A

22124 **120 MINUTES**

1. The divergence of magnetic vector potential is
   A) $\mu_0 J$ B) $\mu_0 B$ C) 0 D) $\mu_0 I$

2. The momentum density stored in the fields of electromagnetic waves in terms of pointing vector and velocity of the wave can be expressed as
   A) S/c B) S/c^2 C) S.c D) $S.c^2$

3. For a good conductor of electric current
   A) skin depth independent of frequency
   B) skin depth increases with increase in frequency
   C) skin depth decreases with increase in frequency
   D) skin depth first increases and then decreases with increase in frequency

4. In the case of electric dipole radiation
   A) No radiation along the axis of the dipole
   B) No radiation along equatorial plane of dipole
   C) Maximum radiation along equatorial plane of dipole
   D) Both A and C

5. A long cylinder carries a charge density proportional to the distance from the axis. Then the electric field intensity inside the cylinder at a distance r from the axis is proportional to:
   A) r B) r^2 C) $1/r^2$ D) 1/r

6. The differential form of Faraday's law of electromagnetic induction is:
   A) $\nabla . E = -\frac{\partial B}{\partial t}$ B) $\nabla . E = 0$
   C) $\nabla X B = 0$ D) $\nabla X E = -\frac{\partial B}{\partial t}$

7. The electric field at a distance r from an infinite plane sheet of charge varies with r as
   A) r B) r^0 C) $1/r^2$ D) 1/r

8. Lenz's law is a consequence of law of conservation of:
   A) energy B) charge C) momentum D) mass

9. A diatomic rigid molecule is raised from J=0 state (ground state rotational level) to J=1 state, the energy absorbed in terms of rotational constant B is:
   A) B B) 4B C) 6B D) 2B

10. For a molecule undergoing simple harmonic vibrations the zero-point energy in terms of frequency ν is given by:
    A) hν B) hν/2 C) 2hν D) 3hν

11. The frequency of oscillation of a hydrogen molecule is about (force constant 480 N/m)
A) 1.2×10^{10} Hz B) 1.2×10^{12} Hz
C) 1.2×10^{14} Hz D) 1.2×10^{15} Hz

12. When atoms of a rigid diatomic molecule are replaced by its isotope
A) inter bond distance remains same
B) inter bond distance changes
C) electron charge distribution changes
D) mass of the molecule remains same

13. Water molecule doesn't possess center of symmetry. Then all of its vibrations are:
A) IR active B) Raman active
C) both A and B D) neither A nor B

14. For a nucleus with both atomic number and mass number even, its total spin is
A) 0 B) integer
C) half integer D) Both A and B

15. In ESR the energy transitions occur in ----- region of electromagnetic spectrum
A) microwave B) IR C) UV D) visible

16. If a graph of the temperature of a body in ^{0}C versus ^{0}F is plotted, then the sine of the angle made by the straight line graph with 'F' axis is:
A) 5/86 B) 5/9 C) $9 / \sqrt{106}$ D) $5 / \sqrt{106}$

17. The isothermal bulk modulus of a perfect gas at atmospheric pressure is:
A) 1.013×10^5 N/m^2 B) 1.985×10^6 N/m^2
C) 1.418×10^5 N/m^2 D) 7.236×10^4 N/m^2

18. If a gas has f degrees of freedom, then its ratio of specific heat ($\gamma = \frac{c_p}{c_v}$) is:
A) (f+2) / f B) f/2 C) 2f D) f / (f+2)

19. Light of wavelength 4000 Å is incident on a photosensitive metal plate whose work function is 2.1 eV. The maximum kinetic energy of the emitted photo electron is:
A) 2 eV B) 1 eV C) 1.5 eV D) 10 eV

20. If the transmitted power in radar is increased by a factor of 16, then the maximum range will be increased by a factor of
A) 4 B) 8 C) 2 D) 16

21. A 9 V stabilized voltage is required to play a car stereo (R_L= 450 Ω) using a 12 V car battery. If a Zener diode with V_Z = 9 V and P_{max} = 0.27 W is used as voltage regulator, the value of series resistance required is:
A) 40 Ω B) 60 Ω C) 80 Ω D) 30 Ω

22. The maximum efficiency of a solar cell fabricated using silicon is

A) 22 % B) 40.6 % C) 81.2 % D) 78 %

23. A common source FET amplifier has a load resistance, R_L= 700 kΩ. If the ac drain resistance and amplification factor of the FET are 100 kΩ and 24 respectively, then the voltage gain of the amplifier will be:

A) 10 B) 20 C) 30 D) 15

24. If a large number of bullets are fired in all possible directions with the same speed u, then the maximum area on the ground on which these bullets will spread is:

A) $\frac{\pi u^4}{2g}$ B) $\frac{\pi u^2}{g}$ C) $\frac{\pi u^4}{g^2}$ D) $\frac{\pi^2 u^2}{g^2}$

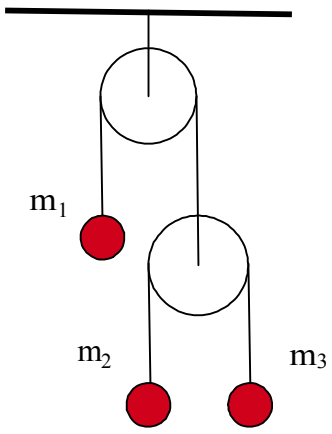
25. The change in internal energy of a system when it absorbs 5 kcal of heat energy and at the same time does 1000 J of work is:

A) 4000 J B) 2000 J C) 20000 J D) 40000 J

26. A particle of mass m is fired vertically upward with a speed v_0. Maximum height attained will be (R- radius of earth, g - acceleration due to gravity)

A) $\frac{R^2}{R-(v_0^2/2g)} - R$ B) $\frac{R^2}{R-(v_0^2/g)} - R$ C) $\frac{R^2}{2R-(v_0^2/2g)} - R$ C) $\frac{3R^2}{R-(v_0^2/2g)} - R$

27. In the following system, all the masses are initially held to be at rest. When released, what should be the value of m_3 so that m_1 does not move. (Assume that pulleys are friction less)



A) $\frac{m_1}{2m_2-m_1}$ B) m_1+2m_2 C) $\frac{m_1 m_2}{2m_2+m_1}$ D) $\frac{m_1 m_2}{4m_2-m_1}$

28. A disc of mass M and radius R rotates about an axis inclined 45^0 to normal to the plane. Its moment of inertia is...

A) $\frac{4MR^2}{5}$ B) $\frac{3MR^2}{8}$ C) $\frac{4MR^2}{2\sqrt{2}}$ D) $\frac{MR^2}{4\sqrt{2}}$

29. If A, B, C are any three dynamical variables and [ ] represents the Poisson Bracket, then $[A,[B,C]]+[B,[C,A]]=...$

A) $[[A,B],C]$ B) $[A+B,-C]$
C) $2\,(AB-BC+CA)$ D) $[C,[A,B]]$

30. Alpha particle of energy 10 MeV gets elastically scattered at angle 90^0 from a $^{91}_{40}Zr$ target. Impact parameter will be approximately ... $(1\text{fm}=10^{-15}\,\text{m})$

A) 2.45fm B) 12.4 fm C) 5.76 fm D) 0.25 fm

31. Residual resistivity is due to:
A) scattering by impurities
B) scattering by phonons
C) scattering by lattice vibrations
D) both A and B

32. Which of the following is true of Hall constant?
A) Directly proportional to electron concentration
B) Inversely proportional to electron concentration
C) Sign independent of sign of charge carriers
D) Independent of magnitude of charge of charge carriers

33. Which of the following is **not** a property of Bloch function?
A) it has the form of a travelling plane wave
B) it has an associated momentum hk/2π
C) it is delocalized throughout a solid
D) it is localized around any particular atom

34. The paramagnetic susceptibility depends on temperature as:
A) T^0 B) T C) T^{-1} D) T^2

35. Which of the following is the characteristic property of an ideal Op-Amp
A) Infinite voltage gain and zero input impedance
B) Finite voltage gain and zero output impedance
C) Infinite voltage gain and zero output impedance
D) Zero input impedance and infinite output impedance

36. For a tuned collector oscillator, the resonant frequency is 5 MHz. If the value of capacitance is increased by 21 %, then the new resonant frequency becomes:
A) 23.8 MHz B) 4.5 MHz C) 4.1 MHz D) 1.1 MHz

37. The de Broglie wavelength of an electron accelerated through a potential difference of 10 kV is:
A) 1.23 Å B) 1.23 nm C) 0.123 Å D) 0.123 nm

38. For the Hamiltonian operator H and co-ordinate operator x, the value of [x, [x,H]] equals:
A) iħ B) $m\hbar^2$ C) –iħ D) $-\hbar^2/m$

39. For a particle in one dimensional potential well of width a, the allowed energy and eigen functions are respectively:

A) $\frac{n^2\hbar^2}{2ma^2}$ and $\sqrt{\frac{a}{2}}\sin(\frac{n\pi}{a}x)$ B) $\frac{n^2h^2}{8ma^2}$ and $\sqrt{\frac{2}{a}}\sin(\frac{n\pi}{a}x)$

C) $\frac{n^2\hbar^2\pi^2}{8ma^2}$ and $\sqrt{\frac{a}{2}}\sin(\frac{a\pi}{n}x)$ D) $\frac{n^2h}{8ma}$ and $\sqrt{\frac{2}{a}}\sin(\frac{n\pi}{a}x)$

40. The non-existence of the electron in the nucleus can be substantiated using:

A) Pauli's exclusion principle B) Heisenberg's uncertainty principle
C) Correspondence principle D) Thomas-Fermi model

41. An object moves in a circle with a relativistic speed 0.6c emits a radiation of 12×10^{11} Hz. A detector placed at center of circle measures the frequency as ...

A) 11.4×10^{11} Hz B) 16.8×10^{11} Hz
C) 12×10^{11} Hz D) 9.6×10^{11} Hz

42. In a hypothetical experiment, if the speed of a rod approaches speed of light, then its length changes to:

A) Infinite B) Double the original length
C) Half its original length D) Zero

43. A particle of kinetic energy T moves in (r - Θ) plane under a potential $= \frac{-k}{r}$. If P_r and P_Θ represent conjugate momenta corresponding to the two coordinates, then $(\oint P_r dr + \oint P_\Theta d\Theta) =$

A) $\frac{1}{3}\oint(T-2V)dt$ B) $2\oint Tdt$

C) $\frac{1}{2}\oint Vdt$ D) $\frac{1}{2}\oint(T+V)dt$

44. Which of the following is true about crystal defects?

A) Vacancies and interstitials are responsible for the observed electrical conductivity of ionic crystals
B) Vacancies and interstitials alter the optical properties of ionic crystals
C) Dislocations are essential in explaining the observed strength of real crystals
D) All the above.

45. Given the generating function, $F(q, Q) = \sum_{k=1}^{n} q_k Q_k$, then Hamiltonian $H(q_k, p_k) =$

A) $H(-P_k, Q_k)$ B) $H(P_k, Q_k)$
C) $H(P_k, -Q_k)$ D) $H(-P_k, -Q_k)$

46. Equations of motion in terms of action-angle variables (J, θ) will be:
(H − Hamiltonian, t − time)

A) $\frac{\partial J}{\partial t} = -\frac{\partial H}{\partial \Theta}, \quad \frac{\partial \Theta}{\partial t} = -\frac{\partial H}{\partial J}$ B) $\frac{\partial J}{\partial t} = -\frac{\partial H}{\partial \Theta}, \quad \frac{\partial \Theta}{\partial t} = \frac{\partial H}{\partial J}$

C) $\frac{\partial J}{\partial t} = \frac{\partial H}{\partial \Theta}, \quad \frac{\partial \Theta}{\partial t} = -\frac{\partial H}{\partial J}$ D) $\frac{\partial J}{\partial t} = \frac{\partial H}{\partial J}, \quad \frac{\partial \Theta}{\partial t} = \frac{\partial H}{\partial J}$

47. Hamilton Jacobi equation for a free particle moving along x axis and having action S(x, t) is:

A) $\frac{\partial S}{\partial t} = -\frac{1}{2m}\left(\frac{\partial S}{\partial x}\right)^2$ B) $\frac{\partial S}{\partial t} = \frac{1}{2m}\frac{\partial^2 S}{\partial x^2} + \frac{1}{2m}\left(\frac{\partial S}{\partial x}\right)^2$

C) $\frac{\partial S}{\partial t} = \frac{1}{2m}\frac{\partial^2 S}{\partial x^2} - \frac{1}{2m}\left(\frac{\partial S}{\partial x}\right)^2$ D) $\frac{\partial S}{\partial t} = \frac{1}{2m}\left(\frac{\partial S}{\partial x}\right)^2$

48. A particle follows a trajectory given by the equation, $(x + xy)\frac{dy}{dx} + y = 0$. If y(1)=1, then

A) $xy = e^{-y}$ B) $xy^2/3 = e^y$ C) $xy = e^{1-y}$ D) $xy = e^{y+1}$

49. $\int_{-\infty}^{\infty} x^2\,\delta(2x-3)dx =$ ……..

A) 9/8 B) ∞ C) 26/3 D) 0

50. If $\dot{\Psi} = \frac{d\Psi}{dt}$ and $\dot{x} = \frac{dx}{dt}$, then $\frac{\partial \dot{\Psi}}{\partial \dot{x}}$ = ……

A) $\frac{\partial^2 \Psi}{\partial x^2}$ B) $\frac{\partial \Psi}{\partial x}$ C) $\frac{\Psi}{\dot{x}}$ D) $\frac{d\Psi}{dx}$

51. For crystals like graphite and boron nitride, the specific heat capacity C_v at low temperature is proportional to:

A) T^3 B) T C) T^2 D) T^0

52. The probability of finding an electron with energy equal to the Fermi energy in a metal at any temperature T is:

A) 1 B) 1/2 C) 0 D) $\frac{1}{\exp\left(\frac{\Delta E}{kT}\right) - 1}$

53. The ratio of rms speed to most probable speed for a gas is

A) $\sqrt{2} : \sqrt{3}$ B) $2\sqrt{2} : \sqrt{3}$ C) $\sqrt{3} : \sqrt{2}$ D) $\sqrt{3} : 2\sqrt{2}$

54. If the entropy of a thermodynamic system is represented as a function of temperature T and volume V, then the thermodynamical relation expressing TdS equation is:

A) $TdS = C_p dT + T\left(\frac{\partial S}{\partial V}\right)_T$ B) $TdS = C_v dT - T\left(\frac{\partial P}{\partial T}\right)_V dV$

C) $TdS = C_v dT + T\left(\frac{\partial P}{\partial T}\right)_V dV$ D) $TdS = C_p dT - T\left(\frac{\partial P}{\partial T}\right)_V dV$

55. In a CE configuration, the pd across 10 kΩ collecter resistance is 10 V. If the current gain of the transistor $\alpha = 0.98$, then the base current is

A) 20.4 mA B) 0.0204 μA C) 0.0204 A D) 20.4 μA

56. A sample of pure Ge crystal has a hole density of 10^{14} cm^{-3} at room temperature. When it is doped with bismuth, the hole density falls to 10^{13} cm^{-3}. Now the electron density of doped Ge crystal is:

A) 10^{15} cm^{-3} B) 10^{16} cm^{-3} C) 10^{14} cm^{-3} D) 10^{12} cm^{-3}

57. A piece of red glass when heated to red hot will appear to be:

A) Red B) Green C) Invisible D) white

58. The relative probability between two different energy states having energy difference 4.83×10^{-21} J at temperature 175 K is:

A) e^2 B) e^{-2} C) e^{-1} D) e

59. For two systems in thermal contact with a heat reservoir, the property central to the use of canonical ensemble is (ρ being probability density)

A) $\rho = \rho_1 + \rho_2$ B) $\rho = \rho_1 \rho_2$

C) $\log \rho = \log \rho_1 - \log \rho_2$ D) $\log \rho = \log \rho_1 + \log \rho_2$

60. The Fermi energy for sodium is 3.1 eV. Then its Fermi temperature is:

A) 2.3×10^4 K B) 3.6×10^4 K C) 2.3×10^{23} K D) 3.6×10^3 K

61. The temperature at which an intrinsic semiconductor behaves like insulator is

A) $0\ ^0C$ B) 300 K C) 0 K D) 6000 K

62. In a step-up transformer, the turn ratio is 1: 5. If a Daniel cell of emf 1.08 V is connected across its primary, then the voltage across the secondary is:

A) 0.216 V B) 0 V C) 5.4 V D) 1.08 V

63. A (2x2) matrix M has eigen values $\exp(i\pi/6)$ and $\exp(i\pi/5)$. Smallest value of n such that $M^n = I$ is …… (I is the unit matrix)

A) 10 B) 3 C) 60 D) 8

64. Let $J_1(x)$ be the bessel function of first order, then its Laplace transform, F(t), is …

A) $\frac{t}{\sqrt{1+t^2}}$ B) $\frac{\sqrt{1+t^2}-t}{\sqrt{1+t^2}}$ C) $\frac{t-\sqrt{2+t^2}}{2\sqrt{3+t^2}}$ D) $\frac{\sqrt{2t}}{1-t}$

65. Let $J_n(x)$ is the n^{th} order Bessel function, then $\frac{d}{dx}\left(J_4(x)\left(x^4+\frac{1}{x^4}\right)\right)$ = …..

A) $\left(x^4-\frac{3}{x^4}\right)J_3-\frac{8}{x^5}J_4$ B) $\left(x^4+\frac{2}{x^4}\right)J_3+\frac{8}{x^5}J_4$

C) $\left(x^4+\frac{1}{x^4}\right)J_3-\frac{8}{x^5}J_4$ D) $\left(x^4-\frac{1}{x^4}\right)J_3-\frac{16}{x^5}J_4$

66. Orthogonality of Laguerre functions is given by, $\int_0^\infty f(x)L_m(x)L_n(x)dx = k$. Here,

A) $f(x) = x^2$ and $k = n!\,\delta_{mn}$ B) $f(x) = \exp(-x^2)$ and $k = n!\,\delta_{mn}$

C) $f(x) = \exp(-x)$ and $k = \delta_{mn}$ D) $f(x) = \exp(-x)$ and $k = n!\,\delta_{mn}$

67. Let $H_n(x)$ be the n^{th} order Hermite function, then $H_0(x) = 0$ if

A) $x \to \pm\infty$ B) x = 1, 2, 3, ….. C) x = 0 D) $x = \pi, 2\pi, 3\pi, \ldots$.

68. Let $M = \begin{pmatrix} 2 & -0.1 \\ 0 & 3 \end{pmatrix}$ and $M^{-1} = \begin{pmatrix} \frac{1}{2} & a \\ 0 & b \end{pmatrix}$ then a + b = ……

A) $\frac{1}{6}$ B) $\frac{7}{20}$ C) $\frac{2}{13}$ D) $\frac{3}{14}$

69. Let $X\begin{bmatrix} 1 \\ -1 \end{bmatrix} = -\begin{bmatrix} 1 \\ -1 \end{bmatrix}$ and $X\begin{bmatrix} 1 \\ -2 \end{bmatrix} = -2\begin{bmatrix} 1 \\ -2 \end{bmatrix}$ then X is given by:

A) $\begin{bmatrix} 0 & -2 \\ 1 & -3 \end{bmatrix}$ B) $\begin{bmatrix} 1 & -1 \\ 1 & 3 \end{bmatrix}$ C) $\begin{bmatrix} -3 & -2 \\ -1 & 4 \end{bmatrix}$ D) $\begin{bmatrix} 0 & 1 \\ -2 & -3 \end{bmatrix}$

70. $f(x) = \begin{cases} 1 + \frac{2x}{\pi} \; ; & -\pi \le x \le 0 \\ 1 - \frac{2x}{\pi} \; ; & 0 \le x \le \pi \end{cases}$

Then Fourier series of *f(x)* is given by:

A) $\sum_{n=1}^{\infty} \left(\frac{4}{\pi^2 n^2}(1 + (-1)^n\right) cos\, nx$

B) $\sum_{n=0}^{\infty} \left(\frac{4}{\pi^2 (n+1)^2}\right) sin\, nx$

C) $\sum_{n=1}^{\infty} \left(\frac{4}{\pi^2 n^2}(1 + \cos n\pi\right) cos\, nx + \sum_{n=0}^{\infty} \left(\frac{4}{\pi^2 (n+1)^2}\right) sin\, nx$

D) $\sum_{n=0}^{\infty} \left(\frac{2}{\pi^2 n^2}\right) cos\, nx$

71. Modulus of complex number (3 + 4i) will be:

A) 10 B) 25 C) 9 D) 5

72. Let Z and W are two complex numbers, then:

A) $|Z - W| = |Z| - |W|$ B) $|Z + W| = |Z| + |W|$

C) $|Z + W| \ge |Z| + |W|$ D) $|Z - W| \ge |Z| - |W|$

73. Given $\rho(x) = Ae^{-|x|} - Be^{-2|x|}$ is a probability density function for a continuous and real random variable x which is defined over the X-axis. A and B are positive real numbers. Then:

A) A+ B = 2/3 B) 2A – B = 1 C) A + B = 1 D) A – B =1/5

74. Standard deviation of a random variable which is uniformly distributed between 0 and 1 is

A) $\frac{1}{\sqrt{15}}$ B) $\frac{1}{\sqrt{2}}$ C) $\frac{1}{\sqrt{12}}$ D) $\frac{1}{2}$

75. When a static potential V is applied across the Josephson junction the frequency of ac produced across the junction is

A) 2eV/h B) eV/h C) 3eV/h D) 4eV/h

76. For a three dimensional isotropic harmonic oscillator, the degree of degeneracy is:

A) $\frac{1}{2}(n+1)(n+2)$ B) n

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

77. The expectation value of momentum p can be represented as:

A) $\int \varphi(\frac{\hbar}{i}\nabla)\varphi^* d\tau$ B $\int \varphi^*(\frac{\hbar}{i}\nabla)\varphi d\tau$

C) $\int(\frac{\hbar}{i}\nabla)\varphi^*\varphi d\tau$ D) $\int \varphi^*\varphi^*(\frac{\hbar}{i}\nabla)d\tau$

78. The wave function of a certain particle is represented by $\varphi = A\,cos^2 x$ for the limit x= $\frac{-\pi}{2}$ to $\frac{\pi}{2}$. Now, the value of A using normalization condition is:

A) $\sqrt{\frac{2}{a}}$ B) $\sqrt{\frac{3}{2\pi}}$ C) $\sqrt{\frac{8}{3\pi}}$ D) $\sqrt{\frac{3\pi}{2}}$

79. If the components of arbitrary vectors $\vec{A}$ and $\vec{B}$ commute with those of Pauli's spin matrix σ, then the value of $(\boldsymbol{\sigma} \cdot \vec{A})\ (\boldsymbol{\sigma} \cdot \vec{B})$ = ...

A) $\vec{A} \times \vec{B}$ + i $\boldsymbol{\sigma}\,(\vec{A} \cdot \vec{B})$ B) $\vec{A} \cdot \vec{B}$ + i $\boldsymbol{\sigma} \cdot (\vec{A} \times \vec{B})$

C) i $\boldsymbol{\sigma} \cdot (\vec{A} \times \vec{B})$ D) i $\boldsymbol{\sigma}\,(\vec{A} \cdot \vec{B})$

80. For the raising and lowering operators, J_+ an J_- , of general angular momentum J, the product J_+J_- equals:

A) $J^2 - J_x^2 + \hbar J_x$ B)) $J^2 + J_z^2 + \hbar J_z$

C) $J^2 - J_y^2 + \hbar J_y$ D) $J^2 - J_z^2 + \hbar J_z$

81. The ratio of the kinetic energy of an electron to that of a proton if their wavelengths are equal is:

A) $\frac{1}{1836}$ B) 1836 C) 42.8 D) 1

82. One mole of an ideal gas undergoes adiabatic expansion from state P_1, V_1, T_1 to state P_2, V_2, T_2. Now, the work done by the system is

A) $RT_1 \ln(V_2/V_1)$ B) $\frac{R}{\gamma}$ $(T_1 - T_2)$

C) $RT_2 \ln(V_2/V_1)$ D) $C_v (T_1 - T_2)$

83. 1 kg of ice melts at 0 ^{0}C into water at the same temperature. The entropy change during this process is (Given Latent heat of fusion of water = 80 cal/g) -------.
A) 293 cal/K B) 0 C) 0.293 cal/K D) infinity

84. The expression for free energy F in terms of canonical partition function Z is:
A) $F = kT \frac{\partial(lnZ)}{\partial T}$ B) $F = kT^2 \frac{\partial(lnZ)}{\partial V}$
C) $F = - kT\, lnZ$ D) $F = - \frac{\partial(lnZ)}{\partial Z}$

85. A system containing 8 distinguishable spin ½ particles is placed in a magnetic field of strength B. If the system possesses energy $2\mu_B B$, then the numbers of distinct possible configurations are
A) 16 B) 64 C) 128 D) 256

86. The melting point of substances, which contracts on melting, decreases with.....
A) decrease of pressure B) increase of pressure
C) decrease of temperature D) increase of temperature

87. For an isotropic medium of volume V, the total number of stationary wave modes of vibration lying in the frequency range between υ and υ + d υ is .....(velocity of longitudinal and transverse waves being v_l and v_t)
A) $4\pi V(\frac{1}{V_l^3} + \frac{2}{V_t^3})\, \upsilon^2 d\upsilon$ B) $2\pi V(\frac{2}{V_l^3} + \frac{1}{V_t^3})\, \upsilon^2 d\upsilon$
C) $4\pi V(\frac{2}{V_l^3} + \frac{2}{V_t^3})\, \upsilon^{3/2} d\upsilon$ D) $2\pi V(\frac{1}{V_l^3} + \frac{2}{V_t^3})\, \upsilon^{3/2} d\upsilon$

88. Value of integral $\int_C \frac{cos2\pi z}{(2z-1)(z-3)}$ = ……where C is the closed curve given by $|Z| = 1$
A) $\frac{\pi i}{2}$ B) $\frac{\pi i}{5}$ C) $\frac{2\pi i}{5}$ D) π i

89. Directional derivative of ϕ (x, y, z) = $2x^2 + 3y^2 + z^2$ at (2,1, 3) along a vector $\vec{f} = 8\hat{\imath} - 6\hat{\jmath}$ will be ……
A) 5.7 B) 1.7 C) 3.1 D) 2.8

90. Which of the following is correct?
A) gluon-gluon interactions does not exist since they are vector bosons
B) electron and positron beams of sufficient energy can produce quark-anti quark pairs
C) Parity of photons is positive
D) Z^0 is a (red - anti blue) color combination

91. Quark structure of meson singlet is:
A) $\frac{1}{\sqrt{3}}(u\bar{u} - d\bar{d})$ B) $\frac{1}{\sqrt{3}}(u\bar{u} + d\bar{d} - s\bar{s})$
C) $\frac{1}{\sqrt{3}}(u\bar{u} + d\bar{d} + s\bar{s})$ D) $\frac{1}{\sqrt{3}}(u\bar{u} - d\bar{d} - s\bar{s})$

92. In the decay $\sum^{+} \rightarrow p + \gamma$, forces involved are:
A) weak and electromagnetic B) weak only
C) electromagnetic and strong D) electromagnetic only

93. Assume the reaction ${}^{88}A\ ({}^{20}X, {}^{12}Y)\ {}^{88}B$ has a Q value – 10 MeV. Threshold energy will be ….
A) -27.8 MeV B) -10 MeV C) 12.5 MeV D) 10 MeV

94. Ground state spin-parity of ${}^{53}_{24}Cr$ according to single particle shell model will be….
A) $\frac{1^-}{2}$ B) $\frac{7^+}{2}$ C) $\frac{5^-}{2}$ D) $\frac{3^-}{2}$

95. Let S, I, L represent total spin, isospin and orbital angular momentum quantum numbers. For a deuteron, their values are:
A) S = 0 ; L = 0, 2 ; I = 1 B) S = 1 ; L = 1 ; I = 1
C) S = 0 ; L = 0, 2 ; I = 0 D) S = 1 ; L = 0, 2 ; I = 0

96. By liquid drop model, Coulomb energy difference between two mirror nuclei is 10 MeV. Let Z_1 and Z_2 be their atomic numbers ($Z_1 > Z_2$) such that $Z_1^2 - Z_2^2 = 50$. Radius of nucleus with Z_1 will be nearly equal to …..
A) 1.34 *fm* B) 8.63 *fm* C) 4.32 *fm* D) 9.64 *fm*

97. The ratio of rate of stimulated emission to that of spontaneous emission at 1000 K for a radiation of wavelength 5000 Å is:
A) 3.1×10^{-11} B) 3.1×10^{-13} C) 3.1×10^{-9} D) 3.1×10^{-8}

98. A measurement of the Stark components (Stark effect) gives a method for the accurate determination of:
A) magnetic dipole moment B) electric dipole moment
C) magnetic energy levels D) Both A and B

99. What is the change in the rotational constant B when hydrogen is replaced by deuterium in hydrogen molecule?
A) B B) 2B C) B/2 D) 4B

100. The time base of a CRO is developed by:
A) Sawtooth wave form
B) Square wave form
C) Sine wave form
D) None of these

101. The strength of magnetic field to give a precessional frequency of 100 MHz for O^{17} nucleus (given g_N=0.757, $\mu_N = 5.05 \times 10^{-27}$ SI units and I=5/2)
A) 1.733 B) 17.33 C) 0.173 D) 173.3

102. The Bohr magneton associated with an electron is about ------ SI units.
A) 9.2×10^{-24} B) 9.2×10^{-21} C) 9.2×10^{-18} D) 9.2×10^{-23}

103. In hydrogen spectrum the fine structure of H_α line have ----- components.
A) 5 B) 3 C) 2 D) 4

104. In Zeeman effect on applying a magnetic field of about 3 T a single spectral line split into:
A) 2 B) 5 C) 3 D) 4

105. The reciprocal lattice of bcc lattice is:
A) bcc lattice B) fcc lattice
C) simple cubic lattice D) simple trigonal lattice

106. The particle like entity which carries the unit of energy of the elastic field is
A) photon B) graviton C) phonon D) gluon

107. The magnetic susceptibility of a superconducting state is about:
A) 0 B) +1 C) -1 D) 300

108. Which of the following is paramagnetic?
A) copper B) gold C) mercury D) aluminium

109. According to Dulong-Petit law the specific heat at constant volume at high temperature varies with temperature as:
A) constant B) T C) T^2 D) T^3

110. According to free electron model, the electrical conductivity of a metal does not depend on:
A) number density of free electrons
B) temperature
C) effective mass of free electrons
D) length of the conductor

111. Choose the correct statement for beta decay:
A) $\frac{7^-}{2}$ to $\frac{3^+}{2}$ is a first forbidden transition by Fermi selection rule
B) $\frac{1^-}{2}$ to $\frac{1^+}{2}$ is an allowed transition by Fermi selection rule
C) $\frac{5^+}{2}$ to $\frac{1^-}{2}$ is a first forbidden transition by Gamow-Teller selection rule
D) $\frac{5^+}{2}$ to $\frac{3^-}{2}$ is an allowed transition by Gamow-Teller selection rule

112. Which of the following radiative (γ) transitions in nuclear levels has multipolarity = 2 and non-zero parity change?
A) Electric dipole B) Magnetic dipole
C) Electric quadrupole D) Magnetic quadrupole

113. Let the neutral kaon and its antiparticle are represented as the states $|K^0>$ and $|\overline{K^0}>$ respectively. We take a superposition $|\phi> = \frac{1}{\sqrt{2}}(|K^0> + |\overline{K^0}>)$. If C and P represent charge conjugation and parity operations, the CP $|\phi> = \ldots$.

A) $|\phi>$ B) $-|\phi>$ C) $|K^0>$ D) $\frac{1}{\sqrt{3}}|\overline{K^0}>$

114. A transmission line is said to be lossless if:
A) conductors of the line are perfect
B) medium separating the lines is lossless
C) both A and B
D) conductors of the lines are not perfect

115. A transmission line can support only ----- mode of electromagnetic wave propagation
A) TEM B) TM C) TE D) HE

116. In a rectangular wave guide the lowest order of all the TM_{mn} modes is
A) TM_{10} B) TM_{01} C) TM_{00} D) TM_{11}

117. If ρ is the volume charge density then Gauss' law can be expressed as:
A) $\nabla.D = \rho$ B) $\nabla.E = \rho$ C) $\nabla XD = \rho$ D) $\nabla XE = \rho$

118. The Ampere's circuital law can be expressed as
A) $\nabla XB = J$ B) $\nabla XH = J$ C) $\nabla XB = I$ D) $\nabla XH = I$

119. The normal component of electric field is discontinuous by an amount ----- at any boundary:
A) $\sigma/2\varepsilon_0$ B) σ/ε_0 C) $2\sigma/\varepsilon_0$ D) $3\sigma/\varepsilon_0$

120. At a boundary between two different media, the parallel components of H are discontinuous by an amount proportional to
A) surface current B) surface current density
C) surface charge D) surface charge density
