SUBJECT CODE	SUBJECT
A-16-18	PHYSICAL SCIENCES

HALL TICKET NUMBER							

PAPER
II

OMR SHEET NUMBER					

NUMBER OF QUESTIONS
100

DURATION	MAXIMUM MARKS	NUMBER OF PAGES
2 HOURS	200	16

QUESTION BOOKLET NUMBER

This is to certify that, the entries made in the above portion are correctly written and verified.

Candidates Signature | **Name and Signature of Invigilator**

Instructions for the Candidates

1. Write your Hall Ticket Number in the space provided on the top of this page.
2. This paper consists of hundred multiple-choice type of questions.
3. At the commencement of examination, the question booklet will be given to you. In the first 5 minutes, you are requested **to open the booklet and compulsorily examine it as below** :
   (i) To have access to the Question Booklet, tear off the paper seal on the edge of this cover page. Do not accept a booklet without sticker-seal and do not accept an open booklet.
   (ii) **Tally the number of pages and number of questions in the booklet with the information printed on the cover page. Faulty booklets due to pages/questions missing or duplicate or not in serial order or any other discrepancy should be got replaced immediately by a correct booklet from the invigilator within the period of 5 minutes. Afterwards, neither the Question Booklet will be replaced nor any extra time will be given.**
   (iii) After this verification is over, the Test Booklet Number should be entered in the OMR Sheet and the OMR Sheet Number should be entered on this Test Booklet.
4. Each item has four alternative responses marked (A), (B), (C) and (D). You have to darken the circle as indicated below on the correct response against each item.
   Example : (A) (B) ● (D)
   where (C) is the correct response.
5. Your responses to the items are to be indicated in the **OMR Answer Sheet given to you**. If you mark at any place other than in the circle or half circle or semi circle in the Answer Sheet, it will not be evaluated.
6. Read instructions given inside carefully.
7. Rough Work is to be done in the end of this booklet.
8. If you write your name or put any mark on any part of the OMR Answer Sheet, except for the space allotted for the relevant entries, which may disclose your identity, you will render yourself liable to disqualification.
9. **The candidate must handover the OMR Answer Sheet to the invigilators at the end of the examination compulsorily** and must not carry it with you outside the Examination Hall. The candidate is allowed to take away the carbon copy of OMR Sheet and used Question paper booklet at the end of the examination.
10. **Use only Blue/Black Ball point pen.**
11. **Use of any calculator or log table etc., is prohibited.**
12. **There is no negative marks for incorrect answers.**

అభ్యర్థికి సూచనలు

1. ఈ పుట పై భాగంలో ఇవ్వబడిన స్థలంలో మీ హాల్‌టికెట్ నంబరు రాయండి.
2. ఈ ప్రశ్న పత్రము వంద (100) బహుళైచ్ఛిక ప్రశ్నలను కలిగి ఉంది.
3. పరీక్ష ప్రారంభమున ఈ ప్రశ్నాపత్రము మీకు ఇవ్వబడుతుంది మొదటి ఐదు నిమిషములలో <u>ఈ ప్రశ్నాపత్రమును తెరిచి కింద తెలిపిన అంశాలను తప్పనిసరిగా సరిచూసుకోండి.</u>
   (i) ఈ ప్రశ్న పత్రమును చూడడానికి కవర్ పేజి అంచున ఉన్న కాగితపు సీలును చించండి. కాగితపు సీలులేని మరియు ఇదివరకే తెరిచి ఉన్న ప్రశ్నాపత్రమును మీరు అంగీకరించవద్దు.
   (ii) **కవరు పేజి పై ముద్రించిన సమాచారం ప్రకారం ఈ ప్రశ్న పత్రములోని పేజీల సంఖ్యను మరియు ప్రశ్నల సంఖ్యను సరిచూసుకోండి. పేజీల సంఖ్యకు సంబంధించి గానీ లేదా సూచించిన సంఖ్యలో ప్రశ్నలు లేకపోవుట లేదా నిజప్రతి కాకపోవుట లేదా ప్రశ్నలు క్రమపద్ధతిలో లేకపోవుట లేదా ఏవైనా తేడాలుండుట వంటి దోషపూరితమైన ప్రశ్న పత్రాన్ని వెంటనే మొదటి ఐదు నిమిషాల్లో పరీక్షా పర్యవేక్షకునికి తిరిగి ఇచ్చివేసి దానికి బదులుగా సరిగ్గా ఉన్న ప్రశ్నపత్రాన్ని తీసుకోండి. తదనంతరం ప్రశ్నపత్రము మార్చబడదు అదనపు సమయం ఇవ్వబడదు.**
   (iii) పై విధంగా సరిచూసుకొన్న తర్వాత ప్రశ్నాపత్రం సంఖ్యను OMR పత్రము పై అదేవిధంగా OMR పత్రము సంఖ్యను ఈ ప్రశ్నాపత్రము పై నిర్ధిష్ట స్థలంలో రాయవలెను.
4. ప్రతి ప్రశ్నకు నాలుగు ప్రత్యామ్నాయులు (A), (B), (C) మరియు (D) లుగా ఇవ్వబడ్డాయి. ప్రతి ప్రశ్నకు సరైన జవాబును ఎన్నుకొని OMR పత్రములో ప్రతి ప్రశ్నా సంఖ్యకు ఇవ్వబడిన నాలుగు వృత్తాల్లో సరైన జవాబు సూచించే వృత్తాన్ని బాల్ పాయింట్ పెన్‌తో కింద తెలిపిన విధంగా పూరించాలి
   ఉదాహరణ : (A) (B) ● (D)
   (C) సరైన ప్రతిస్పందన అయితే.
5. ప్రశ్నలకు జవాబును ఈ ప్రశ్నపత్రముతో ఇవ్వబడిన OMR పత్రము పైన ఇవ్వబడిన వృత్తాల్లోనే పూరించి గుర్తించాలి. అలాకాక సమాధాన పత్రం పై వేరొక చోట గుర్తించిన లేక సగ వృత్తం లేదా అసంపూర్ణ వృత్తాన్ని నింపిన మీ జవాబు మూల్యాంకనం చేయబడదు.
6. ప్రశ్న పత్రము లోపల ఇచ్చిన సూచనలను జాగ్రత్తగా చదవండి.
7. చిత్తుపనిని ప్రశ్నపత్రము చివర ఇచ్చిన ఖాళీ స్థలములో చేయాలి.
8. OMRపత్రము పై నిర్ణీత స్థలంలో సూచించవలసిన వివరాలు తప్పించి ఇతర స్థలంలో మీ గుర్తింపును తెలిపే విధంగా మీ పేరు రాయడం గానీ లేదా ఇతర చిహ్నాలను పెట్టడం గానీ చేసినట్లయితే మీ అనర్హతకు మీరే బాధ్యులవుతారు.
9. **పరీక్ష పూర్తయిన తర్వాత OMR పత్రాన్ని తప్పనిసరిగా పరీక్ష పర్యవేక్షకుడికి ఇవ్వాలి.** వాటిని పరీక్ష గది బయటకు తీసుకువెళ్ళకూడదు. పరీక్ష పూర్తయిన తరువాత అభ్యర్థులు ప్రశ్న పత్రాన్ని OMR పత్రం యొక్క కార్బన్ కాపీని తీసుకువెళ్ళవచ్చు
10. **నీలి/నల్ల రంగు బాల్ పాయింట్ పెన్ మాత్రమే ఉపయోగించాలి.**
11. **లాగరిథమ్ టేబుల్స్, క్యాలిక్యులేటర్‌లు, ఎలక్ట్రానిక్ పరికరాలు మొదలగునవి పరీక్ష గదిలో ఉపయోగించడం నిషేధం.**
12. **తప్పు సమాధానాలకు మార్కుల తగ్గింపు లేదు.**

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PHYSICAL SCIENCES
Paper – II

1. If a, b, c are vectors and a + b + c = 0 |a| = 7, |b| = 5, |c| = 3, then the angle between b and c is

(A) 90° (B) 60°

(C) 45° (D) 30°

2. The Eigen value of the matrix

$$\begin{bmatrix} 6 & -2 & 2 \\ -2 & 3 & -1 \\ 2 & -1 & 3 \end{bmatrix} \text{ is}$$

(A) (4, 1, 1) (B) (4, 2, 3)

(C) (8, 2, 2) (D) (6, 3, 3)

3. Which of the following statement (s) are incorrect for the rank of a matrix ?

I. The rank of null matrix is 1

II. The rank of non-zero matrix ≥ 1

III. The rank of $m \times n$ matrix is $\leq m$ if $m \geq n$

IV. The rank of every 'n' square non singular matrix is 'n'

(A) IV and III (B) I and IV

(C) II and IV (D) Both I and III

4. If a and b are the order and degree of the differential equation $\left[\frac{d^5y}{dx^5} + \frac{d^3y}{dx^3}\right]^{3/2} = \frac{d^2y}{dx^2}$.
Then 2a + b is

(A) 11 (B) 8

(C) 13 (D) 15

5. Match the following :

I. Legendre polynomial a. $\frac{e^{-\frac{xt}{1-t}}}{1-t}$

II. Bessel polynomial b. $(1-2+x+t^2)^{-1/2}$

III. Hermite polynomial c. $e^{\frac{x}{2}\left(t-\frac{1}{t}\right)}$

IV. Laguerre polynomial d. $x^2-(t-x)^2$

	I	II	III	IV
(A)	b	d	a	c
(B)	c	b	a	d
(C)	b	c	d	a
(D)	c	a	b	d

6. Inverse Laplace transform of $\frac{1}{s^2(s+1)}$ is

(A) $t - 1 + e^{-t}$ (B) $\frac{1}{2}t^2e^t$

(C) $\frac{1}{2}t^2 - 1 + e^t$ (D) $t^2 - 1 + e^{-t}$

7. The Fourier transform of derivative of Dirac delta function is proportional to

(A) 0 (B) i_k

(C) 1 (D) cosk

8. At all points in a complex plane, which of the following is the analytical function of z ?

(A) $|z|^2$ (B) $\sqrt{z}$

(C) z^2 (D) $\frac{1}{z^2}$

9. Which of the following distribution mean and variance are equal ?
(A) Normal distribution
(B) Binomial distribution
(C) Poisson distribution
(D) Bernoulli distribution

10. The trapezoidal rule for the integral

$\int_{-1}^{1} e^{x}\,dx$ is

(A) $\frac{h}{3}[e^{-1}+2e^{0}+e^{1}]$

(B) $\frac{h}{2}[e^{-1}+2e^{0}+e^{1}]$

(C) $\frac{h}{3}[e^{-1}+4e^{0}+e^{1}]$

(D) $\frac{h}{2}[e^{-1}+4e^{0}+e^{1}]$

11. By applying Euler's method, the value of y(0.2) for the differential equation $\frac{dy}{dx}=1+y^{2}$ at x = 0, y = 1 with a step size of 0.1 is
(A) 1.102 (B) 1.202
(C) 1.303 (D) 1.404

12. The number of degrees of freedom of a rigid body in n- dimensional space is
(A) n! (B) 2n
(C) 6 (D) n (n + 1)/2

13. The second law of Kepler for planetary motion is a consequence of the law of conservation
(A) Energy
(B) Linear momentum
(C) Angular momentum
(D) Isospin

14. According to special theory of relativity, the speed 'v' of a free particle of mass 'm' and total energy 'E' is

(A) $v=c\sqrt{1-\left(\frac{mc^{2}}{E}\right)^{2}}$

(B) $v=c\sqrt{1-\left(\frac{mc^{2}}{E}\right)}$

(C) $v=\sqrt{\frac{2E}{m}}\left(1+\frac{mc^{2}}{E}\right)$

(D) $v=c\sqrt{1+\left(\frac{mc^{2}}{E}\right)^{2}}$

15. An electron gains energy so that its mass becomes $2m_0$ then it's speed is

(A) $\frac{\sqrt{3}}{2}c$ (B) $\frac{3}{4}c$
(C) $\frac{3}{2}c$ (D) $\sqrt{\frac{3}{2}}c$

16. Choose the correct statement (s).

i. The generating function $F=\sum_k q_k p_k$ generates the identity transformation
ii. The generating function $F=-\sum_k q_k p_k$ generates the transformation
iii. The generating function $F=\sum_k q_k p_k$ cannot generate the identity transformation
iv. The generating function $F=-\sum_k q_k p_k$ generates the identity transformation

(A) i only (B) ii only
(C) iv only (D) i and ii only

17. For a charged particle in an electromagnetic field, the Hamiltonian H is represented as

(A) $H = \frac{1}{2m}(p - qA)^2 + q\phi$

(B) $H = \frac{1}{2m}(p - qA)^2 - q\phi$

(C) $H = \frac{1}{2m}[p - q\,(A)]^2 + q\phi$

(D) $H = \frac{1}{2m}(p + qA)^2 - q\phi$

18. Identify the correct statements.

i. The number of physical quantities that are required to uniquely and completely define the position (or) configuration of the system is called degrees of freedom.

ii. The number of degrees of freedom of the system consisting of a cylinder rolling on a stationary inclined plane is two.

iii. The number of degrees of freedom of a double pendulum is two (assume in extensible string).

iv. The number of degrees of freedom of a conical pendulum and a spherical pendulum are two.

(A) ii, iii and iv are correct
(B) i, iii and ii are correct
(C) i, ii and iii are correct
(D) i and iii are correct

19. The dimensional space required to represent a system of 'n' particles with 'l' constraints is

(A) 3n dimensions
(B) (3n – l) dimensions
(C) (3n + l) dimensions
(D) l dimensions

20. If 'f' be a function depending on positions 'q', moment 'p' and time 't', the equation of motion in Poisson-Bracket form is

(A) $\frac{df}{dt} = [f, H]_{q,\,p}$ (B) $\frac{df}{dt} = [f, H]_{q,\,p} + \frac{\partial f}{\partial t}$

(C) $\frac{df}{dt} = [H, f]_{q,\,p}$ (D) $\frac{df}{dt} = [H, f]_{q,\,p} - \frac{\partial f}{\partial t}$

21. The Lagrangian of a particle moving in one dimensions is given by $L = \frac{x^2}{2x} - v(x)$. Thus the Hamiltonian is

(A) $\frac{1}{2}p_x^2 x - v(x)$ (B) $p_x x - v(x)$

(C) $\frac{1}{2}p_x^2 x + v(x)$ (D) $p_x x + v(x)$

22. Hamilton – Jacobi theory provides the canonical transformation in which _______ is/are cyclic.

(A) position
(B) momentum
(C) position and momentum
(D) velocity

23. A charge Q is uniformly distributed over a semicircular ring of radius R. The electric field at the center of the semicircular ring is

(A) $\frac{Q}{\pi^2 \in_0 R}$ (B) $\frac{Q}{\pi \in_0 R^2}$

(C) $\frac{Q}{2\pi^2 \in_0 R^2}$ (D) $\frac{Q}{\pi \in_0 R}$

24. A circular loop of resistance R and area A is subjected to a magnetic field $B_0 \sin\omega t$; B_0 is positive constant. Then the amplitude of the induced current in the loop at an angular position of π radians of current is

(A) $B_0 RA$ (B) $\frac{B_0 A}{R}$

(C) $\frac{B_0 R}{A}$ (D) Zero

25. The torque on a rectangular coil placed in a uniform magnetic field is large when

(A) number of turns of the coil is less

(B) number of turns of the coil is large

(C) plane of the coil is parallel to the field

(D) area of the coil is small

26. If a charge moves along a rectangular loop and uniform magnetic field is applied in a direction perpendicular to the plane of the loop, then

(A) Kinetic energy of the charge remains constant

(B) Potential energy is higher than kinetic energy of the charge

(C) Kinetic energy is not constant along the loop

(D) Force is non-uniform in one direction and uniform in another direction of the loop

27. The vector potential at the position defined by vector $\vec{r}$ in a uniform magnetic field $\vec{B}$ can be represented

(A) $\vec{B}\times\vec{r}$ (B) $\frac{1}{2}(\vec{B}\times\vec{r})$

(C) $\vec{\nabla}\times(\vec{B}\times\vec{r})$ (D) $(\vec{\nabla}\times\vec{B})\times\vec{r}$

28. In the following equations, which one represents that the electric field is to be zero; $\vec{E}$ is electric field and $\vec{B}$ is magnetic field

(A) $\int_{area} \vec{E}\cdot\vec{ds} = 0$

(B) $\oint \vec{E}\cdot\vec{dl} = 0$

(C) $\int_{area} \vec{E}\cdot\vec{ds} = -\frac{d}{dt}\oint\vec{B}\cdot\vec{dl}$

(D) $\oint\vec{B}\cdot\vec{dl} = \mu_0 I + \mu_0 \epsilon_0 \frac{\partial}{\partial t}\int\vec{E}\cdot\vec{ds}$

29. For a vector potential $\vec{A}(\vec{r}, t)$, the divergence of $\vec{A}$ is $\vec{\nabla}\cdot\vec{A} = -\frac{kt}{r^3}$ where k is a constant of appropriate dimension. If the vector and scalar potential are in Lorentz gauge, then the scalar potential is

(A) $\frac{kt^2}{r^3}$ (B) $\frac{kc^2t^2}{2r^3}$

(C) $\frac{kt}{r^4}$ (D) $\frac{kt^2}{c^3r^3}$

30. In a rectangular wave guide, the mode that propagates with minimum attenuation through the wave guide is

(A) TE_{01} (B) TE_{10}

(C) TM_{10} (D) TM_{11}

31. An electromagnetic wave is propagating in free space along Z-direction. If the electric field is given by $\vec{E} = \cos(\omega t - kz)\hat{i}$, where $\omega = ck$; $k = \frac{2\pi}{\lambda}$; then the magnetic field is

(A) $\vec{B} = \frac{1}{c}\cos(\omega t - kz)\hat{j}$

(B) $\vec{B} = \frac{1}{c}\sin(\omega t - kz)\hat{j}$

(C) $\vec{B} = \frac{1}{c}\cos(\omega t - kz)\hat{i}$

(D) $\vec{B} = \frac{1}{c}\sin(\omega t - kz)\hat{i}$

32. Given a wave with the dispersion relation $\omega = ck + m$ with $k > 0$ and $m > 0$, which one of the following is true ?

(A) Group velocity is greater than phase velocity

(B) Group velocity is smaller than phase velocity

(C) Group velocity and phase velocity are equal

(D) No define relation between group velocity and phase velocity

33. A scalar potential ϕ and vector potential $\overline{A}$ in coulomb gauge, can satisfy Poisson's equation only if

(A) ϕ is independent of time and $\overline{A}$ is solenoidal

(B) ϕ is independent of time and $\overline{A}$ is irrotational

(C) ϕ is independent of time and $\overline{A}$ is dependent on time

(D) ϕ is constant

34. If a particle moving in a potential V (x) = $\frac{1}{2}$ kx^2, where k is a constant, then the probability amplitude of a ground state at x = 0 in relation to all other states is

(A) minimum

(B) zero

(C) negative

(D) maximum

35. A linear Hermitian operator A has infinite number of eigen values a_i and has a complete set of orthonormal eigen states $|a_i\rangle$. If the system is in a state $|\psi\rangle = |a_1\rangle + \frac{i}{2}|a_2\rangle$ the probability of getting a value a_2 for A on measurement is

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

(B) $\frac{1}{5}$

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

(D) zero

36. The operation of parity operator on a wave function is given by $\pi\psi(r) = \psi(-r)$. Choose the correct statement from the following.

(A) π is unitary but not Hermitian

(B) π is Hermitian but not unitary

(C) π is Hermitian and unitary

(D) $\pi^2 = \pi$

37. The evaluation of commutation $[x, p^2]$ gives

(A) $i\hbar$

(B) $2i\hbar$

(C) $2i\hbar x$

(D) $2i\hbar p$

38. The eigen functions of an infinite potential well

$$V(x) = 0 \quad \text{if } 0 \le x \le a$$
$$= \infty \quad \text{otherwise}$$

are given by

$$\psi_n(x) = \sqrt{\frac{2}{a}}\sin\left(\frac{n\pi}{a}\right)x \quad n = 1, 2, 3, ...$$

This system is perturbed by

$$H' = V_0 \quad \text{for } 0 \le x \le a$$
$$= 0 \quad \text{otherwise}$$

Based on the first order perturbation, the correction to the n^{th} energy state is

(A) $\frac{V_0}{n}$

(B) $V_0 n$

(C) $\frac{V_0}{2}$

(D) V_0

39. Any function $G(\bar{r}, \bar{r}')$ is called Green's function for the operator A, if

(A) $A(\bar{r}, \nabla)\, G(\bar{r}, \bar{r}') = 0$

(B) $A(\bar{r}, \nabla)\, G(\bar{r}, \bar{r}') = 1$

(C) $A(\bar{r}, \nabla)\, G(\bar{r}, \bar{r}') = \delta(\bar{r}, -\bar{r}')$

(D) $A(\bar{r}, \nabla)\, G(\bar{r}, \bar{r}') = A(\bar{r}, \nabla)$

40. The scattering under Born approximation leads Fourier transform of the potential with respect to momentum transfer to the target. This approximation is valid when the scattering potential is

(A) weak and the incident energy of the projectile is high

(B) strong and the projectile energy high

(C) weak and the projectile energy is low

(D) strong and the projectile energy is low

41. The electronic energy levels in the helium atom are divided into spin triplet and singlet states due to

(A) spin wavefunction in the triplet state is of antisymmetric character

(B) the spin wavefunction in the singlet state is of antisymmetric character

(C) spin and space wavefunctions in the singlet state are of antisymmetric nature under exchange

(D) spin and space wavefunctions in the singlet state are of symmetric in nature

42. If $\psi(\bar{r}, t) = ae^{i(\bar{k}.\bar{r} - wt)}$ is the solution of the Klein-Gordon equation of a particle $\left(\nabla^2 - \frac{1}{c^2}\frac{\partial^2}{\partial t^2}\right)\psi(\bar{r}, t) = \frac{m^2c^2}{\hbar^2}\psi(r, t)$ then the energy of that particle can write represented as

(A) $E = mc^2$

(B) $E = \pm\sqrt{c^2p^2 + m^2c^4}$

(C) zero

(D) $E = c^2p^2 + m^2c^4$

43. If the equation of motion of the Dirac particle to evaluate the velocity is $i\hbar\dot{\bar{r}} = [\bar{r}, H]$, then the x-component of the velocity is

(A) ν_x

(B) βc

(C) $\alpha_x c$

(D) $\alpha_x \nu_x$

44. The product of spin –½ angular momentum operators $s_x s_y s_z s_y s_z s_x$ gives

(A) $-\frac{i\hbar^5}{32}$

(B) $\frac{i\hbar^5}{32} S_z$

(C) $-\frac{\hbar^6}{64}$

(D) $\frac{\hbar^6}{64}$

45. If q is the partition function of one molecule, then the partition function of the gas consisting of N non-interacting molecules is

(A) $\frac{1}{N!}q^N$

(B) $N!q^N$

(C) $\frac{1}{N!}q$

(D) $\frac{N}{N!}q^N$

46. According to the law of equipartition of energy, the average energy per molecule is

(A) $\frac{1}{2}K_BT$ (B) $\frac{2}{3}K_BT$

(C) $\frac{3}{2}K_BT$ (D) $\frac{5}{2}K_BT$

47. Which of the following equation is true for Clausious Clapeyron's latent heat ?

(A) $\frac{dP}{dS}=\frac{T}{L(V_2-V_1)}$

(B) $\frac{dP}{dT}=\frac{L}{T(V_2-V_1)}$

(C) $\frac{dS}{dT}=\frac{L}{T(P_2-P_1)}$

(D) $\frac{dV}{dT}=\frac{L}{T(P_2-P_1)}$

48. There is a possibility of average occupation of a single particle energy level becoming infinity for

(A) M – B system

(B) F – D system

(C) B – E system

(D) for all systems for $T \to \infty$

49. Gibbs paradox has been resolved by

(A) going from classical to quantum statistics

(B) including spin of the particles

(C) correct Boltzmann counting

(D) taking relativistic effects into account

50. Paramagnetic susceptibility of free electron gas

(A) Obeys Curie law

(B) Obeys Curie-Weiss law

(C) Almost temperature independent

(D) Is negative as in diamagnets

51. The magnetic susceptibility of a system can be related to the second order derivative of Helmholtz free energy with respect to

(A) Magnetization (B) Temperature

(C) Volume (D) Magnetic field

52. Which of the following relation between the specific heat C and canonical partition function Z is correct ?

(A) $C=\frac{\partial}{\partial T}\left[K_BT^2\frac{\partial}{\partial T}\ln Z\right]$

(B) $C=\frac{\partial}{\partial T}\left[K_B^2T^2\frac{\partial}{\partial T}\ln Z\right]$

(C) $C=K_B^2T^2\frac{\partial^2}{\partial T^2}\ln Z$

(D) $C=\frac{1}{K_BT}\frac{\partial^2}{\partial T^2}\ln Z$

53. The quantum distribution functions reduces to classical distribution functions when

(A) $\lambda^3 << \frac{V}{N}$ (B) $\lambda^3 >> \frac{V}{N}$

(C) $\lambda^3 = \frac{V}{N}$ (D) $\lambda^3 = \frac{N}{V}$

where λ = de Broglie wave length
N = Number of particles
V = Volume

54. The model Hamiltonian of a spin system in terms of weighted components α and β is

$$H = -\sum_{i,j} J_{ij}\left[\alpha\left(S_i^x S_j^x + S_i^y S_j^y\right) + \beta S_i^z S_j^z\right]$$

If $\alpha = \beta = 1$ then the model is called

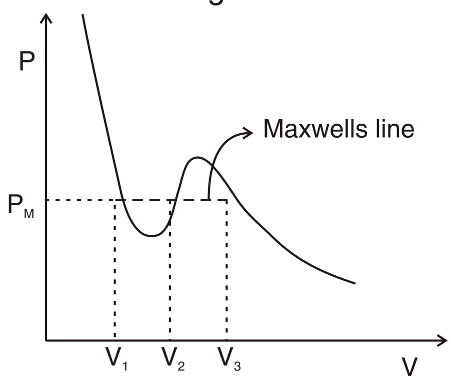
(A) Ising model

(B) XY model

(C) Hubbard model

(D) Heisenberg model

55. For $T < T_C$ the Vander Waals isotherm is shown in the figure



The Maxwells line is constructed by using the condition

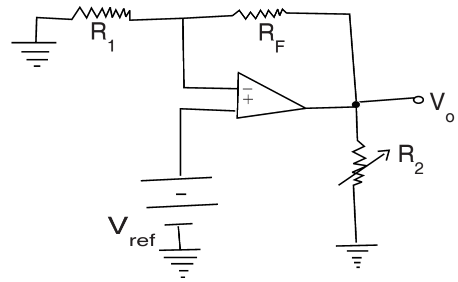
(A) $P_M(V_3 - V_1) = \int_{V_1}^{V_3} PdV$

(B) $P_M(V_2 - V_1) = \int_{V_1}^{V_2} PdV$

(C) $P_M(V_3 - V_2) = \int_{V_2}^{V_3} PdV$

(D) $P_M(V_2 - V_3) = \int_{V_1}^{V_3} PdV$

56. The following circuit represents



(A) Differentiator

(B) Current follower

(C) Adder

(D) Voltage regulator

57. The relation between emitter current amplification (α) and base current amplification factor (β) is

(A) $\beta = \frac{\alpha}{1+\alpha}$

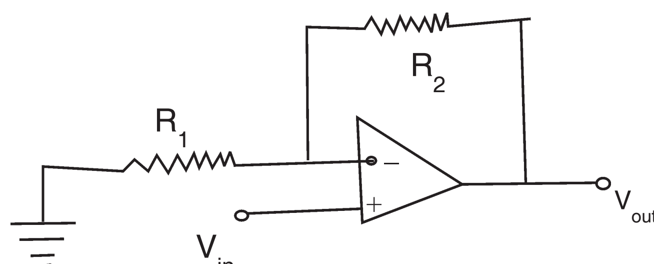
(B) $\alpha = \frac{\beta}{1+\alpha}$

(C) $\beta = \frac{\alpha}{1-\alpha}$

(D) $\beta = \frac{\alpha}{1-2\beta}$

58. The op-amp circuit shown in figure has a non-inverting gain of 101.

If $R_2 = 1\text{m}\ \Omega$ Value then R_1 should be



(A) 100 KΩ

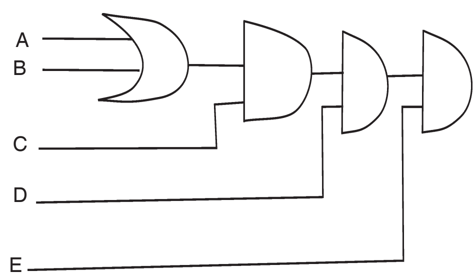
(B) 10 KΩ

(C) 1.1 KΩ

(D) 5 KΩ

59. A tunnel diode works on the principle(s) of
   i. Tunneling of charge carriers across the junction
   ii. Thermionic emission
   iii. Diffusion of charge carriers across the junction
   iv. Attraction of charge carriers across the junction
   (A) i and iii are correct
   (B) ii and iv are correct
   (C) i is correct
   (D) iii is correct

60. Derive the Boolean expressions for the logic circuit shown below :



   (A) C (A + B) DE
   (B) [C (A + B) D + E]
   (C) [C (A+ B) + D] E
   (D) ABCDE

61. For using 8085 microprocessor-based system
   i. No program is required
   ii. Program must be stored in memory
   iii. Program need not be stored in memory
   iv. Program is stored in the internal register
   (A) only i is correct
   (B) only ii is correct
   (C) i and ii are correct
   (D) iii and iv are correct

62. Match the following :

a. RAM size-8085 microprocessor i. 32 kb
b. RAM size-8051 microcontroller ii. 64 kb
c. ROM size-8085 microprocessor iii. 128 bytes
d. ROM size-8051 microcontroller iv. 4 kb

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

63. The program counter (PC) in a microprocessor
   (A) Counts the number of programs being executed
   (B) Counts the number of instructions being executed
   (C) Counts the number of interrupts handled
   (D) Keeps the address of the next address to be fetched

64. A half-adder can be constructed using two(2) - input logic gates; one of them is an AND gate then the other one is
   (A) EX-OR (B) NAND
   (C) NOR (D) OR

65. The first byte of an absolute jump instruction in 8051 consists of
   (A) 3 LSBs of opcode and 5 MSBs of 11-bit address
   (B) 5 MSBs of opcode and 3 LSBs of 11-bit address
   (C) 6 MSBs of opcode and 1 LSB of 11-bit address
   (D) 5 LSBs of opcode and 3 MSBs of 11-bit address

66. With 8051 microcontroller timers with the crystal frequency of 22 MHz then what is the maximum delay that can be generated ?
   (A) 2978.9 sec (B) 0.011 msec
   (C) 11.63 sec (D) 2.97 msec

67. The quantum numbers of two electrons in a two valence electron atom are given below

$n_1 = 6, l_1 = 3, s_1 = ½$
$n_2 = 5, l_2 = 1, s_2 = ½$

Then the possible values of J from J-J coupling are

(A) 0, 1, 2, 3, 4 (B) 0, 2, 3, 4, 5
(C) 1, 2, 3, 4, 5 (D) 0, 1, 2, 5, 6

68. For d^8 configuration, the total number of optical electrons is

(A) 1 (B) 2
(C) 3 (D) 4

69. The degeneracy of spectral term 3F is

(A) 7 (B) 9
(C) 15 (D) 21

70. The doublets observed in alkali spectra are due to

(A) Screening of the K-electrons
(B) Spin-orbit interaction of electrons
(C) Pressure of isotopes
(D) Spin of electrons only

71. The hyperfine splitting of spectral lines of an atom is due to

(A) The coupling between the spins of two or more electrons
(B) The coupling between the spins and orbital angular momentum of electrons
(C) The coupling between electron spins and nuclear spin
(D) The effect of external electro-magnetic fields

72. The number of strong-magnetic field levels of ^2D term is

(A) 8 (B) 10
(C) 12 (D) 5

73. The precessional frequency ω_L of an electron with an angular momentum vector $\vec{L}$ in a magnetic field $\vec{B}$ and orbital magnetic moment $\vec{\mu}_l$ is

(A) $\frac{|\vec{B}|}{|\mu_L||\vec{L}|}$ (B) $\frac{|\vec{\mu}_l|}{|\vec{B}||\vec{L}|}$
(C) $\frac{|\vec{\mu}_l||\vec{L}|}{|\vec{B}|}$ (D) $\frac{|\vec{\mu}_l||\vec{B}|}{|\vec{L}|}$

74. The Lande g factor for the term $^2D_{3/2}$ is

(A) $\frac{2}{3}$ (B) $\frac{4}{7}$
(C) $\frac{4}{5}$ (D) $\frac{2}{5}$

75. To observe the infrared absorption spectrum in a molecular medium

(A) The molecule should possess a permanent dipolemoment
(B) The electric dipolemoment of the molecule is zero
(C) The molecule should have a very strong absorption band in the visible region
(D) The molecule should have a very strong absorption band in the ultraviolet region

76. Raman effect is due to collision of

(A) Photon with electron
(B) Photon with molecule
(C) Electron with atom
(D) Electron with electron

77. Match the typical spectra of stable molecules with the corresponding wave number range.

1. Electronic spectra	i. 10^6 cm^{-1} and above
2. Rotational spectra	ii. $10^5 - 10^6$ cm^{-1}
3. Molecule dissociation	iii. $10^8 - 10^2$ cm^{-1}

(A) 1 – ii, 2 – i; 3 – iii
(B) 1 – ii, 2 – iii; 3 – i
(C) 1 – iii, 2 – ii; 3 – i
(D) 1 – i, 2 – ii; 3 – iii

78. The no. of Bravais lattices in monoclinic crystal structure
(A) 1 (B) 2
(C) 3 (D) 4

79. In a cubic crystal, the Bragg's angle for first order reflection from (1, 1, 0) plane is 30°. If the wavelength of X-rays is 1.54 A°, the lattice parameter is
(A) 2.37 A° (B) 2.27 A°
(C) 2.17 A° (D) 2.07 A°

80. Which of the following parameters are related to Grevneisen relation ?
(A) Thermal conductivity, thermal expansion coefficient, heat capacity
(B) Thermal expansion coefficient, specific heat and compressibility
(C) Thermal expansion coefficient, specific heat and electrical conductivity
(D) Thermal conductivity, heat capacity and compressibility

81. Which of the following statement is incorrect ?
(A) Hall effect explains the type of charge carriers
(B) Hall effect measures the mobility of charge carriers
(C) Hall effect measures the resistance of charge carriers
(D) Hall effect provides the density of charge carriers

82. The temperature (T) dependence of ferromagnetic susceptibility (χ) with curie temperature (T_c) is
(A) $\frac{C}{T+T_c}$ for $T < T_c$
(B) $\frac{C}{T+T_c}$ for $T > T_c$
(C) $\frac{C}{T-T_c}$ for $T > T_c$
(D) $\frac{C}{T-T_c}$ for $T < T_c$

83. The second Brillouin zone range of K-values
(A) From $-\frac{\pi}{a}$ to $+\frac{\pi}{a}$
(B) From 0 to $\frac{\pi}{a}$
(C) From $-\frac{\pi}{a}$ to $-\frac{2\pi}{a}$ and $+\frac{\pi}{a}$ to $\frac{2\pi}{a}$
(D) From 0 to $\frac{-\pi}{a}$

84. Which of the following is the plane defect ?

(A) Vacancy

(B) Dislocations

(C) Grain boundaries

(D) Frenkel defects

85. Which of the following property does not change when a material changes from normal state to superconducting state ?

(A) Entropy

(B) Specific heat

(C) Magnetic properties

(D) Crystal structure

86. Which of the following liquid crystal has the helical structure ?

(A) Nematic

(B) Smectic

(C) Cholesteric

(D) None of the above

87. Which of the following equation represents the critical magnetic field ?

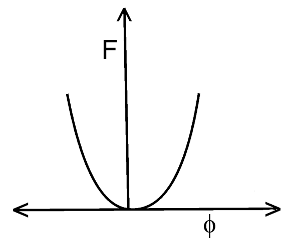
(A) $H_c = H_o\left[1-\left(\frac{T}{T_c}\right)\right]^2$

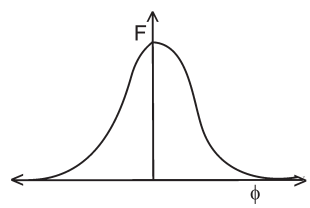
(B) $H_c = H_o\left[1+\left(\frac{T}{T_c}\right)\right]^2$

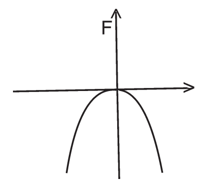
(C) $H_c = H_o\left[1-\left(\frac{T}{T_c}\right)^2\right]$

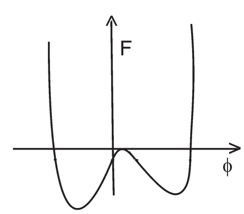
(D) $H_c = H_o\left[1+\left(\frac{T}{T_c}\right)^2\right]$

88. Which of the following graphs shows the dependence of free energy F on the order parameter of a superconductor at a fixed temperature $T < T_c$ (where T_c is the superconducting transition temperature) ?

(A) 

(B) 

(C) 

(D) 

89. Lattice part of the specific heat in metals at low temperatures

(A) Proportional to temperature and larger than the classical value

(B) Proportional to temperature and smaller than the classical value

(C) Proportional to cube of temperature and smaller than the classical value

(D) Proportional to cube of temperature and larger than the classical value

90. The range (R) and energy (E) relationship for alpha particles can be represented as
(A) $E = CR^{3/2}$ (B) $E = CR^{2/3}$
(C) $R = CE^{2/3}$ (D) $E = CR^{1/3}$

91. Which of the following is not a lepton ?
(A) electron (B) proton
(C) muon (D) neutrino

92. The baryon quantum numbers for protons, neutrons, electrons and pions are ____, _____, _____, and ______ respectively.
(A) 1, 1, 0, 0 (B) 0, 0, 1, 1
(C) 1, 1, 1, 0 (D) 1, 1, 0, 1

93. The energy of the fission fragments is _____ to their masses.
(A) proportional
(B) inversely proportional
(C) exponential
(D) none of the above

94. Isomeric states of nuclei are related to
(A) Higher order electric multipole transitions
(B) Higher order magnetic multipole transitions
(C) Admixture of electric and magnetic multipole transitions
(D) Internal conversion transitions only

95. The energy required to probe elementary particles is of the order of
(A) eV (B) KeV
(C) MeV (D) GeV

96. Nuclear size and shape are measurable through
(A) High energy electron scattering and nuclear quadrupole measurements
(B) Hyperfine splitting of spectral lines in w – meson atoms
(C) High energy electron scattering
(D) Neutron scattering

97. The rotational motion of the nucleus was observed in
(A) liquid drop model
(B) shell model
(C) collective model
(D) optical model

98. The nuclear magneton is about __________ times smaller than the Bohr magneton.
(A) 2 (B) 20
(C) 200 (D) 2000

99. **Assertion** : The deuteron is a loosely bound structure.
Reason : The two nucleons in deuteron spend a considerable amount of time outside the range of the attractive potential which bounds them together.
(A) Both assertion and reason are incorrect
(B) Assertion is correct whereas reason is incorrect
(C) Assertion is incorrect but reason is correct
(D) Both assertion and reason are correct

100. Thermal newton scattering in single crystal is employed to
(A) investigate electron band structure
(B) measure directional dielectric properties of materials
(C) determine fission reaction cross-section
(D) measure phonon dispersion

Space for Rough Work