3-CH_2-CH_2-\overset{\oplus}{C}H_2$

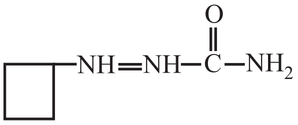
124. Which of the following chemicals can be added for sweetening of food items at cooking temperature and does not provide calories?
(a) Sucrose (b) Glucose
(c) Fructose (d) Sucralose

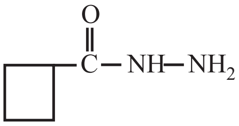
125. Which of the following sets of species have similar bond order?
(a) N_2, O_2^{2-}, NO^+ (b) N_2, F_2, O_2^{2-}
(c) N_2, N_2^{2-}, O_2^- (d) N_2, CO, NO^+

126. The cyclobutanone of semicarbazone is represented as

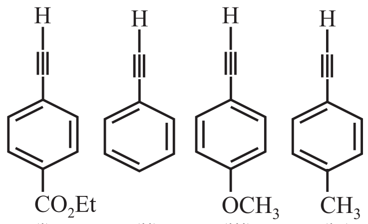
(a) 

(b) 

(c) 

(d) 

127. Decreasing order of acidity of the following terminal acetylenes is



(i) (ii) (iii) (iv)

(a) (i) > (iii) > (ii) > (iv) (b) (i) > (ii) > (iv) > (iii)
(c) (i) > (iv) > (ii) > (iii) (d) (i) > (iii) > (iv) > (ii)

128. In which of the following substances will hydrogen bonds be strongest?
(a) HCl (b) H_2O (c) HI (d) H_2S

129. The geometry with respect to the central atom of the molecules $N(SiH_3)_3 \cdot Me_3N$, $(SiH_3)_3P$, respectively are
(a) planar, pyramidal, planar
(b) planar, pyramidal, pyramidal
(c) pyramidal, pyramidal, pyramidal
(d) pyramidal,planar, pyramidal

130. A gaseous mixture of 3 gases *A, B* and *C* has a pressure 10 atm. The total number of moles are 10. If partial pressure of gases *A* and *B* are 3 atm and 1 atm respectively and if molar mass of gas *C* is 2. Calculate the weight of *C* in the mixture.
(a) 12 g (b) 24 g (c) 8 g (d) 2 g

131. Choose the incorrect statement among the following.
A. The reactivity of aromatic aldehydes and ketones is less than that of aliphatic carbonyl compounds toward nucleophilic addition reactions.
B. Benzaldehyde does not give Fehling's test.
C. The H-atoms in ethanal are acidic in nature.
D. *p*-nitro benzaldehyde is less reactive than benzaldehyde towards nucleophilic addition reactions.
(a) A (b) B (c) C (d) D

132. The solubility product of $Ni(OH)_2$ at 298 K is 2×10^{-15} $mol^3\ dm^{-9}$. The pH value if, its aqueous and saturated solution is
(a) 5 (b) 7.5 (c) 9 (d) 13

133. Assertion : Boron has a smaller first ionisation enthalpy than beryllium.
Reason : The penetration of a 2*s*-electron to the nucleus is more than the 2*p*-electron hence, 2*p*-electron is more shielded by the inner core of electrons than 2s-electrons.
(a) Assertion and Reason both are correct statements but Reason is not correct explanation for Assertion.
(b) Assertion is correct statement but Reason is wrong statement.
(c) Assertion and Reason both are correct statements and Reason is correct explanation for Assertion
(d) Assertion and Reason both are wrong statements.

134. Among the following oxides, which one is weakly basic and yet a powerful oxidant?
(a) CO_2 (b) SnO_2 (c) SiO_2 (d) PbO_2

135. One mole of oxygen gas at STP is equal to
(a) 6.022×10^{23} molecules of oxygen
(b) 6.022×10^{23} atoms of oxygen
(c) 16 g of oxygen
(d) 3.2 g of oxygen

136. Find the correct equation among the following.

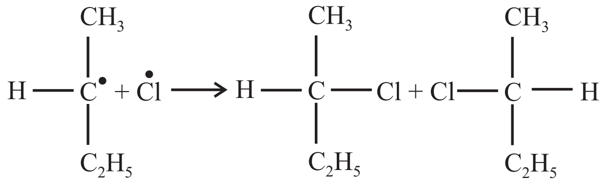
(a) $\ln k - \ln A = \dfrac{E_a}{RT}$ (b) $k = \dfrac{AE_a}{RT}$

(c) $\ln k + \ln A = \dfrac{E_a}{RT}$ (d) $\dfrac{E_a}{RT} = \ln A - \ln k$

137. Calculate the wave number and frequency of orange radiation having wavelength 6300 Å.

(a) $1.587 \times 10^8\ m^{-1}$, $4.761 \times 10^{16} s^{-1}$
(b) $1.587 \times 10^4\ m^{-1}$, $4.761 \times 10^{14} s^{-1}$
(c) $1.587 \times 10^6\ m^{-1}$, $4.761 \times 10^{14} s^{-1}$
(d) $1.587 \times 10^6\ m^{-1}$, $4.761 \times 10^{16} s^{-1}$

138. The products in the reaction given below are .... '•' denotes a free radical.



(a) Meso forms (b) Racemic mixture
(c) *d*- and *l*-forms (d) *Cis-trans* isomers

139. 160 g of non-volatile solute '*A*' is dissolved in 54 mL of water at 373 K. What is the vapour pressure of aqueous solution of *A*.
(Given, molecular weight of $A = 160\ g\ mol^{-1}$)

(a) 760 Torr (b) 720 Torr
(c) 570 Torr (d) 450 Torr

140. "The properties of elements are periodic functions of their atomic weights." This periodic law was given by

(a) Dobereiner (b) Lothar Meyer
(c) Mendeleev (d) Alexander

141. A 40% HCl solution has density $1.2\ g\ mL^{-1}$. The molarity of the solution is nearly ....

(a) 11 M (b) 12 M (c) 13 M (d) 14 M

142. Copper matte is composed of ....

(a) Cu_2S and Cu_2O (b) Cu_2S and FeS
(c) $CuFeS_2$ and Cu_2S (d) CuS and FeS

143. 10 g NaOH is dissolved in 500 mL of aqueous solution. Calculate the molarity of this solution.
(Given, formula weight of NaOH = 40)

(a) 0.5×10^{-3} M (b) 0.4 M
(c) 0.25×10^{-3} M (d) 0.5 M

144. Which among the following statements is correct?

A. There is a complete order of molecules in gases.
B. There is a complete disorder of molecules in gases.
C. Molecules are not always in random motion in gases.
D. Molecules are fixed at respective position in gases.

(a) A (b) B (c) C (d) D

145. In which of the following reactions of H_2O_2 acts as an oxidising agent (either in acidic, alkaline or neutral medium) ?

(i) $2Fe^{2+} + H_2O_2 \rightarrow$
(ii) $2MnO_4^- + 6H^+ + 5H_2O_2 \rightarrow$
(iii) $I_2 + H_2O_2 + 2OH^- \rightarrow$
(iv) $Mn^{2+} + H_2O_2 \rightarrow$

(a) (ii), (iii) (b) (i). (iv) (c) (i), (iii) (d) (ii), (iv)

146. Glucose does not react with which of the following.

(a) NH_2OH (b) HCN (c) Br_2/Water (d) $NaHSO_3$

147. Find the observed EMF of the cell Cd | Cd^{2+} (0.01 M) || Cu^{2+} (0.01M) | Cu under conditions, internal resistance of 4 Ω and producing a current of 0.15 A.
(Given, $E^\circ_{Cu^{2+}/Cu} = 0.35$ V and $E^\circ_{Cd^{2+}/Cd} = -0.4$ V)

(a) 0.75 V (b) 0.15 V
(c) 0.6 V (d) 0.9 V

148. Which among the following is most common in alkyl halides?

(a) Nucleophilic substitution
(b) Electrophilic substitution
(c) Electrophilic addition
(d) Nucleophilic addition

149. Which of the following is an extensive property?

(a) Temperature (b) Volume
(c) Density (d) Pressure

150. The correct statement about Cr^{2+} and Mn^{3+} among the following is
(Given, atomic number of Cr = 24 and Mn = 25)

(a) Cr^{2+} is a reducing agent.
(b) Mn^{3+} is a reducing agent.
(c) Both Cr^{2+} and Mn^{3+} exhibit d^5 outer electronic configuration.
(d) When Cr^{2+} is used as reducing agent, it attains d^5 configuration.

151. Two metals *A* and *B* having similar ionic radii, react with oxygen to give only monoxides and react with nitrogen to give nitrides. Then, *A* and *B* respectively are

(a) Li and Na (b) Na and Ca
(c) Li and Mg (d) Na and Be

152. Isochores are drawn at ....

(a) constant volume, pressure *vs* temperature
(b) constant pressure, volume *vs* temperature
(c) constant temperature, pressure *vs* volume
(d) constant temperature, volume *vs* temperature

153. How many lone pairs of electrons are present in a hydroxyl ion?

(a) Two pairs (b) Three pairs
(c) One pair (d) Four pairs

154. The insecticide DDT is considered as ....

(a) greenhouse gas
(b) biodegradable pollutant
(c) non-biodegradable pollutant
(d) a fertiliser

155. Geometrical isomerism can be found in which of the following?

(a) Butyric acid (b) Aspartic acid
(c) Palmitic acid (d) Cinnamic acid

156. Which among the following polymers exhibit hydrogen bonding?

(a) Polyvinyl chloride (b) Nylon-6, 6
(c) Neoprene (d) Teflon

157. Acidity of BF_3 can be explained on the basis of which of the following concepts?
(a) Arrhenius concept
(b) Bronsted-Lowry concept
(c) Lewis concept
(d) Bronsted-Lowry as well as Lewis concept

158. The correct order for wavelengths of absorption in the visible region for the following complexes will be
(a) $[Ni(NH_3)_6]^{2+} < [Ni(H_2O)_6]^{2+} < [Ni(NO_2)_6]^{4-}$
(b) $[Ni(NO_2)_6]^{4-} < [Ni(NH_3)_6]^{2+} < [Ni(H_2O)_6]^{2+}$
(c) $[Ni(NH_3)_6]^{2+} < [Ni(NO_2)_6]^{4-} < [Ni(H_2O)_6]^{2+}$
(d) $[Ni(NO_2)_6]^{4-} < [Ni(H_2O)_6]^{2+} < [Ni(NH_3)_6]^{2+}$

159. Which of the compounds among N_2O, NO, N_2O_3, NO_2, N_2O_4, N_2O_5 are diamagnetic?
(a) NO, NO_2, N_2O_3
(b) N_2O, N_2O_3, N_2O_4, N_2O_5
(c) NO, NO_2
(d) N_2O_4, N_2O_5

160. BF_3 is used as a catalyst in several industrial processes due to its
(a) strong reducing nature
(b) weak reducing action
(c) strong Lewis acid nature
(d) weak Lewis acid character

ANSWER KEY

1	(d)	**17**	(c)	**33**	(d)	**49**	(a)	**65**	(c)	**81**	(c)	**97**	(c)	**113**	(b)	**129**	(b)	**145**	(b)
2	(c)	**18**	(c)	**34**	(b)	**50**	(d)	**66**	(c)	**82**	(b)	**98**	(a)	**114**	(c)	**130**	(a)	**146**	(d)
3	(a)	**19**	(b)	**35**	(c)	**51**	(d)	**67**	(a)	**83**	(a)	**99**	(c)	**115**	(a)	**131**	(d)	**147**	(b)
4	(b)	**20**	(c)	**36**	(b)	**52**	(d)	**68**	(b)	**84**	(b)	**100**	(*)	**116**	(d)	**132**	(c)	**148**	(a)
5	(c)	**21**	(d)	**37**	(a)	**53**	(d)	**69**	(a)	**85**	(a)	**101**	(c)	**117**	(c)	**133**	(c)	**149**	(b)
6	(d)	**22**	(a)	**38**	(b)	**54**	(c)	**70**	(d)	**86**	(b)	**102**	(c)	**118**	(c)	**134**	(d)	**150**	(a)
7	(a)	**23**	(b)	**39**	(c)	**55**	(a)	**71**	(d)	**87**	(b)	**103**	(b)	**119**	(c)	**135**	(a)	**151**	(c)
8	(b)	**24**	(c)	**40**	(b)	**56**	(b)	**72**	(c)	**88**	(a)	**104**	(a)	**120**	(a)	**136**	(d)	**152**	(a)
9	(a)	**25**	(a)	**41**	(b)	**57**	(c)	**73**	(a)	**89**	(b)	**105**	(b)	**121**	(a)	**137**	(c)	**153**	(b)
10	(c)	**26**	(b)	**42**	(b)	**58**	(c)	**74**	(a)	**90**	(b)	**106**	(c)	**122**	(c)	**138**	(b)	**154**	(c)
11	(a)	**27**	(a)	**43**	(a)	**59**	(c)	**75**	(a)	**91**	(c)	**107**	(b)	**123**	(N)	**139**	(c)	**155**	(d)
12	(c)	**28**	(b)	**44**	(a)	**60**	(b)	**76**	(a)	**92**	(a)	**108**	(c)	**124**	(d)	**140**	(c)	**156**	(b)
13	(d)	**29**	(c)	**45**	(d)	**61**	(d)	**77**	(a)	**93**	(c)	**109**	(b)	**125**	(d)	**141**	(c)	**157**	(c)
14	(d)	**30**	(c)	**46**	(d)	**62**	(b)	**78**	(c)	**94**	(c)	**110**	(a)	**126**	(b)	**142**	(b)	**158**	(b)
15	(b)	**31**	(d)	**47**	(a)	**63**	(d)	**79**	(Bonus)	**95**	(d)	**111**	(a)	**127**	(b)	**143**	(d)	**159**	(b)
16	(d)	**32**	(a)	**48**	(b)	**64**	(d)	**80**	(b)	**96**	(a)	**112**	(c)	**128**	(b)	**144**	(b)	**160**	(c)

Hints & Solutions

MATHEMATICS

1. **(d)** $I=\int\left(\frac{x^3-1}{x^3+x}\right)dx=\int\left(1-\frac{x+1}{x^3+x}\right)dx$

$\Rightarrow I=\int 1\cdot dx-\int\frac{(x+1)}{x^3+x}dx=x-\int\frac{(x+1)}{x(x^2+1)}dx$

Let $\frac{x+1}{x(x^2+1)}=\frac{A}{x}+\frac{Bx+C}{x^2+1}$

$\Rightarrow (x+1)=A(x^2+1)+(Bx+C)x$

$\Rightarrow (x+1)=(A+B)x^2+Cx+A$

On comparing coefficient, we get

$A+B=0, C=1, A=1$

$\Rightarrow B=-1$

$\therefore I=x-\int\frac{1}{x}dx-\int\frac{(1-x)}{x^2+1}dx$

$\Rightarrow I=x-\log|x|-\tan^{-1}x+\frac{1}{2}\log(x^2+1)+C$

2. **(c)** Let $y=f(x)=x^3+3x^2-2$

$\frac{dy}{dx}=3x^2+6x$

For stationary points $\frac{dy}{dx}=0$

$\Rightarrow 3x(x+2)=0$

$\Rightarrow x=0,-2$

3. **(a)** We have,

In radius $(r)=\frac{\Delta}{s}$, where Δ = Area, S = Semi-perimeter

$\Rightarrow \Delta=(r.s) \Rightarrow \Delta=8\times\frac{36}{2}=144\text{ cm}^2$

4. **(b)** Let $y=f(x)=([x]^2-[x]-2)^{-1/2}$

$\Rightarrow y=\frac{1}{\sqrt{[x]^2-[x]-2}}$

For real valued

$[x]^2-[x]-2>0$

$\Rightarrow \{[x]-2\}\cdot\{[x]+1\}>0$

$[x]\in R-[-1,2]$

So, $[x]\in R-[-1,3)$ is correct option.

5. **(c)** Given straight lines

$2x^2+5xy+3y^2+6x+7y+4=0$

We know that angle between straight lines represented by

$ax^2+by^2+2gx+2fy+c+2hxy=0$ is

$\tan\theta=\frac{2\sqrt{h^2-ab}}{a+b}$

$\tan\theta=\frac{2\sqrt{\left(\frac{5}{2}\right)^2-6}}{5}=\pm\frac{1}{5}$

$\Rightarrow \theta=\tan^{-1}k=\tan^{-1}\left(\pm\frac{1}{5}\right)$

$\Rightarrow \left(k=\pm\frac{1}{5}\right)$

6. **(d)** **Case I:** When $x^2-x-6\geq 0$ i.e., $x\in(-\infty,-2]\cup[3,\infty)$

$\therefore x^2-x-6=x+2$

$\Rightarrow x^2-2x-8=0 \Rightarrow x=-2, 4$

Case II: When $x^2-x-6<0$ i.e., $x\in(-2,3)$

$x^2-x-6=-x-2$

$\Rightarrow x^2=4 \Rightarrow x=2$

Hence, $x=\{-2,2,4\}$.

7. **(a)** A set formed with whose order of occurrence of real numbers a, b, c is preassigned is called an ordered triad.

8. **(b)** Given that $3f(x)-2f\left(\frac{1}{x}\right)=x$,

Differentiate both sides *w.r.t* x

$\Rightarrow 3f'(x)-2f'\left(\frac{1}{x}\right)\left(-\frac{1}{x^2}\right)=1$

Put $x=2$

$\Rightarrow 3f'(2)+\frac{1}{2}f'\left(\frac{1}{2}\right)=1$ …(i)

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

$3f'\left(\frac{1}{2}\right)+8f'(2)=1$ …(ii)

On solving equations (i) and (ii), we get

$\Rightarrow f'(2)=\frac{1}{2}$

9. **(a)** Let $I=\int_1^{e^2}\frac{dx}{x(1+\log x)^2}$

Let $1+\log x=t$

Differentiate w.r.t x

$\frac{1}{x}dx=dt$

$I=\int_1^3\frac{dt}{t^2}=\left[\frac{t^{-1}}{-1}\right]_1^3=\left(\frac{3^{-1}}{-1}+\frac{1^{-1}}{1}\right)$

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

10. **(c)** Given expansion is $\left(\frac{x}{2}+\frac{1}{x}+\sqrt{2}\right)^5 = I$ (say)

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

$$\Rightarrow I = \frac{(x+\sqrt{2})^{10}}{32x^5}$$

This have constant term in the expansion

$$= \frac{\text{Coefficient of } x^3 \text{ in } (x+\sqrt{2})^{10}}{32}$$

$$\Rightarrow \frac{{}^{10}C_5 \times 4\sqrt{2}}{32} = \frac{a\sqrt{2}}{2}$$

$\Rightarrow (a = 63)$

11. **(a)** Given expression is

$$\cos^2 x + \cos^2\left(x+\frac{\pi}{3}\right)+\cos^2\left(x-\frac{\pi}{3}\right)$$

Since $\cos^2 x = \frac{\cos 2x + 1}{2}$

$$\Rightarrow \left[\frac{1+\cos 2x}{2}\right]+\left[\frac{1+\cos\left(2x+\frac{2\pi}{3}\right)}{2}\right] + \left[\frac{1+\cos\left(2x-\frac{2\pi}{3}\right)}{2}\right]$$

$$\Rightarrow \frac{1}{2}\left[1+\cos 2x + 1 + \cos\left(2x+\frac{2\pi}{3}\right) + 1 + \cos\left(2x-\frac{2\pi}{3}\right)\right]$$

$$\Rightarrow \frac{1}{2}\left[3+\cos 2x + 2\cos 2x \cdot \cos\frac{2\pi}{3}\right]$$

$$\Rightarrow \frac{1}{2}\left[3+\cos 2x + 2\cos 2x\left(-\frac{1}{2}\right)\right]$$

$$\Rightarrow \frac{1}{2}[3+\cos 2x - \cos 2x] = \left(\frac{3}{2}\right)$$

12. **(c)** Given, circle $x^2+y^2-4x-6y+11=0$

$\Rightarrow$ Centre $= (-g, -f) = (2, 3)$

One end of diameter = (3, 4) (Given)

So, $\frac{h+3}{2} = 2, \frac{k+4}{2} = 3$

$h = 1, k = 2 \Rightarrow (1, 2)$

13. **(d)** Given cos 48° cos 12°

$$= \frac{1}{2}(2\cos 48° \cos 12°)$$

$$= \frac{1}{2}(\cos 60° + \cos 36°) = \frac{1}{2}\left[\frac{1}{2}+\frac{\sqrt{5}+1}{4}\right]$$

$$= \left(\frac{3+\sqrt{5}}{8}\right)$$

14. **(d)** Given $\sin\theta + \operatorname{cosec}\theta = 2$

Maximum value of $\sin\theta = 1$

So, $\sin^{2020}\theta + \operatorname{cosec}^{2020}\theta = 1 + 1 = 2$

15. **(b)** Given $\frac{\sqrt{1+x}+(1-x)^{3/2}}{(1+x)+\sqrt{1+x}}$

Here $|x|$ is very small, x^2 is negligible.

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

$$= \frac{2-x}{2+\frac{3x}{2}} = \frac{4-2x}{4+3x}$$

$$= \frac{(4-2x)(4-3x)}{(16-9x^2)} = \frac{16-20x+6x^2}{16-9x^2}$$

$$= 1 - \frac{5x}{4} \qquad [\because x^2 \text{ negligible}]$$

16. **(d)** Given $f: Z \to Z$

$f(x+y) = f(x) + f(y);\ x, y \in Z$

$\therefore f(x) = kx$

So, there are infinitely many bijections.

17. **(c)** Given matrix

$$A = \begin{bmatrix} \frac{1}{\sqrt{2}} & \frac{1}{\sqrt{2}} \\ -\frac{1}{\sqrt{2}} & -\frac{1}{\sqrt{2}} \end{bmatrix}$$

$$A^2 = \begin{bmatrix} \frac{1}{\sqrt{2}} & \frac{1}{\sqrt{2}} \\ -\frac{1}{\sqrt{2}} & -\frac{1}{\sqrt{2}} \end{bmatrix}\begin{bmatrix} \frac{1}{\sqrt{2}} & \frac{1}{\sqrt{2}} \\ -\frac{1}{\sqrt{2}} & -\frac{1}{\sqrt{2}} \end{bmatrix}$$

$$A^2 = \begin{bmatrix} 0 & 0 \\ 0 & 0 \end{bmatrix} \text{ null matrix}$$

So, A is nilpotent matrix.

18. **(c)** Given parabolas,

$169[(x-1)^2+(y-3)^2] = (5x-12y+17)^2$

$$\Rightarrow (x-1)^2+(y-3)^2 = \left(\frac{5x-12y+17}{13}\right)^2$$

$\Rightarrow (SP = PM)$

where S is focus and M is foot of perpendicular

Here, focus is $S(1, 3)$

and directrix $(5x-12y+17) = 0$

$\therefore$ Distance of focus from directrix

$$\Rightarrow 2a = \left|\frac{5-36+17}{\sqrt{25+144}}\right|$$

$$\Rightarrow 2a = \frac{14}{13}$$

$$\therefore \text{Latus rectum} = 4a = \frac{28}{13}$$

19. **(b)** Given tan h $(x) = \frac{1}{3}$ $\left\{\because \tanh(x) = \left(\frac{e^x - e^{-x}}{e^x + e^{-x}}\right)\right\}$

$\Rightarrow \frac{e^x - e^{-x}}{e^x + e^{-x}} = \frac{1}{3} \Rightarrow 2e^x = 4e^{-x} \Rightarrow (e^{2x} = 2)$

and tan h $(3x) = \frac{e^{3x} - e^{-3x}}{e^{3x} + e^{-3x}} = \frac{(e^{2x})^3 - 1}{(e^{2x})^3 + 1} = \frac{8-1}{8+1} = \frac{7}{9}$

20. **(c)** Let $A(0, 0)$, $B(1, 0)$, $C(1, 1)$ and $D(0, 1)$ be vertices of the square, which is formed by given lines.
Here equation of AC,

$y = \left(\frac{1-0}{1-0}\right)x \Rightarrow (y = x)$

Equation of BD
$y - 0 = -1(x - 1)$
$\Rightarrow y = -x + 1 \Rightarrow x + y = 1$

21. **(d)** Given centre (5, 4) of the circle touches Y-axis.
So, radius = 5 units
Equation of circle
$\Rightarrow (x - 5)^2 + (y - 4)^2 = 5^2$
$\Rightarrow x^2 + y^2 - 10x - 8y + 16 = 0$

22. **(a)** Since, according to question
Tossing of three coins
So, $\rho(X^{-1}(2))$ means probability of getting two tails when three coins are tossed.

$\Rightarrow \rho(X^{-1}(2)) = \frac{3}{8}$

23. **(b)** Since, according to question

$p = \frac{|0 + 0 - k|}{\sqrt{\sec^2\theta + \operatorname{cosec}^2\theta}}$,

$q = \frac{|0 + 0 - k\ \cos^2\theta|}{\sqrt{\cos^2\theta + \sin^2\theta}}$

$\Rightarrow p^2 = \frac{k^2}{\sec^2\theta + \operatorname{cosec}^2\theta}, q^2 = k^2\cos^2 2\theta$

$\Rightarrow p^2 = \frac{k^2}{4}\sin^2 2\theta, q^2 = k^2\cos^2 2\theta$

Thus, $p^2 + \frac{q^2}{4} = \frac{k^2}{4} \Rightarrow 4p^2 + q^2 = k^2$

24. **(c)** Given circle $x^2 + y^2 + 6x + 2ky + 25 = 0$ touches Y-axis centre $(-3, -k)$ and radius = 3units

Also radius = $\sqrt{9 + k^2 - 25}$

$\Rightarrow \sqrt{k^2 - 16} = 3$

$\Rightarrow k^2 = 25 \Rightarrow k = \pm 5$

25. **(a)** Number of ways = ${}^8C_4 \times {}^5C_3 = 700$

26. **(b)** Here $\left(\frac{x^4}{x^3 - 3x + 2}\right)$ is a improper fraction since (degree of number ≥ degree of denominator) for a improper fraction.

27. **(a)** Number of ways = ${}^6P_4 = 360$

28. **(b)** Given $[a, b]$ is range of $\frac{x+2}{2x^2 + 3x + 6}$ and $x \in R$

Let $y = \frac{x+2}{2x^2 + 3x + 6}$

$\Rightarrow 2yx^2 + 3xy + 6y = x + 2$
or $2yx^2 + (3y - 1)x + 6y - 2 = 0, x \in R$. So, $D \geq 0$
$\Rightarrow (3y - 1)^2 - 4(6y - 2)(2y) \geq 0$
$\Rightarrow 39y^2 - 10y - 1 \leq 0 \Rightarrow (3y - 1)(13y + 1) \leq 0$

$\Rightarrow y\ \ y \in \left[-\frac{1}{13}, \frac{1}{3}\right]$ So, $a = -\frac{1}{13}, b = \frac{1}{3}$

$\therefore\ a < 0, b > 0$

29. **(c)** Let the distance $P(h, k)$ on the circle

So, given equation $\frac{|4h + 3k - 12|}{5} = \frac{4}{5}$

$\Rightarrow (4h + 3k = 16) \Rightarrow (4h + 3k = 8)$
Since (h, k) lies on circle so
$h^2 + k^2 = 4$

$\Rightarrow \left[h^2 + \left(\frac{16 - 4h}{3}\right)^2 = 4\right]$ or $\left[h^2 + \left(\frac{8 - 4h}{3}\right)^2 = 4\right]$

$\Rightarrow (25h^2 - 128h + 220 = 0)$ or $(25h^2 - 64h + 28 = 0)$

So, $25h^2 - 64h + 28 = 0$ will be considered and $\left(h = 2, \frac{14}{25}\right)$

At $h = 2, k = 0$

At $h = \frac{14}{25}, k = \frac{48}{25}$

So, $(h, k) = (2, 0)$ or $\left(\frac{14}{25}, \frac{48}{25}\right)$

30. **(c)** Since, we know that

$\cos C = \frac{a^2 + b^2 - c^2}{2ab}$

or $\cos 60° = \frac{a^2 + b^2 - c^2}{2ab}$

$\Rightarrow \frac{1}{2} = \frac{a^2 + b^2 - c^2}{2ab} \Rightarrow a^2 + b^2 = ab + c^2$

Now, $\frac{c(a + b) + (a^2 + b^2)}{(b + c)(c + a)} = \frac{ca + bc + ab + c^2}{bc + ab + c^2 + ac} = 1$

31. **(d)** Given $f(0) = f(1) = 3f(2) = -3$
Let $f(x) = ax^2 + bx + c$ is a two degree polynomials
$\Rightarrow c = -3, a + b + c = -3$
$\Rightarrow a + b = 0$ and $4a + 2b + c = -1$
$\Rightarrow 4a + 2b = 2 \Rightarrow a = 1, b = -1$

$\int \frac{f(x)}{x^3 - 1}dx = \int \frac{x^2 - x - 3}{x^3 - 1}dx$

Now $\frac{x^2 - x - 3}{x^3 - 1} = \frac{A}{x - 1} + \left(\frac{Bx + C}{x^2 + x + 1}\right)$

Comparing coefficients, we get
$A + B = 1, A - B + C = -1, A - C = -3$

we get, $A = -1, B = 2, C = 2$

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

$$= -\log|x+1| + \int \frac{(2x+1)}{x^2+x+1}dx + \int \frac{1\,dx}{x^2+x+1}$$

$$= -\log|x-1| + \log(x^2+x+1) + \int \frac{dx}{\left(x+\frac{1}{2}\right)^2+\left(\sqrt{\frac{3}{2}}\right)^2}$$

$$= \log\left(\frac{x^2+x+1}{|x-1|}\right) + \frac{2}{\sqrt{3}}\tan^{-1}\left(\frac{2x+1}{\sqrt{3}}\right) + C$$

32. **(a)** $\sqrt{x+1} - |\sqrt{x-1}| = \sqrt{4x-1}$

Here $x \geq 1$ to define each

Now, $\sqrt{x+1} - \sqrt{4x-1} = |\sqrt{x-1}|$

On squaring on both sides, we get

$\Rightarrow x + 1 + 4x - 1 - 2\sqrt{(x+1)(4x-1)} = x - 1$

$\Rightarrow 4x + 1 = 2\sqrt{(x+1)(4x-1)}$

Again, squaring both the sides, we get

$\Rightarrow 16x^2 + 1 + 8x = 4(4x^2 + 3x - 1)$

$\Rightarrow 4x = 5 \Rightarrow x = \frac{5}{4}$

33. **(d)** According to the given conditions (i) and (ii) both are correct.

34. **(b)** Given function

$f(x) = \cos^{-1}\left(\frac{x-3}{2}\right) - \log_{10}(4-x)$

Here, domain of $\log_{10}(4-x) \Rightarrow 4 - x > 0$

$\Rightarrow x < 4$

and domain of $\cos^{-1}\left(\frac{x-3}{2}\right)$

$\Rightarrow -1 \leq \frac{x-3}{2} \leq 1 \Rightarrow 1 \leq x \leq 5$

Now domain of $f(x)$ will be $x \in [1, 4]$

35. **(c)** Given $\int\left(1 + \frac{x}{1!} + \frac{x^2}{2!} + \ldots\infty\right)dx$

$= \int e^x \cdot dx = (e^x + c)$

36. **(b)** Given $|a| = 2, |b| = 3$ and $(a, b) = \frac{\pi}{6}$

$|\vec{a} \times \vec{b}|^2 = [|\vec{a}||\vec{b}|\sin\theta]^2 = \left(2 \times 3 \times \frac{1}{2}\right)^2 = 9$

37. **(a)** Given $\cos x - \sin x = 0$

$\Rightarrow \tan x = 1 \Rightarrow x = n\pi + \frac{\pi}{4}; (n \in Z)$

38. **(b)** Given $\sum_{i=1}^{n=1} \frac{1}{2-a^i}$

$1, \alpha, \alpha^2, \ldots, \alpha^{n-1}$ are the nth root of unity.

$\because x^n - 1 = 0$

$\Rightarrow x^n - 1 = (x-1)(x-\alpha)(x-\alpha^2)\ldots(x-\alpha^{n-1})$

Taking log both side

$\Rightarrow \log(x^n - 1) = \log(x-1) + \log(x-\alpha) + \ldots \log(x-\alpha^{n-1})$

Differentiating w.r.t. 'x', we get

$$\Rightarrow \frac{nx^{n-1}}{x^n-1} = \frac{1}{(x-1)} + \frac{1}{(x-\alpha)} + \ldots + \frac{1}{(x-\alpha^{n-1})}$$

At $(x = 2)$

$$\Rightarrow \frac{n\cdot 2^{n-1}}{2^n-1} = 1 + \frac{1}{2-\alpha} + \frac{1}{2-\alpha^2} + \ldots + \frac{1}{2-\alpha^{n-1}}$$

$$\Rightarrow \sum_{i=1}^{n=1}\frac{1}{2-a^i} = \left(\frac{n\cdot 2^{n-1}}{2^n-1} - 1\right) = \frac{(n-2)2^{n-1}+1}{2^n-1}$$

39. **(c)** Given differential equation $(e^{y-x})\,dy = (e^x - e^y)\,dx$

$\Rightarrow e^y \cdot \frac{dy}{dx} = e^{2x} - e^x \cdot e^y \Rightarrow e^y \cdot \frac{dy}{dx} + e^x \cdot e^y = e^{2x}$

Let $e^y = t$

$\Rightarrow e^y \cdot \frac{dy}{dx} = \frac{dt}{dx} \Rightarrow \frac{dt}{dx} + e^x \cdot t = e^{2x}$

$\text{IF} = e^{\int e^x\,dx} = e^{e^x}$

$\therefore$ Solution is

$t \cdot e^{e^x} = \int e^{2x} \cdot e^{e^x} \cdot dx + c$

Let $e^x = u \Rightarrow e^x\,dx = du$

$\Rightarrow t \cdot e^{e^x} = \int u \cdot e^u\,du + c = ue^u - e^u + c$

$\Rightarrow e^y \cdot e^{e^x} = e^{e^x}(e^x - 1) + c$

40. **(b)** Since $(2+\sqrt{3})^5 = {}^5C_0 \cdot 2^5 \cdot (\sqrt{3})^0 + {}^5C_1 \cdot 2^4 \cdot (\sqrt{3})$
$+ {}^5C_2 \cdot 2^3(\sqrt{3})^2 + {}^5C_3 \cdot 2^2 \cdot (\sqrt{3})^3$
$+ {}^5C_4 \cdot 2 \cdot (\sqrt{3})^4 + {}^5C_5 \cdot 2^0 \cdot (\sqrt{3})^5$

$= 32 + 80\sqrt{3} + 240 + 120\sqrt{3} + 90 + 9\sqrt{3}$

$(2+\sqrt{3})^5 = 362 + 209\sqrt{3} = 723.99$

$\Rightarrow [(2+\sqrt{3})^5] = 723 \Rightarrow 723 = 3^1 \times 24^1$

Now, positive integral divisors of

$723 = (1+1)(1+1) = 4$

41. **(b)** Since direction cosines are $\cos\alpha, \cos\beta, \cos\gamma$

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

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

42. **(b)** Since, circle is passing three $(0, 0)$ and intercepts are a and b.

$$f(x) = (x-3)(x-5)\begin{vmatrix} 1 & 2(x+3) & 3(x^2+9+3x) \\ 1 & 2(x+5) & 4(x^2+25+5x) \\ 1 & 2 & 3 \end{vmatrix}$$

Hence, $f(x)$

$$= \begin{vmatrix} x-3 & 2(x-3)(x+3) & 3(x-3)(x^2+9+3x) \\ x-5 & 2(x-5)(x+5) & 4(x-5)(x^2+25+5x) \\ 1 & 2 & 3 \end{vmatrix}$$

$\Rightarrow f(3) = f(5) = 0$

So, $f(1)f(3) + f(3)\cdot f(5) + f(5)f(1) = f(3)$

43. **(a)** Given ellipse is $2x^2 + 3y^2 - 4x - 12y + 13 = 0$

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

Here, centre $(h, k) = (1, 2)$

Now, $e = \sqrt{1 - \frac{b^2}{a^2}} = \sqrt{1 - \frac{1/3}{1/2}} = \frac{1}{\sqrt{3}}$

$\Rightarrow a = \frac{1}{\sqrt{2}}, b = \frac{1}{\sqrt{3}} \Rightarrow ae = \frac{1}{\sqrt{6}}$

Hence, foci $(h \pm ae, k) \equiv \left(1 \pm \frac{1}{\sqrt{6}}, 2\right)$

44. **(a)** Let $P(K) = \frac{k^5}{5} + \frac{k^3}{3} + \frac{7k}{15}, k \in N$

$$= \frac{3k^5}{15} + \frac{5k^3}{15} + \frac{(15-5-3)k}{15}$$

$$= \frac{3}{15}(k^5 - k) + \frac{5}{15}(k^3 - k) + k$$

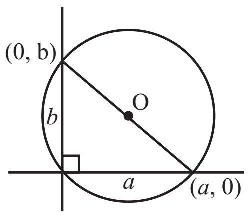
$$= \frac{1}{5}\underbrace{k(k^2+1)(k+1)(k-1)}_{\text{divisible by 5}} + \frac{1}{3}\underbrace{k(k+1)(k-1)}_{\text{divisible by 3}} + k$$

So, overall it is a natural number.

or for objective point of view you can assume $k = 1$ ($k \in N$) and solve k.

Now, we will get natural number.

45. **(d)** Centre $= \left(\frac{a}{2}, \frac{b}{2}\right)$, Radius $= \frac{\sqrt{a^2+b^2}}{2}$



Hence, equation of circle is

$$\Rightarrow \left(x - \frac{a}{2}\right)^2 + \left(y - \frac{b}{2}\right)^2 = \frac{a^2+b^2}{4}$$

$\Rightarrow x^2 + y^2 - ax - bx = 0$

46. **(d)** Since equation of angle bisector for $ax^2 + 2hxy + by^2 = 0$ is

$$\Rightarrow \frac{x^2 - y^2}{a-b} = \frac{xy}{h}$$

Hence for $x^2 - 2pxy - y^2 = 0$

$$\Rightarrow \frac{x^2-y^2}{1-(-1)} = \frac{xy}{-p} \Rightarrow x^2 - y^2 + \frac{2xy}{p} = 0$$

Given equation of angle bisector is $x^2 - 2qxy - y^2 = 0$

On comparing the coefficients, we get

$\Rightarrow \frac{2}{p} = -2q \Rightarrow pq = -1$

47. **(a)** Given $P^{2006} = O$ and $PQ = P + Q$ where P and Q are square matrix

$\Rightarrow P^{2006}Q = P^{2006} + Q \cdot P^{2005} \Rightarrow O = O + Q \cdot P^{2005}$

$\Rightarrow P^{2005} \cdot Q = O \Rightarrow$ det. $(P^{2005} \cdot Q) = O$

$\Rightarrow$ det P^{2005} (det Q) $= O \Rightarrow$ det $Q = O$

48. **(b)** Let $I = \int \left(\frac{2 \tan x}{1 + 2\tan^2 x}\right) dx$

$$= \int \frac{2 \sin x \cdot \cos x}{\cos^2 x + 2\sin^2 x} dx = \int \frac{2 \sin x \cdot \cos x}{1 + \sin^2 x} dx$$

Let $1 + \sin^2 x = t \Rightarrow 2 \sin x \cdot \cos x \, dx = dt$

$I = \int \frac{dt}{t} = \log|t| + c_1 = \log|1 + \sin^2 x| + c_1$

$= \log|2\sin^2 x + \cos^2 x| + c_1$

$$= \log 2 + \left|\sin^2 x + \frac{\cos^2 x}{2}\right| + c_1$$

$$= \log\left|\frac{\cos^2 x}{2} + \sin^2 x\right| + c \qquad [\because \log 2 + c_1 = c]$$

49. **(a)** Since, given that

$\theta \in \left[-\frac{\pi}{2}, \frac{\pi}{2}\right]$

So, $\cos^{-1}(\sin\theta) \Rightarrow \cos^{-1}\left[\cos\left(\frac{\pi}{2} - \theta\right)\right] = \left(\frac{\pi}{2} - \theta\right)$

50. **(d)** Given $\vec{a} = \alpha\hat{i} + 3\hat{j} - 6\hat{k}, \vec{b} = 2\hat{i} - \hat{j} + \beta\hat{k}$

For $(\vec{a})$ and $(\vec{b})$ may be collinear $(\vec{a} \times \vec{b}) = 0$

$$\Rightarrow \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ \alpha & 3 & -6 \\ 2 & -1 & \beta \end{vmatrix} = 0$$

$\Rightarrow \hat{i}(3\beta - 6) - \hat{j}(\alpha\beta + 12) + \hat{k}(-\alpha - 6) = 0$

$\Rightarrow (3\beta - 6) = 0, (\alpha\beta + 12) = 0$ and $(\alpha + 6) = 0$

$\Rightarrow (\beta = 2), (\alpha = -6)$

51. **(d)** Given $2\alpha = -1 - i\sqrt{3}, 2\beta = -1 + i\sqrt{3}$

Now, $5\alpha^4 + 5\beta^4 + 7\alpha^{-1}\beta^{-1}$

$$\Rightarrow 5(\alpha^4 + \beta^4) + \frac{7}{\alpha\beta}$$

or $5[(\alpha^2 + \beta^2) - 2\alpha^2\beta^2] + \frac{7}{\alpha \cdot \beta}$

$$= 5\left[\left\{\frac{1}{4}(2\alpha+2\beta)^2 - 2\alpha\beta\right\}^2 - 2\alpha^2\beta^2\right] + \frac{7}{\alpha\cdot\beta}$$

$$= 5\left[\left(\frac{1}{4}\times 4 - 2\right)^2 - 2\right] + 7$$

$= 5[1-2] + 7 = 2$

52. **(d)** Let l, m, n be the direction cosines of the required line. Given it is perpendicular to the lines whose direction cosines are proportional to 1, – 2, –2 and 0, 2, 1 respectively.

Thus, $l - 2m - 2n = 0$ and $2m + n = 0$

On solving, $\frac{l}{2} = \frac{m}{-1} = \frac{n}{2}$

Direction ratios of required line are proportional to (2, – 1, 2)

Thus Direction cosines are = $\left(\frac{2}{3}, -\frac{1}{3}, \frac{2}{3}\right)$

53. **(d)** Given integrals $\int_{\sqrt{2}}^{x} \frac{dt}{|t|\sqrt{t^2-1}} = \frac{\pi}{12}$

$$\Rightarrow \left[\sec^{-1} t\right]_{\sqrt{2}}^{x} = \frac{\pi}{12} \Rightarrow \sec^{-1} x - \sec^{-1}\sqrt{2} = \frac{\pi}{12}$$

$$\Rightarrow \sec^{-1} x = \frac{\pi}{12} + \frac{\pi}{4} = \frac{\pi}{3} \Rightarrow x = \sec\left(\frac{\pi}{3}\right) = 2$$

54. **(c)** Given equations of lines $2x + 11y - 7 = 0$ and $x + 3y + 5 = 0$

Hence, their slopes are $m_1 = -\frac{2}{11}, m_2 = -\frac{1}{3}$

$$\tan\theta = \left|\frac{m_1 - m_2}{1 + m_1 m_2}\right| = \frac{1}{7}$$

$$\theta = \tan^{-1}\left(\frac{1}{7}\right)$$

55. **(a)** Condition of tangency is $(c^2 = a^2m^2 + b^2)$

For $\frac{x^2}{a^2} + \frac{y^2}{b^2} = 1$ and $y = mx + c$ is tangent.

Here, $\frac{x^2}{5} + \frac{y^2}{3} = 1$ and $y = 2x + k$ is a tangent

$\Rightarrow k^2 = 5 \times 4 + 3 \Rightarrow k = \pm\sqrt{23}$

56. **(b)** Since we know that is correct and (ii) is incorrect.

57. **(c)** Given expansion is

$(1 - x + x^2)^{10} = a_0 + a_1x + a_2x^2 + \ldots + a_{20}x^{20}$

On differentiating

$10(1 - x + x^2)^9 \cdot (-1 + 2x)$

$= a_1 + 2a_2x + 3a_3x^2 + \ldots + 20a_{20}x^{19}$

At $x = 1 \Rightarrow a_1 + 2a_2 + 3a_3 + \ldots + 20a_{20} = 10$

At $x = 0 \Rightarrow a_1 = -10$

So, $2a_2 + 3a_3 + \ldots + 20a_{20} = 20$

58. **(c)** Given $y = \sin^{98} x \cdot \cos^{39} x$

Now, $\frac{dy}{dx} = \sin^{98} x \cdot 39\cos^{38} x(-\sin x)$

$+ \cos^{39} x \cdot 98\sin^{97} x(\cos x)$

$= 98\sin^{97} x \cdot \cos^{40} x - 39\sin^{99} x \cdot \cos^{38} x$

$= 98\cos^{99} x \cdot \sin^{38} x - 39\sin^{40} x \cdot \cos^{97} x$

59. **(c)** Given inverse trigo functions $\tan^{-1}\left[\frac{x}{1+\sqrt{1-x^2}}\right]$

Let $y = \tan^{-1}\left(\frac{x}{1+\sqrt{1-x^2}}\right)$, $u = \sec^{-1}\left(\frac{1}{2x^2-1}\right)$

Put $x = \cos\theta \Rightarrow y = \tan^{-1}\left(\frac{\cos\theta}{1+\sin\theta}\right)$

and $u = \sec^{-1}(\sec 2\theta)$

or $y = \tan^{-1}\left(\frac{1}{\sec\theta + \tan\theta}\right)$ and $(u = 2\theta)$

$y = \tan^{-1}(\sec\theta - \tan\theta)$

$\Rightarrow \tan y = \sec\theta - \tan\theta$

$$\Rightarrow \sec^2 y\frac{dy}{d\theta} = \sec\theta\cdot\tan\theta - \sec^2\theta \text{ and } \frac{du}{d\theta} = 2$$

$$\text{or } \frac{dy}{d\theta} = \frac{\sec\theta\cdot\tan\theta - \sec^2\theta}{\sec^2 y}, \frac{du}{d\theta} = 2$$

$$\frac{dy}{d\theta} = \frac{\sec\theta\cdot\tan\theta - \sec^2\theta}{1 + (\sec\theta - \tan\theta)^2}, \frac{du}{d\theta} = 2$$

$$\frac{dy}{du} = \frac{1}{2}\left[\frac{\sec\theta\cdot\tan\theta - \sec^2\theta}{1 + \sec^2\theta + \tan^2\theta - 2\sec\theta\cdot\tan\theta}\right]$$

$$= \frac{1}{2}\frac{\sec\theta(\tan\theta - \sec\theta)}{2\sec^2\theta - 2\sec\theta\cdot\tan\theta} \Rightarrow \frac{dy}{du} = \frac{1}{4}$$

60. **(b)** Since, we know in radius

$$= \frac{\Delta}{s} = \frac{\sqrt{s(s-a)(s-b)(s-c)}}{s}$$

$$= \frac{\sqrt{10(4)(5)(1)}}{10} = \sqrt{2}$$

61. **(d)** Given $a + bi = \frac{i}{1-i}$

$$\Rightarrow a + bi = \frac{i(1+i)}{2} = -\frac{1}{2} + \frac{i}{2} \Rightarrow a = -\frac{1}{2}, b = \frac{1}{2}$$

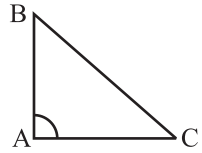
62. **(b)** Given $\overrightarrow{OB} = 3\hat{i} - 2\hat{j} + \hat{k}$

$\overrightarrow{OC} = 5\hat{i} + \hat{j} - 3\hat{k}$

Hence, $\overrightarrow{BC} = 2\hat{i} + 3\hat{j} - 4\hat{k}$

max $\{AB, BC, AC\} = BC$

$\therefore$ $\overrightarrow{BC}$ is hypotenuse of ΔABC



$\angle A = 90°$

$\therefore$ $\overrightarrow{AB}\cdot\overrightarrow{AC} = 0$

$\overrightarrow{BA}\cdot\overrightarrow{BC} = |\overrightarrow{BA}||\overrightarrow{BC}|\cos B$

$\overrightarrow{CA}\cdot\overrightarrow{CB} = |\overrightarrow{CA}||\overrightarrow{CB}|\cos C$

$\therefore\ \overrightarrow{AB}-\overrightarrow{AC}+\overrightarrow{BA}-\overrightarrow{BC}+\overrightarrow{CA}-CB$

$= 0+|\overrightarrow{BC}|(|\overrightarrow{AB}|\cos B+|\overrightarrow{CB}|\cos C)$

$= 0+|\overrightarrow{BC}||\overrightarrow{BC}|$ [$\because$ By projection formula]

$= |\overrightarrow{BC}|^2-(\sqrt{(2)^2+3^2+4^2})^2$

$= 4+9+16+29$

63. **(d)** Given lines are

$3x+4y-5=0$ …(i)

$2x+3y-4=0$ …(ii)

and $px+4y-6=0$ …(iii)

From equation (i) and (ii), we get

$x=-1, y=2$

This should be satisfy IIIrd equation

So, $-p+8-6=0 \Rightarrow p=2$

64. **(d)** Given $a>0, n\in R$

$\Rightarrow \lim\limits_{x\to a} x^n = a^n$

65. **(c)** $\int_{-\pi}^{\pi} x^2(\sin x)\,dx$

x^2 $(\sin x)$ is an odd function

By property of odd & even function

For $f(-x)=-f(x)$ then $\int_{-a}^{a} f(x)dx=0$

$\Rightarrow \int_{-\pi}^{\pi} x^2(\sin x)\,dx = 0$

66. **(c)** Given differential equation

$\left\{x\cos\left(\frac{y}{x}\right)+y\sin\left(\frac{y}{x}\right)\right\}y\,dx$

$=\left\{y\sin\left(\frac{y}{x}\right)-x\cos\left(\frac{y}{x}\right)\right\}x\,dy$

Hence, $\frac{dy}{dx}=\left[\frac{x\cos\left(\frac{y}{x}\right)+y\sin\left(\frac{y}{x}\right)}{y\sin\left(\frac{y}{x}\right)-x\cos\left(\frac{y}{x}\right)}\right]\cdot\frac{y}{x}$

Let $\frac{y}{x}=V \Rightarrow \frac{dy}{dx}=V+x\frac{dV}{dx}$

$\Rightarrow V+x\frac{dV}{dx}=\left(\frac{\frac{1}{V}\cos V+\sin V}{\sin V-\frac{1}{V}\cos V}\right)\cdot V$

or $V+x\frac{dV}{dx}=\left(\frac{\cos V+V\sin V}{V\sin V-\cos V}\right)V$ or $x\frac{dV}{dx}$

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

or $\frac{(V\sin V-\cos V)}{V\cos V}dV=2\frac{dx}{x}$

Now, put $V\cos V=t$

$\Rightarrow$ $(\cos V-V\sin V)\,dV=dt$

So, $\int -\frac{dt}{t}=2\int\frac{dx}{x} \Rightarrow 2\ln x+c=-\ln t$

or $2\ln x+c=-\ln\left(\frac{y}{x}\cos\frac{y}{x}\right)$

or $\ln\left(xy\cos\frac{y}{x}\right)=-C \Rightarrow xy\cdot\cos\frac{y}{x}=\pm e^{-C}$

67. **(a)** Given $f(x)=\left(\frac{1}{2}\right)^x$

Let $y=\left(\frac{1}{2}\right)^x$ on R

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

$\because \left(\frac{dy}{dx}<0\right)$ so strictly decreasing.

68. **(b)** Given pair of straight lines is

$6x^2-5xy+y^2=0$

it can be written as

$\left(\frac{y}{x}\right)^2-5\left(\frac{y}{x}\right)+6=0 \Rightarrow \left(\frac{y}{x}-3\right)\left(\frac{y}{x}-2\right)=0$

$\Rightarrow$ $y=3x$ and $y=2x$ are straight lines

$\tan\alpha=3$, $\tan\beta=2$

$\tan(\alpha-\beta)=\frac{\tan\alpha-\tan\beta}{1+\tan\alpha\tan\beta}=\frac{3-2}{1+6}=\frac{1}{7}.$

69. **(a)** Given, curve is

$\left(\frac{x}{31}\right)^n+\left(\frac{y}{1209}\right)^n=2$

On differentiating

$\frac{nx^{n-1}}{31^n}+\frac{ny^{n-1}}{1209^n}\frac{dy}{dx}=0$

$\frac{dy}{dx}=-\left(\frac{nx^{n-1}\times 1209^n}{ny^{n-1}\cdot 31^n}\right) \Rightarrow \frac{dy}{dx}=-\left(\frac{x}{y}\right)^{n-1}\times(39^n)$

Hence, slope of tangent at (31, 1209)

$=-\left(\frac{1}{39}\right)^{n-1}\times(39^n)=-39$

70. **(d)** Given hyperbola is $x^2-9y^2=9$

$\frac{x^2}{9}-\frac{y^2}{1}=1$

We know that

$y = mx\pm\sqrt{9m^2-1}$ represent tangents which passes through (3, 2)

So, $m=\frac{5}{12}$

Now, tangents are $12y=5x+9$ and $x=3$

and chord of contact will be $\frac{xx_1}{a^2} - \frac{yy_1}{b^2} = 1$

$\Rightarrow \frac{3x}{9} - \frac{2y}{1} = 1$ or $x - 6y = 3$

The vertices of the triangle formed with tangents and chord will be (3, 2), (3, 0) and $\left(-5, -\frac{4}{3}\right)$.

So, area of $\Delta = \frac{1}{2}\begin{vmatrix} 3 & 2 & 1 \\ 3 & 0 & 1 \\ -5 & -\frac{4}{3} & 1 \end{vmatrix} = 8$ unit^2

71. **(d)** Given standard deviation $\sigma = 3.5$
So, mean of the given numbers is

Mean $(\bar{x}) = \frac{2+3+2x+11}{4} = \left(4 + \frac{x}{2}\right)$

$\sigma^2 = \frac{1}{n}\Sigma(x_i - \bar{x})^2$

$\Rightarrow (3.5)^2 = \frac{1}{4}\left[\left(-2-\frac{x}{2}\right)^2 + \left(-1-\frac{x}{2}\right)^2 + \left(\frac{3x}{2} - 4\right)^2 + \left(7 - \frac{x}{2}\right)^2\right]$

$\Rightarrow 3x^2 - 16x + 21 = 0 \Rightarrow x = \frac{7}{3}, 3$

72. **(c)** Given expression $x^{2019} \cdot y^{2020} = (x+y)^{4039}$

On differentiating both the sides, we have

$\Rightarrow 2020y^{2019}\frac{dy}{dx}x^{2019} + 2019x^{2018} \cdot y^{2020}$

$= 4039(x+y)^{4038} \cdot \left(1 + \frac{dy}{dx}\right)$

$\Rightarrow 2020\frac{(x+y)^{4039}}{y}\frac{dy}{dx} + 2019\frac{(x+y)^{4039}}{x}$

$= 4039(x+y)^{4038} \cdot \left(1 + \frac{dy}{dx}\right)$

$\Rightarrow \left(\frac{2020}{y}\frac{dy}{dx} + \frac{2019}{x}\right)(x+y) = 4039\left(1 + \frac{dy}{dx}\right)$

$\Rightarrow \frac{2020(x+y)}{y} . \frac{dy}{dx} + \frac{2019}{dx} + \frac{2019}{x}(x+y)$

$= 4039\left(1 + \frac{dy}{dx}\right)$

$\Rightarrow \frac{dy}{dx}\left[\frac{2019y - 2020x}{y}\right] = \frac{2019(x+y)}{x} - 4039$

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

73. **(a)** Given $\lambda = 3$, B = 5, $G = 8$

$P(B) = \frac{5}{16} \Rightarrow P(\bar{B}) = \frac{11}{16}$

74. **(a)** Given $y = 5x^2 + 6x + 6$, $x = 2$
and $\Delta x = 0.001$
Now, $dy = (10x + 6)\, dx$
$\Rightarrow dy = (10 \times 2 + 6) \times 0.001 \Rightarrow dy = 0.026$

75. **(a)** Let $S_1 \equiv x^2 + y^2 + 8x + 8y - m = 0$
$S_2 = x^2 + y^2 - 2x + 4y + n = 0$
So, equation of radical axis (common chord)
$\Rightarrow S_1 - S_2 = 0$
$\Rightarrow 10x + 4y - (m+n) = 0$
$\Rightarrow 10x + 4y = (m+n)$
Centre of bisected circle is (–4, –4) which will lie on radical axis.
So, $\{(m+n) = -56\}$

76. **(a)** Given equation is $x \cos\theta + y \sin\theta = P$
The axis are rotated through angle (θ), then
$x = X\cos\theta - Y\sin\theta$ and $y = X\sin\theta + Y\cos\theta$
Put in Eq. (i)
$\cos\theta\,(X\cos\theta - Y\sin\theta) + \sin\theta\,(X\sin\theta + Y\cos\theta)$
$\Rightarrow X\cos^2\theta - Y\sin\theta \cdot \cos\theta + X\sin^2\theta + Y\sin\theta \cdot \cos\theta = P$
$\Rightarrow X = P$

77. **(a)** Since irrational roots exist in pair.
So, the degree of $f(x)$ will be an even number.

78. **(c)** $\int \sin^3 x \cdot \cos^3 x\, dx$

$= \int \sin^3 x \cdot \cos x\,(1 - \sin^2 x)\, dx$

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

$\Rightarrow \int t^3 \cdot (I - t^2)\, dt = \int (t^3 - t^5)\, dt$

$\Rightarrow \frac{t^4}{4} - \frac{t^6}{6} + C = \frac{\sin^4 x}{4} - \frac{\sin^6 x}{6} + C$

79. **(Bonus)** Given 5 different coloured flowers.
So, number of different garlands

$= \frac{4!}{2} = 12$

80. **(b)** Given $\lim_{x \to 0} \frac{8}{\sin^8 x}\left\{1 - \cos\left(\frac{x^2}{2}\right) - \cos\left(\frac{x^2}{4}\right) + \cos\left(\frac{x^2}{2}\right)\cos\left(\frac{x^2}{4}\right)\right\}$

On simplifying, we get

$\Rightarrow \lim_{x \to 0} \frac{8}{\sin^8 x}\left\{\left[1 - \cos\left(\frac{x^2}{2}\right)\right]\left[1 - \cos\left(\frac{x^2}{4}\right)\right]\right.$

or $\lim_{x \to 0} \frac{8}{\sin^8 x}\left(2\sin^2\left(\frac{x^2}{4}\right)\right)\left(2\sin^2\left(\frac{x^2}{8}\right)\right)$

or $\lim_{x \to 0} \frac{32\sin^2\left(\frac{x^2}{4}\right) \cdot \sin\left(\frac{x^2}{8}\right)}{\sin^8 x}$

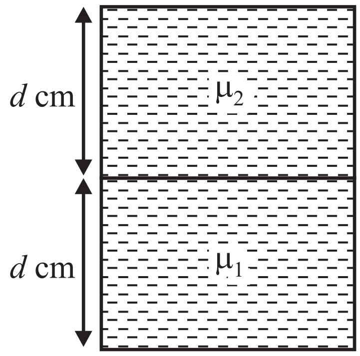
$\Rightarrow \lim_{x \to 0} \frac{32\sin^2\left(\frac{x^2}{4}\right) \cdot \sin^2\left(\frac{x^2}{8}\right) \times x^8}{\left(\frac{x^2}{4} \times \frac{x^2}{8}\right)^2 \cdot \sin^8 x \times (4 \times 8)^2} = \frac{1}{32}$

PHYSICS

81. **(c)** Microwaves have short wavelength. So energy dispersion during long distance communication is very low. So, we use it in rooar system.

82. **(b)** $(d_1)_{app} = \dfrac{d}{\mu_1}$

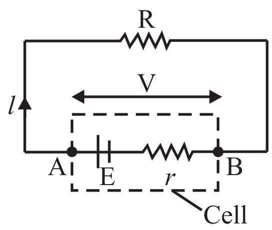
$(d_2)_{app} = \dfrac{d}{\mu_2}$



So, $d_{\text{app}} = \dfrac{d}{\mu_1} + \dfrac{d}{\mu_2} = d\left(\dfrac{1}{\mu_1} + \dfrac{1}{\mu_2}\right)$

83. **(a)** The energy stored in the coil is in the form of magnetic energy and is equal to $E = \dfrac{1}{2}LI^2$

84. **(b)**

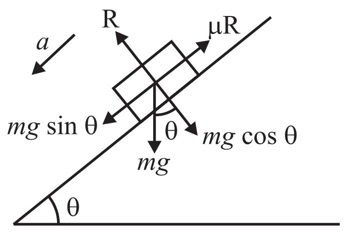


When cell is discharging, then terminal potential difference across the cell is given as

$V = E - Ir$ [By using KVL between A and B]

where I = current drawn by cells.

85. **(a)**



According to Newton's second law of motion,

$mg \sin\theta - \mu R = ma$

$\Rightarrow mg \sin\theta - \mu mg \cos\theta = ma$

$\Rightarrow a = g \sin\theta - \mu g \cos\theta$

$\Rightarrow a = g(\sin\theta - \mu \cos\theta)$

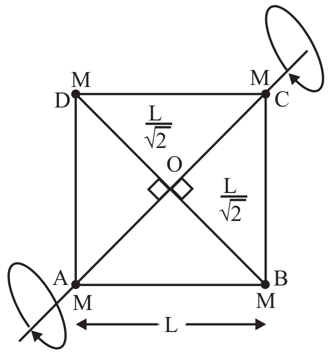
86. **(b)** Numerical aperture, $NA = 0.8$

Wavelength, $\lambda = 0.6\ \mu m$

$\therefore$ Limit of resolution

$= \dfrac{\lambda}{2(NA)} = \dfrac{0.6}{2 \times 0.8} = \dfrac{0.3}{0.8} = \dfrac{3}{8}\ \mu m$

87. **(b)** The given masses system are shown in figure.



$\therefore$ Moment of inertia of given system about the diagonal AC

$I_{AC} = I_A + I_B + I_C + I_D$

$= 0 + M\left(\dfrac{L}{\sqrt{2}}\right)^2 + 0 + M\left(\dfrac{L}{\sqrt{2}}\right)^2$

$= \dfrac{ML^2}{2} + \dfrac{ML^2}{2} = ML^2$

88. **(a)** Angular displacement in $t = 10$ s is given as

$\theta = \omega_0 t + \dfrac{1}{2}\alpha t^2$ [$\because$ $\omega_0 = 0$ and $\alpha = 2$ rad/s^2]

$= 0 \times 10 + \dfrac{1}{2} \times 2 \times 10^2 = 100$ rad.

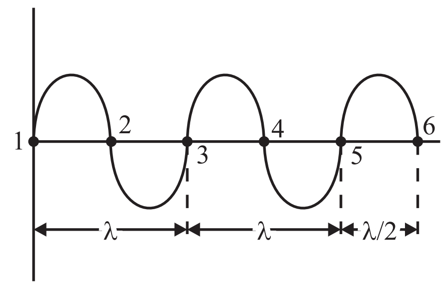
Number of revolution $= \dfrac{\theta}{2\pi} = \dfrac{100}{2\pi} \approx 16$

89. **(b)** According to given diagram, net charge enclosed through the surface S_2 is zero.

Net flux through surface,

$S_2 = \dfrac{\text{Charge inclosed}}{\varepsilon_0}$ = *By gauss law*

90. **(b)** Since, distance between 6 successive nodes is equivalent to $2\lambda - \dfrac{\lambda}{2} = \dfrac{5\lambda}{2}$



$\therefore d = \dfrac{5\lambda}{2} = 0.85$

$\Rightarrow \lambda = \dfrac{0.85 \times 2}{5} = 0.34$ m

$\therefore$ Speed of sound in tube,

$v = f\lambda = 1000 \times 0.3$

$= 340\ ms^{-1}$

91. **(c)** Let T be equilibrium temp.

Then, by the principle of calorimetry

$H_{gain} = H_{loss}$

$\Rightarrow 5c(T - 20) = 10c(60 - T)$

$\Rightarrow T - 20 = 120 - 2T$

$\Rightarrow 3T = 140$

$T = 46.67° \approx = 47°C$

92. **(a)** For surface e^-

$E_{photon} = \phi + (K.E.)_{max}$

So, $(K.E.)_{max} = \frac{1}{2}mv^2_{max} = E - \phi = 6.2 - 4.2 = 2$ eV

$= 2 \times 1.6 \times 10^{-19}$ J

$\Rightarrow \frac{1}{2}mv^2_{max} = 3.2 \times 10^{-19}$ J

93. **(c)** We have

${}^{11}_{6}C \rightarrow {}^{11}_{5}B + \beta + X$ …(i)

When positron (β) is emitted from a nuclei, then atomic number decreases by one unit, while the mass number remains the same. This is β^+ decay therefore.

So, X is neutrina.

94. **(c)** Heat lost by steam,

$Q' = mL_f + m_s c\Delta t$

$= 10^3 \times 540 + 10^3 \times 1 \times (150 - 90)$

$= 54 \times 10^4 + 6 \times 10^4$

$= 10^4(54 + 6) = 60 \times 10^4$ cal

Mass of 20 L water, $m_w = 20$ kg $= 20 \times 10^3$ g

Heat gained by water, $Q'' = 20 \times 10^3 \times 1 \times \Delta T$

Now, Heat lost = Heat gained

$60 \times 10^4 = 20 \times 10^3 \times \Delta T$

$\Rightarrow \Delta T = \frac{60 \times 10^4}{20 \times 10^3} = 30°C$

95. **(d)** As $W = q(V_1 - V_2) = q[0] = 0$

96. **(a)** $\gamma = a \sin(\omega t - kx)$

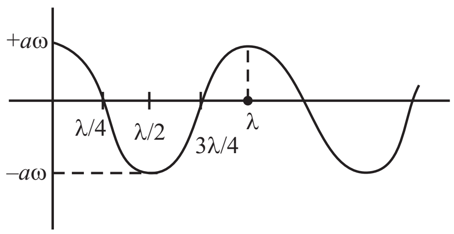
$V_P = \frac{d\gamma}{dt} = a\omega \cos(\omega t - kx)$

$V_P \big|_{t=0} = a\omega \cos(-kx)$

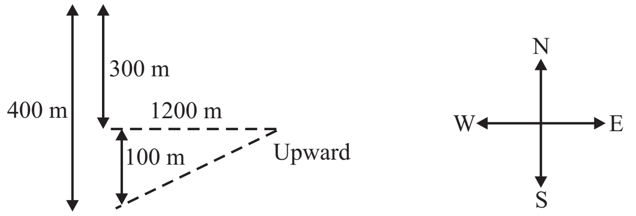
$= a\omega \cos(kx)$

when $x = 0$

$V_P = a\omega$ so the graph will be



97. **(c)** The various displacements of airplane is shown below



Net displacement

$d = \sqrt{100^2 + 1200^2}$

$= \sqrt{1450000} = 120416$ m $= 1200$ m

98. **(a)** Reynold's number determines the type of flow.

(i) If $R < 2100$, then flow is laminar.

(ii) If $2100 < R < 4000$, then flow is stream line.

(iii) If $R > 4000$, then flow is turbulent.

99. **(c)** Work done by a constant force is given as

$W = Fs \cos\theta$

where, θ = angle between the direction of force and displacement.

When, $\theta = 0°$, then $W = Fs$ (positive)

When $\theta = 90°$, then $W = Fs \cos 90°$

$= 0$ (zero)

When, $\theta = 180°$, then $W = Fs \cos 180°$

$= -Fs$ (negative)

Hence, work done may be positive, negative or zero depending on angle between force and displacement.

100. **(*)** At NTP,

Temperature = 300 K

Pressure = 76 cm of Hg

By ideal gas equation, we get

$\frac{p_1V_1}{T_1} = \frac{p_2V_2}{T_2}$

$\Rightarrow V_2 = \frac{p_1V_1T_2}{p_2T_1}$

$= \frac{78 \times 251 \times 300}{76 \times 293} = 263.8\ cm^3$

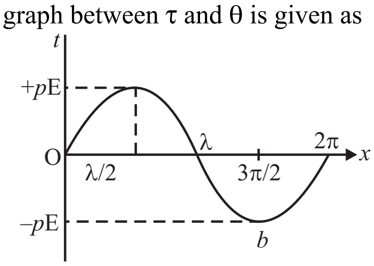
No option is matched.

101. **(c)** Frank and Hertz's experiment confirms the prediction of quantum theory that electrons occupy only discrete, quantised energy states.

102. **(c)** Torque on electric dipole placed in uniform electric field E is given as

$\tau = pE \sin\theta$ …(i)

Hence, graph between τ and θ is given as



103. **(b)** Let the final temperature be T.

Then, $H_{gain} = mg\,\Delta T = 50s\,(T - 10)$

$H_{loss} = mg\,\Delta T = 50s\,(100 - T)$

Now, Heat gain = Heat loss

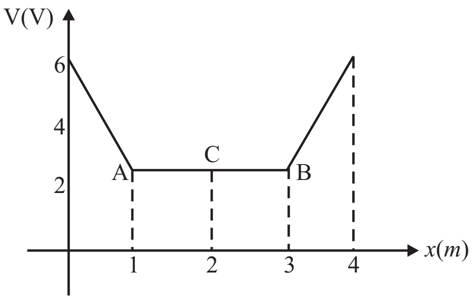
$\Rightarrow H_{gain} = H_{loss}$

$\Rightarrow 50s(T - 10) = 50s\,(100 - T)$

$\Rightarrow 2T = 110$

$T = 55°C$

104. **(a)** Potential is constant in region AB as shown in diagram



i.e., V = constant

$\therefore$ Electric field at $x = 2$ m (at point C)

$$E = \frac{-dV}{dx} = 0 \qquad [\because \; V = \text{constant}]$$

105. **(b)** Let water equivalent of the calorimeter is W_{gram}.

Heat lost by warm water = Heat gained by cold water + Heat gained by the calorimeter

$\Rightarrow m_2(T_2 - T_3) = m_1(T_3 - T_1) + W(T_3 - T_1)$

$\Rightarrow 300(60 - 40) = 500(40 - 30) + W(40 - 30)$

$\Rightarrow 10W = 1000$

$\Rightarrow W = 100 \text{ g} = \dfrac{100}{1000} = 0.1 \text{ kg}$

106. **(c)** We have

$$g_{eff} = g - a_0 \qquad \ldots(i)$$

Hence, the pressure by the fluid at the bottom of vessel is given as

$$p = p_0 + pgh = p_0 + \rho(g - a_0)\,h \qquad \text{[From Eq. (i)]}$$

107. **(b)** Weak nuclear force always operates between heaviour elementary particles.

108. **(c)** $\dfrac{\text{Lateral strain}}{\text{Longitudinal strain}}$ = Poisson's ratio = 0.26

Or, Lateral strain = 0.26 × longitudinal strain

$$= 0.26 \times \frac{\Delta l}{l} = 0.26 \times \frac{3 \times 10^{-3}}{3}$$

$= 0.26 \times 10^{-3}$

109. **(b)** Rms value of AC, $V_{rms} = 220$ V

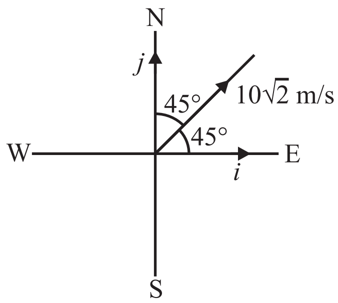
Peak value of AC,

$V_0 = \sqrt{2}\,V_{rms} = \sqrt{2} \times 220 = 311$ V

$V_{DC} = 220$ V

Since, peak value of 220 V AC is 311 V which is much more than 220 DC. Hence, 220 V AC is more dangerous than 220 V DC.

110. **(a)**



Initial velocity

$u = 10\sqrt{2}\cos 45°\,\hat{i} + 10\sqrt{2}\cos 45°\,\hat{j}$

$= 10$ (itg)

Acceleration applied

$a_s = -2\hat{j}$

$\therefore$ Velocity after 5 s is

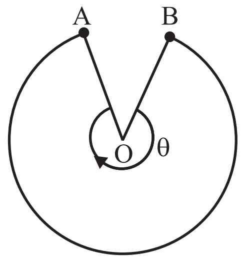
$v = u + a_s t$

$= 10(\hat{i} + \hat{j}) + (-2\hat{j}) \times 5 = 10\hat{i} + 10\hat{j} - 10\hat{j} = 10\hat{i}$

Hence, body will move towards east with the velocity 10 ms^{-1}.

111. **(a)** Magnetic field at the centre due to current carrying circular loop is given as

$$B_C = \frac{\mu_0 I}{2r} \qquad \ldots(i)$$



Magnetic field due to current carrying circular arc making an angle θ at the centre, is given as

$$B = \frac{\theta}{2\pi} \cdot B_C = \frac{\theta}{2\pi} \cdot \frac{\mu_0 I}{2r} \qquad \text{[From Eq. (i)]}$$

$$B = \frac{\mu_0 I \theta}{4\pi r} = \frac{\mu_0 I}{r}\left(\frac{\theta}{4\pi}\right)$$

112. **(c)** Induced emf,

$$e = L\frac{dI}{dt} = L\frac{\Delta I}{\Delta t} = 8 \times 10^{-3} \times \frac{2}{0.1} = 16 \times 10^{-2} \text{ V}$$

113. **(b)** Acceleration due to gravity above the surface (at altitude) is given as

$$g' = \frac{g}{\left(1 + \dfrac{h}{R_e}\right)^2} \qquad \ldots(i)$$

From Eq. (i), it is clear that acceleration due to gravity decreases with altitude.

114. (c) $F_c = \dfrac{mv^2}{r}$

$$\frac{F_2}{F_1} = \frac{m_2}{m_1} \cdot \left(\frac{v_2}{v_1}\right)^2 \cdot \left(\frac{r_1}{r_2}\right) \quad \ldots(\text{i})$$

When, mass, speed and radius of circular path of particle increases by 100%, i.e., these become double.

Hence, $m_2 = 2m_1$, $V_2 = 2V_1$, $r_2 = 2r_1$

$\therefore$ From Eq. (i), we have

$$\frac{F_2}{F_1} = \frac{2m_1}{m_1}\left(\frac{2v_2}{v_1}\right)^2\left(\frac{r_1}{2r_2}\right)$$

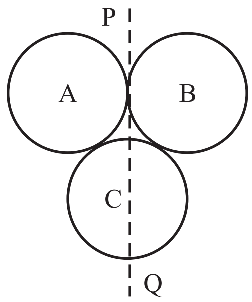
$\Rightarrow F_2 = 4F_1$

Percentage increase

$$\frac{\Delta F}{F_1} = \frac{F_2 - F_1}{F_1} \times 100 = \frac{4F_1 - F_1}{F_1} \times 100 = 300\%$$

115. (a) Moment of inertia of each solid sphere,

$$I = \frac{2}{5}mr^2$$



where, m = mass and r = radius

The moment of inertia of the system about axis PQ as shown in the figure

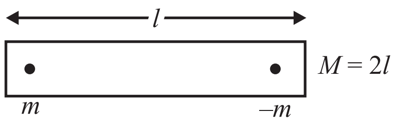
$$I_{PQ} = I_A + I_B + I_C$$

$$= (I_{cm} + mr^2) + (I_{cm} + mr^2) + \frac{2}{5}mr^2$$

$$= \left[\left(\frac{2}{5}mr^2\right) + mr^2\right] + \left[\left(\frac{2}{5}mr^2\right) + mr^2\right] + \left[\frac{2}{5}mr^2\right]$$

$$= \frac{16}{5}mr^2$$

116. (d) Dipole moment of a magnet,



$M = IA$

$\Rightarrow 2ml = IA$ [m = pole strength]

$\Rightarrow m = \dfrac{IA}{2l}$ [$\because$ $M = m(2l)$]

Unit of pole strength $(m) = \dfrac{Am^2}{m} = Am$

117. (c) $m = -\dfrac{P}{V}x$

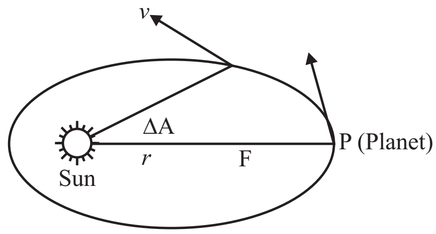
x (isothermal) = 1

x (adiabatic) = γ

So, $\dfrac{m_{\text{iso}}}{m_{\text{adi}}} = \dfrac{-\dfrac{P}{V}\cdot 1}{-\dfrac{P}{V}\cdot \gamma} = \dfrac{1}{P}$

118. (c) According to Kepler"s second law of planetary motion, the radius vector joining planet to the sun sweeps out equal areas, in equal interval of time.

i.e., $\dfrac{\Delta A}{\Delta t}$ = constant



According to figure, r be the position vector of the planet w.r.t. sun and F be the gravitational force.

on the planet due to the sun. Then, torque exerted on the planet by this force about the sun is

$\tau = r \times F = 0$ [$\because$ r and F are oppositely directed]

But $\tau = \dfrac{dL}{dt}$

$\therefore \dfrac{dL}{dt} = 0 \Rightarrow L$ = constant

Angular momentum = constant

Hence, kepler's second law (law of areas) is equivalent to law of conservation of angular momentum.

119. (c) We have = 560 cm, $R = 10\ \Omega$.

So, $l_2 = l_1 = 60$

$\Rightarrow$ $l_2 = 560 - 60 = 500$ cm

$\therefore$ Internal resistance of cell is given by

$$r = \left(\frac{l_1 - l_2}{l_2}\right)R = \left(\frac{560 - 500}{500}\right)10$$

$$= \frac{60}{500} \times 10 = \frac{6}{5} = 1.2\ \Omega.$$

120. (a) $H = \dfrac{R}{4}\tan\theta \Rightarrow H = \dfrac{2H}{4}\tan\theta \Rightarrow \tan\theta = 2$

So, $\sin\theta = \dfrac{2}{\sqrt{5}}$ and $\cos\theta = \dfrac{1}{\sqrt{5}}$

Then, Range $= \dfrac{v^2 \sin 2\theta}{g} = \dfrac{v^2 \,.\, 2\sin\theta\cos\theta}{g}$

$$= \frac{v^2 \times 2 \times \frac{2}{\sqrt{5}} \times \frac{1}{\sqrt{5}}}{g} = \frac{4v^2}{g}.$$

CHEMISTRY

121. (a) For isoelectronic set of ions greater the charge on cation smaller will be its size and greater the size on anion larger will be its size. Hence, the order of ionic radii will be

$Mg^{2+} < Na^{+} < Cl^{-} < S^{2-}$.

122. (c) Antibiotics have either killing effect or a static (inhibitory) effect on microbes.

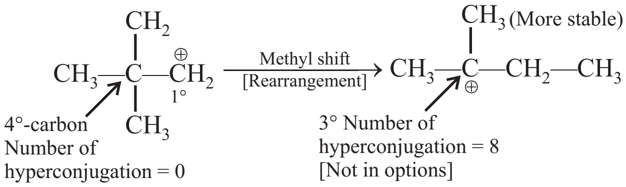
Bactericidal antibiotics are:

Penicillin ofloxacin etc.

Bacteriostatic antibiotics are:

tetracycline, chloramphenicol etc.

123. (N)



124. (d) Sucralose is trichloro derivative of sucrose. It is an artificial sweetening agent which is stable at cooking temperature and does not provide calories.

125. (d) Bond order, $= \frac{N_b - N_a}{2}$

Bond order of N_2 ($14e^-$): BO $= \frac{10-4}{2} = 3$

Bond order of O_2^{2-} ($18e^-$): BO $= \frac{10-8}{2} = 1$

Bond order of NO^+ ($14e^-$): BO $= \frac{10-4}{2} = 3$

Bond order of F_2($18e^-$): BO $= \frac{10-8}{2} = 1$

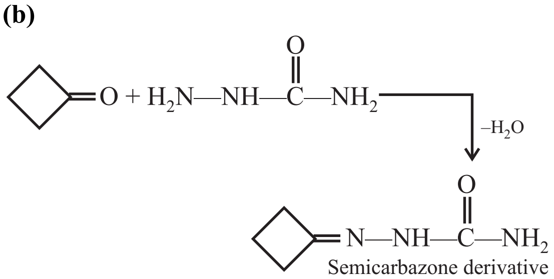
Bond order of N_2^{2-} ($16e^-$): BO $= \frac{10-6}{2} = 2$

Bond order of O_2^- ($17e^-$): BO $= \frac{10-7}{2} = 1.5$

Bond oder of CO ($14e^-$): BO $= \frac{10-4}{2} = 3$

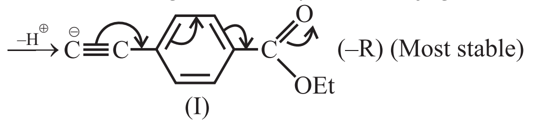
Hence, (N_2, CO, NO^+) have similar bond order, 3.

126. (b)

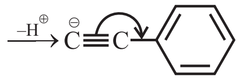


Semicarbazone derivative
of cyclobutaone

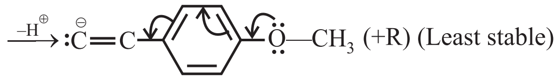
127. (b) Acidic strength of an acid can be predicted by determining the stability of its conjugated base.



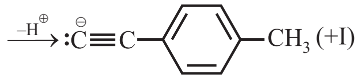
(I)



(II)



(III)



(IV)

Electron with drawing group (– *R*) stabilise carbanions but Electron donating groups (+*R* > + *I*) destabillise carbanions.

A stronger acid produces stable conjugate base. So, the order of acidity will be

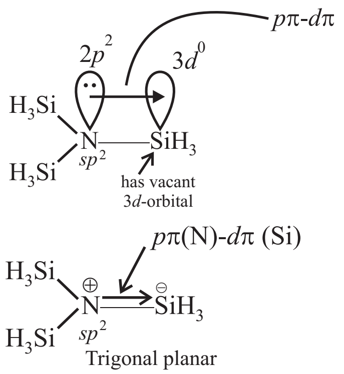
(*i*) > (*ii*) > (*iv*) > (*iii*).

128. (b) Strength of hydrogen bonding depends on the electronegativity of elements. Here, only H_2O will give strongest H-bonding.

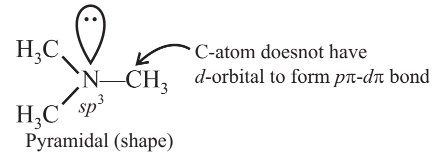
HI and H_2S cannot make H-bonds. In HCl, H-bonding is very weak in nature.

129. (b)

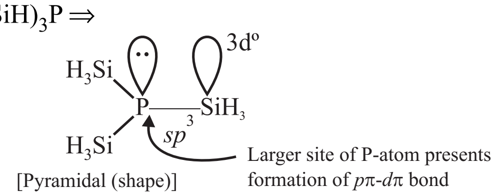
$N(SiH_3)_3 \Rightarrow$



$Me_3N \Rightarrow$



$(SiH)_3P \Rightarrow$



130. (a) $p_{\text{total}} = p_A + p_B + p_C$ (According to Dalton's law)

$\Rightarrow p_C = p_{\text{total}} - (p_A + p_B) = 10 - (3 + 1) = 6$ atm

$\Rightarrow p_C = X_C \cdot p_{\text{total}}$

$$\Rightarrow p_C = \frac{n_C}{n_A + n_B + n_C} \times p_{\text{total}}$$

$$\Rightarrow \frac{6}{10} \times 10 = n_C$$

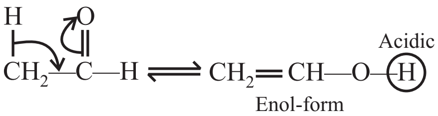
$\Rightarrow n_C = 6.$

Weight of C is the mixture $= n_C \times$ molar mass of $C = 6 \times 2 = 12$ g.

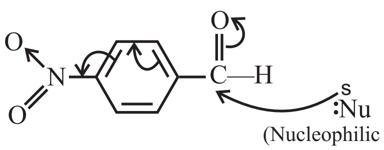
131. (d) (A) Reactivity of aromatic aldehyde and ketones is less than aliphatic carbonyl compound due to steric hindrance caused due to bulkier aryl group.

(B) Fehling's solution is being a very mild oxidising agent, benzaldehyde does not respond to it.

(C) Ethanal on tautomerisation produces its enol form.



(D) Because of the presence of $—NO_2$ group at *para* position (– R effect), the carbon atom. (sp^2) of $>C=O$ group becomes more susceptible for nucleophilic attack because the sp^2 carbon gains more partial positive charge.



(Nucleophilic addition)

132. (c) $Ni(OH)_2 \rightleftharpoons \underset{s\text{ mol/L}}{Ni^{2+}} + \underset{2s\text{ mol/L}}{2OH^-}$

$\Rightarrow K_{sp} = [Ni^{2+}][OH^-]^2 = s \times (2s)^2 = 4s^3$

2×10^{-15} (mol/L)$^3 = 4s^3$

$$\Rightarrow s = \left(\frac{2}{4} \times 10^{-15}\right)^{1/3} = 7.9 \times 10^{-6} = 8 \times 10^{-6} \text{ mol/L}$$

$[OH^-] = 2s = 2 \times 8 \times 10^{-6}$ mol/L

pOH = 6 – log 16 = 4.983 $\simeq$ 5

$\therefore$ pH = 14 – pOH = 14 – 5 = 9 at 25°C.

133. (c) Electronic configuration of boron ($Z = 5$); [He] $2s^2 2p^1$. First ionisation will take place from unpaired p^1-electron. $2p^1$-electron of B experience lesser nuclear attractive force for ionisation.

Removal of electron takes place from paired $2s^2$-electrons which requires more energy.

Electronic configuration of Be ($Z = 4$) : [He]$2s^2$.

134. (d) PbO_2 is weakly basic in nature. In PbO_2, Pb is in + 4 which is less stable than its + 2 oxidation state because of inert pair effect.

Hence, Pb^{4+} of PbO_2 has a tendency to be reduced into more stable Pb^{2+} (PbO) showing strong oxidising nature of PbO_2.

135. (a) 1 mole of O_2 gas $= 6.022 \times 10^{23}$ molecules of O_2

= 32 g of O_2

= 22.4 L of O_2 at STP.

136. (d) The temperature dependence of the rate of a chemical reaction can be explained by Arrhenius equation,

$k = A \,.\, e^{E_a/RT}$

Taking ln on both side

$$\Rightarrow \ln k = \ln A - \frac{E_a}{RT}$$

$$\Rightarrow \frac{E_a}{RT} = \ln A - \ln k.$$

137. (c) For orange radiation of $\lambda = 6300$ Å

$= 63 \times 10^{-8}$ m

Wave number,

$$\bar{v} = \frac{1}{\lambda} = \frac{1}{63 \times 10^{-8}\text{ m}} = 1.587 \times 10^6 \text{ m}^{-1}$$

$$\text{Frequency,} \quad v = \frac{c}{\lambda} = \frac{3 \times 10^8 \text{ m s}^{-1}}{63 \times 10^{-8} \text{ m}}$$

$= 4.761 \times 10^{14}$ s^{-1}.

138. (b) Carbon free radical is sp^2 hybridised and is triangular planar. the given reaction is the chain termination step of a free radical substitution reaction. Here, the trigonal planar free radical $(C_2H_5—\dot{C}H—CH_3)$ gets attracked by Cl^- with equal ease of retention and inversion in configuration. So, the final product is the equimolar mixture of d- and l-forms called racemic mixture, which is optically inactive.

139. (c) Relative lowering in vapour pressure

$$= \frac{(p^\circ - p)}{p^\circ} = X_A$$

[Given $p^\circ = 760$ torr. Let, d water = 1 g/mL $\therefore$ 54 mL = 54 g water]

$$\Rightarrow X_A = \frac{n_A}{n_A + n_{H_2O}}$$

$$\Rightarrow \frac{760 - p}{760} = \frac{\frac{160}{160}}{\frac{160}{160} + \frac{54}{18}} = \frac{1}{4}$$

$$\Rightarrow p = \frac{3}{4} \times 760 = 570 \text{ torr.}$$

140. (c) According to Mendeleev's periodic law "The properties of elements are periodic functions of their atomic weights."

141. (c) Given, density (d) = (1.2 g mL^{-1}),

$$\text{Vol. of sol.} = \frac{\text{mass}}{\text{density}} = \frac{100}{1.2}\ \text{mL}$$

$$\Rightarrow \text{Molarity} = \frac{\text{moles of solute}}{\text{Vol. of solution (in litre)}}$$

$$M = \frac{\text{Given mass} \quad 1000}{\text{Molarmass} \quad V_I(\text{in Litre})}$$

$$M = \frac{40 \times 1.2 \times 1000}{36.5 \times 100} = 13.1\ \text{M.}$$

142. (b) Copper matter is composed of copper sulphite Cu_2S and (Iron Sulphide) FeS.

143. (d) $\therefore$ $\text{Molarity} = \dfrac{W_{NaOH} \quad 1000}{M_{NaOH} \quad V_{solution}(\text{in L})}$

$$= \frac{10 \times 1000}{40 \times 500}\ \text{M} = 0.5\ \text{M.}$$

144. (b) Molecules in gases are in constant random motion with high velocity. Hence, there is a complete disorder of molecules in gases.

145. (b) Let us complete the reactions:

(i) $Fe^{2+} + H_2O_2 \longrightarrow Fe^{3+} + H_2O$

(ii) $Mn^{7+}O_4^- + H^+ + H_2O_2^- \longrightarrow Mn^{2+} + O_2^0 + H_2O$

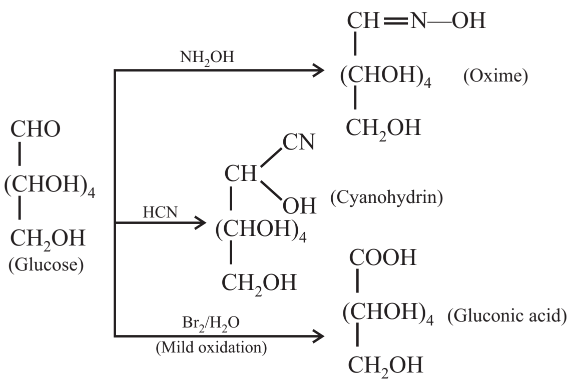
(iii) $I_2^0 + H_2O_2^- + OH^- \longrightarrow I^- + O_2^0 + H_2O$

(iv) $Mn^{2+} + H_2O_2^- \longrightarrow Mn^{4+} + OH^{2-}$

In reactions, (i) and (iv) H_2O_2, acts as oxidising agent and itself gets reduced to H_2O.

146. (d) Glucose does not react with $NaHSO_3$, to form hydrogen sulphide addition product.

Glucose reacts with NH_2OH, HCN and Br_2/H_2O and give oxime, cyanohydrin, gluconic acid respectively.



147. (b) The correct cell representation is

Cd/Cd^{2+} (0.01 M) || Cu^{2+}(0.01 M) | Cu

Given $E_{Cu^{2+}/Cu} = 0.35$ V

$E_{Cd^{2+}/Cd} = -0.4$ V

$$E^\circ_{Cell} = E_{Cu^{2+}/Cu} - E_{Cd^{2+}/Cd} = 0.35 - (-0.4) = 0.75\ \text{V}$$

$$E_{Cell} = E^\circ_{Cell} - \frac{0.059}{2} \log \frac{[Cd^{2+}]}{[Cu^{+2}]}$$

$$E_{Cell} = 0.75 - \frac{0.059}{2} - \log \frac{[0.01]}{[0.01]} \quad (\because \quad \log 1 = 0)$$

$E_{Cell} = 0.75.$

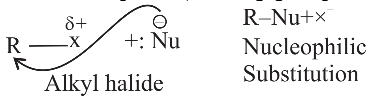
$\Rightarrow E_{cell\ (Observed)} = E_{internal} - E_{external}$ $\begin{Bmatrix} E = V \\ V = IR \end{Bmatrix}$

= 0.75 – (resistance × current)

= 0.75 – (4 × 0.15) = (0.75 – 0.60) V = 0.15 V

148. (a) Alkyl halides readily undergo nucleophilic substitution like S_N2 and S_N1.

Here a stronger nucleophile, $\overset{\ominus}{Nu}$ substitutes a weaker nucleophile (leaving group: X^-) from an alkyl halide.



149. (b) Extensive properties depend on mass of substance volume, enthalpy etc.

Intensive properties does not depend on mass of substance like temperature, pressure and density.

$$\text{where, density} = \frac{\text{mass}}{\text{volume}} = \frac{\text{extensive property}}{\text{extensive property}}$$

= Intensive property.

150. (a) $Cr^{2+} \Rightarrow [Ar]\ 3d^4$, $E^0_{Cr^{3+}/Cr^{2+}} = -0.41$ V

$Mn^{3+} \Rightarrow [Ar]3d^4$, $E^0_{Mn^{3+}/Mn^{2+}} = +1.51$ V

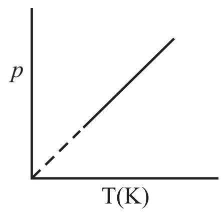
So, reducing power $Cr^{2+} > Mn^{2+}$.

151. (c) Li^+ among group-1 metals and Mg^{2+} of group-2 metals have similar ionic radii Li and Mg react with oxygen to give monoxide Li_2O and MgO respectively with nitrogen they give Li_3N and Mg_3N_2 respectively.

152. (a) Isochores are drawn at constant volume between pressure vs temperature (T, in K) as;

For 1 mole of an ideal gas, $pV = RT$

At isochoric condition, $p \propto T$.

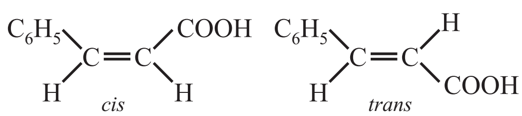


153. (b) In hydroxyl ion, $H\text{–}\ddot{\underset{..}{O}}\!:$

3 lone pair of electrons are present on oxygen atom of hydroxyl ion.

154. (c) The insecticide, DDT is a non-biodegradable pollutant.

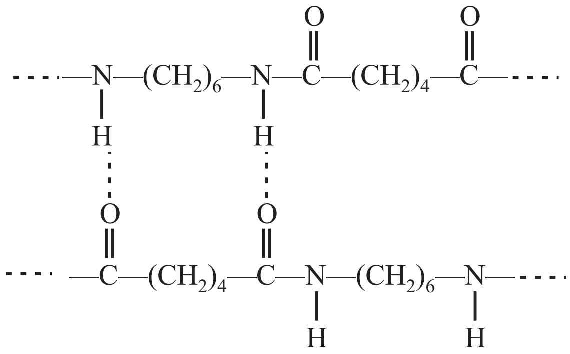
155. (d) Cinnamic acid is able to show geometrical isometrism.



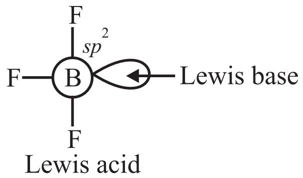
No olefinic C═C is present in butyric acid, aspartic acid and palmitic acid.

156. (b) Polyvinyl chloride, neoprene and teflon are addition homopolymers. They do not have suitable N-atoms to show H-bonding.

Nylon-6, 6 is a polyamide formed by condensation polymerisation of hexamethylene diamine and adipic acid. In which H-bonds are present:



157. (c) B in BF_3 has incomplete octet and thus it is electron deficiency due to which it can accept lone-pair of electrons and acts as Lewis acid.



158. (b) The field strength order of the ligands is

$H_2O < NH_3 < NO_2^-$

So, the order of CFSE values:

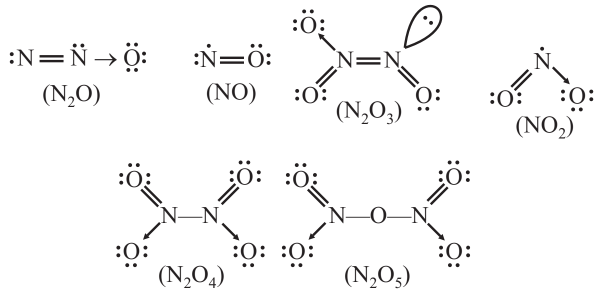
$[Ni(H_2O)_6]^{2+} < [Ni(NH_3)_6]^{2+} < [Ni(NO_2)_6]^{4-}$

We know, $E = \dfrac{hc}{\lambda}$ or $E \propto \dfrac{1}{\lambda}$

Hence, the order of wavelength of absorption in visible region will be,

$[Ni(H_2O)_6]^{2+} > [Ni(NH_3)_6]^{2+} > [Ni(NO_2)_6]^{4-}$

159. (b) NO and NO_2 are



N_2O, N_2O_3, N_2O_4, N_2O_5 do not have unpaired electrons. So, they are diamagnetic

160. (c) BF_3 is used as a catalyst in several industrial processes due to its strong Lewis acid nature.

BF_3 has sp^2 hybridisation and is electron incomplete octet.