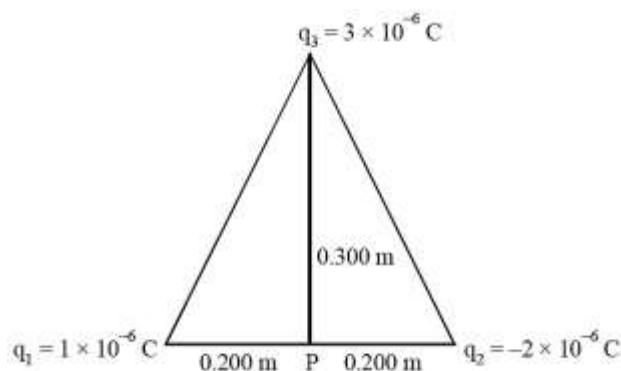


# PART-I PHYSICS

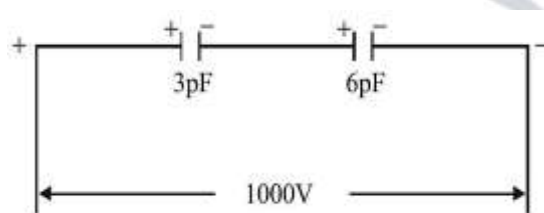
1. A potential difference of 300 V is applied to a combination of 2.0  $\mu\text{F}$  and 8.0  $\mu\text{F}$  capacitors connected in series. The charge on the 2.0  $\mu\text{F}$  capacitor is  
 (a)  $2.4 \times 10^{-4} \text{C}$  (b)  $4.8 \times 10^{-4} \text{C}$   
 (c)  $7.2 \times 10^{-4} \text{C}$  (d)  $9.6 \times 10^{-4} \text{C}$
2. Two -point charges 4  $\mu\text{C}$  and -2  $\mu\text{C}$  are separated by a distance of 1 m in air. Then the distance of the point on the line joining the charges, where the resultant electric field is zero, is (in metre)  
 (a) 0.58 (b) 0.75  
 (c) 0.67 (d) 0.81
3. Figure shows a triangular array of three -point charges. The electric potential V of these source charges at the midpoint P of the base of the triangle is

$$\left[ \frac{1}{4\pi\epsilon_0} = 9 \times 10^9 \text{Nm}^2\text{C}^{-2} \right]$$



- (a) 55kV
- (b) 45kV
- (c) 63kV
- (d) 49kV

4. A current of 5 A is passing through a metallic wire of cross-sectional area  $4 \times 10^{-6} \text{m}^2$ . If the density of the charge carriers in the wire is  $5 \times 10^{26} \text{m}^{-3}$ , the drift speed of the electrons will be [ $e = 1.602 \times 10^{-19} \text{C}$ ]  
 (a)  $1.56 \times 10^{-2} \text{ms}^{-1}$  (b)  $1.98 \times 10^{-2} \text{ms}^{-1}$   
 (c)  $2.42 \times 10^{-2} \text{ms}^{-1}$  (d)  $2.84 \times 10^{-2} \text{ms}^{-1}$
5. The series combination of two capacitors shown in figure is connected across 1000 V. The magnitude of the charges on the capacitors will be



- (a)  $3 \times 10^{-9} \text{C}$
- (b)  $2 \times 10^{-9} \text{C}$
- (c)  $2.5 \times 10^{-9} \text{C}$
- (d)  $3.5 \times 10^{-9} \text{C}$

6. Three resistances of values 2  $\Omega$ , 3  $\Omega$  and 6  $\Omega$  are to be connected to produce an effective resistance of 4  $\Omega$ . This can be done by connecting  
 (a) 6  $\Omega$  resistance in series with the parallel combination of 2  $\Omega$  and 3  $\Omega$   
 (b) 3  $\Omega$  resistance in series with the parallel combination of 2  $\Omega$  and 6  $\Omega$   
 (c) 2  $\Omega$  resistance in series with the parallel combination of 3  $\Omega$  and 6  $\Omega$

- (d)  $2\Omega$  resistance in parallel with the parallel combination of  $3\Omega$  and  $6\Omega$
7. The resistance of a field coil measures  $50\Omega$  at  $20^\circ\text{C}$  and  $65\Omega$  at  $70^\circ\text{C}$ . The temperature coefficient of resistance is  
 (a)  $0.0086/^\circ\text{C}$  (b)  $0.0068/^\circ\text{C}$   
 (c)  $0.0096/^\circ\text{C}$  (d)  $0.0999/^\circ\text{C}$
8. The electrolyte used in Leclanche cell is  
 (a) copper sulphate solution  
 (b) ammonium chloride solution  
 (c) dilute sulphuric acid  
 (d) zinc sulphate
9. A galvanometer has a resistance of  $50\Omega$ . If a resistance of  $1\Omega$  is connected across its terminals, the total current flow through the galvanometer is [ $I_g$  represents the maximum current that can be passed through the galvanometer]  
 (a)  $42I$  (b)  $53I$   
 (c)  $46I_g$  (d)  $51I_g$
10. In a tangent galvanometer, a current of  $1\text{ A}$  produces a deflection of  $30^\circ$ . The current required to produce a deflection of  $60^\circ$  is  
 (a)  $3\text{ A}$  (b)  $2\text{ A}$   
 (c)  $4\text{ A}$  (d)  $1\text{ A}$
11. In the presence of magnetic field 'B' and electric field 'E', the total force on a moving charged particle is  
 (a)  $\vec{F} = \vec{v}[(\vec{q} \times \vec{B}) + \vec{E}]$  (b)  $\vec{F} = q[(\vec{v} \times \vec{E}) + \vec{B}]$   
 (c)  $\vec{F} = q[(\vec{v} \times \vec{B}) + \vec{E}]$  (d)  $\vec{F} = \vec{B}[(\vec{q} \times \vec{E}) + \vec{v}]$
12. A circular coil of radius  $40\text{ mm}$  consists of  $250$  turns of wire in which the current is  $20\text{ mA}$ . The magnetic field in the center of the coil is [ $\mu = 4\pi \times 10^{-7}\text{ Hm}^{-1}$ ]  
 (a)  $0.785\text{G}$  (b)  $0.525\text{G}$   
 (c)  $0.629\text{G}$  (d)  $0.900\text{G}$
13. RMS value of AC is \_\_\_\_\_ of the peak value.  
 (a)  $7\%$  (b)  $7.7\%$   
 (c)  $70\%$  (d)  $70.7\%$
14. Q-factor can be increased by having a coil of  
 (a) large inductance, small ohmic resistance  
 (b) large inductance, large ohmic resistance  
 (c) small inductance, large ohmic resistance  
 (d) small inductance, small ohmic resistance
15. A small piece of metal wire is dragged across the gap between the pole pieces of a magnet in  $0.5$  second. The magnetic flux between the pole pieces is known to be  $8 \times 10^{-4}\text{ Wb}$ . The emf induced in the wire is  
 (a)  $16\text{mV}$  (b)  $1.6\text{ V}$   
 (c)  $1.6\text{mV}$  (d)  $16\text{ V}$
16. Current in the LCR circuit becomes extremely large when  
 (a) frequency of AC supply is increased

- (b) frequency of AC supply is decreased
- (c) inductive reactance becomes equal to capacitive reactance
- (d) inductance becomes equal to capacitance

**17. Our eyes respond to wavelengths ranging from**

- (a) 400 nm to 700 nm
- (b) 700 nm to 800 nm
- (c) 0 to  $\infty$
- (d)  $-\infty$  to  $+\infty$

**18. A new system of units is evolved in which the values of  $\mu_0$  and  $\epsilon_0$  are 2 and 8 respectively. Then the speed of light in this system will be**

- (a) 0.25
- (b) 0.5
- (c) 0.75
- (d) 1

**19. A ray of light strikes a piece of glass at an angle of incidence of  $60^\circ$  and the reflected beam is completely plane polarised. The refractive index of glass is**

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

**20. In an experiment on Newton's rings, the diameter of the 20<sup>th</sup> dark ring was found to be 5.82 mm and that of the 10<sup>th</sup> ring 3.36 mm. If the radius of the plano-convex lens is 1 m, the wavelength of light used is**

- (a)  $5646 \text{ \AA}$
- (b)  $5896 \text{ \AA}$
- (c)  $5406 \text{ \AA}$
- (d)  $5900 \text{ \AA}$

**21. What is the angular momentum of an electron in the fourth orbit of Bohr's model of hydrogen atom?**

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

**22. The transition of an electron from  $n_2 = 5, 6, \dots$  to  $n_1 = 4$  gives rise to**

- (a) Pfund series
- (b) Lyman series
- (c) Paschen series
- (d) Brackett series

**23. The ground state energy of hydrogen atom is 13.6 eV. What is the potential energy of the electron in this state?**

- (a)  $-27.2 \text{ eV}$
- (b)  $-13.6 \text{ eV}$
- (c)  $+13.6 \text{ eV}$
- (d)  $0 \text{ eV}$

**24. The longest wavelength that can be analysed by a sodium chloride crystal of spacing  $d = 2.82 \text{ \AA}$  in the second order is**

- (a)  $2.82 \text{ \AA}$
- (b)  $5.64 \text{ \AA}$
- (c)  $8.46 \text{ \AA}$
- (d)  $11.28 \text{ \AA}$

**25. Which is the incorrect statement of the following?**

- (a) Photon is a particle with zero rest mass
- (b) Photon is a particle with zero momentum
- (c) Photons travel with velocity of light in vacuum
- (d) Photons even feel the pull of gravity

**26. The deBroglie wavelength associated with a steel ball of mass 1000 gm moving at a speed of  $1 \text{ ms}^{-1}$  is  $[h = 6.626 \times 10^{-34} \text{ Js}]$**

- (a)  $6.626 \times 10^{-31} \text{ m}$
- (b)  $6.626 \times 10^{-37} \text{ m}$
- (c)  $6.626 \times 10^{-34} \text{ m}$
- (d)  $6.626 \times 10^{34} \text{ m}$

27. The velocity  $v$ , at which the mass of a particle is double its rest mass is

- (a)  $v = c$  (b)  $V = \sqrt{\frac{3}{4}}c$   
 (c)  $v = \sqrt{\frac{3}{2}}c$  (d)  $v = 2c$

28. How much energy is produced, if 2 kg of a substance is fully converted into energy? [ $c = 3 \times 10^8 \text{ ms}^{-1}$ ]

- (a)  $9 \times 10^{16} \text{ J}$  (b)  $11 \times 10^{16} \text{ J}$   
 (c)  $15 \times 10^{16} \text{ J}$  (d)  $18 \times 10^{16} \text{ J}$

29. The difference between the rest mass of the nucleus and the sum of the masses of the nucleons composing a nucleus is known as

- (a) packing fraction (b) mass defect  
 (c) binding energy (d) isotopic mass

30. The half-life period of Radium is 3 minute. Its mean life time is

- (a) 1.5 minute (b)  $\frac{3}{0.6931}$  minute  
 (c) 6 minute (d)  $(3 \times 0.6931)$  minute

31. 'Pair production' involves conversion of a photon into

- (a) a neutron-electron pair  
 (b) a positron-neutron pair  
 (c) an electron-proton pair  
 (d) an electron-positron pair

32. The sub atomic particles proton and neutron fall under the group of

- (a) mesons (b) photons  
 (c) leptons (d) baryons

33. When the conductivity of a semiconductor is only due to the breaking up of the covalent bonds, the semiconductor is known as

- (a) donor (b) extrinsic  
 (c) intrinsic (d) acceptor

34. In a P-type semiconductor, the acceptor impurity produces an energy level

- (a) just below the valence band  
 (b) just above the conduction band  
 (c) just below the conduction band  
 (d) just above the valence band

35. An oscillator is essentially

- (a) an amplifier with proper negative feedback network circuits  
 (b) converts alternating current into direct current  
 (c) an amplifier with no feedback network  
 (d) an amplifier with proper positive feedback network circuits

36. Which of the following gates can perform perfect binary addition?

- (a) AND gate (b) OR gate  
 (c) EXOR gate (d) NAND gate

37. The frequency of an FM transmitter without signal input is called

- (a) the centre frequency                      (b) modulation factor  
(c) the frequency deviation                  (d) the carrier swing

**38. The fundamental radio antenna is a metal rod which has a length equal to**

- (a)  $\lambda$  in free space at the frequency of operation  
(b)  $\frac{\lambda}{2}$  in free space at the frequency of operation  
(c)  $\frac{\lambda}{4}$  in free space at the frequency of operation  
(d)  $\frac{3\lambda}{4}$  in free space at the frequency of operation

**39. Vidicon works on the principle of**

- (a) electrical conductivity                      (b) photoconductivity  
(c) thermal conductivity                      (d) SONAR

**40. The maximum range,  $d_{\max}$ , of radar is**

- (a) proportional to the cube root of the peak transmitted power  
(b) proportional to the fourth root of the peak transmitted power  
(c) proportional to the square root of the peak transmitted power  
(d) not related to the peak transmitted power at all

## PART-II CHEMISTRY

**41. The equivalent weight of potassium permanganate when it acts as oxidising agent in ferrous ion estimation is**

- (a) 158                      (b) 31.6  
(c) 79                      (d) 39.5

**42. The magnetic moment of lanthanide ions is determined from which one of the following relation?**

- (a)  $\mu = \sqrt{n(n+2)}$  (b)  $\mu = g\sqrt{J(J+1)}$   
(c)  $\mu = g\sqrt{n(n+1)}$  (d)  $\mu = 2\sqrt{n(n+1)}$

**43. Which one of the following has maximum number of unpaired electrons?**

- (a)  $\text{Mg}^{2+}$                       (b)  $\text{Ti}^{3+}$   
(c)  $\text{V}^{3+}$                       (d)  $\text{Fe}^{2+}$

**44. Excess of NaOH reacts with Zn to form**

- (a)  $\text{ZnH}_2$                       (b)  $\text{Na}_2\text{ZnO}_2$   
(c)  $\text{ZnO}$                       (d)  $\text{Zn(OH)}_2$

**45. How many isomers does  $\text{Co(en)}_2\text{Cl}_2^+$  have?**

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

**46.  $\text{NH}_3$  group in a coordination compound is named as**

- (a) ammonium                      (b) ammine  
(c) amine                      (d) ammonia

**47. Name the complex  $\text{Ni(PF}_3)_4$**

- (a) tetrakis (phosphorus (III) fluoride) nickel (0)  
(b) tetra (phosphorus (III) fluoride) nickel

- (c) Nickel tetrakis phosphorus (III) fluoride  
(d) (phosphorus (III) tetrakis fluoride) nickel (0)

**48. The purple colour of  $\text{KMnO}_4$  is due to**

- (a) charge transfer (b) d-d transition  
(c) f-f transition (d) d-f transition

**49. How many lattice points belong to a face centered cubic unit cell?**

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

**50. Schottky defect in solids is due to**

- (a) a pair of cation and anion vacancies  
(b) occupation of interstitial site by a pair of cation and anion  
(c) occupation of interstitial site by a cation  
(d) occupation of interstitial site by an anion

**51. Which one of the following is amorphous?**

- (a) Polystyrene (b) Table salt  
(c) Silica (d) Diamond

**52. The metal that crystallises in simple cubic system is**

- (a) Po (b) Na  
(c) Cu (d) Ag

**53. When ideal gas expands in vacuum, the work done by the gas is equal to**

- (a) PV (b) RT  
(c) 0 (d) nRT

**54. For a closed system consisting of a reaction  $\text{N}_2\text{O}_4(\text{g}) \rightarrow 2\text{NO}_2(\text{g})$ , the pressure**

- (a) remains constant (b) decreases  
(c) increases (d) becomes zero

**55. 6 moles of an ideal gas expand isothermally and reversibly from a volume of 1 litre to a volume of 10 litres at  $27^\circ\text{C}$ . What is the maximum work done?**

- (a) 47 kJ (b) 100 kJ  
(c) 0 (d) 34.465 kJ

**56. The reaction,**

**$\text{Zn}(\text{s}) + \text{CuSO}_4(\text{aq}) \rightarrow \text{ZnSO}_4(\text{aq}) + \text{Cu}(\text{s})$  is an example of a**

- (a) spontaneous process (b) isobaric process  
(c) non-spontaneous process (d) reversible process

**57. For the reaction,  $\text{H}_2(\text{g}) + \text{I}_2(\text{g}) \rightleftharpoons 2\text{HI}(\text{g})$**

- (a)  $K_p = -K_c$  (b)  $K_c = 0$   
(c)  $K_p = K_c$  (d)  $K_p = 0$

**58. The increase of pressure on ice  $\rightleftharpoons$  water at a constant temperature will cause**

- (a) water to vaporize (b) water to freeze  
(c) no change (d) ice to melt

**59. The order of the reaction**

**$\text{N}_2\text{O}_5 \rightarrow \text{N}_2\text{O}_4(\text{g}) + \frac{1}{2}\text{O}_2(\text{g})$  is**

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

60. The reactions with low activation energy are always

- (a) adiabatic (b) slow  
(c) non-spontaneous (d) fast

61. For a cell reaction to be spontaneous, the standard free energy change of the reaction must be

- (a) zero (b) positive  
(c) infinite (d) negative

62. Equivalent conductance of an electrolyte containing NaF at infinite dilution is  $90.1 \text{ Ohm}^{-1} \text{ cm}^2$ . If NaF is replaced by KF what is the value of equivalent conductance?

- (a)  $90.10 \text{ Ohm}^{-1} \text{ cm}^2$  (b)  $111.20 \text{ Ohm}^{-1} \text{ cm}^2$   
(c) 0 (d)  $222.40 \text{ Ohm}^{-1} \text{ cm}^2$

63. The tendencies of the electrodes made up of Cu, Zn and Ag to release electrons when dipped in their respective salt solutions decrease in the order

- (a)  $\text{Zn} > \text{Ag} > \text{Cu}$  (b)  $\text{Cu} > \text{Zn} > \text{Ag}$   
(c)  $\text{Zn} > \text{Cu} > \text{Ag}$  (d)  $\text{Ag} > \text{Cu} > \text{Zn}$

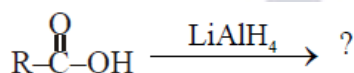
64. The electrode reaction that takes place at the anode of  $\text{CH}_4 - \text{O}_2$  fuel cell is

- (a)  $2\text{O}_2 + 8\text{H}^+ + 8\text{e}^- \rightarrow 4\text{H}_2\text{O}$   
(b)  $\text{CH}_4 + 2\text{H}_2\text{O} \rightarrow \text{CO}_2 + 8\text{H}^+ + 8\text{e}^-$   
(c)  $\text{CH}_4 + 2\text{O}_2 \rightarrow \text{CO}_2 + 2\text{H}_2\text{O}$   
(d)  $2\text{H}^+ + 2\text{e}^- \rightarrow \text{H}_2$

65. What is the hybridization of oxygen atom in an alcohol molecule?

- (a)  $\text{sp}^3$  (b) sp  
(c)  $\text{sp}^2$  (d)  $\text{p}^2$

66.



- (a)  $\text{RCH}_2\text{CH}_2\text{OH}$  (b) RCHO  
(c) RCOR (d)  $\text{RCH}_2\text{OH}$

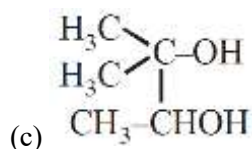
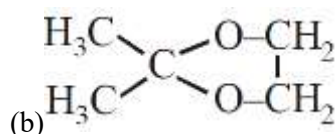
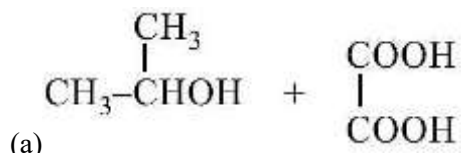
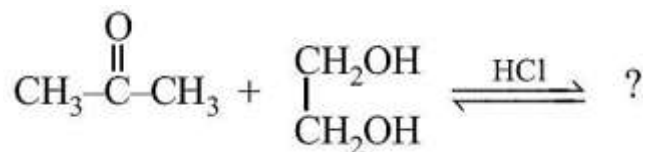
67. Which one of the following is correct?

- (a)  $\text{RCH}_2\text{OH} \xrightarrow{\text{KMnO}_4} \text{No reaction}$   
(b)  $\text{CH}_3\text{CH}_2\text{OH} \xrightarrow{\text{Na}_2\text{Cr}_2\text{O}_7, \text{H}_2\text{SO}_4} \text{No reaction}$   
(c)  $\text{CH}_3\text{CHO} \xrightarrow{\text{Na}_2\text{Cr}_2\text{O}_7, \text{H}_2\text{SO}_4} \text{No reaction}$   
(d)  $\begin{array}{c} \text{CH}_3 \\ | \\ \text{CH}_3-\text{C}-\text{OH} \\ | \\ \text{CH}_3 \end{array} \xrightarrow{\text{alkaline KMnO}_4} \text{No reaction}$

68. Which one of the following products obtained when diethyl ether is boiled with water in presence of dilute acid?

- (a) Glycol (b) Ethyl alcohol  
(c) Ethylene oxide (d) Peroxide

69. Identify the product for the following reaction



(d) No reaction

70. What is the reaction of acetaldehyde with concentrated sulphuric acid?

- (a) No reaction (b) Decomposition  
(c) Charred to black residue (d) Polymerisation

71. Calcium Acetate on heating under distillation gives

- (a) Acetaldehyde and Calcium Oxide  
(b) Calcium Carbonate and Acetic acid  
(c) Acetone and Calcium Carbonate  
(d) Calcium Oxide and  $\text{CO}_2$

72. Identify the correct statement

- (a) Aldehydes on reduction give secondary alcohols  
(b) Ketones on reduction give primary alcohols  
(c) Ketones reduce Fehling's solution and give red cuprous oxide  
(d) Ketones do not react with alcohols

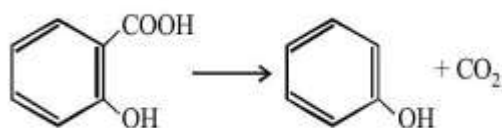
73. The O – H stretching vibration of alcohols absorbs in the region  $3700 - 3500 \text{ cm}^{-1}$ . The O – H stretching of carboxylic acids absorb in the region

- (a)  $3900 - 3700 \text{ cm}^{-1}$   
(b)  $3000 - 2500 \text{ cm}^{-1}$   
(c)  $3700 - 3500 \text{ cm}^{-1}$   
(d)  $1700 - 2000 \text{ cm}^{-1}$

74. Which among the following reduces Fehling's solution?

- (a) Acetic acid (b) Formic acid  
(c) Benzoic acid (d) Salicylic acid

75. Determine the experimental condition for the following reaction



- (a) in presence of KOH (b) on heating  
(c) in presence of NaOH (d) in presence of HCl

76. Which one of the following is an ingredient of Pthalic acid manufacture by catalytic oxidation

- (a) Benzene (b) Salicylic acid  
(c) Anthranilic acid (d) naphthalene

77. On comparison with H – C – H bond angle of methane, the C – N – C bond angle of trimethylamine is

- (a) higher (b) no change  
(c) not comparable (d) lower

78. The treatment of acylazide (RCON<sub>3</sub>) with acidic or alkaline medium gives

- (a) RCONH<sub>2</sub> (b) R – NH<sub>2</sub>  
(c) RCH<sub>2</sub>NH<sub>2</sub> (d) RCOCHNH

79. The sequence of basic strength of alkyl amines follows the order

- (a) RNH<sub>2</sub> < R<sub>2</sub>NH < R<sub>3</sub>N  
(b) R<sub>2</sub>NH<sub>2</sub> < R<sub>2</sub>NH < R<sub>3</sub>N  
(c) R<sub>2</sub>NH < RNH<sub>2</sub> < R<sub>3</sub>N  
(d) RNH<sub>2</sub> < R<sub>2</sub>NH < R<sub>3</sub>N

80. Activation of benzene ring in aniline can be decreased by treating with

- (a) dil. HCl (b) ethyl alcohol  
(c) acetic acid (d) acetyl chloride

### PART - III (MATHEMATICS)

81. The value of x, for which the matrix

$$A = \begin{bmatrix} \frac{2}{x} & -1 & 2 \\ 1 & x & 2x^2 \\ 1 & \frac{1}{x} & 2 \end{bmatrix} \text{ is singular, is}$$

- (a)  $\pm 1$  (b)  $\pm 2$   
(c)  $\pm 3$  (d)  $\pm 4$

82. If  $x = -9$  is a root of  $\begin{vmatrix} x & 3 & 7 \\ 2 & x & 2 \\ 7 & 6 & x \end{vmatrix} = 0$ , then other two roots are

- (a) 3, 7 (b) 2, 7  
(c) 3, 6 (d) 2, 6

83. The values of  $\alpha$  for which the system of equation  $x + y + z = 1$ ,  $x + 2y + 4z = \alpha$ ,  $x + 4y + 10z = \alpha^2$  is consistent are given by

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

84. Let  $A = \begin{pmatrix} 1 & 3 & 2 \\ 2 & 5 & t \\ 4 & 7-t & -6 \end{pmatrix}$ , then the values of  $t$  for which inverse of  $A$  does not exist

- (a)  $-2, 1$  (b)  $3, 2$   
(c)  $2, -3$  (d)  $3, -1$

85. The non-integer roots of

$$x^4 - 3x^3 - 2x^2 + 3x + 1 = 0$$

- (a)  $\frac{1}{2}(3 + \sqrt{13}), \frac{1}{2}(3 - \sqrt{13})$   
(b)  $\frac{1}{2}(3 - \sqrt{13}), \frac{-1}{2}(3 + \sqrt{13})$   
(c)  $\frac{1}{2}(3 + \sqrt{17}), \frac{1}{2}(3 - \sqrt{17})$   
(d)  $\frac{1}{2}(3 - \sqrt{17}), \frac{-1}{2}(3 + \sqrt{17})$

86. If  $e^x = y + \sqrt{1 + y^2}$ , then the value of  $y$  is

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

87. Consider an infinite geometric series with the first term  $a$  and common ratio  $r$ . If its sum is 4 and the second term is  $\frac{3}{4}$ , then

- (a)  $a = \frac{4}{7}, r = \frac{3}{7}$  (b)  $a = 2, r = \frac{3}{8}$   
(c)  $a = \frac{3}{2}, r = \frac{1}{2}$  (d)  $a = 3, r = \frac{1}{4}$

88. If  $\alpha$  and  $\beta$  are the roots of the equation  $ax^2 + bx + c = 0$ , then the value of  $\alpha^3 + \beta^3$  is

- (a)  $\frac{3abc+b^3}{a^3}$  (b)  $\frac{a^3+b^3}{3abc}$   
(c)  $\frac{3abc-b^3}{a^3}$  (d)  $\frac{-(3abc+b^3)}{a^3}$

89. The volume of the tetrahedron with vertices  $P(-1, 2, 0)$ ,  $Q(2, 1, -3)$ ,  $R(1, 0, 1)$  and  $S(3, -2, 3)$  is

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

90. If  $\vec{a} = \hat{i} + 2\hat{j} + 3\hat{k}$ ,  $\vec{b} = -\hat{i} + 2\hat{j} + \hat{k}$  and  $\vec{c} = 3\hat{i} + \hat{j}$  then  $t$  such that  $\vec{a} + t\vec{b}$  is at right angle to  $\vec{c}$  will be equal to

- (a) 5 (b) 4  
(c) 6 (d) 2

91. An equation of the plane passing through the line of intersection of the planes  $x + y + z = 6$  and  $2x + 3y + 4z + 5 = 0$  and passing through  $(1, 1, 1)$  is

- (a)  $2x + 3y + 4z = 9$   
(b)  $x + y + z = 3$   
(c)  $x + 2y + 3z = 6$   
(d)  $20x + 23y + 26z = 69$

92. The length of the shortest distance between the lines  $\vec{r} = 3\hat{i} + 5\hat{j} + 7\hat{k} + \lambda(\hat{i} - 2\hat{j} + \hat{k})$  and  $\vec{r} = -\hat{i} - \hat{j} - \hat{k} + \mu(7\hat{i} - 6\hat{j} + \hat{k})$  is

- (a) 83 units (b)  $\sqrt{6}$  units  
(c)  $\sqrt{3}$  units (d)  $2\sqrt{29}$  units

93. The region of the argand plane defined by  $|z - i| + |z + i| \leq 4$  is

- (a) interior of an ellipse  
(b) exterior of a circle

(c) interior and boundary of an ellipse

(d) interior of a parabola

94. The value of the sum  $\sum_{n=1}^{13} (i^n + i^{n+1})$  where  $i = \sqrt{-1}$  equals

- (a) 1 (b)  $i-1$   
(c)  $-1$  (d) 0

95. If  $\sin \theta, \cos \theta, \tan \theta$  are in G.P. then  $\cos^9 \theta + \cos^6 \theta + 3\cos^5 \theta - 1$  is equal to

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

96. If in a triangle ABC,

$5\cos C + 6\cos B = 4$  and  $6\cos A + 4\cos C = 5$ , then  $\tan \frac{A}{2} \tan \frac{B}{2}$  is equal to

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

97. In a model, it is shown that an arc of a bridge is semielliptical with major axis horizontal. If the length of the base is 9 m and the highest part of the bridge is 3 m from horizontal; the best approximation of the height of the arch, 2 m from the centre of the base is

- (a)  $\frac{11}{4}$  m (b)  $\frac{8}{3}$  m  
(c)  $\frac{7}{2}$  m (d) 2 m

98. The number of real tangents through (3, 5) that can be drawn to the ellipses  $3x^2 + 5y^2 = 32$  and  $25x^2 + 9y^2 = 450$  is

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

99. If the normal to the rectangular hyperbola  $xy = c^2$  at the point  $(ct, \frac{c}{t})$  meets the curve again at  $(ct', \frac{c}{t'})$ , then

- (a)  $t^3 t' = 1$  (b)  $t^3 t' = -1$   
(c)  $tt' = 1$  (d)  $tt' = -1$

100. An equilateral triangle is inscribed in the parabola  $y^2 = 4x$  one of whose vertex is at the vertex of the parabola, the length of each side of the triangle is

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

101. If  $f(2) = 4$  and  $f'(2) = 1$ , then  $\lim_{x \rightarrow 2} \frac{xf(2) - 2f(x)}{x-2}$  is equal to

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

102. What is the least value of  $k$  such that the function  $x^2 + kx + 1$  is strictly increasing on (1, 2)

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

103. The maximum value of  $\left(\frac{1}{x}\right)^x$  is

- (a)  $e$  (b)  $e^e$   
(c)  $e^{\frac{1}{e}}$  (d)  $\left(\frac{1}{e}\right)^{\frac{1}{e}}$

104. If  $u = \tan^{-1} \left\{ \frac{x^3 + y^3}{x+y} \right\}$ , then  $x \frac{\partial u}{\partial x} + y \frac{\partial u}{\partial y} =$

- (a)  $\sin 2u$  (b)  $\cos 2u$   
(c)  $\sec^2 2u$  (d)  $\tan 2u$

105. If  $f'(x) = \frac{x}{\sqrt{1+x}}$  and  $f(0) = 0$ , then  $f(x) =$

(a)  $\frac{2}{3} \left\{ (1+x)^{\frac{3}{2}} - 6(1+x)^{\frac{1}{2}} + 1 \right\}$

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

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

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

106. The value of the integral  $\int_0^{\frac{\pi}{2}} \log(\tan x) dx =$

(a) 0

(b) 1

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

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

107. What is the area of a loop of the curve  $r = a \sin 3\theta$  ?

(a)  $\frac{\pi a^2}{6}$

(b)  $\frac{\pi a^2}{8}$

(c)  $\frac{\pi a^2}{12}$

(d)  $\frac{\pi a^2}{24}$

108. The value of the integral  $\int_1^9 e^{\sqrt{t}} dt =$

(a)  $e^3$

(b)  $4e^3$

(c)  $4(e^3 - e)$

(d)  $4e^3 - 2e$

109. The differential equation that represents all parabolas each of which has a latus rectum  $4a$  and whose axes are parallel to the  $x$ -axis is

(a)  $\frac{d^2y}{dx^2} + 2 \frac{dy}{dx} = 0$

(b)  $\frac{d^2y}{dx^2} + \left( \frac{dy}{dx} \right)^3 = 0$

(c)  $a \frac{d^2y}{dx^2} + \left( \frac{dy}{dx} \right)^3 = 0$

(d)  $2a \frac{d^2y}{dx^2} + \left( \frac{dy}{dx} \right)^3 = 0$

110. The solution of  $\left( x \operatorname{cosec} \left( \frac{y}{x} \right) - y \right) dx + x dy = 0$  is

(a)  $\log |x| - \cos \left( \frac{x}{y} \right) = c$

(b)  $\log |x| - \cos \left( \frac{y}{x} \right) = c$

(c)  $\log |x| - \sin \left( \frac{x}{y} \right) = c$

(d)  $\log |x| - \sin \left( \frac{y}{x} \right) = c$

111. The particular integral of  $\frac{d^2y}{dx^2} + 2y = x^2$  is

(a)  $x^2 - 1$

(b)  $x^2 + 1$

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

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

112. The solution of  $(D^2 + 16)y = \cos 4x$  is

(a)  $A \cos 4x + B \sin 4x + \frac{x}{8} \sin 4x$

(b)  $A \cos 4x + B \sin 4x - \frac{x}{8} \sin 4x$

(c)  $A \cos 4x + B \sin 4x + \frac{x}{4} \sin 4x$

(d)  $A \cos 4x + B \sin 4x - \frac{x}{4} \sin 4x$

113. Determine which one of the following relations on  $X = \{1, 2, 3, 4\}$  is not transitive.

(a)  $R_1 = \phi$ , the empty relation

(b)  $R_2 = X \times X$ , the universal relation

(c)  $R_3 = \{(1,3), (2,1)\}$

(d)  $R_4 = \{(1,1), (1,2), (2,3), (1,3), (4,4)\}$

114. Find the number of ways in which five large books, four medium-size books, and three small books can be placed on a shelf so that all books of the same size are together.

(a)  $5 \times 4 \times 3$

(b)  $5! \times 4! \times 3!$

(c)  $3 \times 5! \times 4! \times 3!$

(d)  $3! \times 5! \times 4! \times 3!$

115. Consider the set  $Q$  of rational numbers. Let  $*$  be the operation on  $Q$  defined by  $a * b = a + b - ab$ . The identity element under  $*$  is

(a) 0

(b) 1

(c) 2

(d) not exist

116. The statement  $\sim p \vee q$  is equivalent to

(a)  $p \rightarrow q$

(b)  $\sim p \rightarrow q$

(c)  $\sim p \rightarrow \sim q$

(d)  $p \rightarrow \sim q$

117. In rolling two fair dice, what is the probability of obtaining a sum greater than 3 but not exceeding 6?

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

(b)  $\frac{1}{3}$

(c)  $\frac{1}{4}$

(d)  $\frac{1}{6}$

118. Team A has probability  $\frac{2}{3}$  of winning whenever it plays. Suppose A plays four games. What is the probability that A wins more than half of its games?

(a)  $\frac{16}{27}$

(b)  $\frac{19}{27}$

(c)  $\frac{19}{81}$

(d)  $\frac{32}{81}$

119. An unprepared student takes five-questions of true-false type quiz and guesses every answer. What is the probability that the student will pass the quiz if at least four correct answers is the passing grade?

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

(b)  $\frac{3}{16}$

(c)  $\frac{1}{32}$

(d)  $\frac{3}{32}$

120. The probability density  $f(x)$  of a continuous random variable is given by  $f(x) = Ke^{-|x|}$ ,  $-\infty < x < \infty$ . Then the value of  $K$  is

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

(b) 2

(c)  $\frac{1}{4}$

(d) 4