A

25124 **120 MINUTES**

1. Condition for a vector $\vec{A}$ to be solenoidal:

   A) $\vec{\nabla}.\overrightarrow{A} = 0$ B) $\nabla\overrightarrow{A} = 0$ C) $\vec{\nabla}.\overrightarrow{A} \neq 0$ D) $\nabla \times \overrightarrow{A} = 0$

2. The period of the function $3Cos\left[\frac{\pi}{4}(t-1)\right]$:

   A) 4 s B) 8 s C) ¼ s D) 2 s

3. The mean and standard deviation are 20 and 4 respectively. Get the binomial expression:

   A) $\left(\frac{1}{5}+\frac{4}{5}\right)^{25}$ B) $\left(\frac{4}{5}+\frac{1}{5}\right)^{25}$ C) $\left(\frac{1}{5}+\frac{4}{5}\right)^{100}$ D) None of these

4. Which of the following is **not** true about motion in a central force field?
   A) Has spherical symmetry if force is along the distance from the fixed centre
   B) Angle co-ordinate is cyclic
   C) Orbital plane is parallel to the fixed direction of angular momentum
   D) Angular momentum is conserved.

5. A particle of mass m moves in a one dimensional potential $V(x) = kx^2$; $(k > 0)$. At time t=0, the particle starts from rest at x=A. If A is the amplitude, then the time period for bounded motion is :

   A) Independent of A B) Proportional to $\frac{1}{\sqrt{A}}$
   C) Proportional to $\frac{1}{A}$ D) None of these

6. Zero point energy is a consequence of:
   A) Degeneracy B) Harmonics
   C) Uncertainty principle D) None of these

7. The transition rate between eigen states is described by:
   A) Hartree-Fock equation B) Fermi's golden rule
   C) Optical theorem D) Connection formulas

8. If the energy of a particle is reduced to half, then the percentage increase in the de-Broglie wavelength is:
   A) 100% B) 41 % C) >100% D) None of these

9. The position operator for a proton in momentum space is:

A) $-i\hbar\vec{\nabla}$ B) $i\hbar\frac{\partial}{\partial t}$ C) $\hat{x}$ D) $i\hbar\frac{\partial}{\partial p}$

10. Assertion (A): The eigen functions are all even.
Reason (R): The parity of wave function alternates with each increasing energy level.

A) Both A and R are true and R is the correct explanation of A
B) Both A and R are true, but R is not the correct explanation of A
C) A is true but R is false
D) A is false but R is true

11. Which of the following correctly gives the *TdS* equation?

A) $TdS = C_v dT + T\left(\frac{\partial V}{\partial T}\right)_P dP$

B) $TdS = C_v dT - T\left(\frac{\partial V}{\partial T}\right)_V dV$

C) $TdS = C_p dT - T\left(\frac{\partial V}{\partial T}\right)_p dP$

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

12. The statistical distribution function for a proton gas is:

A) $e^{-\frac{\varepsilon}{kT}}$ B) $\frac{1}{e^{\beta(\varepsilon_i-\mu)}-1}$ C) $\frac{1}{e^{\left(\frac{\varepsilon}{kT}\right)}+1}$ D) $\frac{1}{e^{\beta(\varepsilon_i-\mu)}+1}$

13. Canonical ensemble is related to :

A) The freedom of the system
B) The size and shape of the system
C) An isolated system
D) The thermal equilibrium of the system

14. Which statistics will be applied to deuterons?

A) Maxwell-Boltzmann B) Fermi-Dirac
C) Bose-Einstein D) All of these

15. Identify the correct option about the magnitude of motional e.m.f. in a conductor of length 'l' moving at a speed 'v' perpendicular to a magnetic field 'B'.

A) Blv ; Faradays' law
B) -B/lv ; Biot Savart's law
C) -lB/v ; Ampere's circuital law
D) None of these

16. The trajectory of a charged particle moving in a crossed electromagnetic field ($\vec{E} \perp \vec{B}$) will be:
A) Circular B) Cycloidal C) Linear D) Will not move

17. The magnetic field at a distance 'r' from a long straight wire carrying steady current 'i' is proportional to:
A) $\frac{i}{r^2}$ B) $\frac{i^2}{r}$ C) $\frac{i}{r}$ D) None of these

18. Monochromatic nature of a source is decided by:
A) Spectral coherence B) Spatial coherence
C) Polarization D) Temporal coherence

19. Which of the following is **wrong** as far as rectangular waveguides are considered?
A) TE_{10} is the dominant mode
B) TE_{10} has the highest cut-off wavelength
C) Electric field is perpendicular to the direction of propagation
D) None of these

20. Identify the Lorentz gauge condition. (Given $\vec{A}$ and $\emptyset$ as vector and scalar potentials respectively and c as the speed of electromagnetic wave):

A) $\vec{\nabla} \times \vec{A} = -c^2 \frac{\partial \emptyset}{\partial t}$ B) $\vec{\nabla}.\vec{A} = -c^{-2} \frac{\partial \emptyset}{\partial t}$

C) $\vec{\nabla}.\vec{A} = \frac{1}{c^2} \frac{\partial \emptyset}{\partial t}$ D) $\vec{\nabla} \times \vec{A} = -c^{-2} \frac{\partial \emptyset}{\partial t}$

21. Which of the following is connected to the Morse energy curve?
A) Acoustic resonator B) Phase shift oscillator
C) Anharmonic oscillator D) Hooke's atom

22. A vibration producing change in electric dipole moment of a molecule yields:
A) Infrared spectra B) Raman spectra
C) X-ray spectra D) None of these

23. During an electronic transition, the nuclear configuration of the molecule experiences no significant change. This is:
A) Aufbau principle B) Frank Condon principle
C) Overhauser effect D) Latice-latice relaxation

24. The Lande g-factor for the $^3P_1$ level of an atom is:
A) 5/2 B) 7/2 C) 3/2 D) 1/2

25. The shortest wavelength produced in an X-ray tube operating at 30 keV is:
A) 0.01 Å B) 1.24 Å C) 0. 2 Å D) 0.413 Å

26. The ground state of Sodium (Z=11) is:

A) $^3P_{3/2}$ B) $^5S_{3/2}$ C) $^2S_{1/2}$ D) $^2P_{1/2}$

27. Which among the following neglects the motion of the atomic nuclei while describing the electrons in a molecule?
A) WKB approximation
B) Born-Oppenheimer approximation
C) Born successive approximation
D) None of these

28. The admissible potential between neutron and proton in a deuteron is:
A) Finite square well B) Infinite square well
C) Charge independent D) Spin independent

29. The non-conserved quantity in the reaction $p \rightarrow e^+ + \gamma$:
A) Charge B) Baryon number
C) Strangeness D) None of these

30. Fission fragments are in general radioactive because they are ….?
A) Rich in protons
B) Rich in neutrons
C) Products of radioactive nuclides
D) All of these

31. Identify the correct sequence that shows the nucleon filling and the nucleon number.
A) $1s_{1/2}\ 2p_{1/2}\ 2p_{3/2}\ 3d_{5/2}\ 3d_{3/2}$; 18
B) $1s_{1/2}\ 1p_{3/2}\ 1p_{1/2}\ 1d_{3/2}\ 2s_{1/2}$; 14
C) $1s_{1/2}\ 1p_{3/2}\ 1p_{1/2}\ 1d_{5/2}\ 2s_{1/2}$; 16
D) $1s_{1/2}\ 2p_{3/2}\ 2p_{1/2}\ 3s_{1/2}\ 3p_{3/2}$; 14

32. Violation of mass energy conservation law in meson theory of nuclear force is in accordance with:
A) Gell-Mann–Nishijima formula
B) Heisenberg's uncertainty principle
C) Charge conjugation
D) Selection rules

33. Which among the following has a non-classical origin in the Weizsacker's semi empirical mass formula?

A) Coulomb term B) Surface term
C) Asymmetry term D) Volume term

34. Identify the pair which represents a mirror nuclei:

A) $^{60}_{27}$Co and $^{27}_{13}$Al B) $^{60}_{27}$Co and $^{60}_{69}$Zn

C) $^{60}_{27}$Co and $^{27}_{13}$Al D) $^{52}_{24}$Cr and $^{52}_{28}$Ni

35. The process of transfer of energy from a high excited state nuclei to an inner atomic electron is called:

A) Pick up reaction
B) Internal Conversion
C) Compound nuclei formation
D) Stripping reaction

36. Which of the following is allowed?

A) $\pi^+ \rightarrow \mu^+ + \nu_\mu$ B) $\pi^+ + \pi^- \rightarrow \gamma$
C) $\bar{\nu} + p \rightarrow e^+ + n$ D) None of these

37. The amount of energy released when all the nuclei in 1 kg of deuterium fuse by the reaction:

$$6(^2_1H) \rightarrow 2(^4_2He) + 2p + 2n + 43\ MeV$$

A) 3.456×10^{13}J B) 34.56×10^{12}J
C) 34.56×10^{14}J D) 34.56×10^{13}J

38. The 'yellowcake' is:

A) Uranium B) Plutonium C) Iodoform D) Curcumin

39. Match the following :

List I	List II
a. Electromagnetic decay	1. $K^o \rightarrow \pi^- + \pi^+$
b. Strong decay	2. $n \rightarrow p + e^- + \bar{\nu_e}$
c. Negative β-decay	3. $\Delta^o \rightarrow \pi^o + n$
d. Weak decay	4. $\pi^o \rightarrow e^- + e^+$

A) a-3, b-4, c-1, d-2 B) a-4, b-3, c-2, d-1
C) a-1, b-2, c-3, d-4 D) a-4, b-2, c-3, d-1

40. The speed of a moving relativistic particle whose mass is 3 times its rest mass is:

A) $\frac{8}{9}$c B) $\frac{1}{3}$c C) $\frac{2\sqrt{2}}{3}$c D) 3c

41. Identify the non-directional bond:
A) Covalent B) Metalic C) Ionic D) Co-ordinate

42. Due to Frenkel defect, the density of ionic solids:
A) Decreases B) Decreases and then increase
C) Increases D) Does not change

43. The Bragg angle for 1st order reflection from (111) plane in a crystal is 30º. Wavelength of X-ray is 1.75 Å. Calculate the lattice parameter 'a'.
A) 3.03 Å B) 3.31 Å C) 3.33 Å D) 3.13 Å

44. Calculate the conductivity of an intrinsic semiconductor at 300º K.
Give the below data.
$Carrier\ concentration, n_i = 2.4 \times 10^{19}\ m^{-3}; carrier\ mobility,$
$\mu_n = 0.39\ m^{-2}\ v^{-1}s^{-1}\ and\ \mu_p = 0.19\ m^{-2}\ v^{-1}s^{-1}$

A) 2.93 mho/m B) 3.23 mho/m
C) 2.22 mho/m D) 1.42 mho/m

45. The lattice parameters for an orthorhombic crystal are related by a=2b=3c. Find the interplanar separation between the (110) planes.

A) $\frac{a}{\sqrt{5}}$ B) $\frac{\sqrt{5}}{a}$ C) $\frac{\sqrt{3}}{a}$ D) $\frac{3}{a}$

46. Wave vectors that lie within the 1st Brillouin zone in reciprocal space describes:
A) Matter wave B) Bloch wave
C) Lattice waves D) Bow shock wave

47. The Energy momentum (E-k) relation in a solid is given by $E(k) = \frac{1}{2}(Ak^2 + Bk^4)$, where A and B are constants. Calculate the effective mass of electron at |k| = k_0.

A) Ak_o^2 B) $\left(\frac{Ak_o + 2Bk_o^3}{\hbar^2}\right)$

C) $\hbar^2(A + 6Bk_o^2)$ D) $\frac{\hbar^2}{(A+6Bk_o^2)}$

48. For a metal obeying Sommerfeld model exactly, choose the relation connecting Fermi energy (E_F) at T=0K and Hall coefficient (R_H).

A) $R_H = E_F^{3/2}$ B) $R_H = E_F^{-3/2}$

C) $R_H = E_F^{2/3}$ D) $R_H \; is \; independent \; of \; E_F$

49. Find the separation distance (x) between the two atoms when the potential energy of interaction between them in the field of each other in a diatomic molecule becomes a local minimum (not at $x = \infty$). Given the interaction energy $U(x) = \frac{a}{x^{12}} - \frac{b}{x^6}$.

A) $\left(\frac{2a}{b}\right)^{1/6}$ B) $\left(\frac{9b}{a}\right)^{1/6}$ C) $\left(\frac{2a}{b}\right)^{1/8}$ D) $\left(\frac{9b}{a}\right)^{1/8}$

50. The resonant circuit of a tuned collector transistor oscillator has a resonant frequency of 4.4 MHz. If the capacitance is increased by 21 %, the new resonant frequency will be:

A) 9.6 MHz B) 4 MHz C) 3.6 MHz D) None of these

51. The lowest level programming language used in a microprocessor is:

A) FORTRAN B) Assembly Language
C) COBOL D) Processor States Word

52. Which of the following is **not** true about a Gaussian function?

A) $y = -\frac{h}{\sqrt{\pi}} e^{h^2 x^2}$ is the mathematical expression for a Gaussian distribution
B) The ground state wave function of a quantum harmonic oscillator is a Gaussian function
C) Derivatives of the Gaussian function can be represented using Hermite functions
D) Gaussian functions represent the probability density function of a normal distribution

53. Number of significant figures in 4.50×10^3 and 0.000103 are respectively:

A) 2 and 3 B) 6 and 3 C) 3 and 3 D) 2 and 6

54. PIN diode acts as a ordinary diode at frequencies up to about:

A) 300 MHz B) 100 kHz C) 100 MHz D) 10 MHz

55. A thermometer is calibrated 150ºC to 200ºC. The accuracy is specified within ±0.25% of instrument span. Calculate the maximum static error.

A) ± 0.125ºC B) ± 0.3ºC C) ± 0.4375ºC D) None of these

56. Assertion (A): In successive approximation type ADC, conversion time remains the same.
Reason (R): Conversion time is independent of input voltage.

A) Both A and R are true and R is the correct explanation of A
B) Both A and R are true, but R is not the correct explanation of A
C) A is true but R is false
D) A is false but R is true

57. Match the following:

List I	List II
a. Class-A amplifier	1. Radio works
b. Class-B push-pull amplifier	2. Conduction angle between 180º and 360º
c. Class-AB amplifier	3. Conduction angle = 360º
d. Class-C amplifier	4. Audio works

A) a-3, b-4, c-1, d-2 B) a-4, b-3, c-2, d-1
C) a-3, b-2, c-4, d-1 D) a-3, b-4, c-2, d-1

58. Why Silicon is **not** suitable for the fabrication of Light Emitting Diodes?
A) It is a direct band gap semiconductor
B) It is an indirect band gap semiconductor
C) Wider band gap
D) Narrower band gap

59. The temperature of two black bodies A and B are 400ºK and 200ºK respectively. If the surface area of A is twice than that of B, calculate the ratio of total power emitted by A and B.
A) 32 B) 1 C) 16 D) 4

60. The isotopic shift in very light atoms are due to:
A) Mass effect B) Volume effect
C) Surface effect D) None of these

61. Given the translation vector of a space lattice,
$\vec{a} = \frac{1}{2}\hat{x} + \frac{\sqrt{3}}{2}\hat{y}$; $\vec{b} = -\frac{1}{2}\hat{x} + \frac{\sqrt{3}}{2}\hat{y}$; $\vec{c} = \hat{z}$. Find the volume of unit cell.
A) $\frac{2}{\sqrt{3}}$ B) $\frac{\sqrt{3}}{2}$ C) $2\sqrt{3}$ D) $2\sqrt{2}$

62. Which of the following matrix is Hermitian?
A) $\begin{bmatrix} i & 0 \\ 0 & -i \end{bmatrix}$ B) $\begin{bmatrix} i & 0 \\ 0 & i \end{bmatrix}$ C) $\begin{bmatrix} 0 & i \\ i & 0 \end{bmatrix}$ D) $\begin{bmatrix} 0 & i \\ -i & 0 \end{bmatrix}$

63. A vector 'r' is irrotational if:
A) $\nabla.\vec{r} = 0$ B) $\nabla \times \vec{r} \neq 0$ C) $\nabla.\vec{r} \neq 0$ D) $\nabla \times \vec{r} = 0$

64. If A and B are idempotent matrices, A+B is also idempotent, if and only if,
A) AB = I B) BA = I C) AB+ BA = 0 D) AB +BA = I

65. If H is Hermitian matrix, which of the following is a skew Hermitian matrix?
A) H^T B) iH C) H^{-1} D) All of these

66. If every element in a row of a square matrix is zero, then:
A) $A^2 = I$ B) Determinant of A is zero
C) $A^3 = -A$ D) $A = A^2$

67. If $f = u + iv$, u and v are real numbers then the Cauchy-Reimann equation in cartesian form is:
A) $\frac{\partial u}{\partial x} = \frac{\partial v}{\partial y}$; $\frac{\partial v}{\partial x} = \frac{\partial u}{\partial y}$ B) $\frac{\partial u}{\partial x} = \frac{\partial v}{\partial y}$; $\frac{\partial v}{\partial x} = -\frac{\partial u}{\partial y}$
C) $\frac{\partial u}{\partial x} = -\frac{\partial v}{\partial y}$; $\frac{\partial v}{\partial x} = \frac{\partial u}{\partial y}$ D) $\frac{\partial u}{\partial x} = -\frac{\partial v}{\partial y}$; $\frac{\partial v}{\partial x} = -\frac{\partial u}{\partial y}$

68. The generating function of Legendre polynomial *Pn(x)*is:
A) $(1+2xz-z^2)^{1/2}$ B) $(1-2xz+z^2)^{-1/2}$
C) $(1-2xz-z^2)^{1/2}$ D) $(1-2xz-z^2)^{-1/2}$

69. If δ(x) is Dirac Delta function, then:
A) $\int_{-\infty}^{+\infty} \delta(x)\mathrm{d}x = 0$ B) $\int_{-\infty}^{+\infty} \delta(x)\mathrm{d}x = 1$
C) $\int_{-\infty}^{+\infty} \delta(x)\mathrm{d}x = \infty$ D) $\int_{-\infty}^{+\infty} \delta(x)\mathrm{d}x = -1$

70. The Lagrangian function for simple pendulum is :
A) $L = \frac{1}{2}ml^2\dot{\theta}^2 + mgl(1 - \cos\theta)$
B) $L = \frac{1}{2}ml^2\dot{\theta}^2 - mgl(1 + \cos\theta)$
C) $L = \frac{1}{2}ml^2\dot{\theta}^2 - mgl(1 - \cos\theta)$
D) $L = \frac{1}{2}ml^2\dot{\theta}^2 + mgl(1 + \cos\theta)$

71. The phase curve of simple harmonic oscillator is:
A) Hyperbolic B) Elliptical
C) Circular D) Spiral in towards a fixed centre

72. The moment of inertia of a solid sphere, with mass M and radius R, about the tangent is:
A) $(2/5)\ MR^2$ B) $(7/5)\ MR^2$ C) $(9/5)\ MR^2$ D) $(3/5)\ MR^2$

73. A constraint expressed in the form of inequality is ----- constraint.
A) Holonomic B) Non holonomic
C) Rheonomous D) Scleronomous

74. If q_k and p_l are the position and momentum coordinates, their Poisson bracket is:
A) $[q_k p_l] = -\infty$ B) $[q_k p_l] = \infty$
C) $[q_k p_l] = -1$ D) $[q_k p_l] = \delta_{kl}$

75. If J is the angular momentum of the planet, m is the mass and $\frac{dA}{dt}$ is the areal velocity, then Kepler's second law is:
A) $\frac{dA}{dt} = \frac{J^2}{2m}$ B) $\frac{dA}{dt} = \frac{J}{2m}$ C) $\frac{dA}{dt} = \frac{J^2}{m}$ D) $\frac{dA}{dt} = \frac{J}{m}$

76. If F is the gauge function, the gauge invariance of Lagrangian is:
A) $L' = L + \frac{d^2F}{dt^2}$ B) $L' = L + \frac{dF}{dt}$
C) $L' = L - \frac{d^2F}{dt^2}$ D) $L' = L + \int F\, dt$

77. Brachistochrone curve, curve of fastest descent, on which a bead slides frictionlessly under the influence of a uniform gravitational field to a given end point in the shortest time, is:
A) Catenoid B) Cycloid
C) Straight line D) Hyperbolic

78. If h is Planck's constant, the uncertainty relation for energy and time is:
A) $\Delta E.\Delta t \geq h$ B) $\Delta E.\Delta t = \frac{h}{4\pi}$
C) $\Delta E.\Delta t \geq \frac{h}{2\pi}$ D) $\Delta E.\Delta t \geq \frac{h}{4\pi}$

79. If $\boldsymbol{\psi}$ is the wavefunction and $\boldsymbol{\psi}^*$is its complex conjugate, the expression for probability current density is:
A) $\mathbf{J} = \frac{i\hbar}{2m}(\nabla\boldsymbol{\psi}^* - \nabla\boldsymbol{\psi})$ B) $\mathbf{J} = \frac{i\hbar}{2m}(\boldsymbol{\psi}^*\nabla\boldsymbol{\psi} - \boldsymbol{\psi}\nabla\boldsymbol{\psi}^*)$
C) $\mathbf{J} = \frac{i\hbar}{2m}(\boldsymbol{\psi}\nabla\boldsymbol{\psi}^* - \boldsymbol{\psi}^*\nabla\boldsymbol{\psi})$ D) $\mathbf{J} = \frac{i\hbar}{2m}(\boldsymbol{\psi}\nabla\boldsymbol{\psi}^* + \boldsymbol{\psi}^*\nabla\boldsymbol{\psi})$

80. The one dimensional momentum operator in quantum mechanics is:

A) $+\hbar\frac{\partial}{\partial x}$ B) $-\hbar\frac{\partial}{\partial x}$ C) $-i\hbar\frac{\partial}{\partial x}$ D) $+i\hbar\frac{\partial}{\partial x}$

81. The commutation relation for angular momentum operators is:

A) $[L_y,L_z]=i\hbar L_z$ B) $[L_y,L_z]=i\hbar L_x$

C) $[L_y,L_z]=i\hbar L_x^2$ D) $[L_y,L_z]=i\hbar L_y$

82. The eigen value of total angular momentum operator J^2 is:

A) $j(j+1)\hbar^2$ B) $\sqrt{j(j+1)}\,\hbar^2$

C) $\sqrt{j(j+1)}\,\hbar$ D) $j(j+1)\hbar$

83. Which of the following particle is **not** a fermion?

A) Electron B) Proton C) Neutron D) Photon

84. The Klein Gordon equation is given by:

A) $\left(\nabla^2-\frac{1}{C^2}\frac{\partial^2}{\partial t^2}\right)\psi=\frac{m_0^2C^2}{\hbar^2}\psi$

B) $\left(\nabla^2+\frac{1}{C^2}\frac{\partial^2}{\partial t^2}\right)\psi=\frac{m_0^2C^2}{\hbar^2}\psi$

C) $\left(\nabla^2-\frac{1}{C^2}\frac{\partial^2}{\partial t^2}\right)\psi=\frac{m_0^2C^2}{\hbar}\psi$

D) $\left(\nabla^2+\frac{1}{C^2}\frac{\partial^2}{\partial t^2}\right)\psi=\frac{m_0^2C^2}{\hbar}\psi$

85. The solution of rigid rotator problem in quantum mechanics lead to quantized energy levels with quantum number l=0,1,2…., is given by (ħ=(Planck's constant/2π); I= moment of inertia):

A) $E_l=\frac{l\hbar^2}{2I}$ B) $E_l=\frac{l(l+1)}{2I\hbar^2}$ C) $E_l=\frac{l(l+1)\hbar^2}{2I}$ D) $E_l=\frac{l(l+1)\hbar}{2I}$

86. The validity of WKB approximation can be expressed as:

A) $\frac{\lambda}{2\pi}\frac{1}{k}\left|\frac{dk}{dx}\right|\ll 1$ B) $\frac{\lambda}{2\pi}\frac{1}{k}\left|\frac{dk}{dx}\right|\gg 1$

C) $\frac{\lambda}{2\pi}\frac{1}{k}\left|\frac{dk}{dx}\right|=1$ D) $\frac{\lambda}{2\pi}\frac{1}{k}\left|\frac{dk}{dx}\right|=0$

87. Which of the following is a valid property of Dirac matrices?
A) The matrices commute each other
B) The matrices anticommute in pairs
C) The squares of matrices are not unity
D) None of the above is correct

88. If the lattice parameters of a crystal are $a = b = c$ and $\alpha = \beta = \gamma \neq 90^o < 120^o$, then, the crystal system is:

A) Hexagonal B) Monoclinic
C) Orthorhombic D) Rhombohedral

89. For body centred cubic, atomic packing factor is:
A) 0.52 B) 0.74 C) 0.68 D) 0.25

90. If **a**, **b** and **c** are the primitive lattice vectors in direct lattice, the corresponding reciprocal lattice vector **b***is:

A) $\boldsymbol{b}^* = 2\pi \frac{\boldsymbol{a}\times\boldsymbol{c}}{\boldsymbol{a}.(\boldsymbol{b}\times\boldsymbol{c})}$ B) $\boldsymbol{b}^* = 2\pi \frac{\boldsymbol{b}\times\boldsymbol{a}}{\boldsymbol{a}.(\boldsymbol{b}\times\boldsymbol{c})}$

C) $\boldsymbol{b}^* = 2\pi \frac{\boldsymbol{c}\times\boldsymbol{a}}{\boldsymbol{a}.(\boldsymbol{b}\times\boldsymbol{c})}$ D) $\boldsymbol{b}^* = 2\pi \frac{\boldsymbol{a}\times\boldsymbol{b}}{\boldsymbol{a}.(\boldsymbol{b}\times\boldsymbol{c})}$

91. If K is thermal conductivity and σ is electrical conductivity, according to Wiedmann Franz law:

A) $\frac{K}{\sigma^2} = constant$ B) $\frac{K}{\sigma T} = constant$

C) $\frac{K}{\sigma T} \neq constant$ D) $\frac{\sigma K}{T} = constant$

92. If n is the carrier concentration in metal and e is the electronic charge, the Hall coefficient is given by:

A) $R_H = \frac{-n}{e}$ B) $R_H = \frac{-1}{ne}$ C) $R_H = \frac{n}{e}$ D) $R_H = \frac{+1}{ne}$

93. If energy of free electron is E, k is wavevector and h is Planck's constant ($\hbar = h/2\pi$), according to band theory, the effective mass of electron can be expressed as:

A) $m^* = \frac{\hbar^2}{d^2E/dk^2}$ B) $m^* = \frac{\hbar^2}{dE/dk}$

C) $m^* = \frac{\hbar}{d^2E/dk^2}$ D) $m^* = \frac{\hbar}{dE/dk}$

94. The magnetic permeability (μ_r) is related to magnetic susceptibility χ as:
A) $\mu_r=1+\chi$ B) $\mu_r=1-\chi$ C) $\mu_r=1/\chi$ D) $\mu_r=\chi^2$

95. If T_c is the critical temperature, the variation of critical magnetic field B_c with temperature for a superconductor is:

A) $B_c(T) = B_c(0)\left(1 + \left(\frac{T}{T_c}\right)\right)$

B) $B_c(T) = B_c(0)\left(1 + \left(\frac{T}{T_c}\right)^2\right)$

C) $B_c(T) = B_c(0)\left(1 - \left(\frac{T}{T_c}\right)\right)$

D) $B_c(T) = B_c(0)\left(1 - \left(\frac{T}{T_c}\right)^2\right)$

96. Basic principle of laser is:
A) Spontaneous emission B) Stimulated emission
C) Induced absorption D) None of the above

97. If $\boldsymbol{a^*}$, $\boldsymbol{b^*}$ and $\boldsymbol{c^*}$ are the primitive translation vectors in reciprocal lattice and *h, k, l* are integers, the reciprocal lattice vector is:
A) $\boldsymbol{G} = h\boldsymbol{a}^* + k\boldsymbol{b}^* + l\boldsymbol{c}^*$ B) $\boldsymbol{G} = h\boldsymbol{a}^*.(k\boldsymbol{b}^* + l\boldsymbol{c}^*)$
C) $\boldsymbol{G} = h\boldsymbol{a}^*.(k\boldsymbol{b}^* \times l\boldsymbol{c}^*)$ D) $\boldsymbol{G} = h\boldsymbol{a}^* \times k\boldsymbol{b}^* \times l\boldsymbol{c}^*$

98. If $\boldsymbol{K}$ is the incident wavevector and $\boldsymbol{G}$ is the reciprocal lattice vector, Bragg's law in reciprocal space:
A) $\boldsymbol{K}.\boldsymbol{G} - G^2=0$ B) $2\,\boldsymbol{K}.\boldsymbol{G} - G^2=0$
C) $2\,\boldsymbol{K}\times\boldsymbol{G} - G^2=0$ D) $2\,\boldsymbol{K}.\boldsymbol{G}+G^2=0$

99. Which of the following magnetic properties is temperature independent?
A) Diamagnetism B) Paramagnetism
C) Ferromagnetism D) All of these

100. Germanium is a:
A) Metallic crystal B) Covalently bonded crystal
C) Ionic crystal D) None of these

101. The relation between magnetic field and electric field is:

A) $\vec{B} = \frac{\vec{v}\times\vec{E}}{c}$ B) $\vec{B} = \frac{\vec{v}\times\vec{E}}{c^2}$ C) $\vec{B} = \frac{\vec{v}.\vec{E}}{c^2}$ D) $\vec{B} = -\frac{\vec{v}\times\vec{E}}{c^2}$

102. Electric flux due to electric field E is given by:

A) $\int_s E.dS$ B) $\int_s E \times dS$ C) $-\int_s E.dS$ D) $-\int_s E \times dS$

103. The tangential and perpendicular (normal) components of displacement vector ($\vec{D}$) in a dielectric medium 1 are $\vec{D}_{1t}$ and $\vec{D}_{1n}$ respectively and the corresponding components in dielectric medium 2 are $\vec{D}_{2t}$ and $\vec{D}_{2n}$ respectively. The surface free charge density separating the two media is σ . The boundary condition for displacement vector is:

A) $\vec{D}_{1t} - \vec{D}_{2t} = \sigma$ B) $\vec{D}_{1t} - \vec{D}_{2t} = 0$

C) $\vec{D}_{1n} - \vec{D}_{2n} = \sigma$ D) $\vec{D}_{1n} - \vec{D}_{2n} = 0$

104. The Maxwell's equation which is independent of medium is:

A) $\nabla \times \mathrm{H} = \mathrm{J} + \frac{\partial D}{\partial t}$ B) $\nabla . \mathrm{D} = \rho$

C) $\nabla \times \mathrm{E} = -\frac{\partial B}{\partial t}$ D) $\nabla . \mathrm{B} = 0$

105. The magnetic vector potential at r in uniform magnetic field $\boldsymbol{B}$ is:

A) (½) $\boldsymbol{B}$.r B) (½) $\boldsymbol{B}\times$r C) $\boldsymbol{B}\times$r D) $\boldsymbol{B}$.r

106. For molecular vibration to be Raman active, there should be a change in:

A) Polarizability B) Dipole moment
C) Molecular volume D) None of these

107. The UV Visible spectrum arises due to the transitions among:

A) Rotational energy levels
B) Electronic energy levels
C) Vibrational energy levels
D) None of the above

108. Experiment which provided the evidence for electronic spin:

A) Stern Gerlach Experiment
B) Frank Hertz Experiment
C) Davisson and Germer Experiment
D) Michelson Morley Experiment

109. According to Fermi Dirac distribution law, the probability of electron occupancy at Fermi level is:

A) 0 B) 0.5 C) 1.0 D) ¼

110. The radius of Al nucleus is approximately (Mass number = 27):
A) 1 fermi B) 3.6 fermi C) 5.7 fermi D) 7.8 fermi

111. The relative abundance of an isotope in a chemical can be determined using:
A) Raman spectroscopy B) UV Visible spectroscopy
C) Mass Spectroscopy D) Infrared spectroscopy

112. The value of nuclear magneton is:
A) 2.7×10^{-27} JT^{-1} B) 1.6×10^{-27} JT^{-1}
C) 5.4×10^{-27} JT^{-1} D) 5.05×10^{-27} JT^{-1}

113. For a spherically symmetric nucleus, nuclear quadrupole moment is:
A) 1 B) 0 C) -1 D) ∞

114. The pairing term in liquid drop model maximizes the binding energy if number of protons is--- and number of neutrons is----.
A) Even, even B) Even, odd C) Odd, even D) Odd, odd

115. Which of the following is **not** a magic number for nuclei?
A) 2 B) 8 C) 20 D) 30

116. The temperature coefficient of carbon resistors is:
A) Positive B) Can be positive or negative
C) Negative D) ∞

117. The diode having negative resistance characteristic:
A) Schottky diode B) Laser diode
C) Tunnel diode D) Hot carrier diode

118. A phase shift oscillator has:
A) One RC circuit B) One LC circuit
C) Three RC circuits D) Three LC circuits

119. In JFET, after pinch off, the drain current becomes:
A) Zero B) Constant
C) Suddenly increase D) Slowly increase

120. Which is the feedback element in an Op-Amp integrator?
A) Resistor B) Diode
C) Voltage regulator D) Capacitor
