AIEEE - 2007

Max. Marks :360 **No. of Questions : 120**

SECTION I - PHYSICS

1. A circular disc of radius R is removed from a bigger circular disc of radius 2R such that the circumferences of the discs coincide. The centre of mass of the new disc is α R form the centre of the bigger disc. The value of α is
(a) 1/4 (b) 1/3 (c) 1/2 (d) 1/6

2. A round uniform body of radius R, mass M and moment of inertia I rolls down (without slipping) an inclined plane making an angle θ with the horizontal. Then its acceleration is

(a) $\frac{g\sin\theta}{1-MR^2/I}$ (b) $\frac{g\sin\theta}{1+I/MR^2}$

(c) $\frac{g\sin\theta}{1+MR^2/I}$ (d) $\frac{g\sin\theta}{1-I/MR^2}$

3. Angular momentum of the particle rotating with a central force is constant due to
(a) constant torque
(b) constant force
(c) constant linear momentum
(d) zero torque

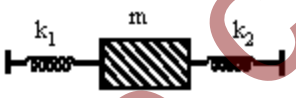
4. A 2 kg block slides on a horizontal floor with a speed of 4m/s. It strikes a uncompressed spring, and compresses it till the block is motionless. The kinetic friction force is 15N and spring constant is 10,000 N/m. The spring compresses by
(a) 8.5 cm (b) 5.5 cm
(c) 2.5 cm (d) 11.0 cm

5. A particle is projected at 60° to the horizontal with a kinetic energy K. The kinetic energy at the highest point is
(a) K/2 (b) K (c) Zero (d) K/4

6. In a Young's double slit experiment the intensity at a point where the path difference is $\frac{\lambda}{6}$ (λ being the wavelength of light used) is I. If I_0 denotes the maximum intensity, $\frac{I}{I_0}$ is equal to

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

7. Two springs, of force constants k_1 and k_2 are connected to a mass m as shown. The frequency of oscillation of the mass is f. If both k_1 and k_2 are made four times their original values, the frequency of oscillation becomes



(a) 2f (b) f/2 (c) f/4 (d) 4f

8. When a system is taken from state i to state f along the path iaf, it is found that Q = 50 cal and W = 20 cal. Along the path ibf Q = 36 cal. W along the path ibf is

(a) 14 cal (b) 6 cal
(c) 16 cal (d) 66 cal

9. A particle of mass m executes simple harmonic motion with amplitude a and frequency ν. The average kinetic energy during its motion from the position of equilibrium to the end is

(a) $2\pi^2 ma^2\nu^2$ (b) $\pi^2 ma^2\nu^2$

(c) $\frac{1}{4}ma^2\nu^2$ (d) $4\pi^2 ma^2\nu^2$

10. The displacement of an object attached to a spring and executing simple harmonic motion is given by $x = 2\times10^{-2}\cos\pi t$ metre. The time at which the maximum speed first occurs is
(a) 0.25 s (b) 0.5 s
(c) 0.75 s (d) 0.125 s

11. In an a.c. circuit the voltage applied is $E = E_0\sin\omega t$. The resulting current in the circuit is $I = I_0\sin\left(\omega t-\frac{\pi}{2}\right)$. The power consumption in the circuit is given by

(a) $P = \sqrt{2}E_0I_0$ (b) $P = \frac{E_0I_0}{\sqrt{2}}$

(c) P = zero (d) $P = \frac{E_0I_0}{2}$

12. An electric charge $10^{-3}\,\mu C$ is placed at the origin (0, 0) of X – Y co-ordinate system. Two points A and B are situated at $(\sqrt{2}, \sqrt{2})$ and (2, 0) respectively. The potential difference between the points A and B will be
(a) 4.5 volts (b) 9 volts
(c) Zero (d) 2 volt

13. A battery is used to charge a parallel plate capacitor till the potential difference between the plates becomes equal to the electromotive force of the battery. The ratio of the energy stored in the capacitor and the work done by the battery will be
(a) 1/2 (b) 1 (c) 2 (d) 1/4

14. An ideal coil of 10H is connected in series with a resistance of 5Ω and a battery of 5V. 2 second after the connection is made, the current flowing in ampere in the circuit is
(a) $(1 - e^{-1})$ (b) $(1 - e)$
(c) e (d) e^{-1}

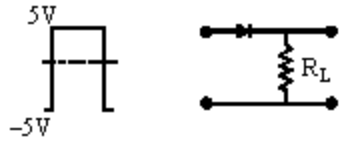
15. A long straight wire of radius *a* carries a steady current i. The current is uniformly distributed across its cross section. The ratio of the magnetic field at a/2 and 2a is
(a) 1/2 (b) 1/4 (c) 4 (d) 1

16. A current I flows along the length of an infinitely long, straight, thin walled pipe. Then
(a) the magnetic field at all points inside the pipe is the same, but not zero
(b) the magnetic field is zero only on the axis of the pipe
(c) the magnetic field is different at different points inside the pipe
(d) the magnetic field at any point inside the pipe is zero

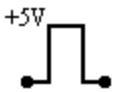
17. If M_0 is the mass of an oxygen isotope ${}_8O^{17}$, M_p and M_N are the masses of a proton and a neutron respectively, the nuclear binding energy of the isotope is
(a) $(M_0 - 17M_N)c^2$
(b) $(M_0 - 8M_p)c^2$
(c) $(M_0 - 8M_p - 9M_N)c^2$
(d) M_0c^2

18. In gamma ray emission from a nucleus
(a) only the proton number changes
(b) both the neutron number and the proton number change
(c) there is no change in the proton number and the neutron number
(d) only the neutron number changes

19. If in a p-n junction diode, a square input signal of 10 V is applied as shown



Then the output signal across R_L will be

(a) 

(b) 

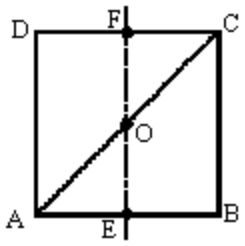
(c) 

(d) 

20. Photon of frequency ν has a momentum associated with it. If c is the velocity of light, the momentum is
(a) $h\nu / c$ (b) ν / c
(c) $h\nu c$ (d) $h\nu / c^2$

21. The velocity of a particle is $v = v_0 + gt + ft^2$. If its position is x = 0 at t = 0, then its displacement after unit time (t = 1) is
(a) $v_0 + g/2 + f$ (b) $v_0 + 2g + 3f$
(c) $v_0 + g/2 + f/3$ (d) $v_0 + g + f$

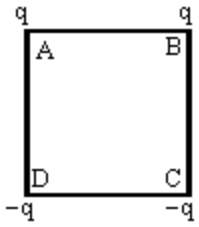
22. For the given uniform square lamina ABCD, whose centre is O,



(a) $I_{AC} = \sqrt{2}\, I_{EF}$ (b) $\sqrt{2} I_{AC} = I_{EF}$
(c) $I_{AD} = 3I_{EF}$ (d) $I_{AC} = I_{EF}$

23. A point mass oscillates along the x-axis according to the law $x = x_0 \cos(\omega t - \pi/4)$. If the acceleration of the particle is written as $a = A\cos(\omega t + \delta)$, then
(a) $A = x_0\omega^2,\ \delta = 3\pi/4$
(b) $A = x_0,\ \delta = -\pi/4$
(c) $A = x_0\omega^2,\ \delta = \pi/4$
(d) $A = x_0\omega^2,\ \delta = -\pi/4$

24. Charges are placed on the vertices of a square as shown. Let $\vec{E}$ be the electric field and V the potential at the centre. If the charges on A and B are interchanged with those on D and C respectively, then



(a) $\vec{E}$ changes, V remains unchanged
(b) $\vec{E}$ remains unchanged, V changes
(c) both $\vec{E}$ and V change
(d) $\vec{E}$ and V remain unchanged

25. The half-life period of a radio-active element X is same as the mean life time of another radio-active element Y. Initially they have the same number of atoms. Then
(a) X and Y decay at same rate always
(b) X will decay faster than Y
(c) Y will decay faster than X
(d) X and Y have same decay rate initially

26. A Carnot engine, having an efficiency of $\eta = 1/10$ as heat engine, is used as a refrigerator. If the work done on the system is 10 J, the amount of energy absorbed from the reservoir at lower temperature is
(a) 100 J (b) 99 J
(c) 90 J (d) 1 J

27. Carbon, silicon and germanium have four valence electrons each. At room temperature which one of the following statements is most appropriate ?
(a) The number of free electrons for conduction is significant only in Si and Ge but small in C.
(b) The number of free conduction electrons is significant in C but small in Si and Ge.
(c) The number of free conduction electrons is negligibly small in all the three.
(d) The number of free electrons for conduction is significant in all the three.

28. A charged particle with charge q enters a region of constant, uniform and mutually orthogonal fields $\vec{E}$ and $\vec{B}$ with a velocity $\vec{v}$ perpendicular to both $\vec{E}$ and $\vec{B}$, and comes out without any change in magnitude or direction of $\vec{v}$. Then
(a) $\vec{v} = \vec{B} \times \vec{E}/E^2$ (b) $\vec{v} = \vec{E} \times \vec{B}/B^2$
(c) $\vec{v} = \vec{B} \times \vec{E}/B^2$ (d) $\vec{v} = \vec{E} \times \vec{B}/E^2$

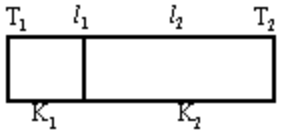
29. The potential at a point x (measured in μm) due to some charges situated on the x-axis is given by $V(x) = 20/(x^2 - 4)$ volt
The electric field E at $x = 4$ μm is given by
(a) (10/9) volt/μm and in the +ve x direction
(b) (5/3) volt/μm and in the –ve x direction
(c) (5/3) volt/μm and in the +ve x direction
(d) (10/9) volt/μm and in the –ve x direction

30. Which of the following transitions in hydrogen atoms emit photons of highest frequency?
(a) n = 1 to n = 2 (b) n = 2 to n = 6
(c) n = 6 to n = 2 (d) n = 2 to n = 1

31. A block of mass m is connected to another block of mass M by a spring (massless) of spring constant k. The block are kept on a smooth horizontal plane. Initially the blocks are at rest and the spring is unstretched. Then a constant force F starts acting on the block of mass M to pull it. Find the force of the block of mass m.
(a) $\frac{MF}{(m+M)}$ (b) $\frac{mF}{M}$
(c) $\frac{(M+m)F}{m}$ (d) $\frac{mF}{(m+M)}$

32. Two lenses of power –15 D and +5 D are in contact with each other. The focal length of the combination is
(a) +10 cm (b) −20 cm
(c) −10 cm (d) +20 cm

33. One end of a thermally insulated rod is kept at a temperature T_1 and the other at T_2. The rod is composed of two sections of length l_1 and l_2 and thermal conductivities K_1 and K_2 respectively. The temperature at the interface of the two section is



(a) $\frac{(K_1 l_1 T_1 + K_2 l_2 T_2)}{(K_1 l_1 + K_2 l_2)}$ (b) $\frac{(K_2 l_2 T_1 + K_1 l_1 T_2)}{(K_1 l_1 + K_2 l_2)}$
(c) $\frac{(K_2 l_1 T_1 + K_1 l_2 T_2)}{(K_2 l_1 + K_1 l_2)}$ (d) $\frac{(K_1 l_2 T_1 + K_2 l_1 T_2)}{(K_1 l_2 + K_2 l_1)}$

34. A sound absorber attenuates the sound level by 20 dB. The intensity decreases by a factor of
(a) 100 (b) 1000
(c) 10000 (d) 10

35. If C_p and C_V denote the specific heats of nitrogen per unit mass at constant pressure and constant volume respectively, then
(a) $C_p - C_V = 28R$ (b) $C_p - C_V = R/28$
(c) $C_p - C_V = R/14$ (d) $C_p - C_V = R$

36. A charged particle moves through a magnetic field perpendicular to its direction. Then
(a) kinetic energy changes but the momentum is constant
(b) the momentum changes but the kinetic energy is constant
(c) both momentum and kinetic energy of the particle are not constant
(d) both momentum and kinetic energy of the particle are constant

37. Two identical conducting wires AOB and COD are placed at right angles to each other. The wire AOB carries an electric current I_1 and COD carries a current I_2. The magnetic field on a point lying at a distance d from O, in a direction perpendicular to the plane of the wires AOB and COD, will be given by

(a) $\frac{\mu_0}{2\pi d}(I_1^2 + I_2^2)$ (b) $\frac{\mu_0}{2\pi}\left(\frac{I_1 + I_2}{d}\right)^{\frac{1}{2}}$

(c) $\frac{\mu_0}{2\pi d}\left(I_1^2 + I_2^2\right)^{\frac{1}{2}}$ (d) $\frac{\mu_0}{2\pi d}(I_1 + I_2)$

38. The resistance of a wire is 5 ohm at 50°C and 6 ohm at 100°C. The resistance of the wire at 0°C will be
(a) 3 ohm (b) 2 ohm
(c) 1 ohm (d) 4 ohm

39. A parallel plate condenser with a dielectric of dielectric constant K between the plates has a capacity C and is charged to a potential V volt. The dielectric slab is slowly removed from between the plates and then reinserted. The net work done by the system in this process is

(a) zero (b) $\frac{1}{2}(K-1)\,CV^2$

(c) $\frac{CV^2(K-1)}{K}$ (d) $(K-1)\,CV^2$

40. If g_E and g_M are the accelerations due to gravity on the surfaces of the earth and the moon respectively and if Millikan's oil drop experiment could be performed on the two surfaces, one will find the ratio

$$\frac{\text{electronic charge on the moon}}{\text{electronic charge on the earth}}$$ to be

(a) g_M / g_E (b) 1
(c) 0 (d) g_E / g_M

SECTION II - CHEMISTRY

41. The equivalent conductances of two strong electrolytes at infinite dilution in H_2O (where ions move freely through a solution) at 25°C are given below :

$\Lambda^\circ_{CH_3COONa} = 91.0$ S cm^2/equiv.

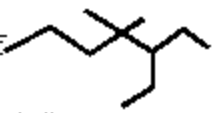
$\Lambda^\circ_{HCl} = 426.2$ S cm^2/equiv.

What additional information/ quantity one needs to calculate Λ° of an aqueous solution of acetic acid?

(a) Λ° of chloroacetic acid ($ClCH_2COOH$)
(b) Λ° of NaCl
(c) Λ° of CH_3COOK
(d) the limiting equivalent coductance of $H^+(\lambda^\circ_{H^+})$.

42. Which one of the following is the strongest base in aqueous solution?
(a) Methylamine (b) Trimethylamine
(c) Aniline (d) Dimethylamine.

43. The compound formed as a result of oxidation of ethyl benzene by $KMnO_4$ is
(a) benzyl alcohol (b) benzophenone
(c) acetophenone (d) benzoic acid

44. The IUPAC name of  is
(a) 3-ethyl-4-4-dimethylheptane
(b) 1, 1-diethyl-2,2-dimethylpentane
(c) 4, 4-dimethyl-5,5-diethylpentane
(d) 5, 5-diethyl-4,4-dimethylpentane.

45. Which of the following species exhibits the diamagnetic behaviour?
(a) NO (b) O_2^{2-} (c) O_2^+ (d) O_2.

46. The stability of dihalides of Si, Ge, Sn and Pb increases steadily in the sequence
(a) $PbX_2 << SnX_2 << GeX_2 << SiX_2$
(b) $GeX_2 << SiX_2 << SnX_2 << PbX_2$
(c) $SiX_2 << GeX_2 << PbX_2 << SnX_2$
(d) $SiX_2 << GeX_2 << SnX_2 << PbX_2$.

47. Identify the incorrect statement among the following.
(a) Br_2 reacts with hot and strong NaOH solution to give NaBr and H_2O.
(b) Ozone reacts with SO_2 to give SO_3.
(c) Silicon reacts with $NaOH_{(aq)}$ in the presence of air to give Na_2SiO_3 and H_2O.
(d) Cl_2 reacts with excess of NH_3 to give N_2 and HCl.

48. The charge/size ratio of a cation determines its polarizing power. Which one of the following sequences represents the increasing order of the polarizing power of the cationic species, K^+, Ca^{2+}, Mg^{2+}, Be^{2+}?
(a) $Ca^{2+} < Mg^{2+} < Be^+ < K^+$
(b) $Mg^{2+} < Be^{2+} < K^+ < Ca^{2+}$
(c) $Be^{2+} < K^+ < Ca^{2+} < Mg^{2+}$
(d) $K^+ < Ca^{2+} < Mg^{2+} < Be^{2+}$

49. The density (in g mL^{-1}) of a 3.60 M sulphuric acid solution that is 29% H_2SO_4 (molar mass = 98 g mol^{-1}) by mass will be
(a) 1.45 (b) 1.64 (c) 1.88 (d) 1.22

50. The first and second dissociation constants of an acid H_2A are 1.0×10^{-5} and 5.0×10^{-10} respectively. The overall dissociation constant of the acid will be
(a) 0.2×10^{-5} (b) 5.0×10^{-5}
(c) 5.0×10^{15} (d) 5.0×10^{-15}.

51. A mixture of ethyl alcohol and propyl alcohol has a vapour pressure of 290 mm at 300 K. The vapour pressure of propyl alcohol is 200 mm. If the mole fraction of ethyl alcohol is 0.6, its vapour pressure (in mm) at the same temperature will be
(a) 360 (b) 350 (c) 300 (d) 700

52. In conversion of lime-stone to lime,
$CaCO_{3(s)} \rightarrow CaO_{(s)} + CO_{2(g)}$
the values of $\Delta H°$ and $\Delta S°$ are +179.1 kJ mol^{-1} and 160.2 J/K respectively at 298 K and 1 bar. Assuming that $\Delta H°$ and $\Delta S°$ do not change with temperature, temperature above which conversion of limestone to lime will be spontaneous is
(a) 1118 K (b) 1008 K
(c) 1200 K (d) 845 K.

53. The energies of activation for forward and reverse reactions for $A_2 + B_2 \rightleftharpoons 2AB$ are 180 kJ mol^{-1} and 200 kJ mol^{-1} respectively. The presence of a catalyst lowers the activation energy of both (forward and reverse) reactions by 100 kJ mol^{-1}. The enthalpy change of the reaction ($A_2 + B_2 \rightarrow 2AB$) in the presence of a catalyst will be (in kJ mol^{-1})
(a) 20 (b) 300 (c) 120 (d) 280

54. The cell,
$Zn|Zn^{2+}(1\ M)||Cu^{2+}(1\ M)|Cu\ (E°_{cell} = 1.10\ V)$
was allowed to be completely discharged at 298 K. The relative concentration of Zn^{2+} to Cu^{2+} $\left(\frac{[Zn^{2+}]}{[Cu^{2+}]}\right)$ is
(a) 9.65×10^4 (b) antilog (24.08)
(c) 37.3 (d) $10^{37.3}$.

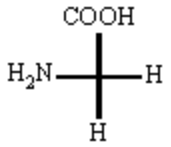
55. The pK_a of a weak acid (HA) is 4.5. The pOH of an aqueous buffer solution of HA in which 50% of the acid is ionized is
(a) 7.0 (b) 4.5 (c) 2.5 (d) 9.5

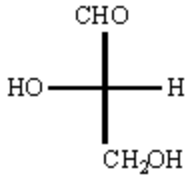
56. Consider the reaction, 2A + B $\rightarrow$ products. When concentration of B alone was doubled, the half-life did not change. When the concentration of A alone was doubled, the rate increased by two times. The unit of rate constant for this reaction is
(a) s^{-1} (b) L mol^{-1} s^{-1}
(c) no unit (d) mol L^{-1} s^{-1}.

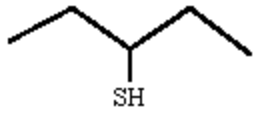
57. Identify the incorrect statement among the following.
(a) 4f and 5f orbitals are equally shielded.
(b) d-Block elements show irregular and erratic chemical properties among themselves.
(c) La and Lu have partially filled d-orbitals and no other partially filled orbitals.
(d) The chemistry of various lanthanoids is very similar.

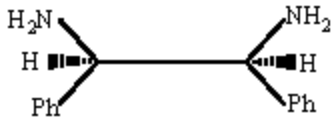
58. Which of the following has a square planar geometry?
(a) $[PtCl_4]^{2-}$ (b) $[CoCl_4]^{2-}$
(c) $[FeCl_4]^{2-}$ (d) $[NiCl_4]^{2-}$
(At. nos.: Fe = 26, Co = 27, Ni = 28, Pt = 78)

59. Which of the following molecules is expected to rotate the plane of plane-polarised light?

(a) 

(b) 

(c) 

(d) 

60. The secondary structure of a protein refers to
(a) fixed configuration of the polypeptide backbone
(b) α – helical backbone
(c) hydrophobic interactions
(d) sequence of α – amino acids.

61. Which of the following reactions will yield 2, 2-dibromopropane?
(a) $CH_3 - CH = CH_2 + HBr \rightarrow$
(b) $CH_3 - C \equiv CH + 2HBr \rightarrow$
(c) $CH_3CH = CHBr + HBr \rightarrow$
(d) $CH \equiv CH + 2HBr \rightarrow$

62. In the chemical reaction,
$CH_3CH_2NH_2 + CHCl_3 + 3KOH \rightarrow (A) + (B) + 3H_2O$, the compounds (A) and (B) are respectively
(a) C_2H_5NC and 3KCl
(b) C_2H_5CN and 3KCl
(c) $CH_3CH_2CONH_2$ and 3KCl
(d) C_2H_5NC and K_2CO_3.

63. The reaction of toluene with Cl_2 in presence of $FeCl_3$ gives predominantly
(a) m-chlorobenzene
(b) benzoyl chloride
(c) benzyl chloride
(d) o- and p-chlorotoluene.

64. Presence of a nitro group in a benzene ring
(a) deactivates the ring towards electrophilic substitution
(b) activates the ring towards electrophilic substitution
(c) renders the ring basic
(d) deactivates the ring towards nucleophilic substitution.

65. In which of the following ionization processes, the bond order has increased and the magnetic behaviour has changed?

(a) $N_2 \rightarrow N_2^+$ (b) $C_2 \rightarrow C_2^+$

(c) $NO \rightarrow NO^+$ (d) $O_2 \rightarrow O_2^+$.

66. The actinoids exhibit more number of oxidation states in general than the lanthanoids. This is because
(a) the 5f orbitals extend further from the nucleus than the 4f orbitals
(b) the 5f orbitals are more buried than the 4f orbitals
(c) there is a similarity between 4f and 5f orbitals in their angular part of the wave function
(d) the actinoids are more reactive than the lanthanoids.

67. Equal masses of methane and oxygen are mixed in an empty container at 25°C. The fraction of the total pressure exerted by oxygen is

(a) 1/2 (b) 2/3

(c) $\frac{1}{3} \times \frac{273}{298}$ (d) 1/3.

68. A 5.25% solution of a substance is isotonic with a 1.5% solution of urea (molar mass = 60 g mol^{-1}) in the same solvent. If the densities of both the solutions are assumed to be equal to 1.0 g cm^{-3}, molar mass of the substance will be
(a) 210.0 g mol^{-1} (b) 90.0 g mol^{-1}
(c) 115.0 g mol^{-1} (d) 105.0 g mol^{-1}.

69. Assuming that water vapour is an ideal gas, the internal energy change (ΔU) when 1 mol of water is vapourised at 1 bar pressure and 100°C, (given : molar enthalpy of vapourisation of water at 1 bar and 373 K = 41 kJ mol^{-1} and R = 8.3 J mol^{-1} K^{-1}) will be
(a) 41.00 kJ mol^{-1} (b) 4.100 kJ mol^{-1}
(c) 3.7904 kJ mol^{-1} (d) 37.904 kJ mol^{-1}

70. In a saturated solution of the sparingly soluble strong electrolyte $AgIO_3$ (molecular mass = 283) the equilibrium which sets in is $AgIO_{3(s)} \rightleftharpoons Ag^+_{(aq)} + IO^-_{3(aq)}$. If the solubility product constant K_{sp} of $AgIO_3$ at a given temperature is 1.0×10^{-8}, what is the mass of $AgIO_3$ contained in 100 ml of its saturated solution?
(a) 1.0×10^{-4} g (b) 28.3×10^{-2} g
(c) 2.83×10^{-3} g (d) 1.0×10^{-7} g

71. A radioactive element gets spilled over the floor of a room. Its half-life period is 30 days. If the initial velocity is ten times the permissible value, after how many days will it be safe to enter the room?
(a) 100 days (b) 1000 days
(c) 300 days (d) 10 days.

72. Which one of the following conformations of cyclohexane is chiral?
(a) Boat (b) Twist boat
(c) Rigid (d) Chair.

73. Which of the following is the correct order of decreasing S_N2 reactivity?
(a) $R_2CH\,X > R_3C\,X > RCH_2\,X$
(b) $RCH\,X > R_3C\,X > R_2CH\,X$
(c) $RCH_2\,X > R_2CH\,X > R_3C\,X$
(d) $R_3C\,X > R_2CH\,X > RCH_2\,X$.
(X is a halogen)

74. In the following sequence of reactions,

$$CH_3CH_2OH \xrightarrow{P+I_2} A \xrightarrow[\text{ether}]{Mg} B \xrightarrow{HCHO}$$

$$C \xrightarrow{H_2O} D$$

the compound D is
(a) propanal (b) butanal
(c) *n*-butyl alcohol (d) *n*-propyl alcohol.

75. Which of the following sets of quantum numbers represents the highest energy of an atom?
(a) n = 3, l = 0, m = 0, s = +1/2
(b) n = 3, l = 1, m = 1, s = +1/2
(c) n = 3, l = 2, m = 1, s = +1/2
(d) n = 4, l = 0, m = 0, s = +1/2.

76. Which of the following hydrogen bonds is the strongest?
(a) O – H - - - F (b) O – H - - - H
(c) F – H - - - F (d) O – H - - - O.

77. In the reaction,

$$2Al_{(s)} + 6HCl_{(aq)} \rightarrow 2Al^{3+}_{(aq)} + 6Cl^-_{(aq)} + 3H_{2(g)}$$

(a) 11.2 L $H_{2(g)}$ at STP is produced for every mole $HCl_{(aq)}$ consumed
(b) 6 L $HCl_{(aq)}$ is consumed for every 3 L $H_{2(g)}$ produced
(c) 33.6 L $H_{2(g)}$ is produced regardless of temperature and pressure for every mole Al that reacts
(d) 67.2 $H_{2(g)}$ at STP is produced for every mole Al that reacts.

78. Regular use of the following fertilizers increases the acidity of soil?
(a) Ammonium sulphate
(b) Potassium nitrate
(c) Urea
(d) Superphosphate of lime.

79. Identify the correct statement regarding a spontaneous process:
(a) Lowering of energy in the process is the only criterion for spontaneity.
(b) For a spontaneous process in an isolated system, the change in entropy is positive.
(c) Endothermic processes are never spontaneous.
(d) Exothermic processes are always spontaneous.

80. Which of the following nuclear reactions will generate an isotope?
(a) β - particle emission
(b) Neutron praticle emission
(c) Positron emission
(d) α – particle emission.

SECTION III - MATHEMATICS

81. The resultant of two forces Pn and 3n is a force of 7n. If the direction of 3n force were reversed, the resultant would be $\sqrt{19}$ n. The value of P is
(a) 3 n (b) 4 n
(c) 5 n (d) 6 n.

82. Two aeroplanes I and II bomb a target in succession. The probabilities of I and II scoring a hit correctly are 0.3 and 0.2, respectively. The second plane will bomb only if the first misses the target. The probability that the target is hit by the second plane is
(a) 0.2 (b) 0.7
(c) 0.06 (d) 0.14.

83. If $D=\begin{vmatrix}1 & 1 & 1\\ 1 & 1+x & 1\\ 1 & 1 & 1+y\end{vmatrix}$ for $x\neq 0, y\neq 0$, then D is
(a) divisible by x but not y
(b) divisible by y but not x
(c) divisible by neither x nor y
(d) divisible by both x and y

84. For the Hyperbola $\frac{x^2}{\cos^2\alpha}-\frac{y^2}{\sin^2\alpha}=1$, which of the following remains constant when α varies=?
(a) abscissae of vertices
(b) abscissae of foci
(c) eccentricity
(d) directrix.

85. If a line makes an angle of $\pi/4$ with the positive directions of each of x- axis and y- axis, then the angle that the line makes with the positive direction of the z-axis is
(a) $\frac{\pi}{4}$ (b) $\frac{\pi}{2}$ (c) $\frac{\pi}{6}$ (d) $\frac{\pi}{3}$

86. A value of c for which conclusion of Mean Value Theorem holds for the function $f(x)=\log_e x$ on the interval [1, 3] is
(a) $\log_3 e$ (b) $\log_e 3$
(c) $2\log_3 e$ (d) $\frac{1}{2}\log_3 e$

87. The function $f(x)=\tan^{-1}(\sin x+\cos x)$ is an increasing function in
(a) $\left(0,\frac{\pi}{2}\right)$ (b) $\left(-\frac{\pi}{2},\frac{\pi}{2}\right)$
(c) $\left(\frac{\pi}{4},\frac{\pi}{2}\right)$ (d) $\left(-\frac{\pi}{2},\frac{\pi}{4}\right)$

88. Let $A=\begin{vmatrix}5 & 5\alpha & \alpha\\ 0 & \alpha & 5\alpha\\ 0 & 0 & 5\end{vmatrix}$. If $|A^2|=25$, then $|\alpha|$ equals
(a) 1/5 (b) 5 (c) 5^2 (d) 1

89. The sum of series $\frac{1}{2!}-\frac{1}{3!}+\frac{1}{4!}-\ldots\ldots$ upto infinity is
(a) $e^{-\frac{1}{2}}$ (b) $e^{+\frac{1}{2}}$ (c) e^{-2} (d) e^{-1}

90. If $\hat{u}$ and $\hat{v}$ are unit vectors and θ is the acute angle between them, then $2\hat{u}\times 3\hat{v}$ is a unit vector for
(a) no value of θ
(b) exactly one value of θ
(c) exactly two values of θ
(d) more than two values of θ

91. A particle just clears a wall of height b at a distance a and strikes the ground at a distance c from the point of projection. The angle of projection is
(a) $\tan^{-1}\frac{bc}{a(c-a)}$ (b) $\tan^{-1}\frac{bc}{a}$
(c) $\tan^{-1}\frac{b}{ac}$ (d) 45°.

92. The average marks of boys in class is 52 and that of girls is 42. The average marks of boys and girls combined is 50. The percentage of boys in the class is
(a) 80 (b) 60
(c) 40 (d) 20.

93. The equation of a tangent to the parabola $y^2=8x$ is $y=x+2$. The point on this line from which the other tangent to the parabola is perpendicular to the given tangent is
(a) (2, 4) (b) (–2, 0)
(c) (–1, 1) (d) (0, 2)

94. If (2, 3, 5) is one end of a diameter of the sphere $x^2+y^2+z^2-6x-12y-2z+20=0$, then the cooordinates of the other end of the diameter are
(a) (4, 3, 5) (b) (4, 3, –3)
(c) (4, 9, –3) (d) (4, –3, 3).

95. Let $\vec{a}=\hat{i}+\hat{j}+\hat{k}, \vec{b}=\hat{i}-\hat{j}+2\hat{k}$ and $\vec{c}=x\hat{i}+(x-2)\hat{j}-\hat{k}$. If the vectors $\vec{c}$ lies in the plane of $\vec{a}$ and $\vec{b}$, then x equals
(a) –4 (b) –2
(c) 0 (d) 1.

96. Let A (h, k), B(1, 1) and C (2, 1) be the vertices of a right angled triangle with AC as its hypotenuse. If the area of the triangle is 1 square unit, then the set of values which 'k' can take is given by
(a) {–1, 3} (b) {–3, –2}
(c) {1, 3} (d) {0, 2}

97. Let P = (–1, 0), Q = (0, 0) and R = $(3, 3\sqrt{3})$ be three point. The equation of the bisector of the angle PQR is

(a) $\frac{\sqrt{3}}{2}x + y = 0$ (b) $x + \sqrt{3}y = 0$

(c) $\sqrt{3}x + y = 0$ (d) $x + \frac{\sqrt{3}}{2}y = 0$.

98. If one of the lines of $my^2 + (1-m^2)xy - mx^2 = 0$ is a bisector of the angle between the lines xy = 0, then m is

(a) 1 (b) 2
(c) –1/2 (d) –2.

99. Let $F(x) = f(x) + f\left(\frac{1}{x}\right)$, where $f(x) = \int_1^x \frac{\log t}{1+t}dt$, Then F(e) equals

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

100. Let $f : R \to R$ be a function defined by $f(x) = \min\{x+1, |x|+1\}$, Then which of the following is true?

(a) f (x) is differentiable everywhere
(b) f (x) is not differentiable at x = 0
(c) f (x) ≥ 1 for all $x \in R$
(d) f (x) is not differentiable at x = 1

101. The function $f : R/\{0\} \to R$ given by $f(x) = \frac{1}{x} - \frac{2}{e^{2x}-1}$ can be made continuous at x = 0 by defining f (0) as

(a) 0 (b) 1
(c) 2 (d) –1

102. The solution for x of the equation $\int_{\sqrt{2}}^{x} \frac{dt}{t\sqrt{t^2-1}} = \frac{\pi}{2}$ is

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

(c) 2 (d) π.

103. $\int \frac{dx}{\cos x + \sqrt{3}\sin x}$ equals

(a) $\log\tan\left(\frac{x}{2} + \frac{\pi}{12}\right) + C$

(b) $\log\tan\left(\frac{x}{2} - \frac{\pi}{12}\right) + C$

(c) $\frac{1}{2}\log\tan\left(\frac{x}{2} + \frac{\pi}{12}\right) + C$

(d) $\frac{1}{2}\log\tan\left(\frac{x}{2} - \frac{\pi}{12}\right) + C$

104. The area enclosed between the curves $y^2 = x$ and $y = |x|$ is

(a) 1/6 (b) 1/3
(c) 2/3 (d) 1.

105. If the difference between the roots of the equation $x^2 + ax + 1 = 0$ is less than $\sqrt{5}$, then the set of possible values of a is

(a) $(3, \infty)$ (b) $(-\infty, -3)$

(c) $(-3, 3)$ (d) $(-3, \infty)$.

106. In a geometric progression consisting of positive terms, each term equals the sum of the next two terms. Then the common ratio of its progression is equals

(a) $\sqrt{5}$ (b) $\frac{1}{2}\left(\sqrt{5}-1\right)$

(c) $\frac{1}{2}\left(1-\sqrt{5}\right)$ (d) $\frac{1}{2}\sqrt{5}$.

107. If $\sin^{-1}\left(\frac{x}{5}\right) + \text{cosec}^{-1}\left(\frac{5}{4}\right) = \frac{\pi}{2}$, then the values of x is

(a) 4 (b) 5
(c) 1 (d) 3.

108. In the binomial expansion of $(a-b)^n$, $n \geq 5$, the sum of 5th and 6th terms is zero, then a/b equals

(a) $\frac{n-5}{6}$ (b) $\frac{n-4}{6}$

(c) $\frac{5}{n-4}$ (d) $\frac{6}{n-5}$.

109. The set S : = {1, 2, 3, ..., 12} is to be partitioned into three sets A, B, C of equal size. Thus $A \cup B \cup C = S$, $A \cap B = B \cap C = A \cap C = \phi$. The number of ways to partition S is

(a) $\frac{12!}{(4!)^3}$ (b) $\frac{12!}{(4!)^4}$

(c) $\frac{12!}{3!(4!)^3}$ (d) $\frac{12!}{3!(4!)^4}$

110. The largest interval lying in $\left(\frac{-\pi}{2}, \frac{\pi}{2}\right)$ for which the function, $f(x) = 4^{-x^2} + \cos^{-1}\left(\frac{x}{2} - 1\right) + \log(\cos x)$, is defined, is

(a) $\left[-\frac{\pi}{4}, \frac{\pi}{2}\right)$ (b) $\left[0, \frac{\pi}{2}\right)$

(c) $[0, \pi]$ (d) $\left(-\frac{\pi}{2}, \frac{\pi}{2}\right)$

111. A body weighing 13 kg is suspended by two strings 5m and 12m long, their other ends being fastened to the extremities of a rod 13m long. If the rod be so held that the body hangs immediately below the middle point, then tensions in the strings are

(a) 5 kg and 12 kg (b) 5 kg and 13 kg
(c) 12 kg and 13 kg (d) 5 kg and 5 kg

112. A pair of fair dice is thrown independently three times. The probability of getting a score of exactly 9 twice is

(a) 8/729 (b) 8/243
(c) 1/729 (d) 8/9.

113. Consider a family of circles which are passing through the point (– 1, 1) and are tangent to x-axis. If (h, k) are the coordinate of the centre of the circles, then the set of values of k is given by the interval

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

(c) $0 \le k \le \frac{1}{2}$ (d) $k \ge \frac{1}{2}$

114. Let L be the line of intersection of the planes $2x + 3y + z = 1$ and $x + 3y + 2z = 2$. If L makes an angle α with the positive x-axis, then $\cos \alpha$ equals

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

115. The differential equation of all circles passing through the origin and having their centres on the x-axis is

(a) $y^2 = x^2 + 2xy\frac{dy}{dx}$

(b) $y^2 = x^2 - 2xy\frac{dy}{dx}$

(c) $x^2 = y^2 + xy\frac{dy}{dx}$

(d) $x^2 = y^2 + 3xy\frac{dy}{dx}$.

116. If p and q are positive real numbers such that $p^2 + q^2 = 1$, then the maximum value of $(p + q)$ is

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

117. A tower stands at the centre of a circular park. A and B are two points on the boundary of the park such that AB (= a) subtends an angle of 60° at the foot of the tower, and the angle of elevation of the top of the tower from A or B is 30°. The height of the tower is

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

118. The sum of the series

$^{20}C_0 - {}^{20}C_1 + {}^{20}C_2 - {}^{20}C_3 + ...$

$- .....+ {}^{20}C_{10}$ is

(a) 0 (b) $^{20}C_{10}$

(c) $-{}^{20}C_{10}$ (d) $\frac{1}{2}{}^{20}C_{10}$

119. The normal to a curve at P(x, y) meets the x-axis at G. If the distance of G from the origin is twice the abscissa of P, then the curve is a

(a) circle (b) hyperbola
(c) ellipse (d) parabola.

120. If $|z + 4| \le 3$, then the maximum value of $|z + 1|$ is

(a) 6 (b) 0 (c) 4 (d) 10