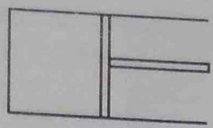
15. n moles of a gas filled in a container at temperature T is in equilibrium initially. If the gas is compressed slowly and isothermally to half itsinitial volume the work done by the atmosphere on the piston is:



(1) $\frac{nRT}{2}$ (2) $-\frac{nRT}{2}$ (3) $nRT\left(\ell n\, 2-\frac{1}{2}\right)$ (4) $-nRT\, ln\, 2$

16. A particle is projected at time t = 0 from a point P on the ground with a speed V_0, at an angle of 45° to the horizontal. What is the magnitude of the angular momentum of the particle about P at time t= v_0/g.

(1) $\frac{mv_0^2}{2\sqrt{2}g}$ (2) $\frac{mv_0^3}{\sqrt{2}g}$ (3) $\frac{mv_0^2}{\sqrt{2}g}$ (4) $\frac{mv_0^3}{2\sqrt{2}g}$

17. A particle performs SHM of amplitude A and angular frequency $\omega = \frac{2\pi}{T}$. The speed of the particle at time $\frac{T}{4}$ after crossing the extreme position is

(1) 0 (2) $\frac{\sqrt{3}}{2}\omega A$ (3) $\frac{\omega A}{2}$ (4) ωA

18. Heat required to vaporize 4g of water by boiling at 373 K is 2160 calories. The specific heat of water in this condition is :
(1) 0.36 cal/g-K (2) 5.4 cal/g-K (3) zero (4) infinity

19. **STATEMENT-1 :** The rate at which energy is being delivered to a light bulb is higher after it has been on for a few seconds than just after it is turned on.
STATEMENT-2 : As the filaments warms up, its resistance rises and the current falls.
(1) Statement-1 is True, Statement-2 is True; Statement-2 is a correct explanation for Statement-1.
(2) Statement-1 is True, Statement-2 is True; Statement-2 is NOT a correct explanation for Statement-1
(3) Statement-1 is True, Statement-2 is False
(4) Statement-1 is False, Statement-2 is True

20. A uniform magnetic field exists in region given by $\vec{B} = 3\hat{i}+4\hat{j}+5\hat{k}$. A rod of length 5 m is placed along y–axis is moved along x–axis with constant speed 1 m/sec. Then induced e.m.f. in the rod will be:
(1) zero (2) 25 volt (3) 20 volt (4) 15 volt

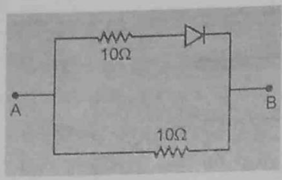
21. A double-slit arrangement produces interference fringes that are 0.25° apart using wavelength 600 nm. If angular separation is increased to 0.3° by changing wavelength of the light used, then the new wavelength must be :
(1) 480 nm (2) 540 nm (3) 720 nm (4) 840 nm.

22. The AM wave contains three frequencies, viz :

(1) $\frac{f_c}{2}, \frac{f_c+f_s}{2}, \frac{f_c-f_s}{2}$ (2) $2f_c$, $2(f_c + f_s)$, $2(f_c - f_s)$
(3) f_c, $(f_c + f_s)$, $(f_c - f_s)$ (4) f_c , f_c, f_c

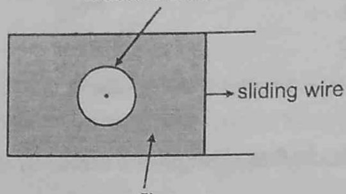
23. Consider atoms H, He^+, Li^{++} in their ground states. If L_1, L_2 and L_3 are magnitude of angular momentum of their electrons about the nucleus respectively then :
(1) $L_1 = L_2 = L_3$ (2) $L_1 > L_2 > L_3$ (3) $L_1 < L_2 < L_3$ (4) $L_1 = L_2 = L_3$

24. If V_A and V_B denote the potentials of A and B, then the equivalent re sistance between A and B in the adjoint electric circuit is-



(1) 10 ohm if $V_A > V_B$ (2) 5 ohm if $V_A < V_B$ (3) 5 ohm if $V_A > V_B$ (4) 20 ohm if $V_A > V_B$

25 The figure shows a soap film in which a closed elastic thread is lying. The film inside the thread is pricked. Now the sliding wire is moved out so that the surface area increases. The radius of the circle formed by elastic thread will



(1) increase (2) decrease (3) remain same (4) data insufficient

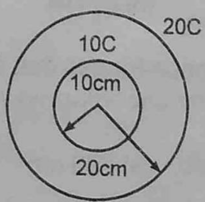
26. If first excitation potential of a hydrogen like atom is V electron volt, then the ionization energy of this atom will be:

(1) V electron volt (2) $\frac{3V}{4}$ electron volt

(3) $\frac{4V}{3}$ electron volt (4) cannot be calculated by given information.

27. A point object 'O' is at the centre of curvature of a concave mirror. The mirror starts to move at a speed u, in a direction perpendicular to the principal axis. Then the initial velocity of the image is:
(1) 2 u, in the direction opposite to that of mirror's velocity
(2) 2 u, in the direction same as that of mirror's velocity
(3) zero
(4) u, in the direction same as that of mirror's velocity.

28. Two concentric uniformly charged spheres of radius 10 cm & 20 cm are arranged as shown in the figure. Potential difference between the spheres is :



(1) 4.5×10^{11} V (2) 2.7×10^{11} V (3) 0 (4) none of these

29. A charged particle is accelerated through a potential difference of 24 kV and acquires a speed of 2×10^6 m/s. It is then injected perpendicularly into a magnetic field of strength 0.2 T. Then the radius of the circle described by it is ?
(1) 6 cm (2) 12 cm (3) 18 cm (4) 30 cm

30. Electric flux through a surface of area 100 m^2 lying in the xy plane is (in V-m) if $\vec{E} = \hat{i} + \sqrt{2}\,\hat{j} + \sqrt{3}\,\hat{k}$
(1) 100 (2) 141.4 (3) 173.2 (4) 200

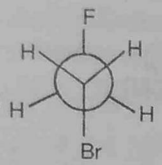
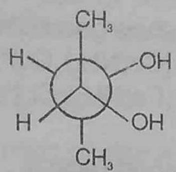
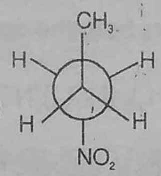
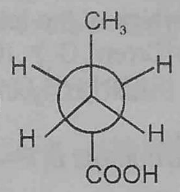
PART-B (CHEMISTRY)

31. Which of the following is the non-reducing sugar ?
(1) Glucose (2) Fructose (3) Lactose (4) Sucrose

32. XeF_6 on complete hydrolysis gives :
(1) Xe (2) XeO_2 (3) XeO_3 (4) XeO_4

33. Which one of the following represents the incorrect order of bond angles ?
(1) $IO_3^- > BrO_3^- > ClO_3^-$ (2) $NO_2^+ > NO_2 > NO_2^-$
(3) $BCl_3 > PCl_3 > AsCl_3 > BiCl_3$ (4) $ClO_2 > H_2O > H_2S > SF_6$

34. Which of the following is the least polar and most stable conformer as compared to its other conformers ?

(1)  (2)  (3)  (4) 

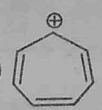
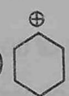
35. The percentage of P_2O_3 in H_3PO_3 is :
(1) 67.07 (2) 33.52 (3) 44.69 (4) 50.04

36. General electronic configuration of lanthanides is:
(1) $(n-2)\ f^{1-14}\ (n-1)s^2\ p^6\ d^{0-1}\ ns^2$ (2) $(n-2)\ f^{10-14}\ (n-1)d^{0-1}\ ns^2$
(3) $(n-2)\ f^{0-14}\ (n-1)\ d^{10}\ ns^2$ (4) $(n-2)\ d^{0-1}\ (n-1)\ f^{1-14}\ ns^2$

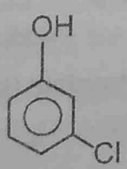
37. A catalyst lowers the energy of activation by 25%, temperature at which rate of uncatalysed reaction will be equal to that of the catalysed one at 27°C is :
(1) 400°C (2) 127°C (3) 300°C (4) 227°C

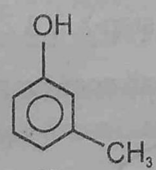
38. The heat evolved from the combustion of carbon is used to heat water. Assuming 50% efficiency, calculate mole of water vaporized at its boiling point if $\Delta H_f\ (CO_2) = -94$ Kcal/mol and $\Delta H_{vap}\ (H_2O) = 9.6$ kcal/mol and 6g C is undergoing combustion.
(1) 1.21 mole (2) 2.42 mole (3) 4.89 mole (4) 9.7 mole

39. The most stable carbocation is

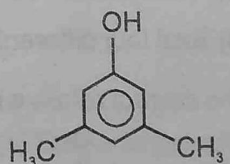
(1)  (2)  (3)  (4) 

40. The correct reactivity order of following compounds towards Br_2 / H_2O is :


I


II


III


IV

(1) I > III > II > IV (2) IV > II > III > I (3) IV > III > II > I (4) III > IV > II > I

41. In which one of the following pairs of species, both the species do not have all bond lengths (i.e. central atom to substituent) identical ?
(1) XeF_4, SF_4 (2) CCl_4, ICl_4^- (3) NH_4^+, SiH_4 (4) XeO_4, SO_4^{2-}

42. An electron, a proton and an alpha particle have kinetic energies of 16E, 4E and E respectively. What is the quantitative order of their de-Broglie wavelengths ?
(1) $\lambda_e > \lambda_p = \lambda_\alpha$ (2) $\lambda_p = \lambda_\alpha = \lambda_e$ (3) $\lambda_p > \lambda_e > \lambda_\alpha$ (4) $\lambda_e > \lambda_\alpha > \lambda_p$

43. Match list I with list II. Choose the correct matching codes from the choices given :

	List I		List II
(a)	Ionic hydride	(p)	NH_3
(b)	Electron rich covalent hydride	(q)	CH_4
(c)	Electron precise covalent hydride	(r)	$TiH_{1.73}$
(d)	Electron deficient covalent hydride	(s)	B_2H_6
		(t)	CaH_2

(1) (a-t), (b-p), (c-q), (d-s) (2) (a-t), (b-p), (c-r), (d-s)
(3) (a-r), (b-p), (c-q), (d-s) (4) (a-s), (b-p), (c-q), (d-t)

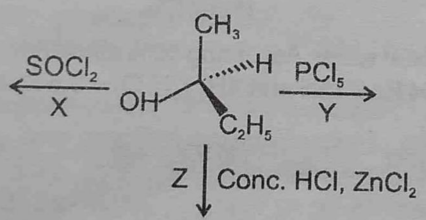
44. Which solution will show the maximum vapour pressure at 300 K.
(1) 1 M NaCl (2) 1 M $AlCl_3$ (3) 1 M $CaCl_2$ (4) 1 M $C_{12}H_{22}O_{11}$

45. In which of the following pairs both the complexes show geometrical isomerism ?
(1) $[Cr(en)_2Cl_2]^+$, $[Cr(en)_3]^{3+}$ (2) $[Co(NH_3)_4Cl_2]^+$, $[Co(en)_2Cl_2]^+$
(3) $[Pt(NH_3)(H_2O)Cl_2]$, $[Co(NH_3)_5(NO_2)](NO_3)_2$ (4) $[Fe(NH_3)_4Cl_2]^+$, $[Fe(NH_3)(CN)_5]^{2-}$

46. The number of P—O—P bonds in tricyclic metaphosphoric acid is :
(1) zero (2) two (3) three (4) four

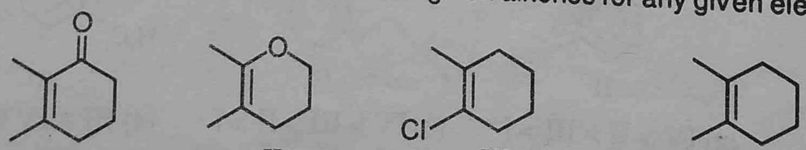
47. A solid has a b.c.c. structure. If the distance of closest approach between the two atoms is 1.73 Å. The edge length of the cell is ;
(1) $\sqrt{2}$ pm (2) $\sqrt{(3/2)}$ pm (3) 200 pm (4) 142.2 pm

48. **Incorrect** statement for the given reactions is ?



(1) Retention of configuration in the product of step - X
(2) Inversion of configuration in the product of step-Y
(3) Recemisation takes place in the products of step - Z
(4) Total four different products are obtained in the step-X, Y & Z.

49. The correct relative rate of reaction of the given alkenes for any given electrophile is :



I II III IV

(1) I > II > IV > III (2) II > IV > III > I (3) II > III > IV > I (4) IV > I > III > II

50. An alloy of A, B and C is found to have A constiting CCP lattice. If B atoms occoupy each edge center and C is present of body centre, the alloy has formula :
(1) A_4B_2C (2) A_4B_3C (3) A_4B_4C (4) A_2B_2C

51. Amongst the following, the total number of species which does/do not exist is :
SF_6, BF_6^{3-}, SF_4, OF_4, AlF_6^{3-}, PH_5, PCl_5, NCl_5, SCl_6
(1) 9 (2) 5 (3) 6 (4) 8

52. Use the standard potentials of the couples Au^+/Au (+1.69 V), Au^{3+}/Au (+1.40 V), and Fe^{3+}/Fe^{2+} (+0.77 V) to calculate the equilibrium constant for the reaction $2Fe^{2+}(aq) + Au^{3+}(aq) \longleftrightarrow 2Fe^{3+}(aq) + Au^{+}(aq)$.

$$2Fe^{2+}(aq) + Au^{3+}(aq) \longleftrightarrow 2Fe^{3+}(aq) + Au^{+}(aq)$$

(1) 4×10^{16} (2) 8×10^{8} (3) 4×10^{-16} (4) 1×10^{14}

53. Which of the following statements is incorrect ?
(1) Both$[Ti(H_2O)_6]Cl_3$ and $[Ni(H_2O)_6]Cl_2$ are coloured solutions.
(2) Removal of water from$[Ti(H_2O)_6]Cl_3$ on heating renders it colourless.
(3) The metal carbon bond in metal carbonyls possess both s and p character.
(4) The M–C π bond in metal carbonyl is formed by the donation of a pair of electrons from the carbon monoxide into a vacant orbital of the metal.

54. Gaseous cyclobutane isomerizes to butadiene following first order process which has half life of 150.5 minute at certain temperature. How long will take for the process to occur to the extent of 40% at the same temperature ?
(1) 103 minutes (2) 121 minutes (3) 111 minutes (4) None of these

55. Which of the following properties of elements of alkaline earth metals does not increase with increasing atomic number ?
(1) Solubility of hydroxide (2) Reactivity with water
(3) Ist ionisation enthalpy (4) Stability of carbonate

56. Which of the following complexes shows a spin-only magnetic moment of 3.87 B.M. is :
(1) $[Co(CO)_4]^-$ (2) $[Co(CN)_4]^{4-}$ (3) $[CoCl_4]^{2-}$ (4) $[Co(PMe_3)_4]$

57. (X) is the product of cross aldol condensation between benzaldehyde (C_6H_5CHO) and acetone What is the structure of X ?

(1) $C_6H_5-CH=CH-\overset{O}{\overset{\|}{C}}-CH_3$ (2) $C_6H_5-CH=C(CH_3)_2$

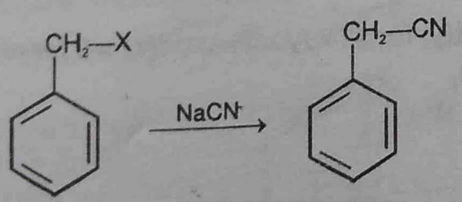
(3) $C_6H_5-\overset{O}{\overset{\|}{C}}-CH_2-\overset{O}{\overset{\|}{C}}-CH_3$ (4) $C_6H_5-CH=CH-\overset{OH}{\overset{|}{C}H}-CH_3$

58. In the reaction sequence which statement is correct :

$$CH_3-\overset{O}{\overset{\|}{C}}-H \xrightarrow[\ominus OH]{HCN} (A) \xrightarrow[\Delta]{H_2O/\overset{\oplus}{H}} \text{Product } (B)$$

(1) Product (A) is α-amino acid.
(2) Product (B) is α-hydroxy amide.
(3) Product (B) is racemic mixture of α-hydroxy acid.
(4) Product (A) are diastereoisomers of cyanohydrin.

59. Adsorption of gases on solid surface is generally exothermic because.
(1) Enthalpy is positive (2) Entropy decreases (3) Entropy increases (4) Free energy increase

60. 

In the given reaction rate is fastest, when (X) is :

(1) $-OH$ (2) $-NH_2$ (3) $-\overset{O}{\overset{\|}{\underset{O}{\underset{\|}{S}}}}-OCH_3$ (4) $-O-\overset{O}{\overset{\|}{\underset{O}{\underset{\|}{S}}}}-CH_3$

PART - C (MATHEMATICS)

61. If in a ΔABC, B is the orthocenter and if circumcenter of ΔABC is (2, 4) and vertex A is (0, 0) then coordinate of vertex C is
(1) (4, 2) (2) (4, 8) (3) (8, 4) (4) (8, 2)

62. If the locus of the mid-points of the chords of the circle $x^2 + y^2 = 4$ such that the segment intercepted by the chord on the curve $x^2 = a(x + y)$ subtends a right angle at origin is $x^2 + y^2 = 2(x + y)$, then the value of 'a' is
(1) 5 (2) – 2 (3) 2 (4) 3

63. Shortest distance of curve $2x^2 + 5xy + 2y^2 = 1$ from origin is
(1) $\frac{2}{3}$ (2) $\frac{2}{\sqrt{3}}$ (3) $\frac{3}{2}$ (4) $\frac{\sqrt{2}}{3}$

64. If $\omega \neq 1$ is a cube root of unity, then sum of series
$S = 1 + 2\omega + 3\omega^2 + ... + 3n\omega^{3n-1}$ $(n \in N)$ is -
(1) $\frac{n}{\omega - 1}$ (2) $3n(\omega^2 - 1)$ (3) 0 (4) None of these

65. If LL′ be the latus rectum through the focus S of a hyperbola and A be the farther vertex of the conic. If $\Delta ALL'$ is equilateral then its eccentricity is
(1) $\sqrt{3}$ (2) $\sqrt{3} + 1$ (3) $(\sqrt{3} + 1)/\sqrt{2}$ (4) $(\sqrt{3} + 1)/\sqrt{3}$

66. Shortest distance between lines
$\frac{x-3}{3} = \frac{y-8}{-1} = \frac{z-3}{1}$ and $\frac{x+3}{-3} = \frac{y+7}{2} = \frac{z-6}{4}$
(1) $\sqrt{30}$ (2) $2\sqrt{30}$ (3) $5\sqrt{30}$ (4) $3\sqrt{30}$

67. The function f(x) is defined for all real x, if $f(x + y) = f\left(\frac{xy}{4}\right)$ $\forall$ x , y and $f(-4) = -4$, then f(2011) is
(1) 2010 (2) 2012 (3) 4 (4) – 4

68. The value of $\lim_{x \to 0} \frac{2-(256-7x)^{1/8}}{(5x+32)^{1/5}-2}$ is-
(1) $\frac{2}{53}$ (2) $\frac{7}{64}$ (3) $\frac{3}{71}$ (4) $\frac{5}{7}$

69. A function $f : R \to R$ satisfies the equation $f(x + y) = f(x) f(y)$ for all $x, y \in R$ and $f(x) \neq 0$ for any x in R. Let function be differentiable at x = 0 and $f'(0) = 2$. Then
(1) f(x) is continuous at x = 0
(2) $f(x) = 2e^x$
(3) f(x) is not differentiable at infinitely many points
(4) none of these

70. If $y = f(x)$ make positive intercepts of 2 and 1 unit on x and y coordinate axes and encloses an area of $\frac{3}{4}$ square units with the axes, then $\int_0^2 x f'(x)\, dx$ is

(1) $\frac{3}{2}$ (2) 1 (3) $\frac{5}{4}$ (4) $-\frac{3}{4}$

71. Value of x which satisfy $\log_{1/4}[\log_2(x+2)] > 0$ and $|x-1| + |x-2| < 2$ is -

(1) $(-1, 0)$ (2) $(-1, 0) \cup \left(\frac{1}{2}, \frac{5}{2}\right)$ (3) $\left(\frac{1}{2}, \frac{5}{2}\right)$ (4) ϕ

72. **Statement-1 :** Orthocenter of Δ where vertices are $(8, -2)$, $(2, -2)$ & $(8, 6)$ is $(2, -2)$
Statement-2 : If Δ is right angle Δ then orthocenter of Δ is a vertex having angle $90°$
(1) Statement-1 is True, Statement-2 is True; Statement-2 is a correct explanation for Statement-1.
(2) Statement-1 is True, Statement-2 is True; Statement-2 is NOT a correct explanation for Statement-1
(3) Statement-1 is True, Statement-2 is False
(4) Statement-1 is False, Statement-2 is True

73. If $(1 + 3x - 2x^2)^{20} = a_0 + a_1x + a_2x^2 + \ldots\ldots a_{40}$, then the value of $a_1 + a_2 + a_3 + \ldots\ldots + a_{39}$ is
(1) -1 (2) $+1$ (3) 0 (4) 2^{20}

74. If the distances of the vertices of a triangle from the point of contact of the incricle with the sides be α, β, γ then r is equal to (where r = inradius)

(1) $\frac{\alpha\beta\gamma}{\alpha+\beta+\gamma}$ (2) $\sqrt{\frac{\alpha\beta\gamma}{\alpha+\beta+\gamma}}$ (3) $\frac{\alpha\beta\gamma}{\alpha\beta+\beta\gamma+\gamma\alpha}$ (4) none of these

75. The image of the point $P(\alpha, \beta, \gamma)$ by the plane $\ell x + my + nz = 0$ is $Q(\alpha', \beta', \gamma')$ then
(1) $\alpha^2 + \beta^2 + \gamma^2 = \ell^2 + m^2 + n^2$ (2) $\alpha^2 + \beta^2 + \gamma^2 = (\alpha')^2 + (\beta')^2 + (\gamma')^2$
(3) $\alpha\alpha' + \beta\beta' + \gamma\gamma' = 0$ (4) $\ell(\alpha - \alpha') + m(\beta - \beta') + n(\gamma - \gamma') = 0$

76. The expression $\tan\theta + 2\tan 2\theta + 2^2\tan 2^2\theta + \ldots + 2^{14}\tan 2^{14}\theta + 2^{15}\cot 2^{15}\theta$ is equal to -
(1) $2^{16}\tan 2^{16}\theta$ (2) $\tan\theta$ (3) $\cot\theta$ (4) $2^{16}[\tan(2^{16}\theta) + \cot(2^{16}\theta)]$

77. $\tan^{-1}\frac{1}{1+x(x+1)} + \tan^{-1}\frac{1}{1+(x+1)(x+2)} + \tan^{-1}\frac{1}{1+(x+2)(x+3)} + \ldots\ldots$ upto n terms is equal to
(1) $\tan^{-1}x$ (2) $\tan^{-1}(x+n)$
(3) $\tan^{-1}(x+n) - \tan^{-1}x$ (4) $n\tan^{-1}x$

78. If $x > 1$, the sum $1 + 3\left(1-\frac{1}{x}\right) + 5\left(1-\frac{1}{x}\right)^2 + 7\left(1-\frac{1}{x}\right)^3 + \ldots\ldots\infty$ is
(1) $2x - x^2$ (2) $2x^2 - x$ (3) $x^2 - x$ (4) $x - x^2$

79. The number of non negative integral solutions of $x + y + z \le n$, where $n \in N$ is
(1) ${}^{n+3}C_3$ (2) ${}^{n+2}C_3$ (3) ${}^{n+3}C_2$ (4) ${}^{n+3}C_4$

80. **Statement 1 :** Let $f(x) = 2 . \tan^{-1}\frac{1-x}{1+x}$ on [0, 1], then the range of $f = \left[0, \frac{\pi}{2}\right]$.

Statement 2 : f decreases from $\frac{\pi}{4}$ to 0.

(1) Statement-1 is True, Statement-2 is True; Statement-2 is a correct explanation for Statement-1.
(2) Statement-1 is True, Statement-2 is True; Statement-2 is NOT a correct explanation for Statement-1
(3) Statement-1 is True, Statement-2 is False
(4) Statement-1 is False, Statement-2 is True

81. In how many ways can 5 rings be worn on four finger if any no. of rings can be wron on any finger:
(1) 625 (2) 1024 (3) 125 (4) 512

82. A boat is to be driven 300 km at a constant speed of x kmph. Speed rules required $25 \le x \le 60$. The full cost Rs. 10 per litre and is consumed at the rate of $2 + \frac{x^2}{600}$ liters/hour the wages of the driver is Rs. 200/hour. The most economical speed to drive the boat in kmph, is
(1) 50 (2) $50\sqrt{3}$ (3) $20\sqrt{3}$ (4) 60

83. $\int_0^1 \frac{x^{\cos\alpha}-1}{\ell nx}dx$ where $\alpha \ne (2n+1)\pi$ is
(1) $\ell n(1-\sin\alpha)$ (2) $\ell n(1+\sin\alpha)$ (3) $\ell n(1-\cos2)$ (4) $\ell n(1+\cos\alpha)$

84. The value of $\lim_{x\to0}\frac{(1+x)^{1/x}-e+\frac{ex}{2}}{11x^2}$ is equal to–
(1) $\frac{5}{24}e$ (2) 0 (3) $\frac{11}{24}e$ (4) $\frac{e}{24}$

85. If $f(x) = x^n$ then

$f(1) + \frac{f'(1)}{1!} + \frac{f''(1)}{2!} + ... + \frac{f^n(1)}{n!}$ is equal to
(1) n (2) 2^n (3) 2^{n-1} (4) $\frac{n(n+1)}{2}$

86. The solution of the differential equation $(1+y^2)dx = (\tan^{-1}y - x)\,dy$ is
(1) $xe^{\tan^{-1}y} = e^{\tan^{-1}y}(\tan^{-1}y-1)+c$ (2) $xe^{\tan^{-1}y}(\tan^{-1}y+1) = c$
(3) $xe^{\tan^{-1}y}(\tan^{-1}y-1) = c$ (4) None of these

87. There are 4 white and 5 black ball in a Box. In an another box there are 5 white and 4 black balls. An unbiased die is rolled. If it shows even no. then a ball is drawn from the second box otherwise from first box. If the ball drawn is white then the probability that the ball was drawn from the first box is

(1) $\frac{5}{9}$ (2) $\frac{4}{9}$ (3) $\frac{7}{9}$ (4) $\frac{1}{9}$

88. If the matrix $A = \begin{bmatrix} 0 & 2b & c \\ a & b & -c \\ a & -b & c \end{bmatrix}$ is an orthogonal matrix, then

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

89. The equation $\sin x - \frac{\pi}{2} + 1 = 0$ has root/roots in the interval -

(1) $\left(0, \frac{\pi}{2}\right)$ (2) $\left(-\frac{\pi}{2}, \pi\right)$ (3) $\left(\pi, \frac{3\pi}{2}\right)$ (4) none of these

90. **Statement -1 :** Let $I_n = \int_0^1 (1-x^5)^n dx$. Then $\frac{I_{10}}{I_{11}} = \frac{55}{54}$

Statement-2 : If u(x) and v(x) are differentiable functions then $\int uv\,dv = u\int v\,dx - \int\left(\frac{du}{dx}\int v dx\right)dx$.

(1) Statement-1 is True, Statement-2 is True; Statement-2 is a correct explanation for Statement-1.
(2) Statement-1 is True, Statement-2 is True; Statement-2 is NOT a correct explanation for Statement-1
(3) Statement-1 is True, Statement-2 is False
(4) Statement-1 is False, Statement-2 is True

Answers

1.	(2)	2.	(1)	3.	(2)	4	(3)	5.	(3)	6.	(3)	7.	(1)
8.	(4)	9.	(2)	10.	(2)	11.	(1)	12.	(2)	13.	(2)	14.	(2)
15.	(1)	16.	(4)	17.	(4)	18.	(4)	19.	(4)	20.	(2)	21.	(3)
22.	(3)	23.	(1)	24.	(3)	25	(3)	26.	(3)	27.	(2)	28.	(1)
29.	(2)	30.	(3)	31.	(4)	32.	(3)	33.	(1)	34.	(1)	35.	(1)
36.	(1)	37.	(2)	38.	(2)	39.	(2)	40.	(2)	41.	(1)	42.	(1)
43.	(1)	44.	(4)	45.	(2)	46.	(3)	47.	(3)	48.	(4)	49.	(2)
50.	(2)	51.	(2)	52.	(1)	53.	(4)	54.	(3)	55.	(3)	56.	(3)
57.	(1)	58.	(3)	59.	(2)	60.	(4)	61.	(2)	62.	(3)	63.	(4)
64.	(2)	65.	(4)	66.	(4)	67.	(4)	68.	(2)	69.	(1)	70.	(4)
71.	(4)	72.	(4)	73.	(1)	74.	(2)	75.	(2)	76.	(3)	77.	(3)
78.	(2)	79.	(1)	80.	(1)	81.	(1)	82.	(4)	83.	(4)	84.	(4)
85.	(2)	86.	(1)	87.	(2)	88.	(3)	89.	(1)	90.	(4)		

HINTS & SOLUTIONS

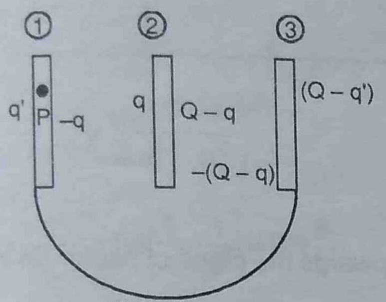
PRACTICE TEST - ONE

PART-A (PHYSICS)

1. The increase in pressure in liquid is given by buoyant force divided by the area of bottom surface.

$$\Delta P = \frac{\rho_L V g}{A} = 1\ \text{N/m}^2$$

2.



As $E_P = 0$

$\therefore$ $q' = Q - q'$

$q' = Q/2$

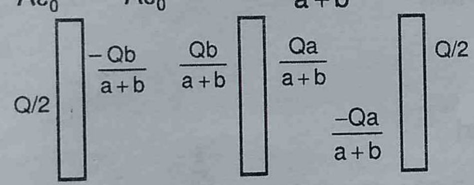
and $Q - q' = Q/2$

Now $V_1 = V_3$

$V_2 - V_1 = V_2 - V_3$

$$\frac{qa}{A\varepsilon_0} = \frac{(Q-q)b}{A\varepsilon_0} \Rightarrow q = \frac{Qb}{a+b}$$

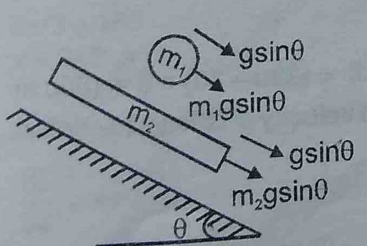
$\therefore$



3. $$a_c = \frac{|\vec{V}|^2}{R} = \frac{(20)^2}{\frac{400}{\pi}} = \pi\ \text{m/s}^2$$

4. $$\frac{m\ell^2}{3} = \frac{m\ell^2}{12} + m\left((x - \frac{\ell}{2})^2 + y^2\right) \qquad \Rightarrow \qquad \left(x - \frac{\ell}{2}\right)^2 + y^2 = \frac{\ell^2}{3} - \frac{\ell^2}{12} = \frac{3\ell^2}{12} = \frac{\ell^2}{4}$$

5.



Neither there is relative motion nor there is tendency of relative motion.

6. Let the gravitational potential energy be zero when spring is at its natural length. Further let H be the height of the water column at natural length of spring. Now if x is the small extension in the spring.

$$\frac{1}{2}kx^2 + (\rho s x)g\left(\frac{H}{2} + \frac{x}{2}\right) + \frac{1}{2}mv^2 = C \Rightarrow \frac{kxdx}{dt} + \rho sgx\frac{dx}{dt} + \rho sg\frac{H}{2}\frac{dx}{dt} + mv\frac{d^2x}{dt^2} = 0 \Rightarrow \omega = \sqrt{\frac{k + \rho sg}{m}}$$

7. $A' = Ae^{-bt/2m}$

$$\frac{A}{e} = Ae^{-bt_0/2m}$$

$$\frac{bt_0}{2m} = 1$$

$$t_0 = \frac{2m}{b} = \frac{2 \times 150}{50} = 6s$$

$$E' = \frac{1}{2}KA^2e^{-bt/m} = \frac{1}{2}KA^2e^{-2}$$

$$\%\text{Loss} = \frac{E - E'}{E} \times 100 = \frac{1 - e^{-2}}{1} \times 100 = \frac{e^2 - 1}{e^2} \times 100$$

8. Magnetic field is increasing with constant rate and its direction is upwards the plane of paper. So induced current will be constant from B to A clockwise

9. $\text{Pitch} = \frac{1}{2}\text{ mm}$

$$\text{least count} = \frac{0.5mm}{50} = 0.01\text{ mm}$$

$$\text{Reading} = [2 \times \frac{1}{2} + 20 \times 0.01 - (-30 \times 0.01)] = 1.5\text{ mm}$$

10. $\Delta\theta = \frac{1.22\lambda}{a} = \frac{1.22 \times 6 \times 10^{-5}}{20\text{cm}}\text{cm} = 0.366 \times 10^{-5}\text{ rad}$

so minimum separation between the stars = $D\Delta\theta = 7.32 \times 10^{-5}$ light years.

11. Velocity of bike $V_b = 30$ m/s
Let velocity of car be V_c

$$f_{obs} = f_{actual} \times \frac{V_{so} + V_b}{V_{so} - V_c}$$

$$120\text{ Hz} = 100\text{ Hz} \times \frac{330 + 30}{330 - V_c}$$

$\Rightarrow V_c = 30$ m/s

Distance between initial and final pulse of horn

$= V_{so} \times \Delta t - V_c\,\Delta t$ (Δt is duration of emission of sound) $= (330 - 30) \times 6 = 1800$ m

This wave train travels with 330 m/s and cross bike rider moving with velocity of 30 m/s towards it.

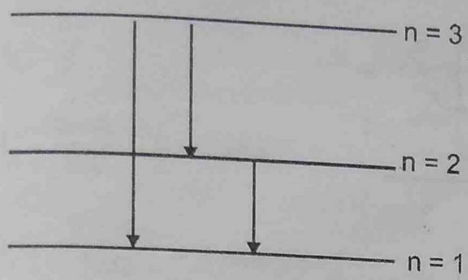
$$\text{time taken} = \frac{\text{length of wave train}}{V_{so} + V_b} = \frac{1800}{330 + 30} = \frac{180}{36} = 5\text{sec}$$

12. $\frac{Q_{in}}{W} = \frac{1}{\frac{T_H}{T_L} - 1} = \frac{T_L}{T_H - T_L} = \frac{270}{30} = 9$

$$W = \frac{Q_{in}}{9} = \frac{1260}{9}\text{ KJ/min} = \frac{1260}{9 \times 60}\text{ KJ/sec.} = \frac{21}{9} = \frac{7}{3}\text{ KJ/sec} = 2.33\text{ KJ/sec}$$

13. $R_n = 3a_0$

$L = mvr = \frac{3h}{2\pi}$ [as n = 3, z = 3]



$$\frac{1}{\lambda} = Rz^2\left(\frac{1}{n_f^2} - \frac{1}{n_1^2}\right)$$

$$\frac{1}{\lambda_{3\to1}} = R9\left[\frac{1}{1} - \frac{1}{9}\right] = 9R\frac{8}{9}$$

$$\frac{1}{\lambda_{2\to1}} = R9\left[\frac{1}{1} - \frac{1}{4}\right] = \frac{3}{4}9R$$

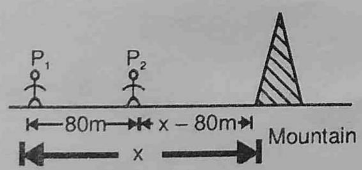
$$\frac{1}{\lambda_{3\to2}} = R9\left[\frac{1}{4} - \frac{1}{9}\right] = \frac{5}{36}9R$$

14. For maximum x coordinate

$0 = 3V_0 - 2a_1t$

$t = \frac{3V_0}{2a_1}$

15.



$\frac{2x}{V} = \frac{60}{40}$ $\Rightarrow$ $x = \frac{3V}{4}$ .....(1)

$\frac{2(x-80)}{V} = 1$ $\Rightarrow$ Put V from (1)

$\therefore$ $2x - 160 = 4x/3$

$2x/3 = 160$

$x = 240$ m

16. $I = 2x^2 - 12x + 27$

$\frac{dI}{dx} = 4x - 12$

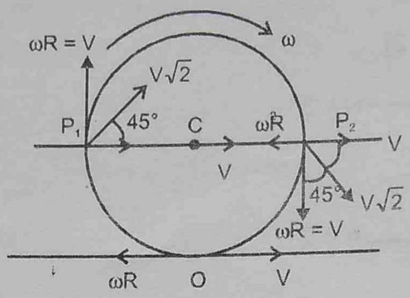
For minimum or maximum

$\frac{dI}{dx} = 0 \Rightarrow x = 3$

$\frac{d^2I}{dx^2} = 4$ Hence I is minimum at x = 3

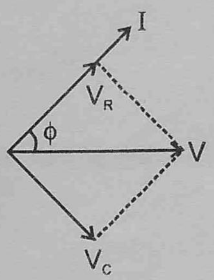
$I = 9$ kg m^2

17. Angle between velocity vectors and acceleration vector is either 45° at P_1 and 135° at P_2



As ; V = Rω

18. $V = \sqrt{V_R^2 + V_c^2}$



$10 = \sqrt{(8)^2 + V_R^2}$

$100 - 64 = V_R^2$

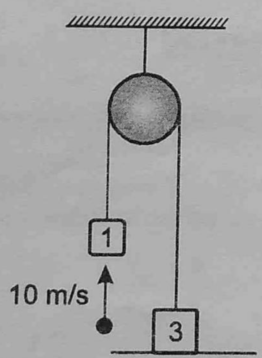
$V_R = 6V$

$\tan\phi = \frac{8}{6} = \frac{4}{3}$

19. $B_0 = \frac{E_0}{C} = \frac{0.5}{3\times10^8} \cong 1.66\times10^{-9}$

$B_z = B_0 \cos\left[2\pi\times10^8\left\{t - \frac{x}{c}\right\}\right]$

20.



Time after which 3 kg will be jerked into motion is $\frac{2\times10}{10} = 2$ s

Velocity at that instant = $\frac{1\times10}{1+3} = \frac{10}{4} = 2.5$ m/s

Retardations = $-\left[\frac{3-1}{3+1}\right]\times10 = -5$ m/s²

Maximum height = $\frac{(2.5)^2}{2\times5} = 0.625$ m

Time taken to reach that height = $\frac{2.5}{5} = 0.5$ s

J = 3 (2.5 – 0)

21. $\beta = \frac{I_C}{I_B}$

$I_B = \frac{I_C}{\beta}$

$I_B = \frac{5mA}{100} = 5 \times 10^{-5}\,A$

$I_C = \frac{10 - V_{CE}}{1\,k\Omega} = 5\,mA$

$R_B = \frac{10 - V_{CE}}{I_B} = \frac{10-0}{5\times10^{-5}} = 2 \times 10^5\,\Omega$

22. $\phi = \frac{m}{2\left(\frac{1}{4\pi G}\right)} \Rightarrow \phi = 2Gm\pi.$

23. $A(t) = Ae^{-\lambda t}$

$975 = 9750\, e^{-\lambda(5)}$

$\frac{1}{10} = e^{-5\lambda}$

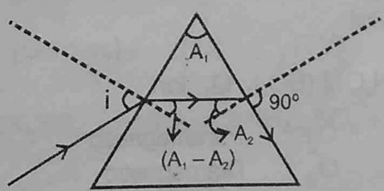
$\ell n10 = 5\lambda$

$\lambda = \frac{1}{5}\, 2.303 \log 10 = 0.461$ per minute

24. $dF = I_2 dx \frac{\mu_0 i_1}{2\pi x} \Rightarrow d\tau = \left(i_2 dx \frac{\mu_0 i_1}{2\pi x}\right) x$

$Mg\frac{L}{2} = \frac{\mu_0 i_1 i_2}{2\pi} \int_0^L dx \Rightarrow i_2 = \frac{Mg\pi}{\mu_0 i_1}$

25. $\mu = \frac{1}{\sin A_2}$



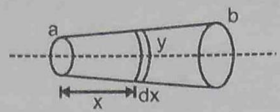
As $r = A_1 - A_2$

$\therefore \quad \sin i_{min} = \frac{1}{\sin A_2} \sin(A_1 - A_2)$

$i_{min} = \sin^{-1}\left[\frac{\sin(A_1 - A_2)}{\sin A_2}\right]$

26. Applying Ampere's law along the upper circular part of the sieve, $\int \vec{B}.\vec{d\ell} = \mu_0 i = \mu_0$ (charge on water falling per sec)=μ_0(vol of water falling per sec x conc. of Na^+ ions x charge on one ion)=$\mu_0$av c e

27. $Y = \dfrac{\dfrac{F}{\pi(y)^2}}{\dfrac{\Delta\ell}{dx}}$



$$\int \Delta\ell = \frac{F}{Y\pi}\int_0^{\ell}\frac{dx}{\left[\left(\frac{b-a}{L}\right)x+a\right]^2} = \frac{FL}{\pi abY}$$

28. $F_{net} = \sigma\pi D - P_{ex} \times \dfrac{\pi D^2}{4}$ $\qquad [P_{ex.} = \left(\dfrac{\sigma}{r_1}+\dfrac{\sigma}{r_2}\right) = \dfrac{\sigma}{r_1} \qquad (r_2 = \infty)]$

$$F_{net} = \sigma\pi D - \frac{2\sigma}{D}\times\frac{\pi D^2}{4} = \frac{\sigma\pi D}{2}$$

29. $E_1 = \dfrac{hC}{\lambda_1} - 13.6eV$; $E_2 = \dfrac{hC}{\lambda_2} - 13.6eV$

$E_1 - E_2 = hC\left(\dfrac{1}{\lambda_1} - \dfrac{1}{\lambda_2}\right)$; $E_1 - E_2 = hC\left(\dfrac{\lambda_2-\lambda_1}{\lambda_1\lambda_2}\right)$ $\Rightarrow h = \dfrac{(E_1-E_2)\lambda_1\lambda_2}{c(\lambda_2-\lambda_1)}$

30. The energy stored in the spherical region between r and r + x is

$$= \text{energy density} \times 4\pi r^2 dx = \frac{I}{c}\times 4\pi r^2\,dx = \frac{P}{4\pi r^2 c}\,4\pi r^2 dx = \frac{Pdx}{c}$$

$\therefore$ Number of photons in the given volume is $= \dfrac{Pdx}{hvc} = \dfrac{P\lambda dx}{hc^2}$

PART-B (CHEMISTRY)

31. Co has $t_{2g}^6\ eg^0$ configuraton in its +3 O.S.

$$[(CH_2O)_4\overset{+3}{Co}(\overset{-2}{O_2})_2\overset{+3}{Co}(H_2O)_4]\ (\overset{-4}{SO_4})_2\quad O_2^{-1}\text{ion}$$

$$\Big\downarrow \text{[X] reagent}$$

$$[(CH_2O)_4\overset{+3}{Co}(\overset{-4}{O_2})_2\overset{+3}{Co}(H_2O)_4]\ (\overset{-4}{SO_4})_2\quad O_2^{-2}\text{ion}$$

Complex-1 $\quad O_2^{-1}$ Paramagnetic
Complex-2 $\quad O_2^{-2}$ Diamagnetic

$$O_2^- \xrightarrow[X]{\text{Reduction}} O_2^{2-}$$

O_2^- is reduced in O_2^{2-} in the presence of reducing agent.

34. $K_{sp} = [Ag^+][Cl^-]$

$1.8 \times 10^{-10} = [Ag^+][0.1]$

$[Ag^+] = 1.8 \times 10^{-9}$ M

$K_{sp} = [Pb^{+2}][Cl^-]^2$

$1.7 \times 10^{-5} = [Pb^{+2}][0.1]^2$

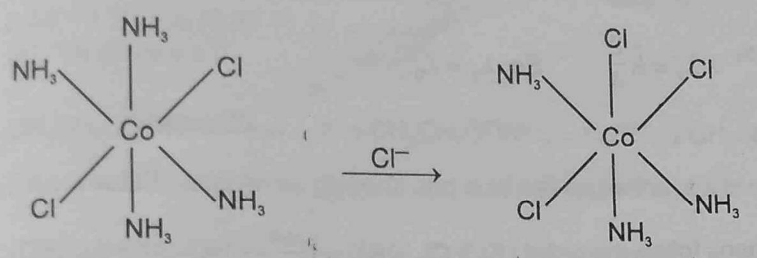
$[Pb^{+2}] = 1.7 \times 10^{-3}$ M

35. (1) The solubility increases down the group because the change in lattice energy is more as compared to hydration energy. Thermal stability and the basic character both increase down the group as metallic character increases.

(2) It is correct statement.

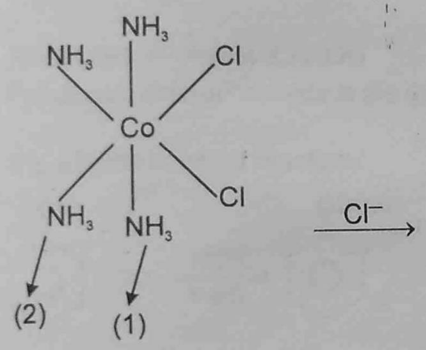
(3) Beryllium and aluminium are diagonally related. Chlorides of both are covalent in nature and thus are soluble in organic solvents. Chlorides of both are electron deficient and thus act as strong Lewis acids.

36.



symmetrical

only single product



two isomers product

replacable positions

37. The correct formula of borax is $Na_2[B_4O_5(OH)_4].8H_2O$.

39. Diamond is like ZnS (Zinc blende)
Carbon forming CCP(FCC) and also occupying half of tetrahedral voids.

Total no. of carbon atoms per unit cell = $\underset{\text{(Corners)}}{8 \times \frac{1}{8}} + \underset{\text{(FC)}}{6 \times \frac{1}{2}} + \underset{\text{(TV)}}{4} = 8$

40. $K_4[Fe(CN)_6] + 6H_2SO_4 + 6H_2O \xrightarrow{\Delta} 2K_2SO_4 + FeSO_4 + 3(NH_4)_2SO_4 + 6CO$

41. Effective $p_\pi - p_\pi$ bonding and bigger size of $-OCH_3$ group.

42. (p) Liquation process is used for purification of impure tin and zinc metals as the impurities present have higher melting point than the metal itself.
(s) Cupellation involves removal of Pb impurity from Ag metal.

43. (1) No. of radial node = n – – 1 = 1
3 – – 1 = 1
= 1

Orbital angular momentum = $\sqrt{\ell(\ell+1)}\,\frac{h}{2\pi} = \sqrt{2}\,\frac{h}{2\pi}$

(2) $2\pi r = n\lambda$

$$r = \frac{n\lambda}{2\pi} \quad \text{for minimum r, n = 1}$$

$$r = \frac{\lambda}{2\pi}$$

(3) $\lambda \propto \frac{1}{v} \propto \frac{n}{z}$ for an electron in a Bohr orbit.

For He^+ : $\lambda_1 = k\frac{1}{2}$; For Be^{3+} : $\lambda_2 = k\frac{2}{4}$ So, $\lambda_1 = \lambda_2$.

44. $CaC_2 + N_2 \longrightarrow CaNCN + C$

45. (3) The oxidising power of halogens follow the order : $F_2 > Cl_2 > Br_2 > I_2$.
(4) On reaction of XeF_2 with water, redox change takes place.

$$2XeF_2 + 2H_2O \longrightarrow 2Xe + 4HF + O_2 \text{ (slow)}$$

46. Flocculation power $\propto \frac{1}{\text{Coagulation value}}$

	P	:	Q	:	R
	$\frac{1}{3}$	:	$\frac{1}{0.6}$	:	$\frac{1}{0.08}$
or	1	:	5	:	37.5

47. $\frac{r_A}{r_B} = \sqrt{\frac{M_B}{M_A}}$

$$\frac{M_B}{M_A} = \frac{4}{1}$$

$$\frac{(V_{rms})_A}{(V_{rms})_B} = \sqrt{\frac{\frac{3RT_A}{M_A}}{\frac{3RT_B}{M_B}}} = \sqrt{\frac{T_A}{T_B}.\frac{M_B}{M_A}} = \sqrt{\frac{2}{1} \times \frac{4}{1}} = \sqrt{8} = 2\sqrt{2}$$

48. $Cu \mid Cu^{2+}(aq) \parallel Ag^+(aq) \mid Ag$. $E_1 > 0$.
(1) Due to NH_3 addition, concentration of Ag^+ decreases due to complex formation. Hence, E decrease.
(2) Due to addition of HCl, Ag^+ is consumed to form AgCl solid. Concentration of Ag^+ decreases. So, E decreases.
(3) Adding $AgNO_3$ to anodic chamber result in direct reaction between Cu and Ag^+

$$Cu + 2Ag^+ \longrightarrow Cu^{2+} + 2Ag$$

More Cu^{2+} produced, hence E decreases.
(4) Adding NH_3 in anodic chamber results in complex formation, $[Cu(NH_3)_4]^{2+}$. Hence Cu^{2+} concentration decreases. So E increases.

49. $Eq(HNO_3) = Eq(Fe^{2+})$

$(3 \times 3) \times V = \dfrac{8}{56/1}$ $\qquad V = 0.01588\ L \approx 16\ ml$

50. $r = k[A]^x[B]^y$

$6.0 \times 10^{-3} = K(0.1)^x(0.1)^y$ .... (1)

$2.4 \times 10^{-2} = K(0.1)^x(0.1)^y$ .... (2)

(2) / (1) gives x = 1

$7.2 \times 10^{-2} = K(0.3)^x(0.2)^y$ .... (3)

$2.88 \times 10^{-1} = K(0.3)^x(0.4)^y$ .... (4)

(4) / (3) gives y = 2.

51. $CH_3CH_2COOH \xrightarrow{NH_3} \xrightarrow{\Delta} CH_3CH_2CONH_2 \xrightarrow{Br_2, KOH} CH_3CH_2NH_2$

52. Esters of fatty acid gives glycerol and acid salt on hydrolysis in basic medium.

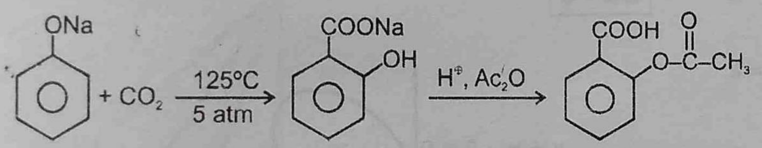
53. $(CH_3)_2CHCH_2{-}OH \xrightarrow{PBr_3} (CH_3)_2CHCH_2{-}Br \xrightarrow{Mg}$

$(CH_3)_2CHCH_2{-}MgBr \xrightarrow{\overset{O}{CH_2-CH_2}} \xrightarrow{H_3O^+} (CH_3)_2CHCH_2CH_2CH_2OH$

54. $R{-}CH_2OH \xrightarrow{PCC} R{-}CH{=}OH$

Pyridinium chlorochromate is the mild oxidising agent.

55. It is a kolbe schmidt reaction.



Asprine
(pain Killer)

56. $CH_3COOH \xrightarrow{LiAlH_4} \underset{(A)}{CH_3CH_2OH} \xrightarrow{PCl_5} CH_3CH_2Cl\ (B)$

$CH_3CH_2Cl \xrightarrow[-HCl]{Alc.\ KOH} \underset{\text{(C) ethylene}}{CH_2{=}CH_2}$

57. Carboxylic acid is more acidic than phenol.

58. Hemiacetal compounds can show mutarotation.

59. $CH_3{-}CH{=}CH{-}CH_3 \xrightarrow[Zn, H_2O]{O_3} CH_3{-}CH{=}O \xrightarrow[\text{Aldol reaction}]{\text{Base}} CH_3{-}\underset{OH}{CH}{-}CH_2{-}CH{=}O$

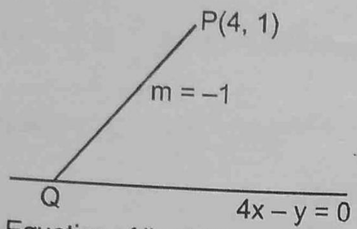
60. $Cl{-}\overset{O}{\overset{\|}{C}}{-}OEt \xrightarrow{CH_3MgBr} CH_3{-}\overset{O}{\overset{\|}{C}}{-}OEt \xrightarrow{CH_3MgBr} CH_3{-}\overset{O}{\overset{\|}{C}}{-}CH_3 \xrightarrow{CH_3MgBr} CH_3{-}\underset{CH_3}{\overset{O^-}{C}}{-}CH_3 \xrightarrow{H_3O^+} CH_3{-}\underset{CH_3}{\overset{OH}{C}}{-}CH_3$

PART-C (MATHEMATICS)

61. Slope of line joining (1, 2) and (13, 1) is $-\frac{1}{12}$

$\therefore$ slope of the required line is 12. $\therefore$ $\frac{2}{3}m = 8$

62.



Equation of line PQ $y - 1 = -1(x - 4)$ $\Rightarrow$ $x + y = 5$

$\therefore$ Q(1, 4) $\therefore$ $PQ = \sqrt{9+9} = 3\sqrt{2}$

63. Choice (3) is not possible since it does not touch the y-axis at origin. Choice (4) is not possible since it does not pass through the origin (3, 4) does not lie on (1).

64. S_1 is true, S_2 is false

The semi latus rectum of a parabola is the harmonic mean of the segment of a focal chord.

$\therefore$ $\frac{2SP.SQ}{SP+SQ} = 4$ $\Rightarrow$ $\frac{2.6.SQ}{6+SQ} = 4$

$\Rightarrow$ $3\,SQ = 6 + SQ$ $\Rightarrow$ $\boxed{SQ = 3}$

65. Let the centre is (h, k), a = 4, b = 2

director circle is

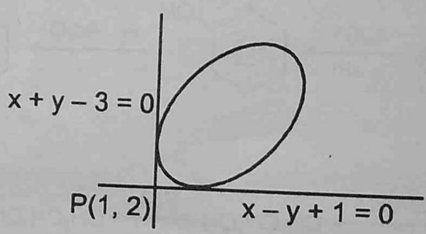
$(x - h)^2 + (y - k)^2 = 20$

It is passing through P(1, 2)

$\therefore$ $(1 - h)^2 + (2 - k)^2 = 20$

$(x - 1)^2 + (y - 2)^2 = 20$

$x^2 + y^2 - 2x - 4y - 15 = 0$



66. Product of roots = $\frac{2-i}{i}$

So, other root = $\frac{1}{i} = -i$

67. $3^{\frac{1}{4}} \times 9^{\frac{1}{8}} \times 27^{\frac{1}{16}}$ ....= $3^{\frac{1}{4}+\frac{2}{8}+\frac{3}{16}+\dots\dots}$ ......(1)

assume S = $\frac{1}{4}+\frac{2}{8}+\frac{3}{16}+$ .... ∞ ......(2)

$\frac{1}{2}S = \frac{1}{8}+\frac{2}{16}+$ .... ∞ ....(3)

Subtract (2) and (3)

$\frac{1}{2}S = \frac{1}{4}+\frac{1}{8}+\frac{1}{16}+$ .... ∞

$\Rightarrow$ $\frac{1}{2}S = \frac{\frac{1}{4}}{1-1/2} = \frac{1}{2}$. So, S = 1 ; from (1) $3^{\frac{1}{4}} \times 9^{\frac{1}{8}} \times 27^{\frac{1}{16}}$ .... $\infty = 3^1 = 3$

68. $2z^2 + 2z + \lambda = 0$

$$z = \frac{-2 \pm \sqrt{4-8\lambda}}{4}$$

for non-real roots $4 - 8\lambda < 0$

$\lambda > 1/2$

for equilatral triangle

$|z_1 - z_2| = |z_2 - z_3| = |z_3 - z_1|$

$$\Rightarrow \left|0 - \frac{-1+i\sqrt{2\lambda-1}}{2}\right| = \left|\frac{-1+i\sqrt{2\lambda-1}}{2} - \frac{-1-i\sqrt{2\lambda-1}}{2}\right| = \left|0 - \frac{-1-i\sqrt{2\lambda-1}}{2}\right|$$

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

$$\Rightarrow \frac{\lambda}{2} = 2\lambda - 1 \qquad \Rightarrow \qquad \lambda = 2/3$$

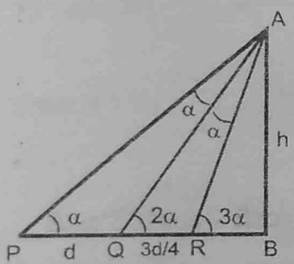
69. $\frac{1}{10} < 10^x < 1000$

$\Rightarrow -1 < x < 3$

Prime number is 2

Only one prime number.

70.



Let angle of elevation at P is α

$\angle BQA = 2\alpha$

$\Rightarrow \angle PAQ = \alpha$ and $AQ = d$

by sine rule in ΔAQR

$$\frac{\sin(180° - 3\alpha)}{d} = \frac{\sin\alpha}{\frac{3d}{4}}$$

$$\Rightarrow \frac{3}{4} = \frac{\sin\alpha}{\sin 3\alpha} \Rightarrow 9 - 12\sin^2\alpha = 4 \Rightarrow \sin^2\alpha = \frac{5}{12} \text{ and } \cos^2\alpha = \frac{7}{12}$$

Now from ΔAQB

$$\sin 2\alpha = \frac{h}{d} \Rightarrow 4\sin^2\alpha\cos^2\alpha = \frac{h^2}{d^2} \Rightarrow 4.\frac{5}{12}.\frac{7}{12} = \frac{h^2}{d^2} \Rightarrow 36h^2 = 35d^2$$

71. $\sin\theta \sec 3\theta + \sin 3\theta \,.\, \sec 3^2\theta + \sin 3^2\theta \sec 3^3\theta + \ldots\ldots$ upto n terms $= \sum_{r=1}^{n} \sin 3^{r-1}\theta . \sec 3^r\theta$

$$= \sum_{r=1}^{n} \frac{\sin 3^{r-1}\theta}{\cos 3^r\theta} = \sum_{r=1}^{n} \frac{2\cos 3^{r-1}\theta \sin 3^{r-1}\theta}{2\cos 3^{r-1}\theta \cos 3^r\theta}$$

$$= \frac{1}{2}\sum_{r=1}^{n} \frac{\sin(2.3^{r-1}\theta)}{\cos 3^{r-1}\theta \cos 3^r\theta} = \frac{1}{2}\sum_{r=1}^{n} \frac{\sin(3^r\theta - 3^{r-1}\theta)}{\cos 3^{r-1}\theta \cos 3^r\theta} = \frac{1}{2}\sum_{r=1}^{n}(\tan 3^r\theta - \tan 3^{r-1}\theta) = \frac{1}{2}\{\tan 3^n\theta - \tan\theta\}$$

72. Inverse of $p \Rightarrow q$ is $\sim p \Rightarrow \sim q$

$\therefore$ inverse of $(p \wedge \sim q) \Rightarrow r$ is

$\sim (p \wedge \sim q) \Rightarrow \sim r$

i.e. $(\sim p \vee q) \Rightarrow \sim r$

73. (i) VCCVCCVCC

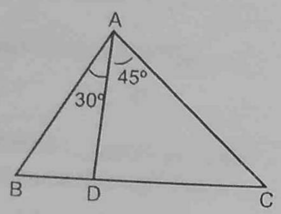
(ii) CVCCVCCVC

(iii) CCVCCVCCV

So no. of ways of arrangement

$= (3)\,(3!)\,(6!) = 18.6!$

$\therefore\ k = 18$

74. 

$\angle C = 180° - (75° + B) = 105° - B$

In ΔABD,

$$\frac{BD}{\sin 30°} = \frac{AD}{\sin B} \Rightarrow BD = \frac{AD}{2\sin B}$$

in ΔADC में,

$$\frac{CD}{\sin 45°} = \frac{AD}{\sin C} \Rightarrow CD = \frac{AD}{\sqrt{2}\sin(105° - B)}$$

$\because\ BD = CD$

$$\Rightarrow 2\sin B = \sqrt{2}\sin(105° - B)$$

$$\Rightarrow \sqrt{2}\sin B = \sin 105° \cos B - \cos 105° \sin B$$

$$\Rightarrow \sqrt{2}\sin B = \frac{\sqrt{3}+1}{2\sqrt{2}}\cos B + \frac{\sqrt{3}-1}{2\sqrt{2}}\sin B$$

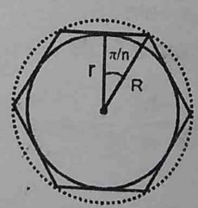
$$\Rightarrow 4\sin B = (\sqrt{3}+1)\cos B + (\sqrt{3}-1)\sin B$$

$$\Rightarrow \cot B = 3\sqrt{3} - 4$$

$$\Rightarrow \sin B = \frac{1}{2\sqrt{11 - 6\sqrt{3}}}$$

$$\because\ BC = 2BD = \frac{AD}{\sin B} = \frac{2\sqrt{11-6\sqrt{3}}}{\sqrt{11-6\sqrt{3}}} = 2$$

75. $\frac{r}{R} = \cos\left(\frac{\pi}{n}\right)$



Let $\cos\frac{\pi}{n} = \frac{2}{3}$ for some $n \geq 3$, $n \in N$

As $\frac{1}{2} < \frac{2}{3} < \frac{1}{\sqrt{2}}$ $\Rightarrow$ $\cos\frac{\pi}{3} < \cos\frac{\pi}{n} < \cos\frac{\pi}{4}$ $\Rightarrow$ $\frac{\pi}{3} > \frac{\pi}{n} > \frac{\pi}{4}$

$\Rightarrow$ $3 < n < 4$, which is not possible

so option (2) is the false statement

so it will be the right choice

Hence correct option is (2)

76. Here $\lim_{x\to 0}\dfrac{ae^x - b\cos x + ce^{-x}}{x\sin x} = 2$

$$\Rightarrow \lim_{x\to 0}\frac{a\left(1+x+\frac{x^2}{2!}+\frac{x^3}{3!}+\ldots\right)-b\left(1-\frac{x^2}{2!}+\frac{x^4}{4!}+\ldots\right)+c\left(1-x+\frac{x^2}{2!}-\frac{x^3}{3!}+\ldots\right)}{x\left(x-\frac{x^3}{3!}+\frac{x^5}{5!}+\ldots\right)} = 2$$

$$\Rightarrow \lim_{x\to 0}\frac{(a-b+c)+(a-c)x+\left(\frac{a}{2!}+\frac{b}{2!}+\frac{c}{2!}\right)x^2+\ldots}{x^2\left(1-\frac{x^2}{3!}+\frac{x^4}{5!}+\ldots\right)} = 2$$

This limit exist if $a-b+c=0$ & $a-c=0$

then $\lim_{x\to 0}\dfrac{\left(\frac{a}{2!}+\frac{b}{2!}+\frac{c}{2!}\right)x^2+\ldots}{x^2\left(1-\frac{x^2}{3!}+\ldots\right)} = 2$ $\qquad \Rightarrow a+b+c=4$ **Ans.**

77. we have $5f\left(\frac{1}{x}\right) + 3f\left(\frac{1}{x}\right) = x+2$ .... (i)

replace x by $\left(\frac{1}{x}\right)$

$5f\left(\frac{1}{x}\right) + 3f(x) = \left(\frac{1}{x}\right) + 2$ .... (ii)

on solving (i) & (ii) we get

$f(x) = \frac{5}{16}x - \frac{3}{16x} + \frac{1}{4}$

$\therefore y = xf(x) = \frac{5}{16}x^2 - \frac{3}{16} + \frac{1}{4}x$ $\qquad \therefore \frac{dy}{dx} = \frac{5}{8}x + \frac{1}{4}$

put x = 1

$\left(\frac{dy}{dx}\right)_{x=1} = \frac{5}{8} + \frac{1}{4} = \frac{5+2}{8} = \frac{7}{8}$

78. Given $\sin^{-1}x + \sin^{-1}(1-x) = \cos^{-1}x$

$\Rightarrow \sin^{-1}(1-x) = \cos^{-1}x - \sin^{-1}x = \frac{\pi}{2} - 2\sin^{-1}x$

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

$\Rightarrow 1-x = \cos 2\theta$ (let $\sin^{-1}x = \theta$)

$\Rightarrow 1-x = 1-2\sin^2\theta$

$\Rightarrow 1-x = 1-2x^2$

$\Rightarrow 2x^2 - x = 0 \Rightarrow x = 0, \frac{1}{2}$

79. we have $R = \{(x, y) : x^2 - 4xy + 3y^2 = 0,\ x, y \in N\}$
Let $x \in N$, then $x^2 - 4x.x + 3x^2 = 0$
$\Rightarrow (x, x) \in R$ $\therefore$ R is reflexive
we have $3^2 - 4.3.1 + 3.1^2 = 9 - 12 + 3 = 0$
$\Rightarrow (3, 1) \in R$
but $(1, 3) \notin R$ as $1^2 - 4.1.3 + 3.3^2 \neq 0$ $\therefore$ R is not symmetric
again $(9, 3) \in R$ as $9^2 - 4.9.3 + 3.3^2 = 0$ & $(3, 1) \in R$
but $(9,1) \notin R$
$\therefore$ R is not transitive

80. f(x) is diff. in [0, 2] so it is continuous also in [0, 2]

$\therefore\ 0 + a + b = -2 + \frac{\pi}{4}$ (LHL = RHL at x = 1)

$\Rightarrow a + b = -2 + \frac{\pi}{4}$ .... (i)

again f(x) is diff. at x = 1
$\therefore\ f'(1^-) = f'(1^+)$

$$\Rightarrow \lim_{x\to1^-} \frac{ax^3 + b - (a+b)}{x-1} = \lim_{x\to1^+} \frac{2\cos\pi x + \tan^{-1}x - (a+b)}{x-1}$$

$$\Rightarrow \lim_{x\to1^-} \frac{a(x^3-1)}{x-1} = \lim_{x\to1^+} \frac{2\cos\pi x + \tan^{-1}x + 2 - \pi/4}{x-1} \quad \text{by (i)}$$

$$\Rightarrow 3a = \frac{1}{2} \Rightarrow a = \frac{1}{6}$$

81. $n(A \cup B) = n(1) + n(2) - n(A \cap B)$
$= 63 + 76 - n(A \cap B) = 139 - n(A \cap B)$
$\because\ n(A \cup B) \le 100$ $\therefore\ 139 - n(A \cap B) \le 100$
$\Rightarrow n(A \cap B) \ge 39$ ...(1)
Now $A \cap B \subseteq A$ & $A \cap B \subseteq B \Rightarrow n(A \cap B) \le 63$ & $n(A \cap B) \le 76$
$\therefore\ n(A \cap B) \le 63$
$\therefore\ 39 \le n(A \cap B) \le 63$

82. $$I = \int \frac{\log\left(1+\frac{1}{x}\right)dx}{x^2\left(1+\frac{1}{x}\right)}$$

put $1 + \frac{1}{x} = t$, $-\frac{1}{x^2}dx = dt$

$$I = -\int \frac{\log t}{t}dt = -\frac{1}{2}\log^2 t + c$$

$$= -\frac{1}{2}\log^2\left(1+\frac{1}{x}\right) + c = -\frac{1}{2}[\log(x+1) - \log x]^2 + c = -\frac{1}{2}\log^2(x+1) - \frac{1}{2}\log^2 x + \log x \log(x+1) + c$$

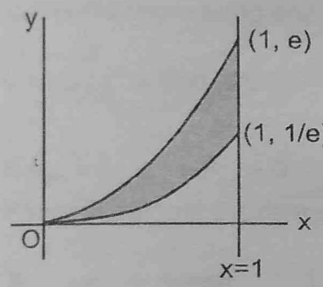
83. $I = \int_{\alpha}^{\beta} \frac{1}{\sqrt{-\alpha\beta - x^2 + x(\alpha+\beta)}} dx$

$= \int_{\alpha}^{\beta} \frac{1}{\sqrt{\left(\frac{\alpha-\beta}{2}\right)^2 - \left(x - \frac{\alpha+\beta}{2}\right)^2}}$

$= \left[\sin^{-1}\left(\frac{x - \frac{\alpha-\beta}{2}}{\frac{\beta-\alpha}{2}}\right)\right]_{\alpha}^{\beta}$

$= \sin^{-1} 1 - \sin^{-1}(-1) = \pi$

84. Required area $= \int_0^1 xe^x dx - \int_0^1 xe^{-x} dx$



$= \left[xe^x - e^x\right]_0^1 - \left[-xe^{-x} - e^{-x}\right]_0^1 = \frac{2}{e}$

85. $\int (by + k)\, dy = \int (ax + h)\, dx$

$\Rightarrow \frac{by^2}{2} + ky = \frac{ax^2}{2} + hx + c$

clearly , it represents a parabola if one of a, b is zero (but not both).

86. Statement–1 is false and Statement–2 is true.

Since $\vec{a}.(\vec{b} \times \vec{c}) = 0$

$\therefore$ $\vec{a}, \vec{b}, \vec{c}$ are coplanar

87. $\vec{r} = x\vec{a} + y\vec{b} + z\vec{c}$

Consider $(\vec{a} \times \vec{b}) \times (\vec{r} \times \vec{c}) = [\vec{a}\ \vec{b}\ \vec{c}]\ \vec{r} - [\vec{a}\ \vec{b}\ \vec{r}]\ \vec{c}$

But $[\vec{a}\ \vec{b}\ \vec{r}] = (\vec{a} \times \vec{b}) \cdot \vec{r} = z[\vec{a}\ \vec{b}\ \vec{c}]$

$\Rightarrow$ above expression $= [\vec{a}\ \vec{b}\ \vec{c}]\ (\vec{r} - z\vec{c})$

Hence sum $= [\vec{a}\ \vec{b}\ \vec{c}]\ (3\vec{r} - x\vec{a} - y\vec{b} - z\vec{c})$

$= [\vec{a}\ \vec{b}\ \vec{c}]\ 2\vec{r}$

88. on putting y = 1

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

$= f(x) + a^x$

$\Rightarrow f(x) = a^x$

$$(a-1)\sum_{i=1}^{n} f(i) = (a-1)(a + a^2 + \ldots\ldots + a^n)$$

$$= (a-1)\,\frac{a(a^n-1)}{a-1} = a^{n+1} - a$$

89. P(atleast one head) = 1 – P(no head)

$$= 1 - \frac{1}{2^n} \quad \ldots\ldots\ldots\ldots(1)$$

$$\text{P(atleast two tails)} = 1 - \text{P(no tail)} - {}^nC_1\left(\frac{1}{2}\right)^1\left(\frac{1}{2}\right)^{n-1}$$

$$= 1 - \left(\frac{1}{2}\right)^n - n.\left(\frac{1}{2}\right)^n \quad \ldots\ldots\ldots(2)$$

(1) – (2)

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

n = 5

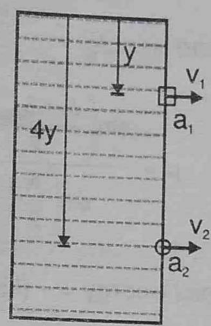
90. $g(f(x)) = \tan\left(x - \frac{\pi}{4}\right) = \frac{\tan x - 1}{\tan x + 1} \Rightarrow \quad g(x) = \frac{x-1}{x+1}$

$$f(g(x)) = \tan\left(\frac{x-1}{x+1}\right).$$

HINTS & SOLUTIONS
PRACTICE TEST - TWO
PART-A (PHYSICS)

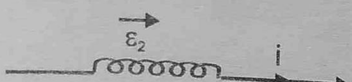
1. Velocity of efflux at a depth h is given by V = Volume of water following out per second from both the holes are equal

$\therefore \quad a_1V_1 = a_2V_2$



or $\quad (L^2)\sqrt{2g(y)} = \pi R^2 \sqrt{2g(4y)}$

or $\quad R = \dfrac{L}{\sqrt{2\pi}}$

2. 

current is decreasing and

$L = \dfrac{17}{25kA} = 680\ \mu H.$

3. If $\vec{a}_{cm} = 0 \qquad \vec{F}_{ext} = 0$

Hence statement 2 is correct explanation for Statement-1.

4. $\dfrac{B}{S} = \dfrac{F}{area} \times \dfrac{length}{F} = \dfrac{1}{length}$ = wave number

5. $y = u_yt + \dfrac{1}{2}a_y t^2 \qquad \Rightarrow \qquad 0 = u_y \times 4 - \dfrac{1}{2} \times 10 \times 4^2$

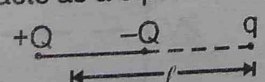
or या $4 = \dfrac{2u_y}{g} \Rightarrow u_y = 20$ m/s $\qquad \Rightarrow \qquad u_y = 20$ m/s

$y = 20 \times 1 - \dfrac{1}{2} \times 10 \times 1^2 = 15$ m

6. Spring constant $K = \dfrac{6.4}{0.1} = 64$ N/m.

Now $T = 2\pi\sqrt{\dfrac{m}{k}} \qquad$ or $\quad \dfrac{\pi}{4} = 2\pi\sqrt{\dfrac{m}{64}} \quad \therefore m = 1$ kg

7. The two plates acts as a dipole



$\therefore$ Force on charge q ;

F = Eq

$= \left(\dfrac{2kQd}{\ell^3}\right).q \qquad = \qquad \dfrac{Qqd}{2\pi\varepsilon_0\ell^3}.$

8. $P_{av.} = \frac{\mu\omega^2 A^2 v_w}{2} = \frac{10^{-4} \times 4\pi^2 10^2 \times 10^{-6} \times \sqrt{10^4}}{2} = 2\pi^2 \times 10^{-6} = 2 \times 10^{-5}$ W

9. Since; $e_{max} = 2V$
therefore 50% of $e_{max} = 1V$ $\Rightarrow$ P.D. across 1Ω at that time is 1V (by KVL)
$\therefore$ $1 = \frac{1}{1} = 1$ A in 1Ω and also in 5 mH $\therefore$ $U = \frac{1}{2}Li^2 = 2.5$ mJ

10. Put $A = \delta_{min}$ and $\mu = \sqrt{2}$

The relation $\mu = \frac{\sin\left(\frac{A+\delta_{min}}{2}\right)}{\sin\left(\frac{A}{2}\right)}$ and solve for A

11. Total Mechanicl energy = – (kinetic energy)
$\therefore$ TME = – E_k
for escape , TME = 0 .
ie. If , E_k is provided then TME. becomes Zero.

12. $m = \frac{\Delta f}{f_c} = \frac{10}{2} = 5$

13. At path difference $\frac{\lambda}{6}$, phase difference is $\frac{\pi}{3}$

$I = I_0 + I_0 + 2I_0 \cos\frac{\pi}{3} = 3\,I_0$ $I_{max} = 4I_0$

So the required ratio is $\frac{3I_0}{4I_0} = 0.75$

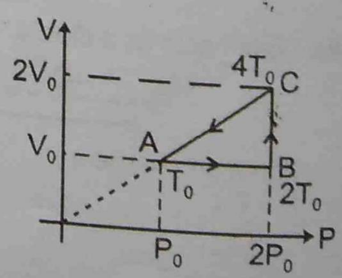
14. $R_{eq} = 200 + \frac{300 \times 600}{300 + 600} + 100 = 500\ \Omega$

$I = \frac{100}{500} = \frac{1}{5}$ amp $\Rightarrow$ $I_{600} = \frac{\frac{1}{600}}{\frac{1}{300} + \frac{1}{600}} \times \frac{1}{5} = \frac{1}{15}$ amp

Reading of volt meter $= I_{600} R_{600} = \frac{1}{15} \times 600 = 40$ V

15. $W = \frac{1}{2}P_0V_0 = \frac{1}{2}RT_0$.

Heat absorbed $= Q_{AB} + Q_{BC} = C_VT_0 + C_P2T_0 = \frac{13}{2}RT_0$



$\therefore$ Efficiency $= \frac{\frac{1}{2}P_0V_0}{\frac{13}{2}P_0V_0} \times 100 \left(\because \frac{13}{2}P_0V_0 = \frac{13}{2}RT_0\right)$

$= \frac{1}{13} \times 100 = 7.7$ %

16. $\tau = I\alpha$

$$Fx = \frac{mL^2}{3}\alpha$$

$$\alpha = \frac{3F}{mL^2}x$$

$$a_{CM} = \frac{L}{2}\alpha = \frac{3F}{2mL}x$$

$a_{CM} \propto x$

$\therefore$ It is a straight line

17. Maximum velocity $v = \omega a$

Maximum acceleration $f = \omega^2 a \Rightarrow f = \frac{v^2}{a}$

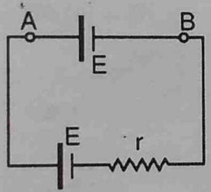
18. $PV = nRT$

$PdV = nRdT$

$$\gamma = \frac{1}{V}\frac{dV}{dT} \quad \text{and} \quad \frac{dV}{dT} = \frac{nR}{P} \qquad \gamma = \frac{1}{T}$$

For given temperature T_0, $\gamma = \frac{1}{T_0}$

19. Statement-2 is wrong as in this case



A is at high potential and B is at low potential and there is no current from A to B. It also justifies Statement-1.

20. When all particles on wire at mean position, the induced emf will be maximum because velocity is maximum at mean position.

$= B\,(a\omega)\,dx$

where $a = A\sin\frac{\pi x}{L}$

$$\therefore \text{ net maximum induced emf} = \int_0^L B\omega A \sin\frac{\pi x}{L}dx = \frac{2BA\omega L}{\pi}$$

21. The distance between nth bright fringe and $(n+1)^{th}$ dark fringe is equal to half fringe width $= \frac{\lambda D}{2d}$

23. $\frac{hc}{\lambda} = 5\,eV_0 + \phi$

$\frac{hc}{3\lambda} = eV_0 + \phi \qquad \Rightarrow \frac{2hc}{3\lambda} = 4eV_0 \qquad \Rightarrow \phi = \frac{hc}{6\lambda}$ **Ans.**

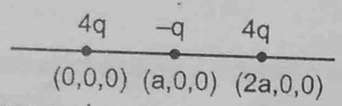
25. We know that surface energy
$U_s = T \times$ Area.
Here. as 2 films are formed because of ring. so
$U_s = T \times 2 \times (1)$
$= 5\ \frac{N}{m} \times 2 \times 0.02\ m^2$. $= 0.2$ J

26. $N = N_0 e^{-\lambda t}$ $N_y = N_0(1 - e^{-\lambda t})$

Rate of formation of $Y = \frac{dN}{dt} = +\lambda N_0 e^{-\lambda t}$ $X \longrightarrow Y$

At $t = 0$, $R = \lambda N_0$ $t = 0$ N_0 0
$t = \infty$, $R = 0$ $t = t$ N $N_y = N_0(1 - e^{-\lambda t})$

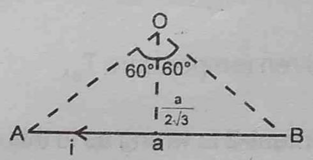
27. In that case n_{rel} is less than 1 so deviation is in upward direction

28. 

All charges are in unstable equilibrium.

29 The magnetic field at the centroid (or circumcentre) because of side AB of triangular loop is

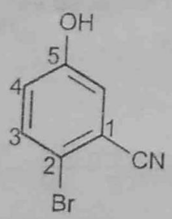
$$\frac{\mu_0}{4\pi}\ \frac{i(\sin 60° + \sin 60°)}{\frac{a}{2\sqrt{3}}} = \frac{3\mu_0 I}{2\pi a}$$



hence the net magnetic field due to all 3 sides is $3 \times \frac{9\mu_0 I}{2\pi a}$

30 $\frac{mv^2}{r} = \frac{\lambda}{2\pi \epsilon_0 r}.e \Rightarrow K = \frac{1}{2}mv^2 = \frac{\lambda e}{4\pi \epsilon_0}$

PART-B (CHEMISTRY)

31. 

2-Bromo-5-hydroxybenzonitrile (–CN group gets higher priority over –OH and –Br)

32. $[Co(II)(NO_2)(NH_3)_5]^{2+} + 2Cl^-$ and now follow IUPAC rules.

33. $2KO_2 + CO_2 \rightarrow K_2CO_3 + \frac{3}{2}O_2$

35. $\frac{h_1}{h_2} = \sqrt{\frac{c_2}{c_1}} \Rightarrow \frac{0.1}{h_2} = \sqrt{\frac{0.01}{0.25}} \Rightarrow h = 0.5 \Rightarrow 50\%$ (3)

36. B_2 bond order $= \frac{6-4}{2} = 1$; O_2^- bond order $= \frac{10-7}{2} = 1.5$

C_2 bond order $= \frac{8-4}{2} = 2$; NO bond order $= \frac{10-5}{2} = 2.5$

37. $\dfrac{K.E._1}{K.E._2} = \dfrac{Z_1^2 \times n_2^2}{n_1^2 \times Z_2^2}$ or, $\dfrac{x}{K.E._2} = \dfrac{2^2 \times 3^2}{2^2 \times 6^2}$

$\therefore$ $K.E._2 = 4x$ [Z for M^{5+} = 6 as it is H-like species]

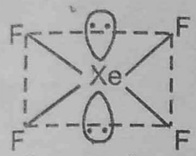
Now, K.E. = – T.E.

$\therefore$ T.E. = – 4x

and I.E. = – T.E. = –(–4x) = +4x

38. Concentration are in the order urea > glucose > sucrose Hence their osmotic pressure are in the same order.

39. $Ph\text{–}C{\equiv}N \xrightarrow[(2)H_2O]{(1)DIBAL\text{–}H} Ph\text{–}CH{=}O \xrightarrow[\Delta]{KOH} Ph\text{–}COOH + Ph\text{–}CH_2OH$

41. 

Square planar

42. $\dfrac{r_{tetrahedral}}{r_{octahedral}} = \dfrac{0.225R}{0.414R} = 0.543$

43. $Ba(N_3)_2(s) \xrightarrow{\Delta} Ba(s) + 3N_2(g)$

44. $\Delta x = 0.1 \times 10^{-9}$ m.
$\Delta V = 5.27 \times 10^{-27}$ ms^{-1}.

$\therefore$ $\Delta x \times m\Delta V = \dfrac{h}{4\pi}$

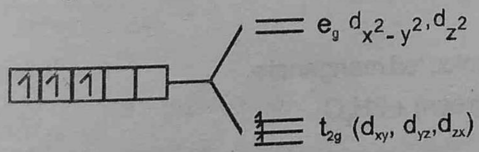
$\therefore$ $0.1 \times 10^{-9} \times m \times 5.27 \times 10^{-27} = 0.527 \times 10^{-34}$.

$\therefore$ m = 0.1 kg. = 100 gm.

45. With $3d^3$ configuration, the magnetic moment of the complex is always 3.83 BM, whether the ligands are strong field or weak field. Thus

$3.83 = \sqrt{n(n+2)}$; or n = 3 (n = No. of unpaired electron)

So, according to CFT the distribution of 3d electrons will be as follow :



46. **Geometrical isomerism :** The geometrical isomerism arises due to different arrangement of groups in space. The two isomers are called cis and trans forms.
Optical isomerism : The optical isomers are non-superimposable mirror images of each other.
Linkage isomerism : This type of isomerism is shown by complexes which have an ambidentate ligand present in it. NO_2^-, CN^-, SCN^- are ambidentate ligands as each of them contain more than one donor atoms. In one structure only one donor atom is bonded to metal atom. e.g., : $[Fe(NO_2)_3Cl_3]$ and $Fe(ONO)_3Cl_3$. In first case, N is donor atom and in second case O is donor atom.

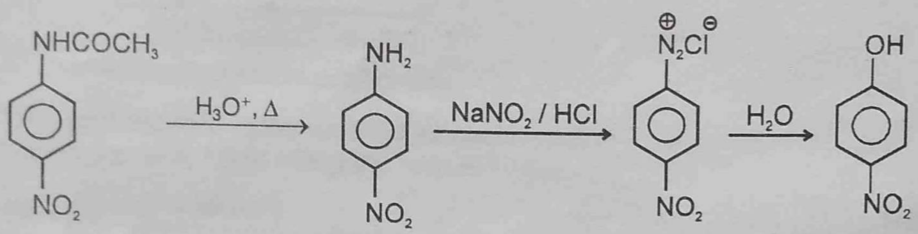
47. $\frac{u_1}{u_2} = \sqrt{\frac{T_1 \times M_2}{T_2 M_1}}$

48. It is an example of electrophilic addition (Markonikov's Addition).
It can be represented as follows :

Step (I) : $CH_3 - CH = CH_2 + \overset{+}{Cl} \xrightarrow{\text{slow}} CH_3 - \overset{+}{C}H - \underset{\displaystyle |\atop Cl}{CH_2}$

Step (II) : $CH_3 - \overset{+}{C}H - \underset{\displaystyle |\atop Cl}{CH_2} + \overset{-}{O}H \xrightarrow{\text{Fast}} CH_3 - \underset{\displaystyle |\atop OH}{CH} - \underset{\displaystyle |\atop Cl}{CH_2}$

49.



50. $\pi V = \frac{w}{M} RT$

$\frac{3.70}{760} \times \frac{100}{1000} = \frac{21.6 \times 10^{-3}}{m} \times 0.0821 \times 298$

m (molecular mass) = 1085 g/mol

51. Oxidation state of S in $S_2O_4^{2-}$, SO_3^{2-} and $S_2O_6^{2-}$ are respectively +3 +4 and +5.

so correct order of increasing oxidation state is : $\overset{+3}{S_2O_4^{2-}} < \overset{+4}{SO_3^{2-}} < \overset{+5}{S_2O_6^{2-}}$

52. Equivalent of $KMnO_4$ = equivalent of $FeSO_4$ + equivalent of FeC_2O_4

$x \times 5 = 1 \times 1 + 1 \times 3$

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

53. Pyrolusite on fusion with KOH in air gives green coloured manganate.

$2MnO_2 + 4KOH + O_2 \longrightarrow 2K_2MnO_2$ (green) $+ 2H_2O$

54.

Anode $\quad Zn \rightarrow Zn^{2+} + 2e^-$

Cathode $\quad 2H^+ + 2e^- \rightarrow H_2$

Cell : $\quad Zn + 2H^+ \rightleftharpoons H_2 + Zn^{2+}$ $\quad ; E^0_{cell} = 0 - (-0.76) = 0.76$ V

$\therefore \quad 0.701 = 0.76 - \frac{0.059}{2} \log \frac{0.01 \times 1}{[H^+]^2}$

$\therefore \quad [H^+] = 10^{-2}$ M

$\therefore$ NaOH required is 0.01 mole = 0.4 grams.

55. As value of 'n' i.e. principal quantum number increases, the size of atom increases and the distance between valence electrons and nucleus increases. As a result, the attraction between the valence electrons and nucleus decreases. This fascilitates the easier removal of valence electrons.

56. $Al_2O_3 + CoO \xrightarrow{\Delta} Al_2O_3.CoO$ (blue mass)
$ZnO.CoO$ is green in colour.

57. $CH_3-CH_2-C \equiv CH \xrightarrow{Na} CH_3-CH_2-C \equiv CNa \xrightarrow[S_N2\text{reaction}]{CH_3I} CH_3-CH_2-C\equiv C-CH_3$

58. It is Hoffmann bromamide reaction which is 100% intramolecular. Cross products are not form.

59. $N_2 + 3H_2 \rightleftharpoons 2NH_3$

$\frac{50}{4} \quad \frac{150}{4}$

$\frac{50}{4} - P \quad \frac{150}{4} - 3P \qquad 2P$

$PV = nRT$

$n = \frac{PV}{RT} \Rightarrow n \propto P$

$$\frac{2P \times 17}{\left(\frac{50}{4} - P\right) \times 28 + 3\left(\frac{50}{4} - P\right) \times 2} = \frac{1}{4}$$

$P = \frac{5}{2}$

So, $P_{NH_3} = 5$, $P_{N_2} = 10$, $P_{H_2} = 30$

$Kp = \frac{25}{10 \times (30)^3} = \frac{25}{27} \times 10^{-4} = 9.26 \times 10^{-5}$

So, Ans. $\sqrt{Kp} = 0.962 \times 10^{-2}$.

60. Sucrose $\longrightarrow$ D-(+)-Glucose + D-(–)-Fructose
$+66.5°$ $\quad +52.7°$ $\quad -92.4°$
The product mixture is overall laevorotatory.

PART-C (MATHEMATICS)

61. $\lim\limits_{x \to a} \frac{\log_e(1 + 6(f(x))}{3f(x)}$ $\left(\frac{0}{0} \text{ form}\right)$

By L-Hospital rule

$$\lim_{x \to a} \frac{\frac{6f'(x)}{1+6f(x)}}{3f'(x)} = \lim_{x \to a} \frac{2}{1+6f(x)} = 2$$

62. S_1 : $y^2 = t$

$2y\frac{dy}{dx} = \frac{dt}{dx}$

$\frac{t}{2}\frac{dt}{dx} + (x + t) = 0$

this is a homogeneous equation

S_2 : Not always true. consider the equation in S_1

63. $\begin{vmatrix} -bc & b^2+bc & c^2+bc \\ a^2+ac & -ac & c^2+ac \\ a^2+ab & b^2+ab & -ab \end{vmatrix} = 0 \Rightarrow (ab+bc+ca)^3 = 0$

$\Rightarrow ab + bc + ca = 0$

64.

	P_i	M_i
(i) 5 one ruppes coin	$\frac{1}{32}$	5
(ii) 4 one rupees + one 2 rupees	$\frac{5}{32}$	6
(iii) 3 one rupees + two 2 rupees	$\frac{10}{32}$	7
(iv) 2 one rupees + 3 two rupees	$\frac{10}{32}$	8
(v) 1 one rupees + 4 two rupees	$\frac{5}{32}$	9
(vi) 5 two rupees	$\frac{1}{32}$	10

Expectation : $\sum P_i M_i = \frac{5}{32} + \frac{30}{32} + \frac{70}{32} + \frac{80}{32} + \frac{45}{32} + \frac{10}{32} = 7.5$ rupees

65. $f(x) = x^2 - 4x + 5$

f(x) is a quadratic polynomial

f(x) is decreasing in $(-\infty, 2]$ and increasing in $[2, \infty)$.

Range of f(x) is $[1, \infty)$

hence f(x) will be invertible for

$X = (-\infty, 2] \quad \rightarrow \quad Y = [1, \infty)$

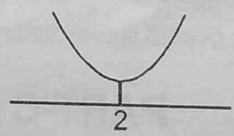
$X = [2, \infty) \quad \rightarrow \quad Y = [1, \infty)$

for $f^{-1}(x)$

$f(f^{-1}(x)) = x$

$\Rightarrow (f^{-1}(x))^2 - 4 . f^{-1}(x) + 5 = x$

$(f^{-1}(x))^2 - 4 . f^{-1}(x) + 5 - x = 0$



$f^{-1}(x) = \dfrac{4 \pm \sqrt{16 - 4(5-x)}}{2}$

$f^{-1}(x) = \dfrac{4 \pm \sqrt{4x-4}}{2} \quad \Rightarrow \quad f^{-1}(x) = 2 \pm \sqrt{x-1}$

$f : (-\infty, 2] \rightarrow [1, \infty),\ f^{-1}(x) = 2 - \sqrt{x-1}$

$f : [2, \infty) \rightarrow [1, \infty),\ f^{-1}(x) = 2 + \sqrt{x-1}$

66. $x^2\left(y\dfrac{d^2y}{dx^2} + \left(\dfrac{dy}{dx}\right)^2\right) - 2xy\dfrac{dy}{dx} + y^2 = 0$

$y\dfrac{d^2y}{dx^2} + \left(\dfrac{dy}{dx}\right)^2 - \dfrac{2xy\dfrac{dy}{dx} - y^2}{x^2} = 0$

$$\Rightarrow \frac{d}{dx}\left(y\frac{dy}{dx}\right)-\frac{d}{dx}\left(\frac{y^2}{x}\right)=0$$

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

put $y^2 = t \Rightarrow 2y\frac{dy}{dx}=\frac{dt}{dx}$

$$\frac{1}{2}\frac{dt}{dx}-\frac{t}{x}=c$$

$$\frac{dt}{dx}-\frac{2t}{x}=c_1$$

$$I.F = e^{-\int\frac{2}{x}dx} = \frac{1}{x^2}$$

$$\frac{t}{x^2} = \int\frac{c_1}{x^2}dx$$

$$\frac{t}{x^2} = -\frac{c_1}{x^2}+c_2$$

$$\frac{y^2}{x^2}=\frac{c_2x-c_1}{x}$$

$$y = \pm\sqrt{x(c_2x-c_1)}$$

67. $I = \int_0^{\pi/4}\left(\frac{\sec^2 x}{1+3x}+\frac{\sec^2(-x)}{1+3^{-x}}\right)dx = \int_0^{\pi/4}\sec^2 x\,dx = (\tan x)_0^{\pi/4}=1$

68. Let $\alpha = \sqrt{3h+2}$ and $\beta = \sqrt{3k}$

$$h = \frac{\alpha^2-2}{3}, \qquad \frac{\beta^2}{3}=k$$

Now $h + k = 1$

$$\frac{\alpha^2-2+\beta^2}{3}=1 \Rightarrow \alpha^2+\beta^2=5$$

Locus $x^2 + y^2 = 5$

69. $f\left(\frac{x+y}{3}\right) = \frac{f(x)+f(y)}{3}$, $f(0) = 0$ and $f'(0) = 3$

Put $y = 0$ and $x = 3x$, we get $f(x) = \frac{f(3x)+f(0)}{3} = \frac{f(3x)}{3}$

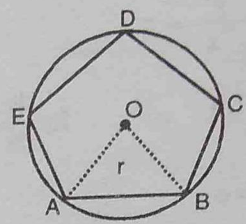
$$f'(x) = \lim_{h\to 0} = \frac{f(x+h)-f(x)}{h} = \lim_{h\to 0} = \frac{f\left(\frac{3x+3h}{3}\right)-f(x)}{h}$$

$$= \lim_{h\to 0}\frac{\frac{f(x)+f(3h)}{3}-\frac{f(3x)+f(0)}{3}}{h}$$

$$= \lim_{h\to 0}\frac{f(3h)-f(0)}{3h} = f'(0) = 3$$

$f(x) = 3x + c$, $f(0) = 0 \Rightarrow c = 0 \Rightarrow f(x) = 3x$

70. $OA = OB = r$ and $\angle AOB = \dfrac{360°}{5} = 72°$



$\therefore$ area $(\Delta AOB) = \dfrac{1}{2} \cdot r \cdot r \cdot \sin 72° = \dfrac{1}{2} r^2 \cos 18°$

area (pentagon) $= \dfrac{5}{2} r^2 \cos 18°$

$A_1/A_2 = \dfrac{2\pi}{5} \sec \dfrac{\pi}{10}$

So A is wrong. & R is correct

71. Equation of normal
$y = mx - 2m - m^3$ it passes through $\left(\dfrac{11}{4}, \dfrac{1}{4}\right)$

$\Rightarrow \dfrac{1}{4} = \dfrac{11m}{4} - 2m - m^3$

$\Rightarrow 4m^3 - 3m + 1 = 0$

$\Rightarrow m = \dfrac{1}{2}, \dfrac{-1 \pm \sqrt{3}}{2}$

so three normals

72. $xy^n = a^{n+1} \Rightarrow \log x + n \log y = (n+1) \log a$

$$\frac{1}{x} + \frac{n}{y}\frac{dy}{dx} = 0$$

$$\frac{dy}{dx} = -\frac{y}{nx}$$

length of subnormal $= y \cdot \dfrac{dy}{dx} = -\dfrac{y^2}{nx} = \dfrac{-y^2 y^n}{na^{n+1}} = \dfrac{-y^{n+2}}{na^{n+1}}$

$n + 2 = 0$
$n = -2$

73. $$\frac{1}{(n+4)(n+5)} \sum_{r=1}^{n} {}^{n+5}C_{r+2}$$

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

$$= \frac{2^{n+5} - 2}{(n+4)(n+5)} - \frac{2}{n+4} - 1$$

74. Total lines $= {}^nC_2$

lines formed by collinear points $= {}^pC_2$

Required lines $= {}^nC_2 - {}^pC_2 + 1$

75. $^5C_3\left(\frac{2}{3}\right)^3\left(\frac{1}{3}\right)^2 + {}^5C_4\left(\frac{2}{3}\right)^4\left(\frac{1}{3}\right)^1 + {}^5C_5\left(\frac{2}{3}\right)^5\left(\frac{1}{3}\right)^0 = \frac{192}{243}$

76.

Wages per week (in Rs.)	Mid-Values (x_i)	Frequency f_i	Cumulative frequency	$\lvert d_i\rvert = \lvert x_i - 45\rvert$	$f\lvert d_i\rvert$
10-20	15	4	4	30	120
20-30	25	6	10	20	120
30-40	35	10	20	10	100
40-50	45	20	40	0	0
50-60	55	10	50	10	100
60-70	65	6	56	20	120
70-80	75	4	60	30	120
		$N = \Sigma f_i = 60$			$f_i \lvert x_i - \bar{X}\rvert = 680$

Here, $N = 60$. So, $\frac{N}{2} = 30$

The cumulative frequency just greater than $\frac{N}{2} = 30$ is 40 and the corresponding class is 40-50.

So, 40-50 is the median class.

$\therefore$ $l = 40,\ f = 20,\ h = 10,\ F = 20$

Now, Median $= l + \frac{N/2 - F}{f} \times h = 40 + \frac{30-20}{20} \times 10 = 45$

Mean deviation from median $= \frac{\Sigma f_i \lvert d_i \rvert}{N} = \frac{680}{60} = 11.33$

77. Contrapositive of $p \to q$ is $\sim q \to \sim p$.

78. Given set is $\{(a, b) : 2a^2 + 3b^2 = 35,\ a, b \in Z\}$

We can see that, $2(\pm 2)^2 + 3(\pm 3)^2 = 35$

$\therefore$ (2, 3), (2, – 3), (– 2, – 3), (– 2, 3), (4, 1), (4, – 1), (– 4, – 1), (– 4, 1) are 8 elements of the set.

$\therefore$ $n = 8$

79. $\lim_{x\to 0} \frac{(1+x)^{1/x} - e + \frac{ex}{2}}{11x^2}$ $\left(\frac{0}{0} \text{ form}\right)$

By expansion

$= \lim_{x\to 0} \frac{e\left(1 - \frac{x}{2} + \frac{11}{24}x^2 + \ldots\right) - e + \frac{ex}{2}}{11x^2} = \frac{e}{24}$

80. $f(1) + \frac{f'(1)}{1!} + \frac{f''(1)}{2!} + \ldots\ldots + \frac{f^n(1)}{n!} = 1 + \frac{n}{1!} + \frac{n(n-1)}{2!} + \ldots + \frac{n!}{n!} = {}^nC_0 + {}^nC_1 + {}^nC_1 + \ldots\ldots + {}^nC_n = 2^n$

81. **Statment-1 :** Let $x - 1 = u$ then $\cos u = \frac{|u|}{10}$

clearly graph of $y = \cos u$ & $y = \frac{|u|}{10}$ cut each other at six real points hence total no. of solutions is 6.

Hence statment-1 is true.

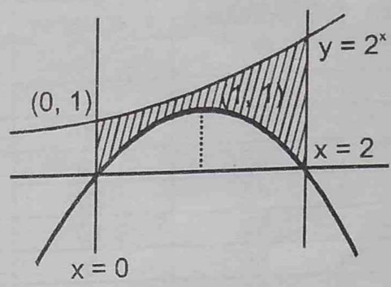
Statement-2 is obviously true and also explains statement-1.

82. Area $\int_0^2 (y_1 - y_2)\,.\,dx = \int_0^2 (2^x - (2x - x^2))\,.\,dx = \int_0^2 (2^x - 2x + x^2)\,.\,dx$

$$\left[\frac{2^x}{\log_e 2} - x^2 + \frac{x^3}{3}\right]_0^2$$

$$\Rightarrow \left[\frac{4}{\log_e 2} - 4 + \frac{8}{3}\right] - \left[\frac{1}{\log_e 2}\right]$$

$$= \frac{3}{\log_e 2} - \frac{4}{3}$$



83. $A = \begin{vmatrix} \lambda & 1 & 1 \\ 1 & \lambda & 1 \\ 1 & 1 & \lambda \end{vmatrix} = \lambda^3 - 3\lambda + 2 = (\lambda - 1)^2 (\lambda + 2)$

at $\lambda = 1$, $|A| = 0$ system have infinite solution so consistent
at $\lambda = -2$, $|A| = 0$ system have no solution so in consistent

$\ell n_{x \to (-2)} \dfrac{|x+2|}{(x+2)(x-2)}$ not have L.H.L. = R.H.L

so not exist

84. $\vec{n}_1 \times \vec{n}_2 = (\hat{i} - 3\hat{j} + \hat{k}) \times (2\hat{i} + 5\hat{j} - 3\hat{k}) = 4\hat{i} + 5\hat{j} + 11\hat{k}$

85. $\sin x + \sin 5x = \sin 2x + \sin 4x$
$\Rightarrow 2 \sin 3x \cos 2x = 2 \sin 3x \cos x$
$\Rightarrow 2 \sin 3x(\cos 2x - \cos x) = 0$

$\Rightarrow \sin 3x = 0 \Rightarrow 3x = n\pi \Rightarrow x = \dfrac{n\pi}{3}$ or $\cos 2x - \cos x = 0 \Rightarrow \cos 2x = \cos x$

$\Rightarrow 2x = 2n\pi \pm x \Rightarrow x = 2n\pi, \dfrac{2n\pi}{3}$

But solutions obtained by $x = 2n\pi$ or $x = \dfrac{2n\pi}{3}$ are all involved in $x = \dfrac{n\pi}{3}$

86. $\displaystyle\int \frac{dx}{x(x^{2010}+1)}$; $\displaystyle\int \frac{dx}{x^{2011}\left(1 + \frac{1}{x^{2010}}\right)}$

Put $1 + x^{-2010} = t$

$$\frac{dx}{x^{2011}} = -\frac{dt}{2010}$$

$$I = -\int \frac{dt}{2010\,(t)} = -\frac{1}{2010}\ell n|t| + c$$

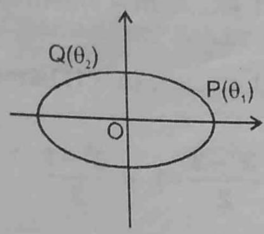
$$= -\frac{1}{2010}\ell n|1 + x^{-2010}| + c$$

87. $\frac{x^2}{2} + \frac{y^2}{1} = 1$

$P[\sqrt{2}\cos\theta_1, \sin\theta_1]$

$Q[\sqrt{2}\cos\theta_2, \sin\theta_2]$

M_1 = Slope of OP = $\frac{1}{\sqrt{2}}\tan\theta_1$



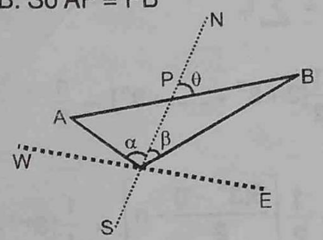
M_2 = Slope of OQ = $\frac{1}{\sqrt{2}}\tan\theta_2$

$\tan\theta_1.\tan\theta_2 = 2$

So, $m_1m_2 = -1$ (so perpendicular at center)

88. The car is moving on the line AB.O is the point of observation. At the time of observation the car is at P. Ten minutes earlier it was at A and ten minutes afterwards it is at B. So AP = PB

Also $\angle POA = \alpha$, $\angle POB = \beta$ and $\angle NPB = \theta$.



In the ΔOPB, $\frac{PB}{\sin\beta} = \frac{OP}{\sin\angle OBP}$

or $\frac{PB}{\sin\beta} = \frac{OP}{\sin(\theta-\beta)}$ .... (i)

in the ΔOPA, $\frac{PA}{\sin\alpha} = \frac{OP}{\sin OAP}$

or $\frac{PA}{\sin\alpha} = \frac{OP}{\sin(180-(\alpha+\theta))}$ .... (ii)

From (i) & (ii) $\frac{\sin(\theta-\beta)}{\sin\beta} = \frac{\sin(\alpha+\theta)}{\sin\alpha}$ $(\because PA = PB)$

$\Rightarrow$ $2\cos\theta = \sin\theta(\cot\beta - \cot\alpha)$ $\Rightarrow$ $\tan\theta = \frac{2}{\cot\beta - \cot\alpha}$

89. $AB \equiv x + y - 2 = 0$

$BC \equiv y - 2x + 4 = 0$

$CA \equiv 2y - x - 4 = 0$

$(AB)_{(4,4)} = 4 + 4 - 2 > 0$

so $(AB)_{(\alpha, 2\alpha)} > 0 \Rightarrow$ $\alpha + 2\alpha - 2 > 0 \Rightarrow$ $\alpha > \frac{2}{3}$ ....(i)

similarly $(BC)_{(0,2)} > 0$ so $(BC)_{(\alpha, 2\alpha)} > 0 \Rightarrow$ $\alpha \in R$ ....(ii)

and $(CA)_{(2,0)} < 0$ so $(CA)_{(\alpha, 2\alpha)} < 0$ $\Rightarrow$ $\alpha < \frac{4}{3}$ ....(iii)

So, (i) $\cap$ (ii) $\cap$ (iii)

$\alpha \in \left(\frac{2}{3}, \frac{4}{3}\right)$

90. $S = 1 + 4 + 13 + 40 + 121 + ... + t_n$

$S = \quad 1 + 4 + 13 + 40 + ... + t_{n-1} + t_n$

$0 = 1 + [3 + 9 + 27 + 81 + ...(n - 1) \text{ terms}] - t_n$

$t_n = 1 + [3 + 9 + 27 + 81 + ... (n - 1) \text{ terms}]$

$$t_n = 1 + 3\left[\frac{3^{n-1}-1}{3-1}\right] \Rightarrow \frac{3^n-3}{2}+1 = \frac{3^n-1}{2}$$

$$t_n = \frac{3^n-1}{2}$$

$$S_n = \sum t_n$$

$$= \frac{1}{2}[3+3^2+......+3^n] - \frac{n}{2}$$

$$S = \frac{1}{2}\left[\frac{3(3^n-1)}{2}-n\right] = \frac{1}{4}[3^{n+1} - 2n - 3]$$

$$S = \frac{1}{4}[3^{n+1} - 2n - 3]$$