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VITEEE 2018 Question Paper

Vellore Institute of Technology Engineering Entrance Examination

SOLVED PAPER (memory based)

VITEEE 2018

GENERAL INSTRUCTIONS

- This question paper contains total 125 questions divided into four parts :
  Part I : Physics Q. No - 1 to 40
  Part II : Chemistry Q. No - 41 to 80
  Part III : Mathematics Q. No - 81 to 120
  Part IV : English Q. No - 121 to 125
- All questions are multiple choice questions with four options, only one of them is correct.
- For each correct response, the candidate will get 1 mark.
- There is no negative marking for the wrong answer.
- The test is of 2½ hours duration.

PART - I (PHYSICS)

1. The resistance of a wire is 'R' ohm. If it is melted and stretched to 'n' times its original length, its new resistance will be

(a) $\frac{R}{n}$ (b) n^2R (c) $\frac{R}{n^2}$ (d) nR

2. A coil of 40 henry inductance is connected in series with a resistance of 8 ohm and the combination is joined to the terminals of a 2 volt battery. The time constant of the circuit is

(a) 20 seconds (b) 5 seconds
(c) 1/5 seconds (d) 40 seconds

3. Which of the following is the correct lens formula?

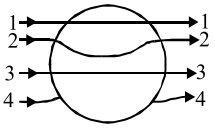
(a) $\frac{1}{v}-\frac{1}{u}=\frac{1}{f}$ (b) $\frac{1}{v}+\frac{1}{u}=\frac{1}{f}$
(c) $v - u = f$ (d) $v + u = f$

4. The magnetic field at a point due to a current carrying conductor is directly proportional to

(a) resistance of the conductor
(b) thickness of the conductor
(c) current flowing through the conductor
(d) distance from the conductor

5. A metallic sphere is placed in a uniform electric field. The line of force follow the path (s) shown in the figure as

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



6. Electron in hydrogen atom first jumps from third excited state to second excited state and then from second excited to the first excited state. The ratio of the wavelength $\lambda_1 : \lambda_2$ emitted in the two cases is

(a) 7/5 (b) 27/20 (c) 27/5 (d) 20/7

7. In a common emitter transistor amplifier $\beta = 60$, $R_o = 5000\ \Omega$ and internal resistance of a transistor is 500 Ω. The voltage amplification of amplifier will be

(a) 500 (b) 460 (c) 600 (d) 560

8. A machine gun has a mass 5 kg. It fires 50 gram bullets at the rate of 30 bullets per minute at a speed of 400 ms^{-1}. What force is required to keep the gun in position?

(a) 10 N (b) 5 N (c) 15 N (d) 30 N

9. The activity of a radioactive sample is measured as 9750 counts per minute at t = 0 and as 975 counts per minute at t = 5 minutes. The decay constant is approximately

(a) 0.922 per minute (b) 0.691 per minute

(c) 0.461 per minute (d) 0.230 per minute

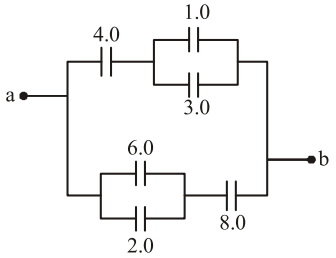
10. The equivalent capacitance between *a* and *b* for the combination of capacitors shown in figure where all capacitances are in microfarad is

(a) 6.0 μF

(b) 4.0 μF

(c) 2.0 μF

(d) 3.0 μF



11. Two coils have a mutual inductance 0.005 H. The current changes in the first coil according to equation $I = I_0 \sin \omega t$, where $I_0 = 10A$ and $\omega = 100\,\pi$ radian/sec. The maximum value of e.m.f. in the second coil is

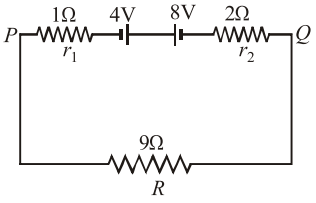
(a) 2π (b) 5π (c) π (d) 4π

12. In Young's double slit experiment intensity at a point is (1/4) of the maximum intensity. Angular position of this point is (separation between slits is *d*)

(a) $\sin^{-1}(\lambda/d)$ (b) $\sin^{-1}(\lambda/2d)$

(c) $\sin^{-1}(\lambda/3d)$ (d) $\sin^{-1}(\lambda/4d)$

13. Two batteries of emf 4 V and 8V with internal resistance 1 Ω and 2 Ω are connected in a circuit with a resistance of 9 Ω as shown in figure.



The current and potential difference between the points *P* and *Q* are

(a) $\frac{1}{3}A$ and 3 V (b) $\frac{1}{6}A$ and 4 V

(c) $\frac{1}{9}A$ and 9 V (d) $\frac{1}{12}A$ and 12 V

14. The horizontal component of the earth's magnetic field is 3.6×10^{-5} tesla where the dip angle is 60°. The magnitude of the earth's magnetic field is

(a) 2.8×10^{-4} tesla (b) 2.1×10^{-4} tesla

(c) 7.2×10^{-5} tesla (d) 3.6×10^{-5} tesla

15. The velocity of water in a river is 18 km/hr near the surface. If the river is 5 m deep, find the shearing stress between the horizontal layers of water. The co-efficient of viscosity of water = 10^{-2} poise.

(a) 10^{-1} N/m^2 (b) 10^{-2} N/m^2

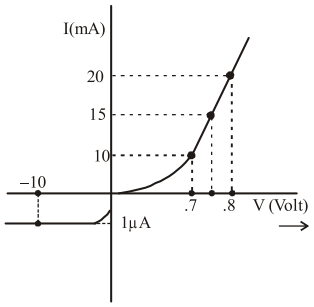
(c) 10^{-3} N/m^2 (d) 10^{-4} N/m^2

16. The magnetic field in a travelling electromagnetic wave has a peak value of 20 nT. The peak value of electric field strength is

(a) 3 V/m (b) 6 V/m (c) 9 V/m (d) 12 V/m

17. The V–I characteristic of a diode is shown in the figure.

The ratio of forward to reverse bias resistance is :



(a) 10 (b) 10^{-6} (c) 10^6 (d) 100

18. The principle of conservation of linear momentum can be strictly applied during a collision between two particles provided the time of impact

(a) is extremely small

(b) is moderately small

(c) is extremely large

(d) depends on particular case

19. The current sensitivity of a moving coil galvanometer depends on

(a) the number of turns in the coil

(b) moment of inertia of the coil

(c) current sent through galvanometer

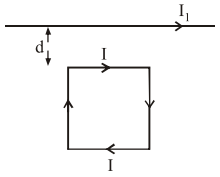
(d) eddy current in Al frame

20. The length of elastic string, obeying Hooke's law is ℓ_1 metres when the tension 4N and ℓ_2 metres when the tension is 5N. The length in metres when the tension is 9N is –

(a) $5\ell_1 - 4\ell_2$ (b) $5\ell_2 - 4\ell_1$

(c) $9\ell_1 - 8\ell_2$ (d) $9\ell_2 - 8\ell_1$

21. A square loop, carrying a steady current I, is placed in a horizontal plane near a long straight conductor carrying a steady current I_1 at a distance d from the conductor as shown in figure. The loop will experience



(a) a net repulsive force away from the conductor
(b) a net torque acting upward perpendicular to the horizontal plane
(c) a net torque acting downward normal to the horizontal plane
(d) a net attractive force towards the conductor

22. The tempertaure of equal masses of three different liquids A, B and C are 12°C, 19°C and 28°C respectively. The temperature when A and B are mixed is 16°C and when B and C are mixed is 23°C . The temperature when A and C are mixed is

(a) 18.2°C (b) 22°C (c) 20.2°C (d) 25.2°C

23. An alternating voltage of 220 V, 50 Hz frequency is applied across a capacitor of capacitance 2 μF. The impedence of the circuit is

(a) $\frac{\pi}{5000}$ (b) $\frac{1000}{\pi}$

(c) 500 π (d) $\frac{5000}{\pi}$

24. The molar specific heats of an ideal gas at constant pressure and volume are denoted by C_p and C_v, respectively. If $\gamma = \frac{C_p}{C_v}$ and R is the universal gas constant, then C_v is equal to

(a) $\frac{R}{(\gamma-1)}$ (b) $\frac{(\gamma-1)}{R}$

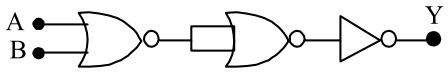
(c) γR (d) $\frac{1+\gamma}{1-\gamma}$

25. The ratio of radii of the first three Bohr orbits is

(a) $1:\frac{1}{2}:\frac{1}{3}$ (b) 1 : 2 : 3

(c) 1 : 4 : 9 (d) 1 : 8 : 27

26. The given electrical network is equivalent to :



(a) OR gate (b) NOR gate
(c) NOT gate (d) AND gate

27. A large number of liquid drops each of radius r coalesce to from a single drop of radius R. The energy released in the process is converted into kinetic energy of the big drop so formed. The speed of the big drop is (given, surface tension of liquid T, density ρ)

(a) $\sqrt{\frac{T}{\rho}\left(\frac{1}{r}-\frac{1}{R}\right)}$ (b) $\sqrt{\frac{2T}{\rho}\left(\frac{1}{r}-\frac{1}{R}\right)}$

(c) $\sqrt{\frac{4T}{\rho}\left(\frac{1}{r}-\frac{1}{R}\right)}$ (d) $\sqrt{\frac{6T}{\rho}\left(\frac{1}{r}-\frac{1}{R}\right)}$

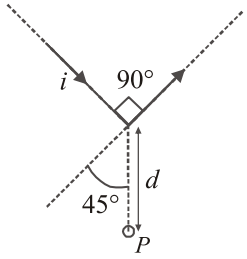
28. Find the magnetic field at P due to the arrangement shown

(a) $\frac{\mu_0 i}{\sqrt{2}\pi d}\left(1-\frac{1}{\sqrt{2}}\right)\otimes$

(b) $\frac{2\mu_0 i}{\sqrt{2}\pi d}\otimes$

(c) $\frac{\mu_0 i}{\sqrt{2}\pi d}\otimes$

(d) $\frac{\mu_0 i}{\sqrt{2}\pi d}\left(1+\frac{1}{\sqrt{2}}\right)\otimes$



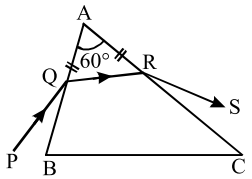
29. The Binding energy per nucleon of ^7_3Li and ^4_2He nuclei are 5.60 MeV and 7.06 MeV, respectively.

In the nuclear reaction $^7_3\text{Li} + {}^1_1\text{H} \rightarrow 2\,{}^4_2\text{He} + Q$, the value of energy Q released is :

(a) 19.6 MeV (b) – 2.4 MeV
(c) 8.4 MeV (d) 17.3 MeV

30. A ray PQ incident on the refracting face BA is refracted in the prism BAC as shown in the figure and emerges from the other refracting face AC as RS such that AQ = AR. If the angle of prism A = 60° and the refractive index of the material of prism is $\sqrt{3}$, then the angle of deviation of the ray is

(a) 60°
(b) 45°
(c) 30°
(d) None of these

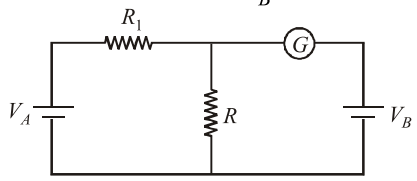


31. In a photoelectric effect measurement, the stopping potential for a given metal is found to be V_0 volt when radiation of wavelength λ_0 is used. If radiation of wavelength $2\lambda_0$ is used with the same metal then the stopping potential (in volt) will be

(a) $\frac{V_0}{2}$ (b) $2V_0$

(c) $V_0 + \frac{hc}{2e\lambda_0}$ (d) $V_0 - \frac{hc}{2e\lambda_0}$

32. In the circuit shown the cells A and B have negligible resistances. For $V_A = 12V, R_1 = 500\Omega$ and $R = 100\Omega$ the galvanometer (G) shows no deflection. The value of V_B is :



(a) 4 V (b) 2 V (c) 12 V (d) 6 V

33. A steel wire of length ℓ has a magnetic moment M. It is then bent into a semicircular arc. The new magnetic moment is

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

34. A running man has half the kinetic energy of that of a boy of half of his mass. The man speeds up by 1m/s so as to have same K.E. as that of the boy. The original speed of the man will be

(a) $\sqrt{2}$ m/s (b) $(\sqrt{2}-1)$m/s

(c) $\frac{1}{(\sqrt{2}-1)}$m/s (d) $\frac{1}{\sqrt{2}}$m/s

35. In Young's double slit experiment the two slits are illuminated by light of wavelenght 5890Å and the distance between the fringes obtained on the screen is 0.2°. If the whole apparatus is immersed in water then the angular fringe width will be, if the refractive index of water is 4/3.

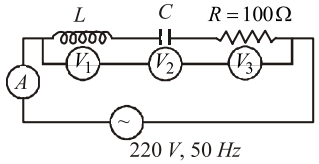
(a) 0.30° (b) 0.15° (c) 15° (d) 30°

36. Four point charges $-Q, -q, 2q$ and $2Q$ are placed, one at each corner of the square. The relation between Q and q for which the potential at the centre of the square is zero is

(a) $Q = -q$ (b) $Q = -\frac{1}{q}$

(c) $Q = q$ (d) $Q = \frac{1}{q}$

37. In the given circuit the reading of voltmeter V_1 and V_2 are 300 volt each. The reading of the voltmeter V_3 and ammeter A are respectively



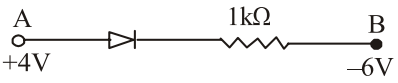
(a) 150 V and 2.2 A (b) 220 V and 2.2 A

(c) 220 V and 2.0 A (d) 100 V and 2.0 A

38. A body cools from 50.0°C to 49.9°C in 5s. How long will it take to cool from 40.0°C to 39.9°C? Assume the temperature of surroundings to be 30.0°C and Newton's law of cooling to be valid

(a) 2.5 s (b) 10 s (c) 20 s (d) 5 s

39. Consider the junction diode as ideal. The value of current flowing through AB is



(a) 0 A (b) 10^{-2} A

(c) 10^{-1} A (d) 10^{-3} A

40. A metal disc of radius 100 cm is rotated at a constant angular speed of 60 rad/s in a plane at right angles to an external field of magnetic induction 0.05 Wb/m^2. The emf induced between the centre and a point on the rim will be

(a) 3 V (b) 1.5 V (c) 6 V (d) 9 V

PART - II (CHEMISTRY)

41. Ionisation energy of He^+ is 19.6×10^{-18} J atom^{-1}. The energy of the first stationary state ($n = 1$) of Li^{2+} is

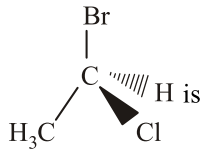
(a) 4.41×10^{-16} J atom^{-1}

(b) -4.41×10^{-17} J atom^{-1}

(c) -2.2×10^{-15} J atom^{-1}

(d) 8.82×10^{-17} J atom^{-1}

42. The chirality of the compound



(a) R (b) S (c) E (d) Z

43. Which of the following compounds is formed when a mixture of $K_2Cr_2O_7$ and NaCl is heated with conc. H_2SO_4 ?

(a) CrO_2Cl_2 (b) $CrCl_3$

(c) $Cr_2(SO_4)_3$ (d) Na_2CrO_4

44. For the process $H_2O(l)$ (1 bar, 373 K) → $H_2O(g)$ (1 bar, 373 K), the correct set of thermodynamic parameters is

(a) $\Delta G = 0, \Delta S = +ve$

(b) $\Delta G = 0, \Delta S = -ve$

(c) $\Delta G = +ve, \Delta S = 0$

(d) $\Delta G = -ve, \Delta S = +ve$

45. Compound 'A' of molecular formula $C_4H_{10}O$ on treatment with Lucas reagent at room temperature gives compound 'B'. When compound 'B' is heated with alcoholic KOH, it gives isobutene. Compound 'A' and 'B' are respectively

(a) 2-methyl-2-propanol and 2-methyl-2-chloropropane

(b) 2-methyl-1 -propanol and 1-chloro-2-methylpropane

(c) 2-methyl-1 -propanol and 2-methyl-2-chloropropane

(d) butan-2-ol and 2-chlorobutane

46. The reagent (s) which can be used to distinguish acetophenone from benzophenone is (are)

(a) 2,4- dinitrophenylhydrazine

(b) aqueous solution of $NaHSO_3$

(c) benedict reagent

(d) $I_2$and Na_2CO_3.

47. In the extraction of Cu, the metal is formed in the bessemer converter due to the reaction :

(a) $Cu_2S + 2Cu_2O \longrightarrow 6Cu + SO_2$

(b) $Cu_2S \longrightarrow 2Cu + S$

(c) $Fe + Cu_2O \longrightarrow 2Cu + FeO$

(d) $2Cu_2O \longrightarrow 4Cu + O_2$

48. For which one of the following systems at equilibrium, at constant temperature will the doubling of the volume cause a shift to the right?

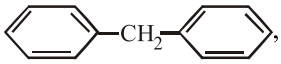
(a) $H_2(g)+Cl_2(g) \rightleftharpoons 2HCl(g)$

(b) $2CO(g)+O_2(g) \rightleftharpoons 2CO_2(g)$

(c) $N_2(g)+3H_2(g) \rightleftharpoons 2NH_3(g)$

(d) $PCl_5(g) \rightleftharpoons PCl_3(g)+Cl_2(g)$

49. The molecular formula of diphenyl methane,



, is $C_{13}H_{12}$.

How many structural isomers are possible when one of the hydrogens is replaced by a chlorine atom?

(a) 6 (b) 4 (c) 8 (d) 7

50. Calculate enthalpy change for the change $8S(g) \longrightarrow S_8(g)$, given that

$H_2S_2(g) \longrightarrow 2H(g) + 2S(g), \quad \Delta H = 239.0 \text{ k cal mol}^{-1}$

$H_2S(g) \longrightarrow 2H(g) + S(g), \quad \Delta H = 175.0 \text{ k cal mol}^{-1}$

(a) + 512.0 k cal (b) – 512.0 k cal

(c) 508.0 k cal (d) – 508.0 k cal

51. Which of the following is best method for reducing 3-bromopropanal to 1-bromopropane–

(a) Wolf-Kishner reduction

(b) Clemmenson reduction

(c) Either (a) or (b)

(d) Stephen's reduction

52. Which one of the following has an optical isomer?

(a) $[Zn(en)(NH_3)_2]^{2+}$

(b) $[Co(en)_3]^{3+}$

(c) $[Co(H_2O)_4(en)]^{3+}$

(d) $[Zn(en)_2]^{2+}$

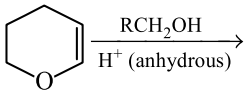
(en = ethylenediamine)

53. An element occuring in the bcc structure has 12.08×10^{23} unit cells. The total number of atoms of the element in these cells will be

(a) 24.16×10^{23} (b) 36.18×10^{23}

(c) 6.04×10^{23} (d) 12.08×10^{23}

54. The major product of the following reaction is



(a) a hemiacetal (b) an acetal

(c) an ether (d) an ester

55. Standard cell voltage for the cell $Pb \mid Pb^{2+} \parallel Sn^{2+} \mid Sn$ is – 0.01 V. If the cell is to exhibit $E_{cell} = 0$, the value of $[Sn^{2+}] / [Pb^{2+}]$ should be antilog of –

(a) + 0.3 (b) 0.5 (c) 1.5 (d) – 0.5

56. HBr reacts with CH_2= CH – OCH_3 under anhydrous conditions at room temperature to give

(a) $BrCH_2 - CH_2 - OCH_3$

(b) $H_3C - CHBr - OCH_3$

(c) CH_3CHO and CH_3Br

(d) $BrCH_2CHO$ and CH_3OH

57. Acetic anhydride reacts with diethyl ether in the presence of anhydrous $AlCl_3$ to give :

(a) CH_3CH_2COOH (b) $CH_3CH_2COOC_2H_5$

(c) CH_3COOCH_3 (d) $CH_3COOC_2H_5$

58. The resistance of 0.01 N solution of an electrolyte was found to be 220 ohm at 298 K using a conductivity cell with a cell constant of $0.88cm^{-1}$. The value of equivalent conductance of solution is –

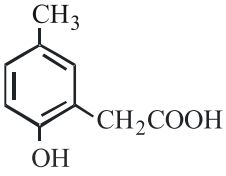
(a) 400 mho cm^2 g eq^{-1}

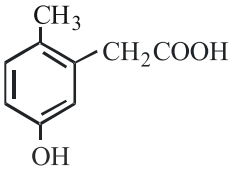
(b) 295 mho cm^2 g eq^{-1}

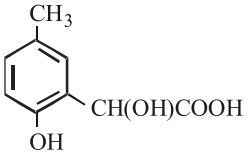
(c) 419 mho cm^2 g eq^{-1}

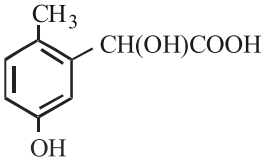
(d) 425 mho cm^2 g eq^{-1}

59. *p*-cresol reacts with chloroform in alkaline medium to give the compound A which adds hydrogen cyanide to form, the compound B. The latter on acidic hydrolysis gives chiral carboxylic acid. The structure of the carboxylic acid is

(a) 

(b) 

(c) 

(d) 

60. The radius of La^{3+} (Atomic number of La = 57) is 1.06Å. Which one of the following given values will be closest to the radius of Lu^{3+} (Atomic number of Lu = 71) ?

(a) 1.40 Å (b) 1.06 Å

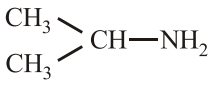
(c) 0.85 Å (d) 1.60 Å

61. In a compound, atoms of element Y form *ccp* lattice and those of element X occupy 2/3rd of tetrahedral voids. The formula of the compound will be

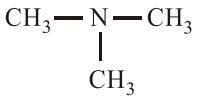
(a) X_4Y_3 (b) X_2Y_3

(c) X_2Y (d) X_3Y_4

62. An organic compound (C_3H_9N) (A), when treated with nitrous acid, gave an alcohol and N_2 gas was evolved. (A) on warming with $CHCl_3$ and caustic potash gave (C) which on reduction gave isopropylmethylamine. Predict the structure of (A).

(a) 

(b) $CH_3CH_2 - NH - CH_3$

(c) 

(d) $CH_3CH_2CH_2 - NH_2$

63. For the reaction $2N_2O_5 \rightarrow 4NO_2 + O_2$, rate and rate constant are 1.02×10^{-4} mol lit^{-1} sec^{-1} and 3.4×10^{-5} sec^{-1} respectively then concentration of N_2O_5 at that time will be

(a) 1.732M (b) 3M

(c) 3.4×10^5M (d) 1.02×10^{-4}M

64. The complex showing a spin-only magnetic moment of 2.82 B.M. is :

(a) $Ni(CO)_4$ (b) $[NiCl_4]^{2-}$

(c) $Ni(PPh_3)_4$ (d) $[Ni(CN)_4]^{2-}$

65. What is order with respect to A, B, C, respectively

[A]	[B]	[C]	rate (M/sec.)
0.2	0.1	0.02	8.08×10^{-3}
0.1	0.2	0.02	2.01×10^{-3}
0.1	1.8	0.18	6.03×10^{-3}
0.2	0.1	0.08	6.464×10^{-2}

(a) –1, 1, 3/2 (b) –1, 1, 1/2

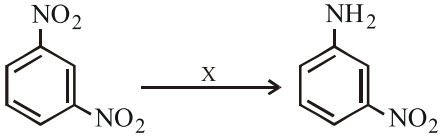
(c) 1, 3/2, –1 (d) 1, –1, 3/2

66. In the silver plating of copper, $K[Ag(CN)_2]$ is used instead of $AgNO_3$. The reason is
(a) a thin layer of Ag is formed on Cu
(b) more voltage is required
(c) Ag^+ ions are completely removed from solution
(d) less availability of Ag^+ ions, as Cu cannot displace Ag from $[Ag(CN)_2]^-$ ion

67. Nitrosoamines ($R_2N - N = O$) are soluble in water. On heating them with concentrated H_2SO_4, they give secondary amines. This reaction is called
(a) Perkin reaction
(b) Sandmeyer's reaction
(c) Fitting reaction
(d) Liebermann nitroso reaction

68. The energies E_1 and E_2 of two radiations are 25 eV and 50 eV, respectively. The relation between their wavelengths i.e., λ_1 and λ_2 will be :
(a) $\lambda_1 = \lambda_2$ (b) $\lambda_1 = 2\lambda_2$
(c) $\lambda_1 = 4\lambda_2$ (d) $\lambda_1 = \frac{1}{2}\lambda_2$

69. In the reaction :



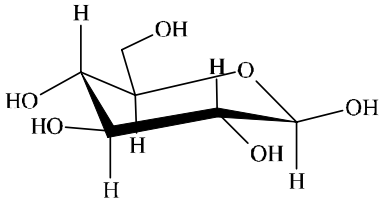
; X is
(a) SiC (b) H_2SO_4
(c) $KMnO_4$ (d) Fe + HCl

70. Nucleotide in DNA are linked by –
(a) hydrogen bond
(b) 3'-5' phosphodiester bond
(c) glycosidic bond
(d) peptide bond

71. The correct order of the thermal stability of hydrogen halides (H–X) is
(a) HI > HCl < HF > HBr
(b) HCl< HF > HBr < HI
(c) HF > HCl > HBr > HI
(d) HI < HBr > HCl < HF

72. The values of ΔH and ΔS for the reaction, $C(graphite) + CO_2(g) \rightarrow 2CO(g)$ are 170 kJ and 170 JK^{-1}, respectively. This reaction will be spontaneous at
(a) 910 K (b) 1110 K
(c) 510 K (d) 710 K

73. The following carbohydrate is



(a) a ketohexose (b) an aldohexose
(c) an α-furanose (d) an α-pyranose

74. Given that the equilibrium constant for the reaction $2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g)$ has a value of 278 at a particular temperature. What is the value of the equilibrium constant for the following reaction at the same temperature?

$$SO_3(g) \rightleftharpoons SO_2(g) + \frac{1}{2}O_2(g)$$

(a) 1.8×10^{-3} (b) 3.6×10^{-3}
(c) 6.0×10^{-2} (d) 1.3×10^{-5}

75. Which one of the following statements is correct?
(a) All amino acids except lysine are optically active
(b) All amino acids are optically active
(c) All amino acids except glycine are optically active
(d) All amino acids except glutamic acids are optically active

76. In case of nitrogen, NCl_3 is possible but not NCl_5 while in case of phosphorus, PCl_3 as well as PCl_5 are possible. It is due to
(a) availability of vacant *d* orbitals in P but not in N
(b) lower electronegativity of P than N
(c) lower tendency of H-bond formation in P than N
(d) occurrence of P in solid while N in gaseous state at room temperature.

77. For the reaction :
$2\ BaO_2(s) \rightleftharpoons 2BaO(s) + O_2(g)$;
ΔH = +ve. In equilibrium condition, pressure of O_2 is dependent on
(a) mass of BaO_2
(b) mass of BaO
(c) temperature of equilibrium
(d) mass of BaO_2 and BaO both

78. In the series of reaction

$$C_6H_5NH_2 \xrightarrow[0-5^\circ C]{NaNO_2/HCl} X$$

$$\xrightarrow[H_2O]{HNO_2} Y + N_2 + HCl, \text{ X and}$$

Y are respectively

(a) $C_6H_5 - N = N - C_6H_5, C_6H_5N_2^{\oplus}Cl^{\ominus}$

(b) $C_6H_5N_2^{\oplus}Cl^{-}, C_6H_5 - N = N - C_6H_5$

(c) $C_6H_5N_2^{\oplus}Cl^{-}, C_6H_5NO_2$

(d) $C_6H_5NO_2, C_6H_6$

79. In XeF_2, XeF_4, XeF_6 the number of lone pairs on Xe are respectively

(a) 2, 3, 1 (b) 1, 2, 3

(c) 4, 1, 2 (d) 3, 2, 1

80. In Williamson synthesis if tertiary alkyl halide is used than

(a) ether is obtained in good yield

(b) ether is obtained in poor yield

(c) alkene is the only reaction product

(d) a mixture of alkene as a major product and ether as a minor product forms.

PART - III (MATHEMATICS)

81. If $12\cot^2\theta - 31\,\text{cosec}\,\theta + 32 = 0$, then the value of $\sin\theta$ is

(a) $\frac{3}{5}$ or 1 (b) $\frac{2}{3}$ or $\frac{-2}{3}$

(c) $\frac{4}{5}$ or $\frac{3}{4}$ (d) $\pm\frac{1}{2}$

82. Amplitude of $\frac{1+\sqrt{3}i}{\sqrt{3}+1}$ is :

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

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

83. The value of $\lim\limits_{x\to 0}\frac{x^3\cot x}{1-\cos x}$ is

(a) 1 (b) –2

(c) 2 (d) 0

84. The connective in the statement :

"2 + 7 > 9 or 2 + 7 < 9" is

(a) and (b) or

(c) > (d) <

85. The number of ways in which 3 prizes can be distributed to 4 children, so that no child gets all the three prizes, are

(a) 64 (b) 62

(c) 60 (d) None of these

86. If A and B are events such that $P(A) = 0.42$, $P(B) = 0.48$ and $P(A \text{ and } B) = 0.16$. then,

I. P(not A) = 0.58

II. P(not B) = 0.52

III. P(A or B) = 0.47

(a) Only I and II are correct.

(b) Only II and III are correct.

(c) Only I and III are true.

(d) All three statements are correct.

87. The focus of the curve $y^2 + 4x - 6y + 13 = 0$ is

(a) (2, 3) (b) (–2, 3)

(c) (2, –3) (d) (–2, –3)

88. If the parabola $y^2 = 4ax$ passes through the point (1, –2), then the tangent at this point is

(a) $x + y - 1 = 0$ (b) $x - y - 1 = 0$

(c) $x + y + 1 = 0$ (d) $x - y - 1 = 0$

89. The no. of points of discontinuity of the function $f(x) = x - [x]$ in the interval (0, 7) are

(a) 2 (b) 4

(c) 6 (d) 8

90. A football is inflated by pumping air in it. When it acquires spherical shape its radius increases at the rate of 0.02 cm/s. The rate of increase of its volume when the radius is 10 cm is _____ π cm/s

(a) 0 (b) 2

(c) 8 (d) 9

91. The interval in which the function $f(x) = \frac{4x^2+1}{x}$ is decreasing is :

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

(c) (–1, 1) (d) [–1, 1]

92. The eccentricity of the ellipse whose major axis is three times the minor axis is:

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

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

93. The equation of the hyperbola with vertices (3, 0), (–3, 0) and semi-latus rectum 4 is given by:

(a) $4x^2 - 3y^2 + 36 = 0$

(b) $4x^2 - 3y^2 + 12 = 0$

(c) $4x^2 - 3y^2 - 36 = 0$

(d) $4x^2 + 3y^2 - 25 = 0$

94. $f(x) = \begin{cases} x \sin 1/x & , \ x \neq 0 \\ 0 & , \ x = 0 \end{cases}$ at x = 0 is

(a) continuous as well as differentiable

(b) differentiable but not continuous

(c) continuous but not differentiable

(d) neither continuous nor differentiable

95. If $\int \frac{3x+1}{(x-3)(x-5)}dx$

$= \int \frac{-5}{(x-3)}dx + \int \frac{B}{(x-5)}dx$, then the value of B is

(a) 3 (b) 4

(c) 6 (d) 8

96. The vector equation of the symmetrical form of equation of straight line $\frac{x-5}{3} = \frac{y+4}{7} = \frac{z-6}{2}$ is

(a) $\vec{r} = (3\hat{i} + 7\hat{j} + 2\hat{k}) + \mu(5\hat{i} + 4j - 6\hat{k})$

(b) $\vec{r} = (5\hat{i} + 4\hat{j} - 6\hat{k}) + \mu(3\hat{i} + 7j + 2\hat{k})$

(c) $\vec{r} = (5\hat{i} - 4\hat{j} - 6\hat{k}) + \mu(3\hat{i} - 7j - 2\hat{k})$

(d) $\vec{r} = (5\hat{i} - 4\hat{j} + 6\hat{k}) + \mu(3\hat{i} + 7j + 2\hat{k})$

97. Let the line $\frac{x-2}{3} = \frac{y-1}{-5} = \frac{z+2}{2}$ lie in the plane $x + 3y - \alpha z + \beta = 0$. Then (α, β) equals

(a) (–6, 7) (b) (5, –15)

(c) (–5, 5) (d) (6, –17)

98. The principal value of $\sin^{-1}\left(\sin\frac{5\pi}{3}\right)$ is

(a) $-\frac{5\pi}{3}$ (b) $\frac{5\pi}{3}$

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

99. If $[1 \ x \ 1]\begin{bmatrix} 1 & 3 & 2 \\ 0 & 5 & 1 \\ 0 & 3 & 2 \end{bmatrix}\begin{bmatrix} x \\ 1 \\ -2 \end{bmatrix} = 0$, then x is

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

(c) 1 (d) – 1

100. If $A = \begin{pmatrix} 2 & -1 \\ -7 & 4 \end{pmatrix}$ and $B = \begin{pmatrix} 4 & 1 \\ 7 & 2 \end{pmatrix}$ then which statement is true ?

(a) $AA^T = I$ (b) $BB^T = I$

(c) $AB \neq BA$ (d) $(AB)^T = I$

101. The value of c in Rolle's Theorem for the function

$f(x) = e^x \sin x, \ x \in [0, \pi]$ is

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

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

102. The area of the region bounded by the curve x = 2y + 3 and lines y = 1 and y = –1 is

(a) 4 sq. units (b) $\frac{3}{2}$ sq. units

(c) 6 sq. units (d) 8 sq. units

103. A signal which can be green or red with probability 4/5 and 1/5 respectively, is received by station A and then trasmitted to station B. The probability of each station receiving the signal correctly is 3/4. If the signal received at station B is given, then the probability that the original signal is green, is

(a) $\frac{3}{5}$ (b) $\frac{6}{7}$

(c) $\frac{20}{23}$ (d) $\frac{9}{20}$

104. The value of the determinant $\Delta = \begin{vmatrix} 1 & 4 & 3 \\ 0 & 12 & 9 \\ 1 & 2 & 2 \end{vmatrix}$ is

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

105. If the equations $x + ay - z = 0, 2x - y + az = 0, ax + y + 2z = 0$ have non-trivial solutions, then $a =$

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

106. If the I.F. of the differential equation $\frac{dy}{dx} + 5y = \cos x$ is $\int e^{Adx}$, then A =

(a) 0 (b) 1
(c) 3 (d) 5

107. What is the length of the projection of $3\hat{i} + 4\hat{j} + 5\hat{k}$ on the xy-plane ?

(a) 3 (b) 5
(c) 7 (d) 9

108. The radius of the sphere

$x^2 + y^2 + z^2 = 49,\ 2x + 3y - z - 5\sqrt{14} = 0$ is

(a) $\sqrt{6}$ (b) $2\sqrt{6}$
(c) $4\sqrt{6}$ (d) $6\sqrt{6}$

109. One of the values of $\left(\frac{1+i}{\sqrt{2}}\right)^{2/3}$ is

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

110. The value of λ does the line $y = x + \lambda$ touches the ellipse $9x^2 + 16y^2 = 144$ is/are

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

111. The combined equation of the asymptotes of the hyperbola $2x^2 + 5xy + 2y^2 + 4x + 5y = 0$ is –

(a) $2x^2 + 5xy + 2y^2 + 4x + 5y + 2 = 0$
(b) $2x^2 + 5xy + 2y^2 + 4x + 5y - 2 = 0$
(c) $2x^2 + 5xy + 2y^2 = 0$
(d) None of these

112. The two curves $x^3 - 3xy^2 + 2 = 0$ and $3x^2y - y^3 - 2 = 0$ intersect at an angle of

(a) $\frac{\pi}{4}$ (b) $\frac{\pi}{3}$
(c) $\frac{\pi}{2}$ (d) $\frac{\pi}{6}$

113. If at $x = 1$, the function $x^4 - 62x^2 + ax + 9$ attains its maximum value on the interval [0, 2], then the value of a is

(a) 110 (b) 10
(c) 55 (d) None of these

114. The value of $\int_{-1}^{1} (x - [x])dx$ (where [.] denotes greatest integer function) is

(a) 0 (b) 1
(c) 2 (d) None of these

115. The correct evaluation of $\int_0^{\pi/2} |\sin^4 x| dx$ is

(a) $\frac{8\pi}{3}$ (b) $\frac{2\pi}{3}$
(c) $\frac{4\pi}{3}$ (d) $\frac{3\pi}{8}$

116. The order and degree of the differential equation whose solution is $y = cx + c^2 - 3c^{3/2} + 2$, where c is a parameter, is

(a) order = 4, degree = 4
(b) order = 4, degree = 1
(c) order = 1, degree = 4
(d) None of these

117. The solution of $\frac{dv}{dt} + \frac{k}{m}v = -g$ is

(a) $v = ce^{-\frac{k}{m}t} - \frac{mg}{k}$

(b) $v = c - \frac{mg}{k}e^{-\frac{k}{m}t}$

(c) $ve^{-\frac{k}{m}t} = c - \frac{mg}{k}$

(d) $ve^{\frac{k}{m}t} = c - \frac{mg}{k}$

118. A unit vector perpendicular to the plane formed by the points (1, 0, 1), (0, 2, 2) and (3, 3, 0) is

(a) $\frac{1}{5\sqrt{3}}(5\hat{i}-\hat{j}-7\hat{k})$ (b) $\frac{1}{5\sqrt{3}}(5\hat{i}-\hat{j}+7\hat{k})$

(c) $\frac{1}{5\sqrt{3}}(5\hat{i}+\hat{j}+7\hat{k})$ (d) None of these

119. If $\vec{a}=(\hat{i}+\hat{j}+\hat{k}), \vec{a}.\vec{b}=1$ and $\vec{a}\times\vec{b}=\hat{j}-\hat{k}$, then $\vec{b}$ is

(a) $\hat{i}-\hat{j}+\hat{k}$ (b) $2\hat{j}-\hat{k}$

(c) $\hat{i}$ (d) $2\hat{i}$

120. The mean and variance of a random variable X having binomial distribution are 4 and 2 respectively, then $P(X=1)$ is

(a) $\frac{1}{4}$ (b) $\frac{1}{32}$

(c) $\frac{1}{16}$ (d) $\frac{1}{8}$

PART - IV (ENGLISH)

Directions (Qs. 121-123): Study the paragraph and answer the questions that follow:

Judiciary has become the centre of controversy, in the recent past, on account of the sudden 'Me' in the level of judicial intervention. The area of judicial intervention has been steadily expanding through the device of public interest litigation. The judiciary has shed its pro-status-quo approach and taken upon itself the duty to enforce the basic rights of the poor and vulnerable sections of society, by progressive interpretation and positive action. The Supreme Court has developed new methods of dispensing justice to the masses through the public interest litigation. Former Chief Justice PN. Bhagwat, under whose leadership public interest litigation attained a new dimension comments that "the Supreme Court has developed several new commitments. It has carried forward participative justice".

121. The steady expansion of judicial intervention is the result of

(a) excessive laws

(b) public interest litigation

(c) Supreme Court's new methods of dispensing justice

(d) new commitments of Supreme Court

122. According to the author, judiciary has become the center of controversy because of

(a) problems arising in dispensing justice in the recent past

(b) public interest litigation

(c) sudden 'Me' in the level of judicial intervention

(d) Supreme Court's supremacy

123. According to Justice PN. Bhagwat, Supreme Court has developed

(a) judicial intervention

(b) various new commitments

(c) participative judicial approach to dispense justice

(d) public interest litigation

Directions (Q.124): In the questions below, a sentence is given, a part of which is printed in bold and underline. This part may contain a grammatical error. Each sentence is followed by phrases a, b, c and d. Find out which phrase should replace the phrase given in bold/underline to correct the error, if there is any to make the sentence grammatically meaningful and correct.

124. Recent incidents of tigers straying have brought to focus the lack of proper regulatory mechanism **and powers with the forest department to take action against the resorts mushroom in forest fringes.**

(a) and powers with the forest department to taking action against the resorts mushroom in forest fringes.

(b) and powers with the forest departments to take action against the resorts mushroom in forest fringes.

(c) and powers with the forest department to take action for the resorts mushroom in forest fringes.

(d) and powers with the forest department to take action against the resorts mushrooming in forest fringes.

125. Choose the best pronunciation of the word 'Mischievous' from the following options.

(a) Mis-chuh-vus (b) Mis-chi-vius

(c) Mis-chi-vus (d) Mis-chu-vies

SOLUTIONS

PART - I (PHYSICS)

1. (b) We know that, $R = \frac{\rho \ell}{A}$

or $R = \frac{\rho \ell^2}{\text{Volume}} \Rightarrow R \propto \ell^2$

According to question $\ell_2 = n\ell_1$

$$\frac{R_2}{R_1} = \frac{n^2 l_1^2}{l_1^2} \text{ or, } \frac{R_2}{R_1} = n^2 \Rightarrow R_2 = n^2 R_1$$

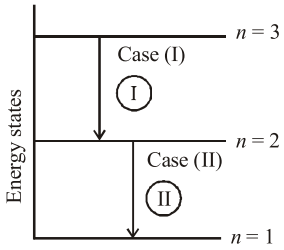
2. (b) Time constant is L/R

Given, $L = 40H$ & $R = 8\Omega$

$\therefore \tau = 40/8 = 5$ sec.

3. (a) **4. (c)** **5. (d)**

6. (c)



The wave number $(\bar{\nu})$ of the radiation

$$= \frac{1}{\lambda}$$

$$= R_\infty \left[\frac{1}{n_1^2} - \frac{1}{n_2^2}\right]$$

Now for case (I) $n_1 = 3, n_2 = 2$

$$\frac{1}{\lambda_1} = R_\infty \left[\frac{1}{9} \frac{-1}{4}\right], R_\infty = \text{ Rydberg constant}$$

$$\frac{1}{\lambda_1} = R_\infty \left[\frac{4-9}{36}\right] = \frac{-5R_\infty}{36}$$

$$\Rightarrow \quad \lambda_1 = \frac{-36}{5R_\infty}$$

$$\frac{1}{\lambda_2} = R_\infty \left[\frac{1}{4} - \frac{1}{1}\right] = \frac{-3R_\infty}{4} \Rightarrow \lambda_2 = \frac{-4}{3R_\infty}$$

$$\Rightarrow \frac{\lambda_1}{\lambda_2} = \frac{-36}{5R_\infty} \times \frac{3R_\infty}{-4} \Rightarrow \frac{\lambda_1}{\lambda_2} = \frac{27}{5}$$

7. (c) Voltage amplification

$$A_v = \beta \frac{R_o}{R_i} = 60 \times \frac{5000}{500} = 600$$

8. (a) Force required $= \frac{\text{change in momentum}}{\text{time taken}}$

$$= \frac{(50 \times 10^{-3} \times 30) \times 400 - (5 \times 0)}{60} = 10 \text{ N}$$

9. (c) $\frac{dN}{dt} = KN$

$9750 = KN_0$ ..... (i)

$975 = KN$ ..... (ii)

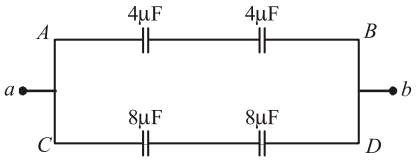
Dividing (i) by (ii)

$$\frac{N}{N_0} = \frac{1}{10}$$

$$K = \frac{2.303}{t} \log \frac{N_0}{N} = \frac{2.303}{5} \log 10$$

$= 0.4606 = 0.461$ per minute

10. (a) Rearranging the circuits, we get the following circuit.



$\therefore$ equivalent capacitance between A and B,

$$C_{AB} = \frac{4 \times 4}{4+4} = 2\mu F$$

and equivalent capacitance between C and D,

$$C_{CD} = \frac{8 \times 8}{8+8} = 4\mu F$$

$$\therefore \quad C_{ab} = 2\mu F + 4\mu F = 6\mu F$$

11. (b) $e = M \frac{di}{dt} = 0.005 \times \frac{d}{dt}(I_0 \sin \omega t)$

$= 0.0005 \times I_0 \omega \cos \omega t$

$\therefore e_{max} = 0.005 \times 10 \times 100\pi = 5\pi \quad [\because \cos \omega t = 1]$

12. (c) If a is the amplitude of the wave then

$$\frac{I_{max}}{4} = a^2 = a^2 + a^2 + 2aa\cos\phi$$

or $\cos\phi = -\frac{1}{2}$

or $\phi = \frac{2\pi}{3}$.

Corresponding path difference,

$$\Delta x = \frac{\phi \times \lambda}{2\pi} = \frac{(2\pi/3) \times \lambda}{2\pi} = \frac{\lambda}{3}$$

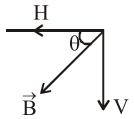
So $d\sin\theta = \frac{\lambda}{3}$

or $\theta = \sin^{-1}\left(\frac{\lambda}{3d}\right)$.

13. (a) $I = \frac{8-4}{1+2+9} = \frac{4}{12} = \frac{1}{3}A$;

$V_P - V_Q = 4 - \frac{1}{3}\times 3 = 3$ volt

14. (c) Horizontal component of earth's field, $H = B\cos\theta$, since, $\theta = 60°$



$3.6\times10^{-5} = B\times\frac{1}{2} \Rightarrow B = 7.2\times10^{-5}$ Tesla

15. (b) $\eta = 10^{-2}$ poise

$v = 18$ km/h $= \frac{18000}{3600} = 5$ m/s

$l = 5$ m

Strain rate $= \frac{v}{l}$

Coefficient of viscosity,

$\eta = \frac{\text{shearing stress}}{\text{strain rate}}$

$\therefore$ Shearing stress = η × strain rate

$= 10^{-2}\times\frac{5}{5} = 10^{-2}$ Nm^{-2}

16. (b) From question,

$B_0 = 20$ nT $= 20\times10^{-9}$T

$\vec{E}_0 = \vec{B}_0 \times \vec{C}$

$|\vec{E}_0| = |\vec{B}_0|.|\vec{C}| = 20\times10^{-9}\times3\times10^{8} = 6$ V/m.

($\because$ velocity of light in vacuum C = 3×10^8 ms^{-1})

17. (b) Forward bias resistance

$= \frac{\Delta V}{\Delta I} = \frac{0.1}{10\times10^{-3}} = 10\,\Omega$

Reverse bias resistance $= \frac{10}{10^{-6}} = 10^7\,\Omega$

Ratio of resistances

$= \frac{\text{Forward bias resistance}}{\text{Reverse bias resistance}} = 10^{-6}$

18. (a) In physics, collision does not means that one particle strike another particle. Infact, two particles may not even touch each other & may still said to be colliding.

The necessary requirements of collision are

(i) A large force for a relatively short time (i.e., an impulse) acts on each colliding particle.

(ii) The motion of the particles (at least one of the particle) is changed abruptly.

(iii) The total momentum (as also the total energy) of particles remains conserved.

19. (a) Current sensitivity $= \frac{nBA}{K}$

where K is constant of torsional rigidity.

20. (b) Let ℓ_0 be the unstretched length and ℓ_3 be the length under a tension of 9N. Then

$Y = \frac{4\ell_0}{A(\ell_1-\ell_0)} = \frac{5\ell_0}{A(\ell_2-\ell_0)}$

$= \frac{9\ell_0}{A(\ell_3-\ell_0)}$

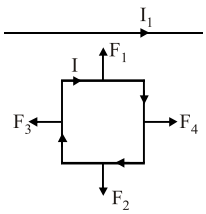
These give

$\frac{4}{\ell_1-\ell_0} = \frac{5}{\ell_2-\ell_0} \Rightarrow \ell_0 = 5\ell_1 - 4\ell_2$

Further, $\frac{4}{\ell_1-\ell_0} = \frac{9}{\ell_2-\ell_0}$

Substituting the value of ℓ_0 and solving, we get $\ell_3 = 5\ell_2 - 4\ell_1$

21. (d) $F_1 > F_2$ as $F \propto \frac{1}{d}$, and F_3 and F_4 are equal and opposite. Hence, the net attraction force will be towards the conductor.



22. (c) Heat gain = heat lost

$C_A(16-12) = C_B(19-16) \Rightarrow \frac{C_A}{C_B} = \frac{3}{4}$

and $C_B(23-19) = C_c(28-23) \Rightarrow \frac{C_B}{C_C} = \frac{5}{4}$

$\Rightarrow \frac{C_A}{C_C} = \frac{15}{16}$ ...(i)

If θ is the temperature when A and C are mixed then,

$C_A(\theta-12) = C_C(28-\theta)$

$\Rightarrow \frac{C_A}{C_C} = \frac{28-\theta}{\theta-12}$ ...(ii)

On solving equations (i) and (ii) $\theta = 20.2°$C

23. (d) Impedence of a capacitor is $X_C = 1/\omega C$

$$X_C = \frac{1}{2\pi fC} = \frac{1}{2\pi \times 50 \times 2 \times 10^{-6}} = \frac{5000}{\pi}.$$

24. (a) $C_p - C_v = R \Rightarrow C_p = C_v + R$

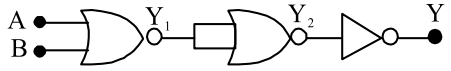
$$\because \gamma = \frac{C_p}{C_v} = \frac{C_v + R}{C_v} = \frac{C_v}{C_v} + \frac{R}{C_v}$$

$$\Rightarrow \gamma = 1 + \frac{R}{C_v} \Rightarrow \frac{R}{C_v} = \gamma - 1$$

$$\Rightarrow C_v = \frac{R}{\gamma - 1}$$

25. (c)

26. (b)



$Y_1 = \overline{A + B}$

$Y_2 = \overline{Y_1 + Y_1} = \overline{Y}_1 = A + B$

$Y = \overline{Y}_2 = \overline{A + B}$ i.e. NOR gate

27. (d) When drops combine to form a single drop of radius R.

Then energy released,

$$E = 4\pi TR^3\left[\frac{1}{r} - \frac{1}{R}\right]$$

If this energy is converted into kinetic energy then

$$\frac{1}{2}mv^2 = 4\pi R^3 T\left[\frac{1}{r} - \frac{1}{R}\right]$$

$$\frac{1}{2} \times \left[\frac{4}{3}\pi R^3 \rho\right] v^2 = 4\pi R^3 T\left[\frac{1}{r} - \frac{1}{R}\right]$$

$$v = \sqrt{\frac{6T}{\rho}\left[\frac{1}{r} - \frac{1}{R}\right]}$$

28. (a) $B = 2\left[\frac{\mu_0}{4\pi}.\frac{i}{d\cos 45°}\{\sin(-45°) + \sin 90°\}\right]$

$$= \frac{\mu_0 i}{\sqrt{2}\pi d}\left[-\frac{1}{\sqrt{2}} + 1\right].\otimes$$

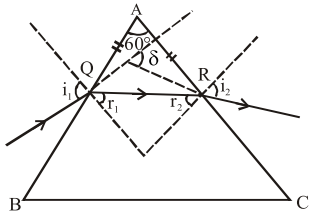
29. (d) BE of $_2He^4 = 4 \times 7.06 = 28.24$ MeV

BE of $^7_3Li = 7 \times 5.60 = 39.20$ MeV

$^7_3Li + ^1_1H \rightarrow {}_2He^4 + {}_2He^4 + Q$

Therefore, $Q = 56.48 - 39.20 = 17.28$ MeV.

30. (a)



Given AQ = AR and $\angle A = 60°$

$\therefore \angle AQR = \angle ARQ = 60°$

$\therefore r_1 = r_2 = 30°$

Applying Snell's law on face AB.

$\sin i_1 = \mu \sin r_1$

$$\Rightarrow \sin i_1 = \sqrt{3}\sin 30° = \sqrt{3} \times \frac{1}{2} = \frac{\sqrt{3}}{2}$$

$\therefore i_1 = 60°$

Similarly, $i_2 = 60°$

In a prism, deviation

$\delta = i_1 + i_2 - A = 60° + 60° - 60° = 60°$

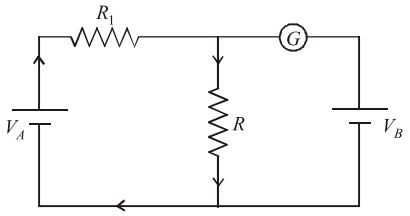
31. (d) $eV_0 = \frac{hc}{\lambda_0} - W_0$ and $eV' = \frac{hc}{2\lambda_0} - W_0$

Subtracting them we have

$$e(V_0 - V') = \frac{hc}{\lambda_0}\left[1 - \frac{1}{2}\right] = \frac{hc}{2\lambda_0}$$

or $$V' = V_0 - \frac{hc}{2e\lambda_0}$$

32. (b)



Since deflection in galvanometer is zero so current will flow as shown in the above diagram.

current, $I = \frac{V_A}{R_1 + R} = \frac{12}{500 + 100} = \frac{12}{600}$

So $$V_B = IR = \frac{12}{600} \times 100 = 2V$$

33. (b) Let pole strength = m

So, $M = m\ell$

When wire is in form of arc, then the distance between poles = $\frac{2\ell}{\pi}$

So, $M' = \frac{m2\ell}{\pi} = \frac{2M}{\pi}$

34. (c) Let m = mass of boy, M = mass of man

v = velocity of boy, V = velocity of man

$$\frac{1}{2}MV^2 = \frac{1}{2}\left[\frac{1}{2}mv^2\right] \quad ...(i)$$

$$\frac{1}{2}M(V+1)^2 = 1\left[\frac{1}{2}mv^2\right] \quad ...(ii)$$

Putting $m = \frac{M}{2}$ and solving $V = \frac{1}{\sqrt{2} - 1}$

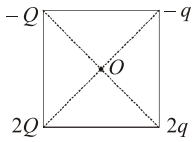
35. (b) $w_a = \lambda/d \Rightarrow w_a \propto \lambda$

$$\frac{(w_a)_{water}}{w_a} = \frac{\lambda_{water}}{\lambda} = \frac{\lambda}{\mu_{water}\lambda}$$

$$(w_a)_{water} = \frac{2\times 3}{4} = 0.15^o.$$

36. (a) Let the side length of square be 'a' then potential at centre O is

$$V = \frac{k(-Q)}{\left(\frac{a}{\sqrt{2}}\right)} + \frac{k(-q)}{\frac{a}{\sqrt{2}}} + \frac{k(2q)}{\frac{a}{\sqrt{2}}} + \frac{k(2Q)}{\frac{a}{\sqrt{2}}} = 0$$



$$= -Q - q + 2q + 2Q = 0 \Rightarrow Q + q = 0$$

$$\Rightarrow Q = -q$$

37. (b) As $V_L = V_C = 300\ V$, resonance will take place

$$\therefore\ V_R = 220\ V;\ I = \frac{220}{100} = 2.2\,A$$

reading of $V_3 = 220\ V$ and reading of $A = 2.2\ A$

38. (b) $$\frac{50-49.9}{5} = K\left(\frac{50+49.9}{2} - 30\right) \quad ....(i)$$

$$\frac{40-39.9}{t} = K\left[\frac{40+39.9}{2} - 30\right] \quad ....(ii)$$

From equations (i) and (ii), we get t ≈ 10 s.

39. (b) Since diode is in forward bias, so the value of current flowing through AB,

$$i = \frac{\Delta V}{R} = \frac{4-(-6)}{1\times 10^3} = \frac{10}{10^3} = 10^{-2}A$$

40. (b) Induced emf produced between the centre and a point on the disc is given by

$$e = \frac{1}{2}\omega BR^2$$

Putting the values,

$\omega = 60$ rad/s, B=0.05 Wb/m^2

and R = 100 cm = 1m

We get $e = \frac{1}{2}\times 60\times 0.05\times (1)^2 = 1.5V$

PART - II (CHEMISTRY)

41. (b) I. $$E = \frac{Z^2}{n^2}\times 13.6\,eV \quad ...(i)$$

or $$\frac{I_1}{I_2} = \frac{Z_1^{\,2}}{n_1^{\,2}}\times\frac{n_2^2}{Z_2^2} \quad ...(ii)$$

Given $I_1 = -19.6\times 10^{-18}$, $Z_1 = 2$, $n_1 = 1$, $Z_2 = 3$ and $n_2 = 1$

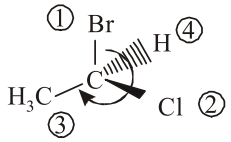
Substituting these values in equation (ii).

$$-\frac{19.6\times 10^{-18}}{I_2} = \frac{4}{1}\times\frac{1}{9}$$

or $$I_2 = -19.6\times 10^{-18}\times\frac{9}{4}$$

$$= -4.41\times 10^{-17}\ J/atom$$

42. (a) Clockwise rotation.



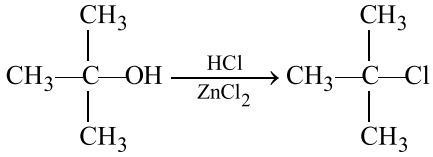
Hence configuration is R.

If the eye travel in a clockwise direction, the configuration is R as the order of priority is Br > Cl > CH_3 > H

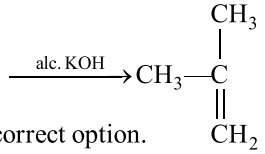
43. (a) $$K_2Cr_2O_7 + 4NaCl + 6H_2SO_4 \xrightarrow{Heat} 2CrO_2Cl_2 + 6NaHSO_4 + 3H_2O$$

44. (a) Since, liquid is passing into gaseous phase so entropy will increase and at 373 K during the phase transformation it remains at equilibrium. So, ΔG = 0.

45. (a) Reaction involved is given as :



(A) 2-methyl-2-propanol (B) 2-methyl-2-chloro propane



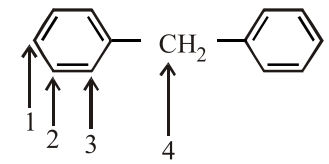
Hence (a) is the correct option.

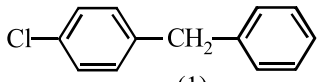
46. (d) I_2 and Na_2CO_3 react with acetophenone ($C_6H_5COCH_3$) to give yellow ppt. of CHI_3 but benzophenone ($C_6H_5COC_6H_5$) does not and hence can be used to distinguish between them.

47. (d) Decomposition of carbonates and hydrated oxides.

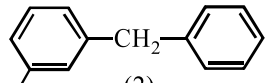
48. (d) When volume is increased the conc. decreases & the equilibrium shifts in the direction where more moles are formed.

49. (b) In diphenylmethane monochlorination at following positions will produce structured isomers

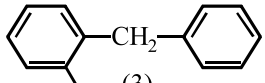




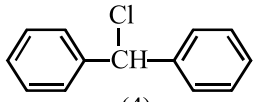
(1)



(2)



(3)



(4)

50. (b) $\Delta H_{S-S} + 2\Delta H_{H-S} = 239$

$2\Delta H_{H-S} = 175$

Hence,

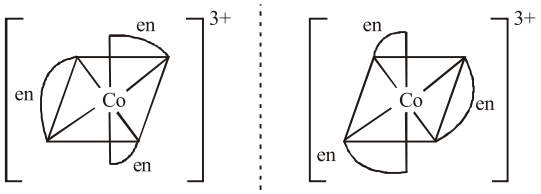
$\Delta H_{S-S} = 239 - 175 = 64$ kcal mol^{-1}

Then, ΔH for $8S_{(g)} \rightarrow S_{8(g)}$ is

$8 \times (-64) = -512$ kcal

51. (b) In Wolf-Kishner reduction $NH_2NH_2/\overline{OH}$ is used. Br^- can be replaced by OH^-.

52. (b) Option (b) shows optical isomerism $[Co(en)_3]^{3+}$



Complexes of Zn^{++} cannot show optical isomerism as they are tetrahedral complexes with plane of symmetry.

$[Co(H_2O)_4(en)]^{3+}$ have two planes of symmetry hence it is also optically inactive.

$[Zn(en)_2]^{2+}$ cannot show optical isomerism

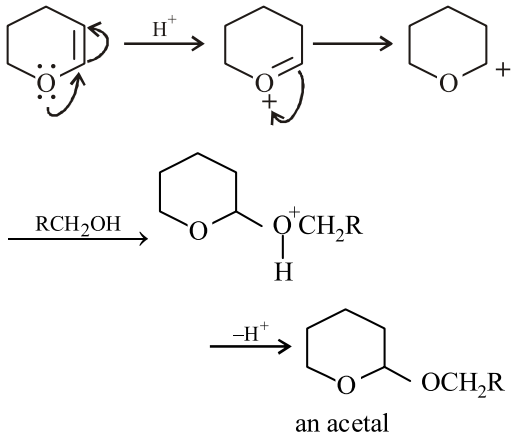
53. (a) There are two atoms in a *bcc* unit cell.

So, number of atoms in

12.08×10^{23} unit cells

$= 2 \times 12.08 \times 10^{23} = 24.16 \times 10^{23}$ atoms.

54. (b)



an acetal

55. (a) Apply Nernst equation to the reaction

$Pb + Sn^{2+} \rightarrow Pb^{2+} + Sn$

or $E^\circ + \frac{0.059}{2}\log\frac{[Sn^{2+}]}{[Pb^{2+}]} = E_{cell}$

or $\log\frac{[Sn^{2+}]}{[Pb^{2+}]} = \frac{0.01 \times 2}{0.059} = 0.3 \quad (\because E_{cell} = 0)$

or $\frac{[Sn^{2+}]}{[Pb^{2+}]} = \text{antilog } (0.3)$

56. (b) Methyl vinyl ether under anhydrous condition at room temperature undergoes addition reaction.

$$CH_2 = CH - OCH_3 \xrightarrow{HBr} CH_3 - \underset{\displaystyle Br}{\underset{|}{CH}} - O - CH_3$$

57. (d) $\underset{\text{acetic anhydride}}{(CH_3CO)_2O} + \underset{\text{diethyl ether}}{C_2H_5OC_2H_5} \xrightarrow{AlCl_3}$

$2CH_3COOC_2H_5$

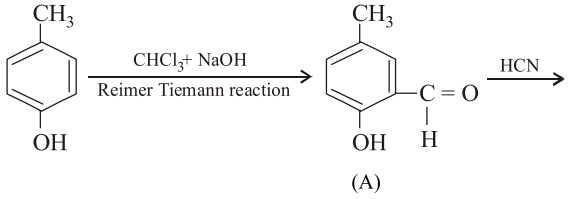
58. (a) $\Lambda_{eq} = \kappa \times \frac{1000}{N} = \frac{1}{R} \times \frac{l}{a} \times \frac{1000}{N}$

$= \frac{1}{R} \times \text{cell constant} \times \frac{1000}{N}$

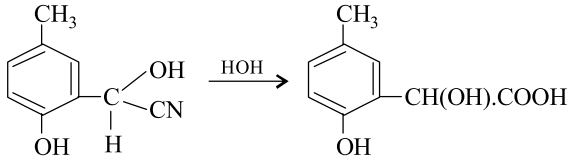
$= \frac{1}{220} \times 0.88 \times \frac{1000}{0.01}$

$= 400$ mho cm^2 g eq^{-1}

59. (c)



(A)



Cyanohydrin
(B)

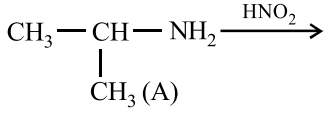
60. (c) Ionic radii $\propto \frac{1}{z}$

Thus, $\frac{z_2}{z_1} \Rightarrow \frac{1.06}{(\text{Ionic radii of } Lu^{3+})} = \frac{71}{57}$

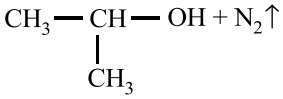
$\Rightarrow$ Ionic radii of $Lu^{3+} = 0.85$ Å

61. (a) From the given data, we have
Number of Y atoms in a unit cell = 4
Number of X atoms in a unit cell $= 8 \times \frac{2}{3} = \frac{16}{3}$
From the above we get the formula of the compound as $X_{16/3}Y_4$ or X_4Y_3

62. (a)



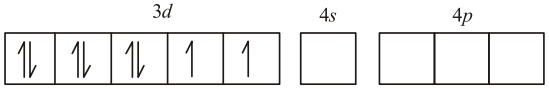
isopropyl amine



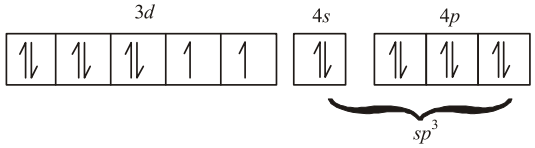
isopropyl alcohol

63. (b) $2N_2O_5 \rightarrow 4NO_2 + O_2$
from the unit of rate constant it is clear that the reaction follow first order kinetics. Hence
by rate law equation, r = k [N_2O_5]
where r = 1.02×10^{-4}, $k = 3.4 \times 10^{-5}$
$1.02 \times 10^{-4} = 3.4 \times 10^{-5}$ [N_2O_5]
[N_2O_5] = 3M

64. (b) $[NiCl_4]^{2-}$, O.S. of Ni = +2
Ni(28) = $3d^8\,4s^2$



Cl⁻ being weak ligand it cannot pair up the two electrons present in 3*d* orbital



No. of unpaired electrons = 2

Magnetic moment, μ = 2.82 BM.

65. (d) If rate = k[A]^x [B]^y [C]^z
From first two given data
8.08×10^{-3} = k [0.2]^x [0.1]^y [0.02]^z .... (1)
2.01×10^{-3} = k [0.1]^x [0.2]^y [0.02]^z .... (2)
Divide (1) by (2) we get, $4 = 2^x\,(1/2)^y$
Similarly, from second and third data
$(9)^y\,(9)^z = 3$
$2y + 2z = 1$.
From first and fourth data $4^z = 8 = 2^3$
$2z = 3$. So $z = 3/2$, $y = -1$, $x = 1$

66. (d) In the silver plating of copper, $K[Ag(CN)_2]$ is used instead of $AgNO_3$. Copper being more electropositive readily precipitate silver from their salt solution

$$Cu + 2AgNO_3 \longrightarrow Cu(NO_3)_2 + Ag$$

whereas in $K[Ag(CN)_2]$ solution a complex anion $[Ag(CN)_2]^-$ is formed and hence Ag^+ are less available in the solution and therefore copper cannot displace Ag from its complex ion.

67. (d) The given reaction is known as Liebermann Nitroso reaction.

68. (b) Given $E_1 = 25$eV $E_2 = 50$ eV

$$E_1 = \frac{hc}{\lambda_1} \quad E_2 = \frac{hc}{\lambda_2} \quad \therefore \frac{E_1}{E_2} = \frac{\lambda_2}{\lambda_1}$$

$$\therefore \frac{\lambda_2}{\lambda_1} = \frac{25}{50} = \frac{1}{2} \quad \therefore \lambda_1 = 2\lambda_2$$

69. (d) The reaction involves the conversion of $-NO_2$ to $-NH_2$ group (reduction) which occurs in presence of Fe/HCl.

70. (b) Phosphate is linked to 3rd & 5th carbon of corresponding sugar.

71. (c) The H–X bond strength decreases from HF to HI. i.e. HF > HCl > HBr > HI. Thus HF is most stable while HI is least stable. The decreasing stability of the hydrogen halide is also reflected in the values of dissociation energy of the H–X bond

H – F	H – Cl	H – Br	H – I
135 kcal mol^{-1}	103 kcal mol^{-1}	87 kcal mol^{-1}	71 kcal mol^{-1}

72. (b) $\Delta G = \Delta H - T\Delta S$

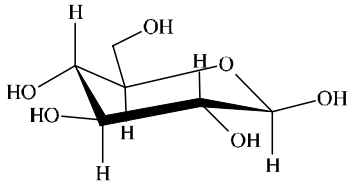
At equilibrium, $\Delta G = 0$

$\Rightarrow 0 = (170 \times 10^3\ J) - T\ (170\ JK^{-1})$

$\Rightarrow T = 1000\ K$

For spontaneity, ΔG is – ve, which is possible only if T > 1000 K.

73. (b)



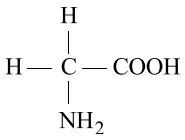
It is a β-pyranose hence it is an aldohexose.

74. (c) $2SO_2 + O_2 \rightleftharpoons 2SO_3 \quad K = 278$ (given)

$SO_3 \rightleftharpoons SO_2 + \frac{1}{2}O_2 \quad K' = \left(\sqrt{\frac{1}{K}}\right)$

$= \sqrt{\frac{1}{278}} = \sqrt{35.97 \times 10^{-4}} = 6 \times 10^{-2}$

75. (c) With the exception of glycine all the 19 other common amino acids have a uniquely different functional group on the central tetrahedral alpha carbon.



glycine

76. (a) ${}_7N = 1s^2\ 2s^2\ 2p^3$; ${}_{15}P = 1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^3$

In phosphorous the 3*d*-orbitals are available. Hence phosphorus can form pentahalides also but nitrogen cannot form pentahalide due to absence of *d*-orbitals.

77. (c) For the reaction

$2BaO_2(s) \rightleftharpoons 2BaO(s) + O_2(g);$

$\Delta H = +\ ve.$

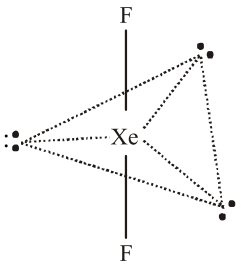
In equilibrium $K_p = P_{O_2}$

Hence, the value of equilibrium constant depends only upon partial pressure of O_2. Further on increasing temperature formation of O_2 increases as this is an endothermic reaction. Hence, pressure of O_2 is dependent on temperature.

78. (c) $C_6H_5NH_2 \xrightarrow[0°C-5°C]{NaNO_2/HCl} \underset{(X)}{C_6H_5N_2^+Cl^-} \xrightarrow[H_2O]{HNO_2} \underset{(Y)}{C_6H_5NO_2} + N_2 + HCl$

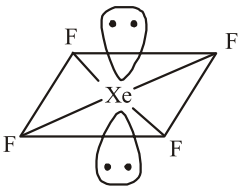
79. (c)

XeF_2 :



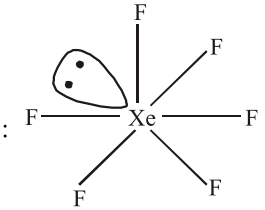
3*l*p

XeF_4 :



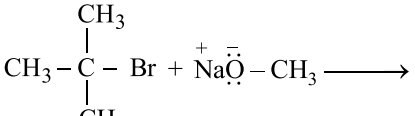
2*l*p

XeF_6 :



1*l*p

80. (c) If a tertiary alkyl halide is used, an alkene is the only reaction product and no ether is formed. For example, the reaction of CH_3ONa with $(CH_3)_3C–Br$ gives exclusively 2-methylpropene.



$CH_3 - \underset{CH_3}{\overset{CH_3}{|}}C = CH_2 + NaBr + CH_3OH$

2-Methylpropene

It is because alkoxides are not only nucleophiles but strong bases as well. They react with alkyl halides leading to elimination reactions.

PART - III (MATHEMATICS)

81. (c) $12\cot^2\theta - 31\operatorname{cosec}\theta + 32 = 0$

$\Rightarrow 12(\operatorname{cosec}^2\theta - 1) - 31\operatorname{cosec}\theta + 32 = 0$

$\Rightarrow 12\operatorname{cosec}^2\theta - 31\operatorname{cosec}\theta + 20 = 0$

$\Rightarrow 12\operatorname{cosec}^2\theta - 16\operatorname{cosec}\theta - 15\operatorname{cosec}\theta + 20 = 0$

$\Rightarrow (4\operatorname{cosec}\theta - 5)(3\operatorname{cosec}\theta - 4) = 0$

$\Rightarrow \operatorname{cosec}\theta = \frac{5}{4}, \frac{4}{3} \quad \therefore \sin\theta = \frac{4}{5}, \frac{3}{4}.$

82. (c) Let $r(\cos\theta + i\sin\theta)$

$$= \frac{1+i\sqrt{3}}{\sqrt{3}+1} = \frac{1}{\sqrt{3}+1} + i\frac{\sqrt{3}}{\sqrt{3}+1}$$

$$\Rightarrow r\cos\theta = \frac{1}{\sqrt{3}+1};\ r\sin\theta = \frac{\sqrt{3}}{\sqrt{3}+1}$$

$$\Rightarrow \tan\theta = \sqrt{3} \Rightarrow \theta = \frac{\pi}{3}.$$

83. (c) $\lim\limits_{x\to 0} \frac{x^3\cot x}{1-\cos x}$

$$= \lim_{x\to 0}\left(\frac{x^3\cot x}{1-\cos x} \times \frac{1+\cos x}{1+\cos x}\right)$$

$$= \lim_{x\to 0}\left(\frac{x}{\sin x}\right)^3 \times \lim_{x\to 0}\cos x \times \lim_{x\to 0}(1+\cos x) = 2$$

84. (b) Connective word is 'or'.

85. (c) Each of the three prizes can be given to any of the four children.

$\therefore$ Total number of ways of distributing prizes

$= 4 \times 4 \times 4 = 64$

Number of ways in which one child gets all prizes = 4

$\therefore$ Number of ways in which no child gets all the three prizes = 64 – 4 = 60

86. (a) I. P(not A) = 1 – 0.42 = 0.58

II. P(not B) = 1 – P(B) = 1 – 0.48 = 0.52

III. $P(A \text{ or } B) = P(A \cup B) = P(A) + P(B) - P(A \cap B) = 0.42 + 0.48 - 0.16 = 0.74$

87. (b) The given equation of curve is:

$y^2 + 4x - 6y + 13 = 0$

which can be written as: $y^2 - 6y + 9 + 4x + 4 = 0$

$\Rightarrow (y^2 - 6y + 9) = -4(x + 1)$

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

Put $Y = y - 3$ and $X = x + 1$

On comparing $Y^2 = 4aX$

Length of focus from vertex, $a = -1$

At focus $X = a$ and $Y = 0 \Rightarrow x + 1 = -1$

$\Rightarrow x = -2$

$\therefore y - 3 = 0 \Rightarrow y = 3$

$\therefore$ Focus is $(-2, 3)$.

88. (c) Since the parabola $y^2 = 4ax$ passes through the point $(1, -2)$,

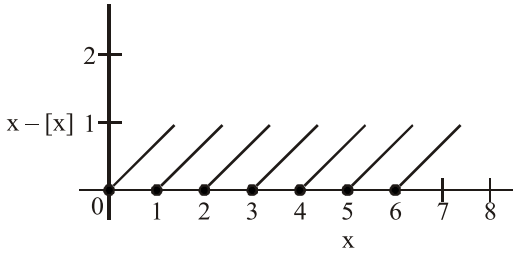
$\therefore (-2)^2 = 4a(1) \Rightarrow a = 1$

Equation of tangent to the parabola at $(1, -2)$ is

$yy_1 = 2a(x + x_1)$ or

$y(-2) = 2(1)(x+1)$ or $x + y + 1 = 0$

89. (c) The graph of the function $f(x) = x - [x]$ for the interval (0, 7) is shown below :



It is obvious from the above graph that the function x – [x] is discontinuous at the points x = 1, 2, 3, 4, 5, 6. Therefore no. of points of discontinuity of the given function in the given interval are 6.

90. (c) $v = \frac{4}{3}\pi r^3$,

$$\frac{dv}{dt} = \frac{4}{3}\pi\frac{d}{dt}r^3 = \frac{4}{3}\pi 3r^2.\frac{dr}{dt} = 4\pi r^2.\frac{dr}{dt}$$

when r = 10 cm;

$$\frac{dv}{dt} = 4\pi(10)^2.(0.02) = 8\ \pi\ \text{cm}^3/\text{s}.$$

91. (a) Given $f(x) = \frac{4x^2+1}{x}$ Thus $f'(x) = 4 - \frac{1}{x^2}$

f(x) will be decreasing if $f'(x) < 0$

Thus $4-\frac{1}{x^2}<0$

$\Rightarrow \frac{1}{x^2}>4 \Rightarrow \frac{-1}{2}<x<\frac{1}{2}$

Thus interval in which f(x) is decreasing,

is $\left(-\frac{1}{2},\frac{1}{2}\right)$.

92. (c) Let a be the major axis and b, the minor axis of the ellipse, then 3 minor axis = major axis. $\Rightarrow$ 3b = a

Eccentricity is given by :

$b^2 = a^2(1-e^2)$

$\Rightarrow b^2 = 9b^2(1-e^2)$

$\Rightarrow \frac{1}{9}=(1-e^2) \Rightarrow e^2=\frac{8}{9} \Rightarrow e=\frac{2\sqrt{2}}{3}$

93. (c) We have $a = 3$ and $\frac{b^2}{a}=4 \Rightarrow b^2=12$

Hence, the equation of the hyperbola is

$\frac{x^2}{9}-\frac{y^2}{12}=1$

$\Rightarrow 4x^2-3y^2=36 \Rightarrow 4x^2-3y^2-36=0$

94. (c) For function to be continuous :

$f(0+h)=f(0-h)=f(0)$

$f(0+h)=\lim_{h\to 0} h \sin 1/h = 0 \times$ (a finite quantity) $= 0$

$f(0-h)=\lim_{h\to 0} -h \sin(1/-h) = 0 \times$ (a finite quantity) $= 0$

Also, $\lim_{x\to 0} x \sin 1/x = 0 \times$ (a finite quantity) $= 0$

$\Rightarrow$ function is continuous at x = 0

For function to be differentiable :

$f'(0+h)=f'(0-h)$

$f'(0+h)=\frac{f(0+h)-f(0)}{h}$

$=\lim_{h\to 0}\frac{h \sin\frac{1}{h}-0}{h}=\lim_{h\to 0}\sin\left(\frac{1}{h}\right)$

which does not exist.

95. (d) We have,

$\frac{3x+1}{(x-3)(x-5)}=\frac{-5}{x-3}+\frac{B}{x-5}$

$3x + 1 = -5(x - 5) + B(x - 3)$

Put x = 5

$3(5) + 1 = B(5 - 3)$

$16 = 2B$ or $B = 8$

96. (d) $\frac{x-x_1}{a}=\frac{y-y_1}{b}=\frac{z-z_1}{c}$ have vector form

$=(x_1\hat{i}+y_1\hat{j}+z_1\hat{k})+\lambda(a\hat{i}+b\hat{j}+c\hat{k})$

Required equation in vector form is

$\vec{r}=(5\hat{i}-4\hat{j}+6\hat{k})+\mu(3\hat{i}+7j+2\hat{k})$

97. (a) $\because$ The line $\frac{x-2}{3}=\frac{y-1}{-5}=\frac{z+2}{2}$ lie in the plane

$x + 3y - \alpha z + \beta = 0$

$\therefore$ *Pt* (2, 1, – 2) lies on the plane i.e. $2 + 3 + 2\alpha + \beta = 0$

or $2\alpha + \beta + 5 = 0$ ....(i)

Also normal to plane will be perpendicular to line,

$\therefore 3 \times 1 - 5 \times 3 + 2 \times (-\alpha) = 0 \Rightarrow \alpha = -6$

From equation (i) then, $\beta = 7$

$\therefore (\alpha, \beta) = (-6, 7)$

98. (c) Let $\theta=\sin^{-1}\left[\sin\frac{5\pi}{3}\right]$

$\Rightarrow \sin\theta=\sin\frac{5\pi}{3}=\sin\left[2\pi-\frac{\pi}{3}\right]$

$\Rightarrow \sin\theta=-\sin\frac{\pi}{3}=\sin\left(\frac{-\pi}{3}\right)$

$(\because \sin(-\theta)=-\sin\theta)$

Therefore, principal value of $\sin^{-1}\left[\sin\frac{5\pi}{3}\right]$ is $\frac{-\pi}{3}$, as principal value of $\sin^{-1}$ x lies between $\frac{-\pi}{2}$ and $\frac{\pi}{2}$.

99. (b) We have $\begin{bmatrix}1 & x & 1\end{bmatrix}\begin{bmatrix}1 & 3 & 2\\ 0 & 5 & 1\\ 0 & 3 & 2\end{bmatrix}\begin{bmatrix}x\\ 1\\ -2\end{bmatrix}=0$

$$\Rightarrow \begin{bmatrix}1 & 5x+6 & x+4\end{bmatrix}\begin{bmatrix}x\\ 1\\ -2\end{bmatrix}=0$$

$$\Rightarrow x+5x+6-2x-8=0 \Rightarrow 4x-2=0 \Rightarrow x=\frac{1}{2}$$

100. (d) Here $AA^T=\begin{pmatrix}2 & -1\\ -7 & 4\end{pmatrix}\begin{pmatrix}2 & -7\\ -1 & 4\end{pmatrix}\neq\begin{pmatrix}1 & 0\\ 0 & 1\end{pmatrix}$

$(BB^T)_{11} = (4)^2 + (1)^2 \neq 1$

$(AB)_{11} = 8 - 7 = 1$, $(BA)_{11} = 8 - 7 = 1$

$\therefore$ $AB \neq BA$ may be not true.

Now, $AB=\begin{pmatrix}2 & -1\\ -7 & 4\end{pmatrix}\begin{pmatrix}4 & 1\\ 7 & 2\end{pmatrix}$

$$=\begin{pmatrix}8-7 & 2-2\\ -28+28 & -7+8\end{pmatrix}=\begin{pmatrix}1 & 0\\ 0 & 1\end{pmatrix}$$

$$\therefore (AB)^T=\begin{pmatrix}1 & 0\\ 0 & 1\end{pmatrix}$$

101. (d) Since Rolle's theorem is satisfied

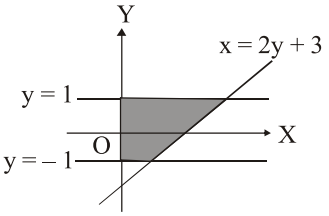
$\therefore f'(c) = 0 \Rightarrow e^c \sin c + \cos e^c = 0$

$\Rightarrow e^c \{\sin c + \cos c\} = 0$

$\therefore \sin c + \cos c = 0 \qquad (\because e^c \neq 0)$

$$\Rightarrow \tan c = -1 \Rightarrow c = \tan^{-1}(-1) = \pi - \frac{\pi}{4} = \frac{3\pi}{4}$$

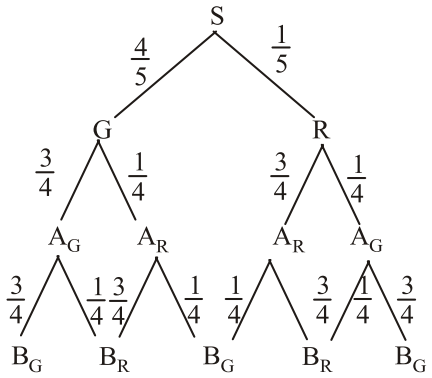
102. (c) We have $x = 2y + 3$, a straight line



Required area = Area of shaded region

$$=\int_{-1}^{1}(2y+3)\,dy=\left[y^2+3y\right]_{-1}^{1}=6 \text{ sq. units}$$

103. (c) From the tree diagram, it follows that



$$P(B_G)=\frac{46}{80}, P(G)=\frac{4}{5}$$

$$P(B_G/G)=\frac{10}{16}=\frac{5}{8}$$

$$\therefore P(B_G \cap G)=\frac{5}{8}\times\frac{4}{5}=\frac{1}{2}$$

$$\left[\because \quad P(B_G \cap G) = P\left(\frac{B_G}{G}\right)\times P(G)\right]$$

Now, $P(G/B_G)$

$$=\frac{P(B_G \cap G)}{P(B_G)}=\frac{1}{2}\times\frac{80}{40}=\frac{20}{23}$$

104. (c) $\Delta=\begin{vmatrix}1 & 4 & 3\\ 0 & 12 & 9\\ 1 & 2 & 2\end{vmatrix}$

$= 1(12 \times 2 - 2 \times 9) - 4\,(0 \times 2 - 1 \times 9)$
$\quad + 3\,(0 \times 2 - 1 \times 12)$
$= 1(24 - 18) - 4(0 - 9) + 3(0 - 12)$
$= 6 + 36 - 36 = 6$

105. (b) $\begin{vmatrix}1 & a & -1\\ 2 & -1 & a\\ a & 1 & 2\end{vmatrix}=0$

Applying $R_2 \to R_2 - 2R_1$ and $R_3 \to R_3 - aR_1$, we get

$$\begin{vmatrix}1 & a & -1\\ 0 & -1-2a & a+2\\ 0 & 1-a^2 & 2+a\end{vmatrix}=0$$

Expanding along C_1, we get

$(a+2)(a^2-2a-2)=0 \Rightarrow a=-2,\ 1\pm\sqrt{3}$

106. (d) The I.F. of the differential equation

$\frac{dy}{dx}+Py=Q$ is $e^{\int P dx}$. Here $P=5$ therefore

I.F. $= e^{\int 5dx}$. Hence $A=5$.

107. (b) xy-plane is perpendicular to z - axis. Let the vector

$\vec{a}=3i+4j+5k$ make angle θ with z - axis, then it makes $90-\theta$ with xy-plane.
unit vector along z-axis is k.

$$\text{So, } \cos\theta=\frac{\vec{a}.\hat{k}}{|\vec{a}|.|\hat{k}|}=\frac{(3i+4j+5k).k}{|3i+4j+5k|}$$

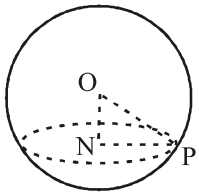
$$=\frac{5}{5\sqrt{2}}=\frac{1}{\sqrt{2}} \Rightarrow \theta=\frac{\pi}{4}.$$

Hence angle with xy- plane $\frac{\pi}{2}-\frac{\pi}{4}=\frac{\pi}{4}$

projection of $\vec{a}$ on xy plane $=|\vec{a}|.\cos\frac{\pi}{4}$

$$=5\sqrt{2}\times\frac{1}{\sqrt{2}}=5.$$

108. (b) The sphere $x^2+y^2+z^2=49$
has centre at the origin (0, 0, 0)
and radius 7.



Disance of the plane

$2x+3y-z-5\sqrt{14}=0$

from the origin

$$=\frac{|2(0)+3(0)-(0)-5\sqrt{14}|}{\sqrt{2^2+3^2+(-1)^2}}$$

$$=\frac{|-5\sqrt{14}|}{\sqrt{14}}=\frac{5\sqrt{14}}{\sqrt{14}}=5$$

Thus in Figure; OP = 7, ON = 5

$NP^2=OP^2-ON^2=(7)^2-(5)^2$

$=49-25=24$

$\therefore$ NP $=2\sqrt{6}$ Hence the radius of the circle

$=$ NP $=2\sqrt{6}$

109. (a) $\left(\frac{1+i}{\sqrt{2}}\right)^{2/3}=\left(\frac{1}{\sqrt{2}}+\frac{1}{\sqrt{2}}i\right)^{2/3}$

$=(\cos 45°+i\sin 45°)^{2/3}$

$=\left(\cos\frac{2}{3}\times 45°+i\sin\frac{2}{3}45°\right)$

$=\cos 30°+i\sin 30°$

$=\frac{\sqrt{3}}{2}+i\times\frac{1}{2}=\frac{1}{2}(\sqrt{3}+i)$

110. (c) $\because$ Equation of ellipse is $9x^2+16y^2=144$ or

$\frac{x^2}{16}+\frac{y^2}{9}=1$

Comparing this with $\frac{x^2}{a^2}+\frac{y^2}{b^2}=1$ then we get $a^2=16$ and $b^2=9$ and comparing the line $y=x+\lambda$ with $y=mx+c$

$\therefore$ $m=1$ and $c=\lambda$

If the line $y=x+\lambda$ touches the ellipse $9x^2+16y^2=144$, then $c^2=a^2m^2+b^2$

$\Rightarrow \lambda^2=16\times 1^2+9 \Rightarrow \lambda^2=25$

$\therefore \lambda=\pm 5$

111. (a) Let the equation of asymptotes be

$2x^2+5xy+2y^2+4x+5y+\lambda=0$ ..... (1)

This equation represents a pair of straight lines,

$\therefore\ abc+2fgh-af^2-bg^2-ch^2=0$

$$\therefore 4\lambda+25-\frac{25}{2}-8-\lambda\times\frac{25}{4}=0$$

$$\Rightarrow -\frac{9\lambda}{4}+\frac{9}{2}=0\Rightarrow\lambda=2$$

Putting the value of λ in eq. (1), we get

$2x^2+5xy+2y^2+4x+5y+2=0$

this is the equation of the asymptotes.

112. (c) $x^3 - 3xy^2 + 2 = 0$

differentiating w.r.t. x :

$$3x^2 - 3x(2y)\frac{dy}{dx} - 3y^2 = 0$$

$$\Rightarrow \frac{dy}{dx} = \frac{3x^2 - 3y^2}{6xy} \text{ and } 3x^2y - y^3 - 2 = 0$$

differentiating w.r.t. x

$$\Rightarrow 3x^2\frac{dy}{dx} + 6xy - 3y^2\frac{dy}{dx} = 0$$

$$\Rightarrow \frac{dy}{dx} = -\left(\frac{6xy}{3x^2 - 3y^2}\right)$$

Now, product of slope

$$= \frac{3x^2 - 3y^2}{6xy} \times -\left(\frac{6xy}{3x^2 - 3y^2}\right) = -1$$

$\therefore$ they are perpendicular.

Hence, angle

$= \pi/2$

113. (d) Let $f(x) = x^4 - 62x^2 + ax + 9$

$\Rightarrow f'(x) = 4x^3 - 124x + a$

It is given that function f attains its maximum value on the interval [0, 2] at x = 1.

$\therefore \; f'(1) = 0 \Rightarrow 4 \times 1^3 - 124 \times 1 + 1 = 0$

$\Rightarrow 4 - 124 + a = 0 \Rightarrow a = 120$

Hence, the value of a is 120.

114. (b) $I = \int_{-1}^{1} (x - [x])dx = \int_{-1}^{1} x dx - \int_{-1}^{1} [x]dx$

$$= \left[\frac{x^2}{2}\right]_{-1}^{1} - \left[\int_{-1}^{0} [x]dx + \int_{0}^{1} [x]dx\right]$$

$$= \frac{1}{2}[1-1] - \left[\int_{-1}^{0} (-1)dx + \int_{0}^{1} 0.dx\right]$$

$$\begin{bmatrix} \text{If } -1 \le x < 0, [x] = -1 \\ \text{If } \; 0 \le x < 1, \; [x] = 0 \end{bmatrix}$$

$$= 0 - [-x]_{-1}^{0} - 0 = 0 - [-0 - (-1)] = 1$$

115. (d) $\int_0^{\pi} |\sin^4 x| dx = \int_0^{\pi/2} \sin^4 x dx$

Applying gamma function,

$$2\int_0^{\pi/2} \sin^4 x \, dx = 2\frac{\Gamma(5/2).\Gamma(1/2)}{2.\Gamma(6/2)} = \frac{3\pi}{8}$$

Aliter : Using Walli's formula

$$= 2\left[\frac{3.1}{4.2}\right]\frac{\pi}{2} = \frac{3\pi}{8}$$

116. (c) $y = cx + c^2 - 3c^{3/2} + 2$ ... (i)

Differentiating above with respect to x, we get $\frac{dy}{dx} = c$.

Putting this value of c in (i), we get

$$y = x\frac{dy}{dx} + \left(\frac{dy}{dx}\right)^2 - 3\left(\frac{dy}{dx}\right)^{3/2} + 2$$

Clearly its order is ONE and after removing the fractional power we get the degree FOUR.

117. (a) $\frac{dv}{dt} + \frac{k}{m}v = -g \Rightarrow \frac{dv}{dt} = -\frac{k}{m}\left(v + \frac{mg}{k}\right)$

$$\Rightarrow \frac{dv}{v + mg/k} = -\frac{k}{m}dt \Rightarrow \log\left(v + \frac{mg}{k}\right)$$

$$= -\frac{k}{m}t + \log C$$

$$\Rightarrow v + \frac{mg}{k} = Ce^{-kt/m} \Rightarrow v = Ce^{-kt/m} - \frac{mg}{k}$$

118. (b) Let A (1, 0, 1), B(0, 2, 2) and C (3, 3, 0) be the given points, then

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

$$\overrightarrow{AB} \times \overrightarrow{BC} = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ -1 & 2 & 1 \\ 3 & 1 & -2 \end{vmatrix} = -5\hat{i} + \hat{j} - 7\hat{k}$$

$\therefore$ unit vector $\perp$ to the plane: ABC

$$= \pm\frac{1}{5\sqrt{3}}(-5\hat{i} + \hat{j} - 7\hat{k})$$

119. (c) $\because\ (\vec{a}\times\vec{b})\times\vec{a}=(\vec{a}.\vec{a})\vec{b}-(\vec{a}.\vec{b})\vec{a}$

$\therefore\quad (\hat{j}-\hat{k})\times(\hat{i}+\hat{j}+k)=(\sqrt{3})^2(\vec{b})-(\hat{i}+\hat{j}+k)$

$\Rightarrow\ 3\hat{b}=3\hat{i}\ \Rightarrow\ \hat{b}=\hat{i}$

120. (a) Given , $P(\overline{A\cup B})=\dfrac{1}{6}$

$\Rightarrow P(A\cup B)=1-\dfrac{1}{6}=\dfrac{5}{6}$

$P(\overline{A})=\dfrac{1}{4}\Rightarrow P(A)=1-\dfrac{1}{4}=\dfrac{3}{4}$

We know,

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

$\Rightarrow\ \dfrac{5}{6}=\dfrac{3}{4}+P(B)-\dfrac{1}{4}\ \Rightarrow P(B)=\dfrac{1}{3}$

$\because\ P(A)\neq P(B)$ so they are not equally likely.

Also $P(A)\times P(B)=\dfrac{3}{4}\times\dfrac{1}{3}=\dfrac{1}{4}=P(A\cap B)$

So A & B are independent.

PART - IV (ENGLISH)

121. (b)

122. (c)

123. (b)

124. (d) 'Mushrooming' should be used which should serve as an adjective.

125. (a)