Signature of Invigilator:_____

University of Hyderabad
ENTRANCE EXAMINATION, JUNE 2010
QUESTION PAPER
Ph.D. (ACRHEM)

Marks: 75
Time: 2.00 Hrs.

Hall Ticket No. | | | | | | | | |

Please confirm that
(a) this booklet has all 28 pages (including 2 blank pages) printed clearly
(b) you are given a clean and clear OMR answer sheet.

Read **carefully all** the instructions given below & on the OMR sheet.

1. Please enter your Hall Ticket Number on Page 1 **(this sheet)** of this booklet **without fail.**
2. Please enter your Hall Ticket Number on the **OMR Answer Sheet without fail**
3. All answers are to be marked on the OMR answer sheet following the instructions provided on the OMR answer sheet.
4. **No additional sheets will be provided.** Rough work is to be done in the booklet itself / space provided at the end of the booklet on pages 27 & 28.
5. **Hand over both** the question paper and OMR answer sheet at the end of the examination.
6. Question paper has two parts: **Part-A** and **Part– B.**
7. **Part-A** consists of 25 objective type questions of one mark each. **There is negative marking of 0.33 marks for every wrong answer.** The marks obtained by the candidate in this part will be used for resolving tie cases.
8. **Part-B** consists of three sections **P (26-50), M (51-75), & C (76-100)** each containing 25 questions.
9. One needs to **answer any 25 questions from Part – B.** Each correct answer carries two marks. There is no negative marking in these sections.
10. **In case the number (N) of answered questions is greater than 25, in part – B, then marks per question shall be 50/N.**
11. Calculators are permitted.
12. All the symbols used in text have their usual meanings.

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PART A : Objective Type questions (25 Marks)

Note : (i) Each question carries 1 mark.
(ii) Each wrong answer carries -0.33 Marks.

1. Suppose the viscosity η of a particular composite fluid is such that it is related to the size r of the fluid particles, their mean square velocity v, their mass m, and their relaxation time τ under some thermal process, through a functional relationship. Which of the following could be a possible form for such an expression ?

A	$\eta = mv^2\tau/r^3$
B	$\eta = mv\tau r$
C	$\eta = \tau v/(mr)$
D	$\eta = mv\tau/r^2$

2. If x denotes the position operator of a quantum mechanical particle, then the eigenfunctions ψ for the operator $x + a\frac{d}{dx}$ (where a is a constant with appropriate dimensions), having eigenvalues λ and wave vector k are described by

A	$\psi = e^{-i\lambda x/a + x^2/(2a)}$
B	$\psi = e^{\lambda x/a - x^2/(2a)}$
C	$\psi = e^{i(k+\lambda)x/a - x^2/(2a)}$
D	$\psi = e^{i\lambda x/a + ikx^2/a}$

3. The magnetic field at a distance z above the centre of a circular loop of radius R carrying a steady current I anticlockwise in $\hat{k}$ is

A	$\mu_0 IR^2/(2z^3)$
B	$2\mu_0 IR/z^2$
C	$\mu_0 IR^2/(2(R^2+z^2)^{3/2})$
D	$\mu_0 IR^2/(2(R^2+2Rz)^{3/2})$

4. The relation between pressure and bulk modulus B of an electron gas at 0 K is

A	$B = -PV$
B	$B = -V\frac{\partial P}{\partial V}$
C	$B = -PV^2$
D	$B = -P\frac{\partial V}{\partial P}$

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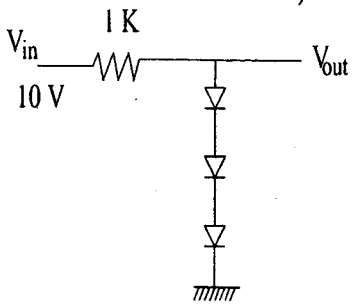
5. The matrix $A = \begin{pmatrix} 1 & 2 \\ 3 & 2 \end{pmatrix}$ has 2 independent eigenvectors given by :

A	$\begin{pmatrix} 2 \\ 3 \end{pmatrix}$ and $\begin{pmatrix} 1 \\ -1 \end{pmatrix}$
B	$\begin{pmatrix} 1 \\ 0 \end{pmatrix}$ and $\begin{pmatrix} 0 \\ 1 \end{pmatrix}$
C	$\begin{pmatrix} 1 \\ 0 \end{pmatrix}$ and $\begin{pmatrix} 1 \\ -1 \end{pmatrix}$
D	$\begin{pmatrix} 0 \\ -1 \end{pmatrix}$ and $\begin{pmatrix} 1 \\ -1 \end{pmatrix}$

6. The output voltage of the given circuit (the diodes are silicon diodes) is



A	9.0 V
B	9.3 V
C	8.66 V
D	7.9 V

7. A canonical ensemble provides a model for

A	an equilibrium system with fixed volume & number of molecules & which exchanges energy with the outside world
B	an equilibrium isolated system with fixed volume, number of molecules and energy
C	an equilibrium system with fixed volume & which can exchange energy & matter with the surroundings
D	a system at constant pressure

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8. Two orthogonally polarized light beams traverse through a birefringent material. If during this passage one of the beams acquires an extra phase of π-with respect to the other, then the material is

A	Half wave plate
B	Quarter wave plate
C	Polarizer
D	Depolarizer

9. The decay constant of a radioactive sample is λ. The half-life and mean-life of the sample are respectively given by

A	$1/\lambda$, $(\ln 2)/\lambda$
B	$(\ln 2)/\lambda$, $1/\lambda$
C	$\lambda(\ln 2)$, $1/\lambda$
D	$\lambda/(\ln 2)$, $1/\lambda$

10. The possible number of ways that a stick of length 20 units will break into 3 pieces of length at least 2 units (the length of any piece may be 1,2,3, ...,20) is

A	9^{20}
B	8×10^3
C	240
D	120

11. To find a root of a transcendental equation, one can use (i) bisection method (ii) secant method. One needs to have the value of the function with opposite signs at two points, when using

A	(i) as well as (ii)
B	(i), need not be for (ii)
C	only (ii), not (i)
D	neither (i) nor (ii)

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12. The ratio of $Pr(i+1)$ and $Pr(i)$ of a binomial distribution with $n = 20$ and $p = 0.3$, changes its behavior at $i =$ __

A	0
B	3
C	10
D	18

13. The coefficient of variation for this data 2,4,6,8,10 is

A	3.16
B	6
C	52.7
D	187.3

14. The ratio of the AM and GM of the roots of the polynomial $F(x) = x^4 - 20x^2 + 64$

A	3.2
B	2.8284
C	0
D	-2.8284

15. The derivative of the integral $\int_{\sin^2 x}^{2\sin x} \exp(t^2)dt$ at $x = \pi$ is

A	2
B	1
C	-1
D	-2

16. The residue of $f(z) = \cot z$ at any of its poles is

A	0
B	1
C	$\sqrt{2}$
D	$2\sqrt{3}$

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17. Let A be an $n \times n$ matrix which is both Hermitian and unitary. Then

A	$A^2 = 1$
B	A is real
C	The eigenvalues of A are -1, 0,1
D	The minima and characteristic polynomials are the same

18. A combustion reaction of an organic molecule can be considered as

A	Complete reduction reaction
B	Rearrangement of functional groups to form oxygens and nitrogens
C	Addition of oxygen atom across the double bonds
D	Complete oxidation reaction

19. According to the Hess Law of heat-summation, the reaction may take place in several stages, nevertheless, the energy evolved (or observed) from the reaction

A	depends only on the initial and final stages of the reactions
B	does not depend on the initial and final stages of the reactions
C	depends on the number of intermediate steps involved
D	depends only on the products formed from the reaction

20. The product obtained in the following reaction $CH_3CH_2CH_2Br \xrightarrow{AlBr_3}$

A	$CH_3CH_2CHBr_2$
B	$BrCH_2CH_2CH_2Br$
C	$CH_3CH{=}CH_2$
D	$CH_3\overset{\overset{Br}{|}}{C}HCH_3$

21. Among the following transitions the one that falls in the visible region of electromagnetic spectrum is

A	$\sigma - \sigma^*$
B	$n - \sigma^*$
C	$\sigma - \pi^*$
D	$n - \pi^*$

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22. The metal present in Vitamin B_{12} is

A	zinc
B	copper
C	nickel
D	cobalt

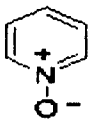
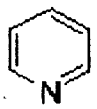
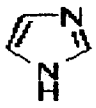
23. Crown ethers have strong affinity towards

A	halides
B	noble gases
C	alkali metal ions
D	transition metal ions

24. Solutions of the following compounds, all at the same molality, were prepared. Which solution has the lowest freezing point?

A	KBr
B	$Al(NO_3)_3$
C	$NaNO_2$
D	$MgCl_2$

25. The molecule among the following that does not undergo nitration reaction with the mixture of HNO_3 and H_2SO_4 is

A		C	
B		D	

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PART B : **(50 Marks)**

Note : (i) Each correct answer carries 2 marks
(ii) If you answer N>25 questions, then marks per question shall be 50/N

Physics Questions :

26. If λ_i $(i = 1, 2, 3)$ denote the eigenvalues of the matrix $H = \begin{pmatrix} 2 & -1 & -3 \\ -1 & 1 & 2 \\ -3 & 2 & 3 \end{pmatrix}$, then $\sum_{i=1}^{3} \lambda_i^2$ is given by

A	36
B	42
C	30
D	24

27. A unit normal $\hat{n}$ to the level curves $f(x, y) = \ln(x^2 + y^2)$ in the plane at the point $P : (2, 1)$ is

A	$\frac{2}{\sqrt{5}}\hat{i} + \frac{\hat{j}}{\sqrt{5}}$
B	$\frac{\hat{i}}{\sqrt{2}} - \frac{\hat{j}}{\sqrt{2}}$
C	$\frac{\hat{i}}{\sqrt{2}} + \frac{\hat{j}}{\sqrt{2}}$
D	$\sqrt{2}\hat{i} + \sqrt{2}\hat{j}$

28. $F = e^{\sigma_2}$, the exponential of the Pauli matrix $\sigma_2 = \begin{pmatrix} 0 & -i \\ i & 0 \end{pmatrix}$, is given by

A $F = \begin{pmatrix} 0 & -i\sin 1 \\ \cos 1 & 0 \end{pmatrix}$

B $F = \begin{pmatrix} \cos 1 & \sin 1 \\ -\sin 1 & \cos 1 \end{pmatrix}$

C $F = \begin{pmatrix} 1- & \sin 1 \\ \sin 1 & 1 \end{pmatrix}$

D $F = \begin{pmatrix} \cosh 1 & -i\sinh 1 \\ i\sinh 1 & \cosh 1 \end{pmatrix}$

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29. A material with cubic structure has got a lattice parameter value $a = 5\mathring{A}$. What is the d-spacing between its (200) planes?

A	$2.5\mathring{A}$
B	$5\mathring{A}$
C	$10\mathring{A}$
D	$7\mathring{A}$

30. In the XRD pattern of a cubic crystal, it is found that reflections corresponding to (1,0,0), (1,1,1) and (3,2,0) are missing. Your conclusion is that

A	The crystal is simple cubic
B	The crystal is body centered cubic
C	The crystal is face centered cubic
D	The crystal is of the perovskite family

31. A square Lead slab of side 50 cm, thickness 5 cm, is subject to a shearing force (on its narrow face) of magnitude 9×10^4 N. The lower edge is riveted to the floor. If the shear modulus of Pb is $5.6 \times 10^9 Pa$, then the upper edge is displaced by

A	0.32 mm
B	0.32 cm
C	0.32 m
D	0.32 dm

32. The terminal velocity of a copper ball of radius 2.0 mm in falling through a tank of oil at 20 °C is $6.5cm/s$ (given the densities of oil & copper : $\rho_{oil} = 1.5 \times 10^3 kg/m^3$, $\rho_{copper} = 8.9 \times 10^3 kg/m^3$). The viscosity of the oil at 20 °C is

A	$99Ns/m^2$
B	$9.9Ns/m^2$
C	$0.99Ns/m^2$
D	$0.099Ns/m^2$

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33. Consider a state described by a complete set of quantum numbers with energy eigenvalue ϵ. The energy is found by computing $U = (kT)^2 \frac{\partial \log Z}{\partial kT}$, where Z is the partition function, T the temperature & k Boltzmann's constant. If no more than *two* particles are characterized by a given set of quantum numbers, the energy is given by

A	$U = \epsilon \left(1 + 2e^{-\epsilon/kT}\right) / \left(e^{\epsilon/kT} + 1 + e^{-\epsilon/kT}\right)$
B	$U = \epsilon / \left(e^{2\epsilon/kT} - 1\right)$
C	$U = \epsilon / \left(2e^{\epsilon/kT} - 1\right)$
D	$U = \epsilon \left(\frac{1}{e^{\epsilon/kT}+1}\right)^2$

34. The average energy of a system in thermal equilibrium is $\langle E \rangle$. The mean square deviation of the energy from $\langle E \rangle$, $\langle (E - \langle E \rangle)^2 \rangle$, when C_v is the heat capacity of the entire system at constant volume, is

A	$C_v T/2$
B	$3C_v kT^2/2 + kt/2$
C	$C_v^2 T^2$
D	$kT^2 C_v$

35. When temperature decreases, the chemical potential of a system of bosons

A	increases & eventually goes to zero
B	decreases & eventually goes to zero
C	increases & becomes negative
D	decreases & becomes negative

36. Suppose right-handed circularly polarized light (defined to be clockwise as the observer looks toward the oncoming wave) is incident on an absorbing slab. The slab is suspended by a vertical thread. The light is directed upwards and hits the underside of the slab. If the light is of 1 Watt at a wavelength of 620 nm, and if all of this light is absorbed by the slab, what is the torque τ_0 exerted on the slab in dyne-cm?

A	3.3×10^{-9}
B	3.3×10^{-6}
C	6.6×10^{-9}
D	9.9×10^{-9}

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37. A possible means for making an airplane invisible to radar is to coat the plane with an anti-reflective polymer. If the radar waves have a wavelength of 3 cm and refractive index of the polymer is 1.5, how thick should the coating be?

A	0.5 cm
B	0.75 cm
C	1.0 cm
D	0.25 cm

38. A He-Ne laser operates at a frequency of 4.74×10^{14} Hz, with a line width of $\Delta\nu = 1.5$ GHz. Light travels between mirrors separated by 30 cm. How many longitudinal modes are possible in this frequency range?

A	5
B	4
C	3
D	2

39. U^{235} undergoes fission when bombarded by thermal neutrons : ${}_{92}U^{235} + n \rightarrow {}_{38}Sr^{94} + {}_{54}Xe^{140} + 2n$. The fission fragments undergo succesive β- decays until ${}_{38}Sr^{94}$ becomes ${}_{40}Zr^{94}$ and ${}_{54}Xe^{140}$. The total energy released in the process is

A	208 MeV
B	501 MeV
C	20.8 MeV
D	5.01 MeV

40. The process $e^+ + e^- \rightarrow \mu^+ + \pi^-$

A	can occur
B	cannot occur since L is not conserved
C	cannot occur since B is not comserved
D	cannot occur since L & spin are not conserved

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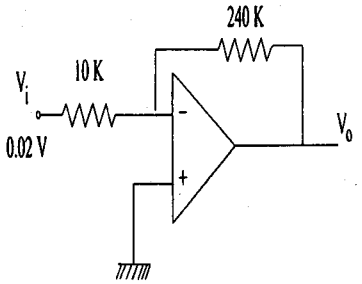
41. The sum of two sinusoidal signals $-5\cos(10t)$ and $-3\sin(10t)$ is

A	5.83 $\cos(10t - 3.682)$
B	-8 $\cos(10t)$
C	5.83 $\cos(10t - 0.541)$
D	-8 $\cos(10t + 0.541)$

42. For the given Op-Amp circuit the output voltage is



A	0.40 V
B	0.45 V
C	0.46 V
D	0.48 V

43. If the potential energy of a particle has a dependence on the radius vector r of the form $U = (2/5)ar^{3/2}$, (a being a constant), then using the virial theorem, the average kinetic energy T and the average total energy E of the particle are :

A	$T = U/5$, $E = (6/5)U$
B	$T = U/3$, $E = (4/3)U$
C	$T = (3/4)U$, $E = (7/4)U$
D	$T = U$, $E = 2U$

44. The Fourier coefficients of a periodic square wave potential defined by $f(x) = -k$ (for $-\pi < x < 0$) and $f(x) = k$ (for $0 < x < \pi$) , $f(x) = f(x + 2\pi)$, are given by $a_0 = 0$, $a_n = 0$, $b_n = \frac{2k}{n\pi}(1 - \cos n\pi)$, a_n and b_n being the cosine and sine Fourier coefficients, respectively. Writing k as its Fourier series we can get

A	$\pi/4 = (1 - 1/3 + 1/5 - 1/7 + ...)$
B	$\pi/4 = (-1 + 1/3 - 1/5 + 1/7 + ...)$
C	$\pi/4 = (1 - 1/3! + 1/5! - 1/7! + ...)$
D	$\pi/4 = (1 - 2/3 + 3/5 - 5/7 + ...)$

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45. The energy levels of a one-dimensional harmonic oscillator of electric charge $2e$, located in a constant electric field E are given by

A	$E_n = (n + \frac{1}{2} - (e^2\|E\|^2)/2m\omega)\hbar\omega$
B	$E_n = (n + \frac{1}{2} - (2e\|E\|)/m\omega^2)\hbar\omega$
C	$E_n = (n + \frac{1}{2})\hbar\omega - 2e\|E\|(h/m\omega)^{1/2}$
D	$E_n = (n + \frac{1}{2})\hbar - \frac{2e^2\|E\|^2}{m\omega^2}$

46. A 3-d isotropic harmonic oscillator has the energy eigenvalues $\hbar\omega(n+3/2)$ where $n = 0, 1, 2, 3, \ldots$ What is the degree of degeneracy of the quantum state n?

A	$3n$
B	$(3n/2)(n-1)$
C	$(n+1)(n+1)/2$
D	$n(n-2)$

47. Using the Bohr-Sommerfeld quantization rule, if a ball is bouncing elastically in a vertical direction, its energy levels (with m being the mass of the ball, g the acceleration due to gravity, h Planck's constant, and $n \in I$) will be

A	$E = \left(\frac{2}{32}mg^2h^2(n+2)^2\right)^{1/3}$
B	$E = (9mg^2n^2h^2/32)^{1/3}$
C	$E = \frac{2}{9}(mg^2h^2)^{1/3}(n+1)^2$
D	$E = \frac{9}{2}(mg^2h^2n(n+1))^{1/3}$

48. The potential of a uniformly charged spherical shell of radius R with surface charge density σ is

A	$V(z) = 2R\sigma/\epsilon_0$ outside, $V(z) = R\sigma/\epsilon_0$ inside
B	$V(z) = R^2\sigma/(\epsilon_0 z)$ outside, at a distance z from the centre, $V(z) = R\sigma/\epsilon_0$ inside
C	$V(z) = R\sigma/\epsilon_0$ outside and inside
D	$V(z) = R^2\sigma/(\epsilon_0 z)$ outside, at a distance z from the centre, $V(z) = 0$ inside

49. A metal sphere of radius a carries a charge Q. It is surrounded out to radius b by a linear dielectric material of permittivity ϵ. Find the potential at the centre

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relative to infinity.

A	$V = \frac{Q}{4\pi}\left(\frac{1}{\epsilon_0 b} + \frac{1}{\epsilon a} - \frac{1}{\epsilon b}\right)$
B	$V = \frac{Q}{4\pi}\left(\frac{1}{\epsilon b} + \frac{1}{\epsilon a}\right)$
C	$V = \frac{Q}{4\pi}\left(\frac{1}{\epsilon a} - \frac{1}{\epsilon b}\right)$
D	$V = \frac{Q}{4\pi\epsilon_0}\left(\frac{1}{a} + \frac{\epsilon_0}{\epsilon b}\right)$

50. A particle of mass m moving with velocity v_1 leaves a space in which its potential energy is a constant U_1, and enters another in which its P.E. is a different constant U_2. If θ_1 and θ_2 are the angles between the normal to the plane and the velocities of the particle v_1 & v_2 of the particle before & after passing the plane, the change in direction of motion of the particle is given by

A	$\frac{\sin\theta_1}{\cos\theta_2} = \sqrt{1 + \frac{2}{mv_1^2}(U_1 - U_2)}$
B	$\frac{\sin\theta_1}{\sin\theta_2} = \sqrt{1 + \frac{2}{mv_1^2}(U_1 - U_2)}$
C	$\theta_1 = \theta_2$
D	$\frac{\sin\theta_1}{\sin\theta_2} = \sqrt{1 - \frac{2}{mv_1^2}(U_1 - U_2)}$

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PART B: **(50 Marks)**

Note: (i) Each correct answer carries 2 marks
(ii) If you answer N>25 questions, then marks per question shall be 50/N

Mathematics Questions:

51. The differential equation $(3a^2x^2+by\cos x)dx+(2\sin x-4ay^2)dy=0$ is exact for

A	B	C	D
a=3, b=2	a=5, b=0	a=4, b=3	a=0, b=1

52. The ratio of Pr(i+1) and Pr(i) for Poisson distribution (with mean 5) is, for i=4,_____

A	B	C	D
5	4	3	1

53. The regression model in the form of y=a+bx for the following information is_____ (n=5, sum(x) = 30 , Sum of squares(x)= 220 , sum of Products (x,y) = 2330 , sum(y)= 295)

A	B	C	D
-25,14	25,-14	14,- 25	-14, 25

54. Let X1,X2,....,X48 be standard uniform random variables then the (S48-a)/ b can be approximated as standard normal distribution (here S48 = X1+X2+...+X48). The values of a and b are

A	B	C	D
-24,2	24,4	-24,4	24,2

55. The average 1st row of SUDOKU of order 9 after successful completion of the puzzle is

A	B	C	D
9	7	5	3

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56.The estimator provided by Hit or Miss method for a definite integral is an _____

(i) unbiased estimator

(ii) consistent estimator

A	B	C	D
(i) as well as (ii)	Only (i) not (ii)	Only (ii) not (i)	neither (i) not (ii)

57.The differential equation (dy/dx)=-3x is invariant with respect to____

(i) Change of scale

(ii) Translation

A	B	C	D
(i) as well as (ii)	(i) but not (ii)	(ii) but not (i)	Neither (i) nor (ii)

58.Let X be a Geometric random variable with P=0.3. Then the Prob(X=5/X>3) is _____

A	B	C	D
0.7	0.3	0.21	0.09

59.The weighted sum of independent identical random variables Xi's for i=1,2,...,n, ($S=\sum WiXi$) is an unbiased estimator for the population mean if $\sum Wi=$

A	B	C	D
n	1	1/n	0

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60. Let A, B and C represent a triangle, and D be point on the plane spanned by ABC. D can be represented as

A	B	C	D
Linear combination of A,B and C	Convex combination of A,B and C	Bericentric combination of A, B and C	Not possible to represent in terms of A,B and C

61. Let P0,P1,P2,P3,....,Pn be n+1 point in points space of d (<n) dimensional representation (ie Pi=(xi1,xi2,...,xid) where xij is real number). Consider Vi=Pi-P0 for i=1,2,...n will

A	B	C	D
Span vector R^d	Span subspace of vector R^d	Be points in R^d	Be always linearly dependent vectors in R^d

62. A Train of length l km is at a platform of length p km. The engine (which pulls the train) is at the medial of the platform. If the train speed should not cross 10kmph while it is crossing any point of the platform, the time required to run the engine at 10kmph (with the assumption that the train can take any speed instantaneously) is _____

A	B	C	D
(p+2l)/20	(2p+l)/20	(p+l)/10	(p+l)/20

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63. In a chemical reactor the compounds A and B participate in forward reaction and produces compound C. C produces A & B in backward reaction. a(t),b(t) and c(t) represents the respective mass of the compounds in the reactors at time t and forward and backward rate of reactions be k1 and k2. A mathematical representation of the process

$\frac{dm}{dt} = Tm \quad where \quad m = \begin{bmatrix} a \\ b \\ c \end{bmatrix}$ and T is_____

A	B	C	D
$\begin{bmatrix} -k_1 & -k_1 & k_2 \\ -k_1 & -k_1 & k_2 \\ k_1 & k_1 & -k_2 \end{bmatrix}$	$\begin{bmatrix} -k_1 & -k_1 & k_2 \\ -k_1 & -k_1 & k_2 \\ k_1 & k_1 & -2k_2 \end{bmatrix}$	$\begin{bmatrix} -k_1 & -k_1 & k_2 \\ -k_1 & -k_1 & k_2 \\ 2k_1 & 2k_1 & -k_2 \end{bmatrix}$	$\begin{bmatrix} -k_1 & -k_1 & k_2 \\ -k_1 & -k_1 & k_2 \\ 2k_1 & 2k_1 & -2k_2 \end{bmatrix}$

64. Let X be any continuous univariate Random Variable and F(.) represent distribution function then the distribution of F(X)

A	B	C	D
Normal distribution	Gamma distribution with p=1	Beta type one distribution with l=1 and m=1	The data/information are not adequate to decide the distribution of F(X)

65. The paired t test is useful for testing the hypothesis of _____

A	B	C	D
Equality of means	Equality of the means of two Random Variables	Equality of means of the two random variables when sample sizes are the same	Equality of means of two correlated random variables when the measurements made available on sample units

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66.Let $f(x,y)=\sqrt{(|xy|)}$, then

A	B	C	D
f_x & f_y donot exist at (0,0)	$f_x(0,0)=1$	$f_x(0,0)=0$	f is differentiable at (0,0)

67.The Sturm-Liouville problem: $y''+\lambda^2 y=0$, $y'(0)=0$, $y'(\pi)=0$ has its eigen vectors given by y=

A	B	C	D
Sin(n+1/2)x	Sin nx	Cos (n+1/2)x	Cos nx

68. Nontrivial solutions of $x^2y''+xy'+4y=0$, $x>0$ are

A	B	C	D
Unbounded and non periodic	Bounded and periodic	Unbounded and periodic	Bounded and non periodic

69.The limit of the sum of (1/(3n+k)) for k=1 to n as $n \to \infty$

A	B	C	D
Log(3/4)	Log(4/3)	Log(3/2)	Log(5/4)

70.Let G be a group such that $a^2=e$ for each $a \in G$, where e is the identity element of G. Then

A	B	C	D
G is cyclic	G is finite	G is abelian	G has a subgroup which is not normal

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71.For $0<q<\pi$, the matrix $A=\begin{bmatrix}\cos q & -\sin q \\ \sin q & \cos q\end{bmatrix}$

A	B	C	D
Has no real eigen value	Is orthogonal	Is symmetric	Is skew symmetric

72.Which of the following statements is false

A	B	C	D
Any product of compact spaces is compact	Any product of Hausdorff spaces is Hausdorff	Any product of connected spaces is connected	Any product of metrizable spaces is metrizable

73.The number of elements of order 5 in symmetric group S_5 is

A	B	C	D
5	20	24	12

74.The set of all eigen values of the Sturm-Liouville problem $y'+\lambda y=0$; $y'(0)=0$, $y'(\pi/2)=0$, is given by

A	B	C	D
$\lambda=2n$, $n=1,2,3...$	$\lambda=4n^2$, $n=1,2,3...$	$\lambda=2n$, $n=0,1,2,3...$	$\lambda=4n^2$, $n=0,1,2,3...$

75.The set of linearly independent solutions of the $D^4y-D^2y=0$ is

A	B	C	D
$\{1,x,e^x,e^{-x}\}$	$\{1,x,e^{-x},xe^{-x}\}$	$\{1,x,e^x,xe^x\}$	$\{1,x,e^x,xe^{-x}\}$

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PART B: **(50 Marks)**

Note: (i) Each correct answer carries 2 marks
(ii) If you answer N > 25 questions, then marks per question shall be 50 / N

Chemistry Questions:

76. The molecule among the following that does not show Raman activity is

A) Li_2
B) LiH
C) H_2O
D) CH_4

77. The well behaved function among the following is

A) exp (-|x|)
B) exp ($-x^2$)
C) exp (x^2)
D) exp (-x)

78. The hermitian operator among the following is

A) d/dx
B) xd/dx
C) xd/dx + (d/dx)x
D) xd/dx – (d/dx)x

79. The wave function that mixes most with the ground state wave function of hydrogen atom in the presence of an electric field along the x-direction is

A)2s
B) $2p_x$
C) $2p_y$
D) $2p_z$

80. Brillouin condition states that

A) $\langle\Psi|\ dH/d\alpha|\ \Psi\rangle = d\langle\Psi|\ H|\ \Psi\rangle/d\alpha$
B) I.P. $= -\ \varepsilon_i$
C) $\langle\ \Psi(\text{singly excited}|H|\ \Psi_{HF}\rangle = 0$
D) First order correction to energy is zero

81. Metal to ligand charge transfer occurs in:

A) Metal in high oxidation state and ligand having low lying acceptor orbitals
B) Metal in low oxidation state and ligand having low lying acceptor orbitals
C) Metal in high oxidation state and ligand having non bonding electrons
D) Metal with low lying empty orbital and ligand having lone pair of higher energy

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82. Among the following that possesses maximum spin only magnetic moment in an octahedral environment is

A) Co^{3+}
B) Mn^{2+}
C) Cr^{3+}
D) V^{2+}

83. Ground state term for Co^{2+} ion is:

A) ^4F
B) ^3F
C) ^5D
D) ^6S

84. The wrong statement regarding Wilkinson's catalyst among the following is

A) Its formula is $(Ph_3P)_3RhCl$
B) It acts as catalyst for hydrogenation
C) It loose chloride ion to form the active species for catalysis
D) It loose one triphenylphosphine ligand to form the active species for catalysis

85. Which among the following is not true for metal nitrosyl compounds:

A) Linear nitrosyl acts as three electron donor
B) Bent nitrosyl act as two electron donor
C) Bent nitrosyl act as one electron donor
D) Metal nitrosyls generally obey 18-electron rule

86. Viscosity co-efficient of gas ----- with increasing temperature whereas viscosity co-efficient of liquid ----- with increasing temperature. Fill in the blanks from the following:

A) increases, decreases
B) decreases, increases
C) does not change, decreases
D) increases, does not change

87. The glass transition temperature (T_g) of polymer is the temperature at which:

A) Crystalline domains of polymer melts
B) Amorphous domains of polymer becomes glassy
C) Crystalline transformation takes place
D) Both crystalline and amorphous domains of polymer melts

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88. The weight average molar mass for a sample containing 10% by weight of polymer of molar mass 10,000 and 90% by weight of polymer of molar mass 1,00,000 is

A) 9.1×10^2

C) 9.1×10^4

B) 3.6×10^4

D) 1.5×10^4

89. The repeating unit of Nylon-6,10 polymer is

A) $\left\{NH-(CH_2)_6-NH-CO-(CH_2)_8-CO\right\}_n$

C) $\left\{NH-(CH_2)_{16}-CO\right\}_n$

B) $\left\{NH-(CH_2)_6-NH-CO-(CH_2)_{10}-CO\right\}_n$

D) $\left\{NH-(CH_2)_{10}-CO\right\}_n$

90. Consider that the tri-nitro toluene (TNT) is completely combusted to form carbon dioxide, water and nitrogen gas, the oxygen balance for the TNT is

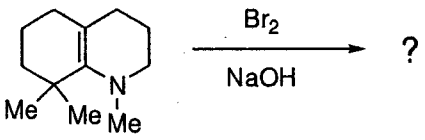
A) –47%

C) +47%

B) +74%

D) –74%

91. Product obtained in the following transformation is



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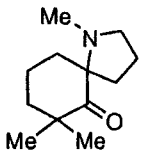

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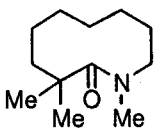

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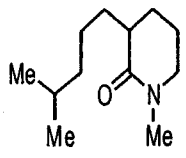
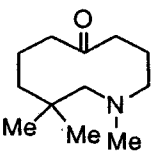


D)



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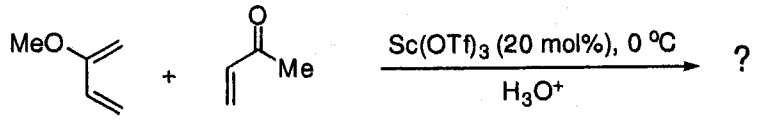
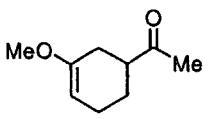
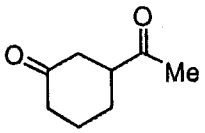
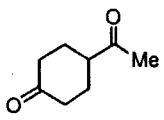
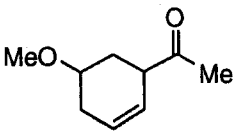
92. Product obtained in the following transformation is



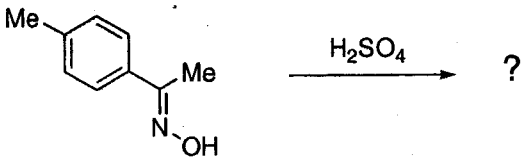
A) 

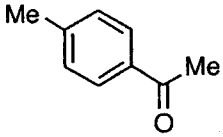
B) 

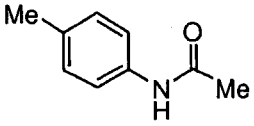
C) 

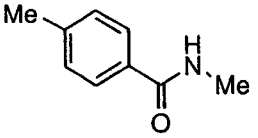
D) 

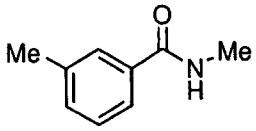
93. Product obtained in the following transformation is



A) 

B) 

C) 

D) 

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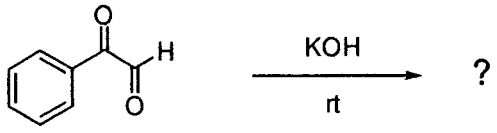
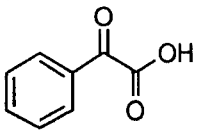
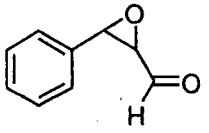
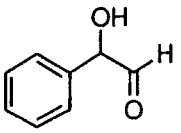
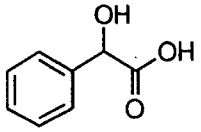
94. Product obtained in the following transformation is



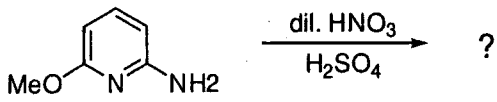
A) 

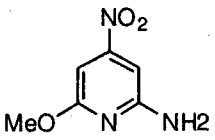
C) 

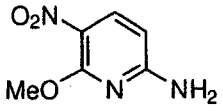
B) 

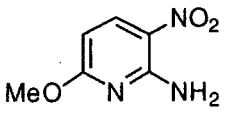
D) 

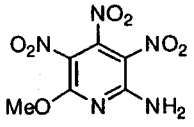
95. Product obtained in the following transformation is



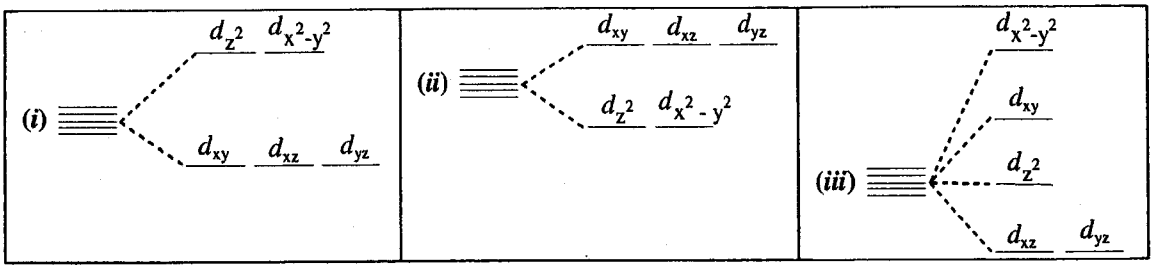
A) 

C) 

B) 

D) 

96. The crystal field splitting diagram of '*d*' orbitals in various fields are given below as (*i*), (*ii*) and (*iii*). The correct matching of splitting diagram for corresponding crystal fields is



(A) (*i*) Octahedral field; (*ii*) Tetrahedral field; (*iii*) Square planar field
(B) (*i*) Tetrahedral field; (*ii*) Octahedral filed; (*iii*) Square planar field
(C) (*i*) Square planar field; (*ii*) Tetrahedral field; (*iii*) Octahedral filed
(D) (*i*) Square planar field; (*ii*) Octahedral filed; (*iii*) Tetrahedral field

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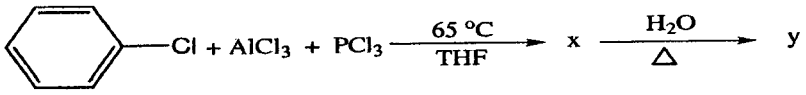
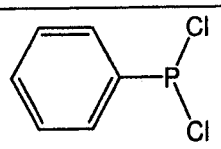
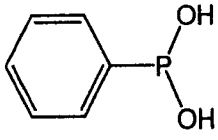
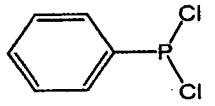
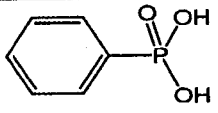
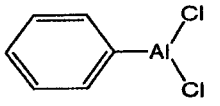
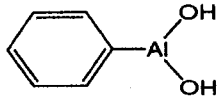
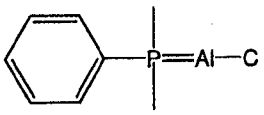
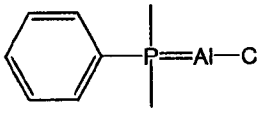
97. The products X and Y in the following reaction are



A	x =  y = 
B	x =  y = 
C	x =  y = 
D	x =  y = 

98. Nitrogen molecule has fundamental vibrational frequency of 6.985×10^{13} s^{-1}. The ratio of the $\nu = 1$ to $\nu = 0$ population at 800 °C is

A) 0.440

C) 0.404

B) 0.044

D) 0.004

99. Calculate E^o for the reaction $M \rightarrow M^{3+} + 3e$. Given $E^o = 0.44$ v for $M \rightarrow M^{2+} + 2e$ and $E^o = -0.77$ v for $M^{2+} \rightarrow M^{3+} + e$

A) 0.563 v

C) 0.850 v

B) 0.0367 v

D) 0.33 v

100. CaF_2 has a face-centered cubic lattice with a=b=c and there are eight F^- and four Ca^{2+} ions per unit cell. The density of CaF_2 at 20 °C is 3.18 g/cm^3. The unit cell length of CaF_2 crystal at 20 °C is

A) 0.546 Å

C) 4.56 Å

B) 5.46 Å

D) 6.54 Å

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