PART A - PHYSICS

1. As an electron makes a transition from an excited state to the ground state of a hydrogen - like atom/ion:

(a) kinetic energy, potential energy and total energy decrease

(b) kinetic energy decreases, potential energy increases but total energy remains same

(c) kinetic energy and total energy decrease but potential energy increases

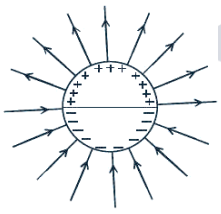
(d) its kinetic energy increases but potential energy and total energy decrease

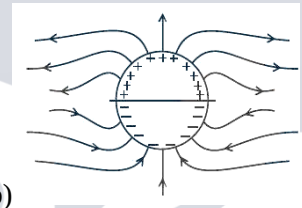
2. The period of oscillation of a simple pendulum is $T = 2\pi\sqrt{\frac{L}{g}}$. Measured value of L is 20.0 cm known to 1 mm accuracy and time for 100 oscillations of the pendulum is found to be 90 s using wrist watch of 1 s resolution. The accuracy in the determination of g is:

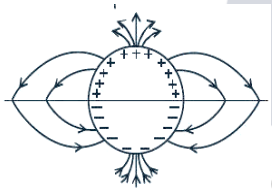
(a) 3% (b) 1%

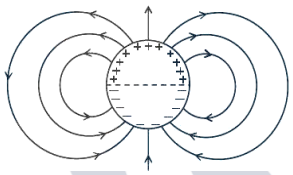
(c) 5% (d) 2%

3. A long cylindrical shell carries positive surface charge σ in the upper half and negative surface charge $-\sigma$ in the lower half. The electric field lines around the cylinder will look like figure given in: (figures are schematic and not drawn to scale)

(a) 

(b) 

(c) 

(d) 

4. A signal of 5kHz frequency is amplitude modulated on a carrier wave of frequency 2MHz. The frequencies of the resultant signal is/are:

(a) 2005kHz, and 1995kHz

(b) 2005kHz, 2000kHz and 1995kHz

(c) 2000kHz and 1995kHz

(d) 2 MHz only

5. Consider a spherical shell of radius R at temperature T. The black body radiation inside it can be considered as an ideal gas of photons with internal energy per unit volume $u = \frac{U}{V} \propto T^4$ and pressure $p = \frac{1}{3}\left(\frac{U}{V}\right)$. If the shell now undergoes an adiabatic expansion the relation between T and R is:

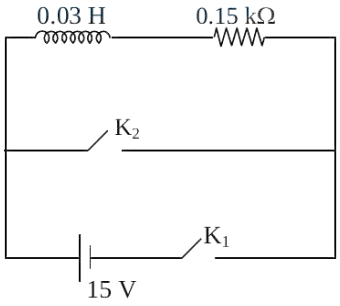
(a) $T \propto e^{-3R}$ (b) $T \propto \frac{1}{R}$

(c) $T \propto \frac{1}{R^3}$ (d) $T \propto e^{-R}$

6. An inductor ($L = 0.03H$) and a resistor ($R = 0.15k\Omega$) are connected in series to a battery of 15 V EMF in a circuit shown. The key K_1 has been kept closed for a long time. Then at $t = 0$, K_1 is opened and key K_2 is closed simultaneously. At $t = 1$ ms, the current in the circuit will be: ($e^5 \cong 150$)

(a) 67 mA (b) 6.7 mA

(c) 0.67 mA (d) 100 mA



7. A pendulum made of a uniform wire of cross-sectional area A has time period T. When an additional mass M is added to its bob, the time period changes to T_M. If the Young's modulus of the material of the wire is Y then $\frac{1}{Y}$ is equal to: (g = gravitational acceleration)

(a) $\left[\left(\frac{T_M}{T}\right)^2 - 1\right]\frac{Mg}{A}$ (b) $\left[1 - \left(\frac{T_M}{T}\right)^2\right]\frac{A}{Mg}$

(c) $\left[1 - \left(\frac{T}{T_M}\right)^2\right]\frac{A}{Mg}$ (d) $\left[\left(\frac{T_M}{T}\right)^2 - 1\right]\frac{A}{Mg}$

8. A red LED emits light at 0.1 watt uniformly around it. The amplitude of the electric field of the light at a distance of 1 m from the diode is:

(a) 2.45 V/m (b) 5.48 V/m

(c) 7.75 V/m (d) 1.73 V/m

9. Two coaxial solenoids of different radii carry current I in the same direction. Let $\vec{F}_1$ be the magnetic force on the inner solenoid due to the outer one and $\vec{F}_2$ be the magnetic force on the outer solenoid due to the inner one. Then:

(a) $\vec{F}_1$ is radially inwards and $\vec{F}_2$ is radially outwards

(b) $\vec{F}_1$ is radially inwards and $\vec{F}_2 = 0$

(c) $\vec{F}_1$ is radially outwards and $\vec{F}_2 = 0$

(d) $\vec{F}_1 = \vec{F}_2 = 0$

10. Consider an ideal gas confined in an isolated closed chamber. As the gas undergoes an adiabatic expansion the average time of collision between molecules increases as V^q, where V is the volume of the gas. The value of q is: $\left(\gamma = \frac{C_p}{C_v}\right)$

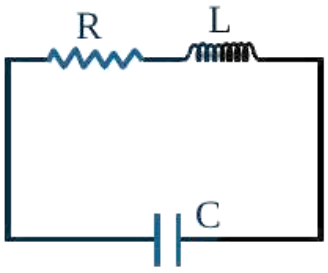
(a) $\frac{3\gamma-5}{6}$ (b) $\frac{\gamma+1}{2}$

(c) $\frac{\gamma-1}{2}$ (b) $\frac{3\gamma+5}{6}$

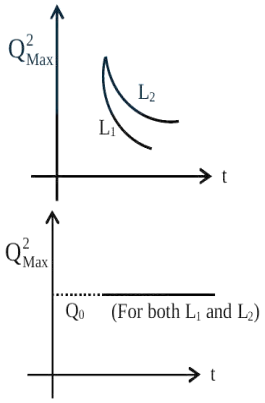
11. An LCR circuit is equivalent to a damped pendulum. In an LCR circuit the capacitor is charged to Q_0 and then connected to the L and R as shown.

If a student plots graphs of the square of maximum charge (Q_{Max}^2) on the capacitor with time (t) for two different values L_1 and $L_2(L_1 > L_2)$ of L then which of the following represents this graph correctly? (Plots are schematic and not drawn to scale)

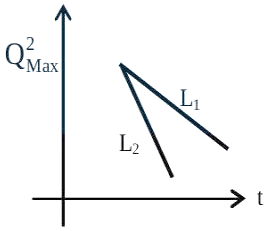
(a)



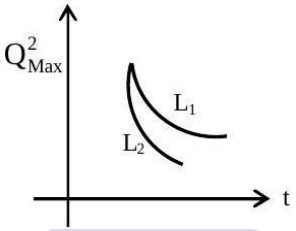
(b)



(c)



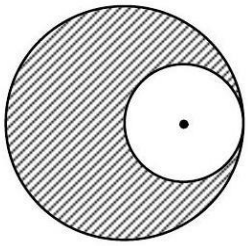
(d)



12. From a solid sphere of mass M and radius R, a spherical portion of radius R/2 is removed, as shown in the figure. Taking gravitational potential $V = 0$ at $r = \infty$, the potential at the centre of the cavity thus formed is (G = gravitational constant)

(a) $-\frac{GM}{R}$ (b) $-\frac{2GM}{3R}$

(c) $-\frac{2GM}{R}$ (d) $\frac{-GM}{2R}$



13. A train is moving on a straight track with speed $20\ ms^{-1}$. It is blowing its whistle at the frequency of 1000 Hz. The percentage change in the frequency heard by a person standing near the track as the train passes him is (speed of sound $= 320\ ms^{-1}$) close to :

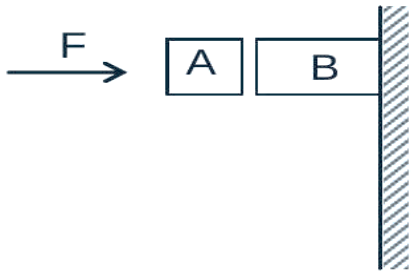
(a) 12% (b) 18%

(c) 24% (d) 6%

14. Given in the figure are two blocks A and B of weight 20 N and 100 N respectively. These are being pressed against a wall by a force F as shown. If the coefficient of friction between the blocks is 0.1 and between block B and the wall is 0.15 , the frictional force applied by the wall on block B is

(a) 80 N (b) 120 N

(c) 150 N (d) 100 N

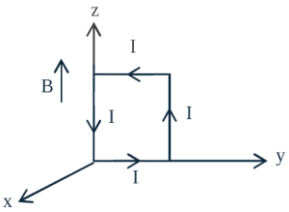


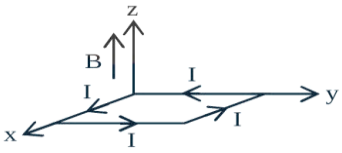
15. Distance of the center of mass of a solid uniform cone from its vertex is z_0. If the radius of its base is R and its height is h then z_0 is equal to:

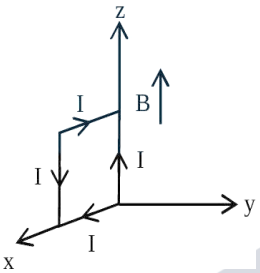
(a) $\frac{3h}{4}$ (b) $\frac{5h}{8}$

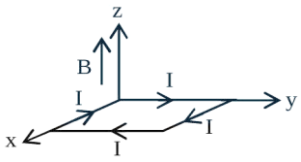
(c) $\frac{3h^2}{8R}$ (d) $\frac{h^2}{4R}$

16. A rectangular loop of sides 10 cm and 5 cm carrying a current I of 12 A is placed in different orientations as shown in the figures below:

(a) 

(b) 

(c) 

(d) 

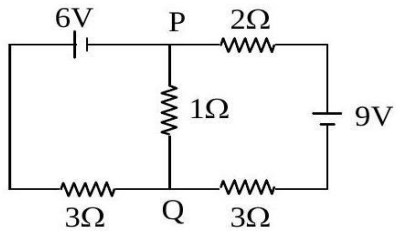
If there is a uniform magnetic field of 0.3 T in the positive z direction , in which orientations the loop would be in (i) stable equilibrium and (ii) unstable equilibrium?

(a) (a) and (c), respectively
(b) (b) and (d), respectively
(c) (b) and (c), respectively
(d) (a) and (b), respectively

17. In the circuit shown, the current in the 1Ω resistor is:

(a) 0 A (b) 0.13 A, from Q to P

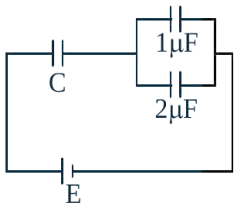
(c) 0.13 A, from P to Q (d) 1.3 A, from P to Q

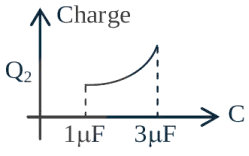


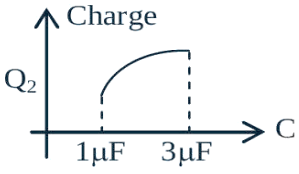
18. A uniformly charged solid sphere of radius R has potential V_0 (measured with respect to ∞) on its surface. For this sphere the equipotential surfaces with potentials $\frac{3V_0}{2}, \frac{5V_0}{4}, \frac{3V_0}{4}$ and $\frac{V_0}{4}$ have radius R_1, R_2, R_3 and R_4 respectively. Then

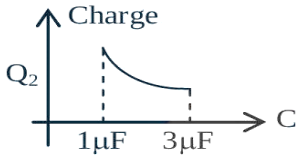
(a) $R_1 \neq 0$ and $(R_2 - R_1) > (R_4 - R_3)$
(b) $R_1 = 0$ and $R_2 < (R_4 - R_3)$
(c) $2R < R_4$
(d) $R_1 = 0$ and $R_2 > (R_4 - R_3)$

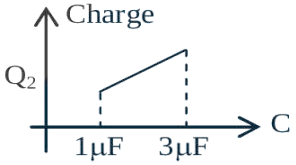
19. In the given circuit, charge Q_2 on the $2\mu F$ capacitor changes as C is varied from $1\mu F$ to $3\mu F$. Q_2 as a function of ' C ' is given properly by : (figures are drawn schematically and are not to scal



(a) 

(b) 

(c) 

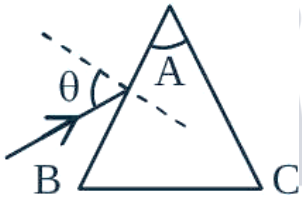
(d) 

20. A particle of mass m moving in the x direction with speed 2v is hit by another particle of mass 2 m moving in the y direction with speed v. If the collision is perfectly inelastic, the percentage loss in the energy during the collision is close to

(a) 50% (b) 56%

(c) 62% (d) 44%

21. Monochromatic light is incident on a glass prism of angle A. If the refractive index of the material of the prism is μ, a ray, incident at an angle θ, on the face AB would get transmitted through the face AC of the prism provided:



(a) $\theta < \sin^{-1}\left[\mu\sin\left(\mathrm{A} - \sin^{-1}\left(\frac{1}{\mu}\right)\right)\right]$

(c) $\theta < \cos^{-1}\left[\mu\sin\left(A + \sin^{-1}\left(\frac{1}{\mu}\right)\right)\right]$

(b) $\theta > \cos^{-1}\left[\mu\sin\left(A + \sin^{-1}\left(\frac{1}{\mu}\right)\right)\right]$

(d) $\theta > \sin^{-1}\left[\mu\sin\left(\mathrm{A} - \sin^{-1}\left(\frac{1}{\mu}\right)\right)\right]$

22. From a solid sphere of mass M and radius R a cube of maximum possible volume is cut. Moment of inertia of cube about an axis passing through its center and perpendicular to one of its faces is :

(a) $\frac{\mathrm{MR}^2}{16\sqrt{2}\pi}$ (b) $\frac{4\mathrm{MR}^2}{9\sqrt{3}\pi}$

(c) $\frac{4\mathrm{MR}^2}{3\sqrt{3}\pi}$ (d) $\frac{\mathrm{MR}^2}{32\sqrt{2}\pi}$

23. Match List - I (Fundamental Experiment) with List - II (its conclusion) and select the correct option from the choices given below the list:

List – I		List – II	
(A)	Franck-Hertz Experiment	(i)	Particle nature of light
(B)	Photo-electric experiment	(ii)	Discrete energy levels of atom
(C)	Davison – Germer Experiment	(iii)	Wave nature of electron
		(iv)	Structure of atom

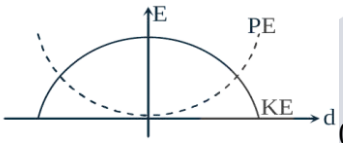
(1) (A) – (ii) (B) – (iv) (C) – (iii)
(2) (A) – (ii) (B) – (i) (C) – (iii)
(3) (A) – (iv) (B) – (iii) (C) – (ii)
(4) (A) – (i) (B) – (iv) (C) – (iii)

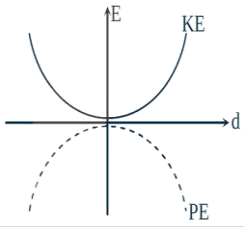
24. When 5 V potential difference is applied across a wire of length 0.1 m, the drift speed of electrons is 2.5×10^{-4} ms^{-1}. If the electron density in the wire is 8×10^{28} m^{-3}, the resistivity of the material is close to:

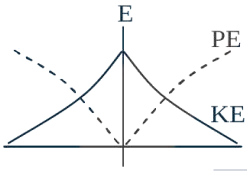
(a) $1.6 \times 10^{-7}\Omega m$ (b) $1.6 \times 10^{-6}\Omega m$
(c) $1.6 \times 10^{-5}\Omega m$ (d) $1.6 \times 10^{-8}\Omega m$

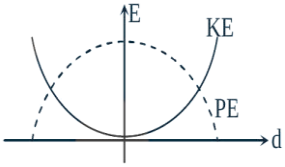
25. For a simple pendulum, a graph is plotted between its kinetic energy (KE) and potential energy (PE) against its displacement d. Which one of the following represents these correctly?

(Graphs are schematic and not drawn to scale)

(a)


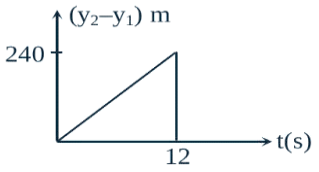
(b)


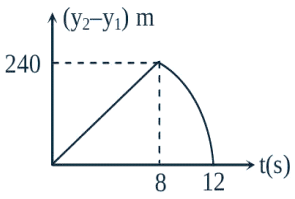
(c)


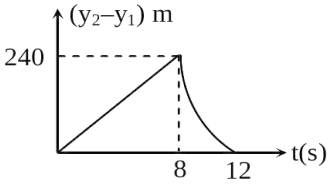
(d)


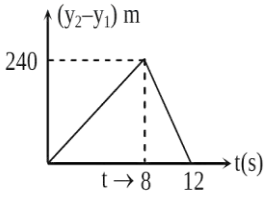
26. Two stones are thrown up simultaneously from the edge of a cliff 240 m high with initial speed of 10 m/s and 40 m/s respectively. Which of the following graph best represents the time variation of relative position of the second stone with respect to the first ?

(Assume stones do not rebound after hitting the ground and neglect air resistance, take $g = 10\ m/s^2$ (The figures are schematic and not drawn to scale)

(a)


(b)


(c)


(d)


27. A solid body of constant heat capacity 1 J/°C is being heated by keeping it in contact with reservoirs in two ways:

(i) Sequentially keeping in contact with 2 reservoirs such that each reservoir supplies same amount of heat.

(ii) Sequentially keeping in contact with 8 reservoirs such that each reservoir supplies same amount of heat. In both the cases body is brought from initial temperature $100^{\circ}C$ to final temperature $200^{\circ}C$. Entropy change of the body in the two cases respectively is:

(a) $\ln 2, \ln 2$ (b) $\ln 2, 2\ln 2$
(c) $2\ln 2, 8\ln 2$ (d) $\ln 2, 4\ln 2$

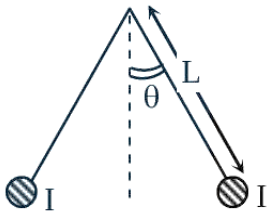
28. Assuming human pupil to have a radius of 0.25 cm and a comfortable viewing distance of 25 cm, the minimum separation between two objects that human eye can resolve at 500 nm wavelength is:

(a) 30μm (b) 100μm
(c) 300μm (d) 1μm

29. Two long current carrying thin wires, both with current I, are held by insulating threads of length L and are in equilibrium as shown in the figure, with threads making an angle ' θ ' with the vertical. If wires have mass λ per unit length then the value of I is: (g = gravitational acceleration)

(a) $2\sin\theta\sqrt{\frac{\pi\lambda \mathrm{gL}}{\mu_0\cos\theta}}$ (b) $2\sqrt{\frac{\pi gL}{\mu_0}\tan\theta}$

(c) $\sqrt{\frac{\pi\lambda gL}{\mu_0}\tan\theta}$ (d) $\sin\theta\sqrt{\frac{\pi\lambda gL}{\mu_0\cos\theta}}$



30. On a hot summer night, the refractive index of air is smallest near the ground and increases with height from the ground. When a light beam is directed horizontally, the Huygens' principle leads us to conclude that as it travels, the light beam:

(a) goes horizontally without any deflection
(b) bends downwards
(c) bends upwards
(d) becomes narrower

PART B - CHEMISTRY

31. Which of the following is the energy of a possible excited state of hydrogen?

(a) -6.8eV (b) -3.4eV
(c) $+6.8$eV (d) $+13.6$eV

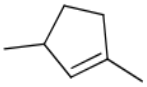
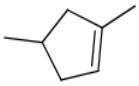
32. In the following sequence of reactions:

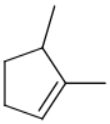
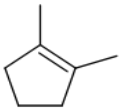
$$\text{Toluene} \xrightarrow{KMnO_4} A \xrightarrow{SOCl_2} B \xrightarrow[BaSO_4]{H_2/d} C,$$

The product C is:

(a) $C_6H_5CH_3$ (b) $C_6H_5CH_2OH$
(c) C_6H_5CHO (d) C_6H_5COOH

33. Which compound would give 5-keto-2-methyl hexanal upon ozonolysis?

(a)  (b) 

(c)  (d) 

34. The ionic radii (in Å) of N^{3-}, O^{2-} and $F^{-}$are respectively:

(a) 1.36,1.71 and 1.40
(b) 1.71,1.40 and 1.36
(c) 1.71,1.36 and 1.40
(d) 1.36,1.40 and 1.71

35. The color of $KMnO_4$ is due to:

(a) $d-d$ transition
(b) L → M charge transfer transition
(c) $\sigma-\sigma^*$ transition
(d) M → L charge transfer transition

36. Assertion: Nitrogen and Oxygen are the main components in the atmosphere but these do not react to form oxides of nitrogen.

Reason: The reaction between nitrogen and oxygen requires high temperature.

(a) Both assertion and reason are correct, but the reason is not the correct explanation for the assertion

(b) The assertion is incorrect, but the reason is correct

(c) Both the assertion and reason are incorrect

(d) Both assertion and reason are correct, and the reason is the correct explanation for the assertion

37. Which of the following compounds is not an antacid?

(a) Cimetidine
(b) Phenelzine
(c) Ranitidine
(d) Aluminium hydroxide

38. In the context of the Hall-Heroult process for the extraction of Al, which of the following statements is false?

(a) Al_2O_3 is mixed with CaF_2 which lowers the melting point of the mixture and brings conductivity

(b) Al^{3+} is reduced at the cathode to form Al

(c) Na_3AlF_6 serves as the electrolyte

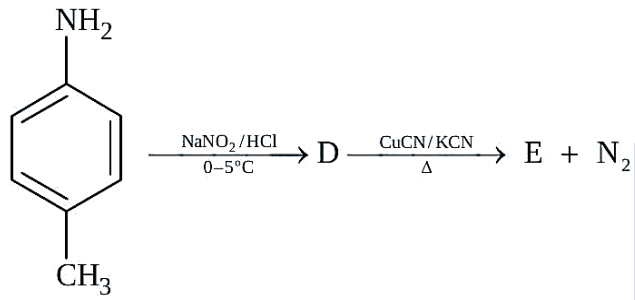
(d) CO and CO_2 are produced in this process

39. Match the catalysts to the correct processes:

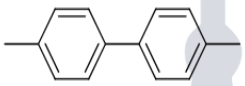
Catalyst	Process
A. $TiCl_3$	i. Wacker process
B. $PdCl_2$	ii. Ziegler - Natta polymerization
C. $CuCl_2$	iii. Contact process
D. V_2O_5	iv. Deacon's process

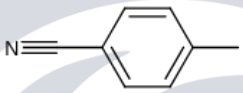
(a) (A) - (ii), (B) - (i), (C) - (iv), (D) - (iii)
(b) (A) - (ii), (B) - (iii), (C) - (iv), (D) - (i)
(c) (A) - (iii), (B) - (i), (C) - (ii), (D) - (iv)
(d) (A) - (iii), (B) - (ii), (C) - (iv), (D) - (i)

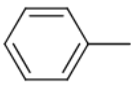
40. In the reaction:



the product E is

(a) 

(b) 

(c) 

(d) 

41. Which polymer is used in the manufacture of paints and lacquers?
(a) Glyptal (b) Polypropene
(c) Poly vinyl chloride (d) Bakelite

42. The number of geometric isomers that can exist for square planar $[Pt(Cl)(py)(NH_3)(NH_2OH)]^+$ is (py = pyridine):
(a) 3 (b) 4
(c) 6 (d) 2

43. Higher order (>3) reactions are rare due to:

(a) increase in entropy and activation energy as more molecules are involved

(b) shifting of equilibrium towards reactants due to elastic collisions

(c) loss of active species on collision

(d) low probability of simultaneous collision of all the reacting species

44. Which among the following is the most reactive?
(a) Br_2 (b) I_2
(c) ICl (d) Cl_2

45. Two Faraday of electricity is passed through a solution of $CuSO_4$. The mass of copper deposited at the cathode is: (at. mass of $Cu = 63.5 amu$)
(a) 63.5 g (b) 2 g
(c) 127 g (d) 0 g

46. 3 g of activated charcoal was added to 50 mL of acetic acid solution (0.06 N) in a flask. After an hour it was filtered and the strength of the filtrate was found to be 0.042 N. The amount of acetic acid adsorbed (per gram of charcoal) is:
(a) 36mg (b) 42mg
(c) 54mg (d) 18mg

47. The synthesis of alkyl fluorides is best accomplished by:
(a) Sandmeyer's reaction
(b) Finkelstein reaction
(c) Swarts reaction
(d) Free radical fluorination

48. The molecular formula of a commercial resin used for exchanging ions in water softening is $C_8H_7SO_3Na$(Mol. Wt. 206). What would be the maximum uptake of Ca^{2+} ions by the resin when expressed in mole per gram resin?
(a) $\frac{1}{206}$ (b) $\frac{2}{309}$
(c) $\frac{1}{412}$ (d) $\frac{1}{103}$

49. Which of the vitamins given below is water soluble?
(a) Vitamin D (b) Vitamin E
(c) Vitamin K (d) Vitamin C

50. The intermolecular interaction that is dependent on the inverse cube of distance between the molecule is:
(a) ion-dipole interaction (b) London force
(c) hydrogen bond (d) ion-ion interaction

51. The following reaction is performed at 298 K.

$$2NO(g) + O_2(g) \rightleftharpoons 2NO_2(g)$$

The standard free energy of formation of NO(g) is 86.6 kJ/mol at 298 K. What is the standard free energy of formation of $NO_2(g)$ at 298 K ? $(K_P = 1.6 \times 10^{12})$
(a) $86600 + R(298)\ln(1.6 \times 10^{12})$
(b) $86600 - \frac{\ln(1.6\times10^{12})}{R(298)}$
(c) $0.5[2 \times 86{,}600 - R(298)\ln(1.6 \times 10^{12})]$
(d) $R(298)\ln(1.6 \times 10^{12}) - 86600$

52. Which of the following compounds is not colored yellow?
(a) $K_3[Co(NO_2)_6]$
(b) $(NH_4)_3[As(Mo_3O_{10})_4]$
(c) $BaCrO_4$
(d) $Zn_2[Fe(CN)_6]$

53. In Carius method of estimation of halogens, 250mg of an organic compound gave 141mg of AgBr. The percentage of bromine in the compound is: (at. Mass $Ag = 108$; $Br = 80$)
(a) 36 (b) 48
(c) 60 (d) 24

54. Sodium metal crystallizes in a body centred cubic lattice with a unit cell edge of 4.29Å. The radius of sodium atom is approximately:

(a) 3.22Å (b) 5.72Å
(c) 0.93Å (d) 1.86Å

55. Which of the following compounds will exhibit geometrical isomerism?
(a) 3-Phenyl-1-butene
(b) 2-Phenyl-1-butene
(c) 1,1-Diphenyl-1-propane
(d) 1-Phenyl-2-butene

56. The vapour pressure of acetone at $20^{\circ}C$ is 185 torr. When 1.2 g of a non-volatile substance was dissolved in 100 g of acetone at $20^{\circ}C$, its vapour pressure was 183 torr. The molar mass $(gmol^{-1})$ of the substance is:
(a) 64 (b) 128
(c) 488 (d) 32

57. From the following statements regarding H_2O_2, choose the incorrect statement:

(a) It decomposes on exposure to light

(b) It has to be stored in plastic or wax lined glass bottles in dark

(c) It has to be kept away from dust

(d) It can act only as an oxidizing agent

58. Which one of the following alkaline earth metal sulphates has its hydration enthalpy greater than its lattice enthalpy?
(a) $BeSO_4$ (b) $BaSO_4$
(c) $SrSO_4$ (d) $CaSO_4$

59. The standard Gibbs energy change at 300 K for the reaction $2A \rightleftharpoons B + C$ is 2494.2 J. At a given time, the composition of the reaction mixture is $[A] = \frac{1}{2}$, $[B] = 2$ and $[C] = \frac{1}{2}$. The reaction proceeds in the:

$[R = 8.314\ J/K/mol, e = 2.718]$

(a) reverse direction because $Q > K_c$

(b) forward direction because $Q < K_c$

(c) reverse direction because $Q < K_c$

(d) forward direction because $Q > K_c$

60. Which one has the highest boiling point?
(a) Ne (b) Kr
(c) Xe (d) He

PART C - MATHEMATICS

61. The sum of coefficients of integral powers of x in the binomial expansion of $(1 - 2\sqrt{x})^{50}$ is :
(a) $\frac{1}{2}(3^{50})$ (b) $\frac{1}{2}(3^{50} - 1)$
(c) $\frac{1}{2}(2^{50} + 1)$ (d) $\frac{1}{2}(3^{50} + 1)$

62. Let $f(x)$ be a polynomial of degree four having extreme values at $x = 1$ and $x = 2$. If $\lim_{x\to 0}\left[1 + \frac{f(x)}{x^2}\right] = 3$, then $f(b)$ is equal to:
(a) -4 (b) 0
(c) 4 (d) -8

63. The mean of the data set comprising of 16 observations is 16. If one of the observation valued 16 is deleted and three new observations valued 3, 4 and 5 are added to the data, then the mean of the resultant data, is:

(a) 16.0 (b) 15.8

(c) 14.0 (d) 16.8

64. The sum of first 9 terms of the series $\frac{1^3}{1}+\frac{1^3+2^3}{1+3}+\frac{1^3+2^3+3^3}{1+3+5}+\cdots$ .... is :

(a) 96 (b) 142

(c) 192 (d) 71

65. Let O be the vertex and Q be any point on the parabola, $x^2 = 8y$. If the point P divides the line segment OQ internally in the ratio $1:3$, then the locus of P is :

(a) $y^2 = x$ (b) $y^2 = 2x$

(c) $x^2 = 2y$ (d) $x^2 = y$

66. Let α and β be the roots of equation $x^2 - 6x - 2 = 0$. If $a_n = \alpha^n - \beta^n$, for $n \geq 1$, then the value of $\frac{a_{10}-2a_8}{2a_9}$ is equal to :

(a) -6 (b) 3

(c) -3 (d) 6

67. If 12 identical balls are to be placed in 3 identical boxes, then the probability that one of the boxes contains exactly 3 balls is :

(a) $55\left(\frac{2}{3}\right)^{10}$ (b) $220\left(\frac{1}{3}\right)^{12}$

(c) $22\left(\frac{1}{3}\right)^{11}$ (d) $\frac{55}{3}\left(\frac{2}{3}\right)^{11}$

68. A complex number z is said to be unimodular if $|z| = 1$. Suppose z_1 and z_2 are complex numbers such that $\frac{z_1-2z_2}{2-z_1\bar{z}_2}$ is unimodular and z_2 is not unimodular. Then the point z_1 lies on a :

(a) straight line parallel to y-axis.

(b) circle of radius 2.

(c) circle of radius $\sqrt{2}$.

(d) straight line parallel to x-axis.

69. The integral $\int \frac{dx}{x^2(x^4+1)^{3/4}}$ equals :

(a) $(x^4+1)^{1/4}+c$ (b) $-(x^4+1)^{1/4}+c$

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

70. The number of points, having both co-ordinates as integers, that lie in the interior of the triangle with vertices $(0,0)$, $(0,41)$ and $(41,0)$, is:

(a) 861 (b) 820

(c) 780 (d) 901

71. The distance of the point $(1,0,2)$ from the point of intersection of the line $\frac{x-2}{3}=\frac{y+1}{4}=\frac{z-2}{12}$ and the plane $x - y + z = 16$, is :

(a) 8 (b) $3\sqrt{21}$

(c) 13 (d) $2\sqrt{14}$

72. The equation of the plane containing the line $2x - 5y + z = 3; x + y + 4z = 5$, and parallel to the plane, $x + 3y + 6z = 1$, is :

(a) $x + 3y + 6z = -7$

(b) $x + 3y + 6z = 7$

(c) $2x + 6y + 12z = -13$

(d) $2x + 6y + 12z = 13$

73. The area (in sq. units) of the region described by $\{(x,y): y^2 \leq 2x \text{ and } y \geq 4x - 1\}$ is :

(a) $\frac{5}{64}$ (b) $\frac{15}{64}$

(c) $\frac{9}{32}$ (d) $\frac{7}{32}$

74. If m is the A.M. of two distinct real numbers ℓ and $n(\ell, n > 1)$ and G_1, G_2 and G_3 are three geometric means between ℓ and n, then $G_1^4 + 2G_2^4 + G_3^4$ equals :

(a) $4\ell m^2 n$ (b) $4\ell mn^2$

(c) $4\ell^2 m^2 n^2$ (d) $4\ell^2 mn$

75. Locus of the image of the point $(2, 3)$ in the line $(2x - 3y + 4) + k(x - 2y + 3) = 0, k \in R$, is a :

(a) straight line parallel to y-axis.

(b) circle of radius $\sqrt{2}$.

(c) circle of radius $\sqrt{3}$.

(d) straight line parallel to x-axis.

76. The area (in sq. units) of the quadrilateral formed by the tangents at the end points of the latera recta to the ellipse $\frac{x^2}{9} + \frac{y^2}{5} = 1$, is :

(a) 18 (b) $\frac{27}{2}$

(c) 27 (d) $\frac{27}{4}$

77. The number of integers greater than 6,000 that can be formed, using the digits 3, 5, 6, 7 and 8, without repetition, is :

(a) 192 (b) 120

(c) 72 (d) 216

78. Let A and B be two sets containing four and two elements respectively. Then the number of subsets of the set A × B, each having at least three elements is :

(a) 256 (b) 275

(c) 510 (d) 219

79. Let $\tan^{-1} y = \tan^{-1} x + \tan^{-1}\left(\frac{2x}{1-x^2}\right)$, where $|x| < \frac{1}{\sqrt{3}}$. Then a value of y is :

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

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

80. The integral $\int_2^4 \frac{\log x^2}{\log x^2 + \log(36-12x+x^2)} dx$ is equal to :

(a) 4 (b) 1

(c) 6 (d) 2

81. The negation of $\sim s \vee (\sim r \wedge s)$ is equivalent to:

(a) $s \wedge (r \wedge \sim s)$ (b) $s \vee (r \vee \sim s)$

(c) $s \wedge r$ (d) $s \wedge \sim r$

82. If the angles of elevation of the top of a tower from three collinear points A, B and C, on a line leading to the foot of the tower, are $30°, 45°$ and $60°$ respectively, then the ratio, AB: BC, is :

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

(c) $2:3$ (d) $\sqrt{3}:1$

83. $\lim_{x\to 0} \frac{(1-\cos 2x)(3+\cos x)}{x\tan 4x}$ is equal to:

(a) 3 (b) 2

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

84. Let $\vec{a}, \vec{b}$ and $\vec{c}$ be three non-zero vectors such that no two of them are collinear and $(\vec{a} \times \vec{b}) \times \vec{c} = \frac{1}{3}|\vec{b}||\vec{c}|\vec{a}$. If θ is the angle between vectors $\vec{b}$ and $\vec{c}$, then a value of $\sin\theta$ is :

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

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

85. If $A = \begin{bmatrix} 1 & 2 & 2 \\ 2 & 1 & -2 \\ a & 2 & b \end{bmatrix}$ is a matrix satisfying the equation $AA^T = 9I$, where I is 3×3 identity matrix, then ordered pair (a, b) is equal to :

(a) $(-2,1)$ (b) $(2,1)$

(c) $(-2,-1)$ (d) $(2,-1)$

86. If the function. $g(x) = \begin{cases} k\sqrt{x+1}, & 0 \le x \le 3 \\ mx+2, & 3 < x \le 5 \end{cases}$ is differentiable, then the value of $k+m$ is :

(a) $\frac{16}{5}$ (b) $\frac{10}{3}$

(c) 4 (d) 2

87. The set of all values of λ for which the system of linear equations:

$$2x_1 - 2x_2 + x_3 = \lambda x_1$$
$$2x_1 - 3x_2 + 2x_3 = \lambda x_2$$
$$-x_1 + 2x_2 = \lambda x_3$$

has a non-trivial solution,

(a) is a singleton.

(b) contains two elements.

(c) contains more than two elements.

(d) is an empty set.

88. The normal to the curve, $x^2 + 2xy - 3y^2 = 0$, at $(1,1)$:

(a) meets the curve again in the second quadrant.

(b) meets the curve again in the third quadrant.

(c) meets the curve again in the fourth quadrant.

(d) does not meet the curve again.

89. The number of common tangents to the circles $x^2 + y^2 - 4x - 6y - 12 = 0$ and $x^2 + y^2 + 6x + 18y + 26 = 0$, is :

(a) 2 (b) 3

(c) 4 (d) 1

90. Let $y(x)$ be the solution of the differential equation $(x\log x)\frac{dy}{dx} + y = 2x\log x, (x \ge 1)$. Then $y(e)$ is equal to :

(a) 0 (b) 2

(c) 2e (d) e