A

17824 **120 MINUTES**

1. Given a vector $\vec{A} = 3\hat{\imath} + 4\hat{\jmath} + 2\hat{k}$, then a unit vector in the direction of $\vec{A}$ is

   A) $2\hat{\imath} + 3\hat{\jmath} + 4\hat{k}$ B) $\frac{\hat{\imath} + \hat{\jmath} + \hat{k}}{\sqrt{29}}$

   C) $3i + 2\hat{\jmath} + 4\hat{k}$ D) $\frac{3\hat{\imath} + 4\hat{\jmath} + 2\hat{k}}{\sqrt{29}}$

2. A force $\vec{F} = (5\,\hat{\imath} + 2\,\hat{\jmath})$N acts about the origin at the point (2, 2) m. The moment of the force is

   A) 0 B) $10\hat{\imath} + 2\hat{\jmath}$ C) $-6\hat{k}$Nm D) $6\hat{k}$ Nm

3. The square roots of 'i' are

   A) $\pm\frac{1}{2}(1 + i)$ B) $(1 - i)$

   C) $\pm(1 + i)$ D) $\pm\frac{1}{\sqrt{2}}(1 + i)$

4. Beta ($\beta(m, n)$) and gamma (Γ(m)) functions are related by

   A) β(m,n) = $\frac{\Gamma(m+n)}{mn}$ B) $\beta(m, n) = \frac{\Gamma(m)\Gamma(n)}{\Gamma(m+n)}$

   C) $\beta(m, n) = \frac{\Gamma(m)}{\Gamma(n)}$ D) $\beta(m, n) =$ Γ(m) Γ(n)

5. The generating function for Hermite polynomials $H_n(x)$ is $(-1)^n\, e^{x^2} \frac{d^n}{dx^n}(e^{-x^2})$, then the value of $H_0(x)$ is

   A) 1 B) 0 C) x D) x^2

6. If the function $f_1(x) = x^2$ is expanded as a Fourier series in the interval $[\pi, -\pi]$, the first term of the series is,

   A) 1 B) π C) $\frac{2}{3}\pi^2$ D) $\frac{\pi^2}{3}$

7. Which one of the following sets form a group under multiplication?

   A) (1, i) B) (i, -i) C) (1, -1) D) (1, 0)

8. Rotations of a circle about an axis passing through its centre and perpendicular to the plane of the circle will form

   A) An orthogonal group B) A unitary group

   C) Lorentz group D) A set only

9. If $z = x + iy$, which one of the following function f(z) is analytic throughout the entire complex plane

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

10. Given $f(Z) = \frac{sinZ}{Z^4}$, $f(Z)$ has a pole of order
A) 3 at Z = 1 B) 3 at Z = 0 C) 4 at Z = 0 D) 2 at Z = 0

11. The eigen values of the matrix $\begin{bmatrix} 3 & 1 \\ 2 & 2 \end{bmatrix}$ are
A) 3 & 2 B) 1 & 2 C) 1 & 4 D) 3 & 1

12. Given $\vec{F} = \hat{\imath}3xy - \hat{\jmath}\, y^2$. The value of the integral $\int_C \overrightarrow{F} . d\vec{r}$ where C is the curve in the xy plane, $y = 2x^2$, from (0, 0) to (1, 2) is
A) $\frac{7}{6}$ B) -7 C) $\frac{6}{7}$ D) $-\frac{7}{6}$

13. Which one of the following is not a tensor?
A) A^i_j B) A^i_{jjk} C) A^i_{jk} D) A^i_{ijk}

14. The dielectric susceptibility of an anisotropic medium is
A) A scalar quantity B) A second rank tensor
C) A vector quantity D) An axial vector

15. Cauchy - Riemann conditions for the analyticity of a complex function $f(z) = u(x, y) + i\, v(x, y)$ are
A) $\frac{\partial u}{\partial x} = \frac{\partial v}{\partial y}$, $\frac{\partial u}{\partial y} = -\frac{\partial v}{\partial x}$ B) $\frac{\partial u}{\partial x} = \frac{\partial v}{\partial y}$, $\frac{\partial u}{\partial y} = \frac{\partial v}{\partial x}$
C) $\frac{\partial u}{\partial y} = -\frac{\partial v}{\partial x}$, $\frac{\partial u}{\partial x} = -\frac{\partial v}{\partial y}$ D) $\frac{\partial u}{\partial y} = \frac{\partial v}{\partial y}$, $\frac{\partial u}{\partial x} = -\frac{\partial v}{\partial x}$

16. A linear symmetric triatomic molecule makes longitudinal free oscillations. Possible number of normal modes of oscillations are
A) Three B) Four C) Two D) One

17. A proton, a deuteron and an alpha particle having the same kinetic energy are moving in circular trajectories in a uniform magnetic field. If r_p, r_d and r_α denote respectively the radii of the trajectories of these particles, then
A) $r_\alpha = r_p > r_d$ B) $r_\alpha = r_p < r_d$
C) $r_\alpha > r_p > r_d$ D) $r_\alpha = r_p = r_d$

18. A stationary body explodes into two, each of rest mass 2.0 kg, that move apart at 0.6c relative to the original body. The mass of the original body is
A) 2.5 kg B) 2.5 g C) 5 kg D) 0.5 kg

19. A particle is placed in a potential given by $V(x) = \frac{1}{2}kx^2 - \frac{1}{4}gx^4$, where k and g are positive constants with g < k. Then,
A) x = 0 is a point of stable equilibrium
B) x = $\sqrt{\frac{k}{g}}$ and x = -$\sqrt{\frac{k}{g}}$ are points of stable equilibrium
C) x = $\sqrt{\frac{k}{g}}$ alone is a point of stable equilibrium
D) x = k/g and x = -k/g are points of stable equilibrium

20. The dimension of total scattering cross section is that of

A) Volume B) Length
C) Dimensionless D) Area

21. The necessary and sufficient condition that the work done be independent of the physical path taken by the particle is that the force $\vec{F}$ can be expressed as

A) $\vec{F} = -\vec{\nabla}V(r)$ B) $\vec{F} = -V(r)$
C) $\vec{F} = -\vec{\nabla}.\, V(r)$ D) $\vec{F} = -\vec{\nabla}\, xV(r)$

22. If the Lagrangian of a system is $L = \frac{1}{2}m(\dot{r}^2 + r\dot{\vartheta}^2 + \dot{z}^2)$, then

A) r alone is a cyclic coordinate
B) z alone is a cyclic coordinate
C) ϑ, z and r are cyclic coordinates
D) ϑ and z are cyclic coordinates

23. Group A contains some important discoveries in Physics. Group B contains the names of the Scientists who discovered. Match the discoveries with the names of the Scientists.

Group A	Group B
a) Quantum physics	(i) Wilhelm Roentgen
b) X- rays	(ii) C V Raman
c) Quantum theory of photoelectric effect	(iii) Max Planck
d) Change in the wavelength of radiation on scattering.	(iv) A. Einstein

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

24. A cylinder of height 2.5 m is filled completely with water. A hole is made at the bottom of the cylinder in such a way that water is coming out of it. What is the velocity of water coming out of the cylinder?

A) 6.4 m/s B) 9.8 m/s C) 2.5 m/s D) 7 m/s

25. The Lagrangian of a system in two dimensions is given by $L = \frac{1}{2}m\dot{x}^2 - m\dot{x}\,\dot{y}$, then the Hamiltonian of the system is

A) $\frac{1}{2m}p_x^2 + \frac{1}{m}p_xp_y$ B) $\frac{1}{2m}p_x^2 - \frac{1}{m}p_xp_y$
C) $-\frac{1}{2m}p_y^2 - \frac{1}{m}p_xp_y$ D) $-\frac{1}{2m}p_x^2 - \frac{1}{m}p_xp_y$

26. A particle of unit mass is moving under the influence of an attractive inverse square law of force directed towards a fixed point. The Lagrangian describing the motion is,

A) $L = \frac{1}{2}\left(\dot{r}^2 + r^2\dot{\theta}^2\right) + \frac{k}{r}$ B) $L = \frac{1}{2}\left(\dot{r}^2 + r^2\dot{\theta}^2\right) - \frac{k}{r}$
C) $L = \frac{1}{2}\left(\dot{r}^2 + r^2\dot{\theta}^2\right)$ D) $L = \frac{1}{2}\left(r^2\dot{\theta}^2\right) + \frac{k}{r}$

27. The Poisson bracket of two dynamical variables which are constants of motion is
A) Zero B) 1
C) Not a constant of motion D) A constant of motion

28. Choose the correct statement
A) Finite rotations of a rigid body commute
B) A rigid body has only three degrees of freedom
C) Infinitesimal rotations of a rigid body do not commute
D) Infinitesimal rotations of a rigid body commute

29. L is the orbital angular momentum vector then the Poisson bracket $[L_i, L_j]$ is
A) $\hbar L_k$ B) $\varepsilon_{ijk} L_k$ C) $i\varepsilon_{ijk} L_k$ D) L_k

30. The Hamilton's equations of motion are,
A) $q_i = \frac{\partial H}{\partial p_i}$, $p_i = \frac{\partial H}{\partial q_i}$ B) $q_i = \frac{\partial H}{\partial p_i}$, $p_i = -\frac{\partial H}{\partial q_i}$
C) $\dot{q}_i = \frac{\partial H}{\partial p_i}$, $\dot{p}_i = -\frac{\partial H}{\partial q_i}$ D) $\dot{q}_i = -\frac{\partial H}{\partial p_i}$, $\dot{p}_i = \frac{\partial H}{\partial q_i}$

31. Lorentz gauge implies
A) $\vec{\nabla} \times \vec{A} + \frac{\partial \varphi}{\partial t} = 0$ B) $\vec{\nabla} \times \vec{A} = 0$
C) $\vec{\nabla}.\vec{A} + \frac{1}{c^2}\frac{\partial \varphi}{\partial t} = 0$ D) $\vec{\nabla}.\vec{A} = 0$

32. The frequency of precession of a charged particle of mass m and charge e in a uniform magnetic field of magnetic induction $\vec{B}$ is
A) $\omega = \frac{eB}{2m}$ B) $\omega = \frac{B}{2m}$
C) $\omega = \frac{eB}{m}$ D) $\omega = eB$

33. Consider a parallel plate condenser. A potential difference V is applied across the plates and disconnected. Now a dielectric slab of uniform thickness is placed in between the plates of the parallel plate condenser, then

A) The value of the capacitance increases
B) The value of the capacitance decreases
C) The value of the capacitance remains unaltered
D) The charge on the condenser decreases.

34. What is the magnitude of the electrical field strength E such that an electron placed in the field would experience an electrical force equal to its weight? (charge of electron: $e = 1.6 \times 10^{-19}$ coulomb)
A) 5.6×10^{-11} N/ C B) 5.6 N/ C
C) 5.6×10^{11} N/ C D) 2.8×10^{-11} N/ C

35. Brewster's Law refers to
A) Polarization by scattering B) Polarization by refraction
C) Polarization by reflection D) Polarization by double refraction

36. Consider a rectangular wave guide with sides a and b such that a $\geq$ b, then value of the lowest cutoff frequency is given by

A) $\omega_{10} = \frac{c}{b}$ B) $\omega_{10} = \frac{a}{c}$

C) $\omega_{10} = \frac{c\pi}{a}$ D) $\omega_{10} = \frac{c\pi}{b}$

37. A left circularly polarized beam ($\lambda_0 = 5893\,\dot{A}$) is incident on a calcite crystal (with its optic axis cut parallel to the surface) of thickness 0.005141 mm. If the electric field of the incident beam at x = 0 is $E_y = \frac{E_0}{\sqrt{2}}\sin\omega t$ and $E_z = \frac{E_0}{\sqrt{2}}\cos\omega t$, then the state of polarization of the emergent beam is (the refractive indices of the ordinary and extraordinary rays are respectively 1.65836 and 1.48641)

A) $E_y = \frac{E_0}{\sqrt{2}}\sin\omega t$, $E_z = \frac{E_0}{\sqrt{2}}\cos\omega t$

B) $E_y = \frac{E_0}{\sqrt{2}}cos\omega t$, $E_z = \frac{E_0}{\sqrt{2}}\sin\omega t$

C) $E_y = \frac{E_0}{\sqrt{2}}\sin\omega t$, $E_z = -\frac{E_0}{\sqrt{2}}\cos\omega t$

D) $E_y = -\frac{E_0}{\sqrt{2}}\sin\omega t$, $E_z = \frac{E_0}{\sqrt{2}}\cos\omega t$

38. For a Fraunhofer diffraction pattern produced by a circular aperture of radius 0.02 cm, the radius of the first dark ring is 3.6 x 10^{-2} cm. Find the wavelength of light if the aperture is kept at the focal plane of a convex lens of focal length 20 cm.

A) 3 x 10^{-5} cm B) 6 x 10^{-5} cm C) 7.2 x 10^{-5} cm D) 5 x 10^{-4} cm

39. In the Michelson interferometer arrangement, if one of the mirrors is moved by a finite distance, 250 fringes cross the field of view. If the wavelength of the light used is 6400 Å, then the mirror is moved through a distance

A) 0.08 mm B) 0.04 mm C) 0.08 cm D) 0.02 mm

40. Choose the correct statement

A) Ampere's law is valid for dynamic current.

B) Displacement current is introduced to modify Faraday's law.

C) Displacement current modifies Coulomb's law.

D) Ampere's law is valid only for steady current

41. The expression for skin depth is given by $\delta = \left(\frac{2}{\omega\mu\sigma}\right)^{1/2}$. For copper, $\mu = 4\pi \times 10^{-7}$ N/amp^2 and $\sigma = 5.8 \times 10^7$ mhos/m. Then the value of the skin depth at a frequency of $\nu = 100$ sec^{-1} would be

A) 5.5 m B) 6.5 x 10^{-3} cm

C) 5.5 x 10^{-2} m D) 6.5 x 10^{-3} m

42. The total power radiated by an oscillating electric dipole

A) Depends on the relative phases of the components of the dipole moment

B) Is independent of the relative phases of the components of the dipole moment

C) Is proportional to the dipole moment

D) Is inversely proportional to the dipole moment

43. In a He- Ne laser,
A) the lasing action is due to transitions taking place in the Ne atom
B) the lasing action is due to transitions taking place in the He atom
C) the Ne atoms excite He atoms by collision
D) Ne atoms are excited by passing an electric discharge through the system

44. Adiabatic expansion of photon gas is determined by the equation
A) $PV = RT$ B) $PV^{\frac{4}{3}}$ = a constant
C) $P\,V^3$ = a constant D) $P\,V^5$ = a constant

45. In a canonical ensemble, a system A of fixed volume is in contact with a large reservoir B, then
A) A can exchange only particles with B
B) A can exchange energy and particles with B
C) A can exchange only energy with B
D) A can exchange neither energy nor particles with B

46. The heat capacity of a degenerate Fermi gas at low temperatures is proportional to
A) T^2 B) $\sqrt{T}$ C) T D) T^3

47. Choose the correct statement
A) Liquid He^3 obeys Bose statistics
B) Bose condensation is an example of quantum phase transition.
C) Liquid He^4 obeys Fermi statistics
D) Bose condensation is a second order phase transition

48. Wien's displacement law says that
A) $\lambda_m T$ = a constant B) $\frac{\lambda_m}{T}$ = a constant
C) $\lambda_m T^3$ = a constant D) None of the above.

49. In a 2n dimensional phase space, the volume of a phase cell is
A) $\hbar^3$ B) $\hbar^{2n}$ C) h D) $\hbar^n$

50. The r.m.s speed of oxygen molecule (mass of oxygen molecule is 5.31×10^{-26} kg, value of Boltzmann constant is $1.38\text{x }10^{-23}$J/K)) at 100^o C is
A) 0 B) 461 m/s C) 46.1 m/s D) 539.2 m/s

51. The energy density of black body radiation at temperature T is proportional to
A) T^{-4} B) T^2 C) T^4 D) T^{-2}

52. The number n(∈) of identical and distinguishable particles in an assembly at temperature T having an energy ∈ with number of states $g(\in)$ is
A) $n(\in) = g(\in)e^{\frac{2\in}{kT}}$ B) $n(\in) = g(\in)e^{-\frac{\in}{kT}}$
C) $n(\in) = e^{\frac{-\in}{kT}}$ D) $n(\in) = g(\in)\frac{\in}{kT}$

53. Nernst's heat theorem states that
A) Absolute zero is attainable
B) Entropy of a system is finite at absolute zero
C) Entropy never decreases
D) Absolute zero is unattainable by a number of finite processes

54. Helmholtz free energy F, internal energy U, temperature T and entropy S are related by
A) F = U - TS B) F = U + TS
C) F = US - T D) F = TS

55. Thermal wavelength of a system is
A) Proportional to temperature
B) Inversely proportional to temperature
C) Proportional to square root of temperature
D) Inversely proportional to square root of temperature.

56. η is the efficiency of a Carnot engine working between temperatures T_1 (source temperature) and T_2 (sink temperature). If the sink temperature is made half of the temperature of the source, the efficiency of the engine will be
A) $\frac{1}{2}$ B) η C) $\frac{3}{2}\eta$ D) 2

57. A particle limited to x –axis has the wave function $\psi = ax$ between $x = 0$ and $x = 1$; $\psi = 0$ elsewhere. The probability that the particle can be found between $x = 0.45$ and $x = 0.55$ is
A) $0.251a^2$ B) $2.51a^2$ C) $0.0251a^2$ D) $0.251a$

58. The normalised wave function of a particle in a box of width L are given by $\psi_n = \sqrt{\frac{2}{L}} \sin(\frac{n\pi x}{L})$. The expectation value $\langle x \rangle$ of the position of the particle trapped in this box in the ground state is
A) L B) $\frac{L}{2}$ C) $\frac{L}{4}$ D) L^2

59. The operator associated with the coordinate x in momentum representation is
A) x B) $-i\hbar\frac{\partial}{\partial x}$ C) $i\hbar\frac{\partial}{\partial p}$ D) $-i\hbar\frac{\partial}{\partial p}$

60. Choose the correct statement.
A) Operators are time dependent in Schrodinger representation
B) Wave function is time dependent in Heisenberg representation.
C) Operators and wave functions are time dependent in Schrodinger representation
D) Operators and wave functions are time dependent in Interaction representation

61. Which one of the following operators is Hermitian ?
A) $\frac{d}{dx}$ B) $\frac{d}{dt}$ C) i $\frac{d^2}{dx^2}$ D) $\frac{d^2}{dx^2}$

62. The ground state wave function of a linear harmonic oscillator is $\psi_0(x) = (\frac{a}{\pi})^{\frac{1}{4}} \exp(-\frac{a}{2}x^2)$. Then the value of (Δx^2) in this state is

A) $\frac{1}{2a}$ B) a C) a^2 D) 0

63. Parity of spherical harmonics $Y_{lm}(\vartheta\varphi)$ is

A) $(-1)^m$ B) $(-1)^{l+m}$ C) $(-1)^l$ D) $(-1)^{-l}$

64. The average value of 1/r for an electron in the hydrogen atom in terms of Bohr radius a_o is

A) a_o B) $\frac{a_0}{2}$ C) ${a_o}^2$ D) $\frac{1}{a_o}$

65. The expectation value $\langle S_x^2 \rangle$ in the eigen state of S_z is

A) $\frac{1}{4}\hbar^2$ B) 0 C) $\hbar$ D) $\frac{1}{2}\hbar$

66. The commutation relation between the components of the angular momentum operator $\vec{L}$ and the components of the position coordinate vector $\vec{r}$ is given by

A) $[L_i, x_j] = 0$ B) $i\hbar\epsilon_{ijk}x_k$

C) $i\hbar\epsilon_{ijk}L_k$ D) $\epsilon_{ijk}x_k$

67. Choose the correct statement

A) Ground state of hydrogen atom shows first order Stark effect.

B) Ground state of hydrogen atom will not show second order Stark effect

C) Ground state of hydrogen atom will not show first order Stark effect

D) Degeneracy of the first excited state of hydrogen atom can be fully removed due to Stark effect.

68. Lamb shift refers to splitting up of

A) ${}^2P_{\frac{1}{2}}$ and ${}^2P_{\frac{3}{2}}$ lines in hydrogen spectra

B) ${}^2P_{\frac{1}{2}}$ and ${}^1S_{\frac{1}{2}}$ lines in the hydrogen spectra

C) ${}^2P_{\frac{1}{2}}$ and ${}^2S_{\frac{1}{2}}$ lines in the hydrogen spectra

D) ${}^2P_{\frac{1}{2}}$ and ${}^2S_{\frac{1}{2}}$ lines in the helium spectra

69. Dirac delta function $\delta(x-a)$ satisfies the relation

A) $\int f(x)\delta(x-a)\,dx = f(a)$ B) $\delta(x-a) = 0$ everywhere

C) $\delta(x-a) = \infty$ everywhere D) $\int \delta(x-a)dx = 0$

70. Which one of the relations given below is not satisfied by Pauli matrices

A) $\sigma_x\sigma_y + \sigma_y\sigma_y = 0$ B) $\sigma_x\sigma_y = i\sigma_z$

C) $\sigma_x^2 = \sigma_y^2 = \sigma_z^2 = 1$ D) $\sigma_x\sigma_y - \sigma_y\sigma_x = 0$

71. Choose the correct statement appropriate for Klein-Gordon equation:
A) Probability density is always positive.
B) Probability density is not always positive and energy can take negative values also.
C) It can describe particles with spin.
D) Probability density is always positive but energy can be negative

72. Experiments show that 13.6 eV is required to separate a hydrogen atom into an electron and a proton. The orbital radius of the electron in a hydrogen atom is (Planck constant: h = 6.63×10^{-34} Js, mass of electron: m = 9.11×10^{-31} kg, charge of electron: e = 1.6×10^{-19} coulomb)
A) 5.3×10^{-11} m B) 5.3×10^{-11} cm
C) 5.3×10^{-10} m D) 2.5×10^{-11} m

73. The longest wavelength present in the Balmer series of hydrogen atom corresponding to the H_α line is
A) 656 mm B) 656 cm C) 656 nm D) 328 nm

74. The expression for Bohr magneton is
A) $\mu_B = \frac{eh}{2m}$ B) $\mu_B = \frac{eh}{m}$
C) $\mu_B = \frac{em}{2\hbar}$ D) $\mu_B = \frac{e\hbar}{2m}$

75. In the normal Zeeman effect, a spectral line of frequency υ_0 is split into
A) 3 B) 2 C) 4 D) no splitting

76. The concept of spin is first introduced to explain
A) Anomalous Zeeman effect B) Stern-Gerlach experiment
C) Splitting up spectral lines D) Stark effect.

77. The term symbol of the first excited state of sodium is $3\,^2P_{1/2}$. The possible j values are
A) j = ½ B) j = 3/2
C) j = ½ , j = 3/2 D) j = 1

78. Hyperfine splitting up of atomic spectral lines is due to the effect of
A) Nuclear spin B) Electron spin
C) External electric field D) External magnetic field.

79. Which one of the following molecule does not give rise to microwave spectra
A) Hydrogen chloride B) Oxygen molecule
C) Carbon monoxide D) Carbon oxysulphide

80. Mossabauer spectroscopy is due to
A) Transitions between energy levels within the nuclei of atoms
B) Transitions between electronic states of a molecule
C) Interactions between electrons and external magnetic field
D) Interactions between nuclei and external magnetic field

81. Choose the correct statement:
A) NMR spectrometers operate at infra red frequencies.
B) NMR spectrometers operate in the radio frequency range.
C) NMR spectrometers operate at optical frequencies.
D) ESR spectrometers operate at short radio frequency range.

82. Choose the correct statement:
A) Frequency of fluorescence radiation is lower than that of the absorbed radiation
B) Frequency of fluorescence radiation is higher than that of the absorbed radiation
C) The frequency of fluorescence radiation is same as that of the absorbed radiation
D) In fluorescence, the molecule gives up some of its rotational energy in collision with other molecules.

83. In CO molecule, the j =0 → j = 1 absorption takes place at a frequency of 1.15×10^{11} Hz. The moment of inertia of the molecule is
A) 1.46×10^{-46} gm.m^2 B) 1.46×10^{-46} kg/m^2
C) The data given is insufficient D) 1.46×10^{-46} kg.m^2

84. Group A contains some important discoveries in Physics. Group B contains the years of these discoveries. Match the discoveries with the year of discoveries .

Group A	Group B
a) Nuclear Fission	(i) 1957
b) Semiconductor transistor	(ii) 1925
c) BCS theory	(iii) 1939
d) Electron spin	(iv) 1947

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

85. Which one of the sample can occur in both crystalline and amorphus forms
A) Boron trioxide B) Gallium arsenide
C) Lead sulphide D) Sodium chloride

86. The Fermi energy of sodium is 3.2 eV. The mass of electron is 9.11×10^{-31} kg. The Fermi velocity of sodium is
A) 1.57×10^6 cm/s B) 1.07×10^6 m/s
C) 0.57×10^6 m/s D) 0.57×10^6 cm/s

87. Weidemann-Franz Law states that
A) The ratio of thermal and electrical conductivities is the same for all metals and is a function of temperature.
B) The ratio between thermal and electrical conductivities is the same for all metals and is a function of square of the temperature.
C) The ratio between thermal and electrical conductivities is a constant
D) None of the statement given above is correct.

88. A dc voltage is applied across the Josephson junction, then
A) a dc current is produced across the junction
B) an oscillating current with frequency $\omega = \frac{2eV}{\hbar}$ is produced across the junction
C) an oscillating current with frequency $\omega = \frac{eV}{\hbar}$ is produced across the junction
D) No current is produced across the junction.

89. The space lattice of diamond is
A) sc B) fcc C) bcc D) hcp

90. The Meissner effect says that magnetic field inside a bulk superconductor is,
A) non zero B) $4\pi M$ C) zero D) curl$\vec{A}$

91. Energy gap in a superconductor is caused by ------ interaction
A) Electron-lattice B) Electron- phonon- photon
C) Electron-photon D) Electron- phonon - electron

92. A colour centre in a crystal is a lattice defect that
A) Absorbs visible light B) Emits visible light
C) Absorbs infra red light D) Scatters visible light.

93. At low temperatures atoms with permanent magnetic moment μ have a
A) Paramagnetic susceptibility inversely proportional to temperature T
B) Paramagnetic susceptibility proportional to temperature T
C) Constant paramagnetic susceptibility
D) Diamagnetic susceptibility inversely proportional to temperature T

94. The resistivity of copper at 20^0 C is $\rho = 1.72 \times 10^{-8}$ Ωm. If the free electron density is 8.48×10^{28} m^{-3} and the Fermi velocity 1.57×10^6 m/s, then the mean free path between collisions of free electrons in copper at 20^0 C is, (mass of electron: m = 9.11×10^{-31} kg, charge of electron: e = 1.6×10^{-19} coulomb)

A) 3.83 nm B) 3.83 mm C) 38.3 mm D) 38.3 nm

95. Group A contains concepts/theories in physics and Group B names of scientists responsible for them. Match the concepts/theories with the names of the scientists responsible for them.

Group A	Group B
a) meson theory of Nuclear force	i) Pauli
b) quark model	ii) Gamow
c) neutrino hypothesis	iii) Yukawa
d) theory of alpha decay	iv) Gell-Mann

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

96. One atomic mass unit when expressed in kilograms is
A) 3×10^{-27} B) 1.66054×10^{-26}
C) 1.66054×10^{-28} D) 1.66054×10^{-27}

97. The energy difference between the spin-up and spin-down states of a proton in a magnetic field of B = 1T is (The spin magnetic moment of proton is 8.96×10^{-8} eV/T)
A) 1.761×10^{-7} MeV B) 2.761×10^{-7} MeV
C) 1.761×10^{-5} eV D) 1.761×10^{-7} eV

98. The Coulomb energy term in the semi empirical mass formula of a nucleus ${}^{A}_{Z}X$ is proportional to

A) $\frac{Z^2}{A^{1/3}}$ B) $\frac{Z-1}{A^{1/3}}$ C) $\frac{Z^2}{A^{2/3}}$ D) $\frac{Z-1}{A^{2/3}}$

99. In 1930 Pauli proposed the existence of the particle neutrino to explain
A) Conservation of momentum in beta decays
B) Conservation of energy in beta decays
C) Conservation of energy in alpha decays
D) Conservation of energy in solar energy production.

100. Nuclear fission can be explained using
A) Liquid drop model B) Shell model
C) Collective model D) One particle model

101. The Geiger-Nuttall rule connecting the decay constant λ and the kinetic energy E of the α particle is given by (A and B are constants)
A) $\lambda = AE + B$ B) $\log \lambda = A \log E + B$
C) $\log \lambda = AE + B$ D) $\lambda = A(\exp BE)$

102. The minimum energy of a photon to undergo pair production is
A) 1.02 MeV B) 2.04 MeV C) 1.02 eV D) 0.5 MeV

103. Nuclear isomers possess
A) Same atomic and mass numbers but have different radioactive properties.
B) Same atomic and mass numbers with the same type of radioactive properties
C) Different atomic numbers but same mass numbers with different radioactive properties.
D) Same mass numbers with different radioactive properties.

104. In cyclotrons, the charged particle is accelerated by
A) The magnetic field applied at right angles to the plane of the dees
B) The electric field between the dees.
C) The gravitational field
D) The electric and magnetic fields.

105. A quark can appear in
A) 2 colours B) 3 colours C) 1 colour D) 4 colours

106. Mediator of strong interaction is
A) quarks B) photons C) gluons D) w bosons

107. Hubble Law states that galaxies are moving away from us with
A) Constant speed
B) With constant acceleration
C) Speeds proportional to the distances of the galaxies from us
D) Speeds inversely proportional to the distances of the galaxies from us

108. Chandrasekhar limit
A) Refers to the lowest mass of stars which can form a white dwarf
B) Refers to the lowest mass of stars which can form a neutron star
C) Refers to the highest mass of stars which can form a neutron star
D) Refers to the highest mass of stars which can form a white dwarf

109. In a microprocessor, which bus is bidirectional?
A) Address bus B) Data bus
C) Address bus and data bus D) Address bus and control bus

110. Negative feedback in an amplifier always helps to
A) Increase its gain B) Stabilize its gain
C) Decrease its output impedance D) Control its output

111. Zener diode is mainly used for
A) Voltage regulation B) Current amplification
C) Voltage amplification D) Current regulation

112. An amplifier has a slew rate given by the manufacturer as $5V/\mu s$. At a signal frequency of 0.2MHz, the maximum amplitude of the undistorted sine-wave is
A) 0.5 V B) 3.98 V C) 0.796 V D) 5V

113. The role of ionosphere in communication purposes is that
A) Visible light gets reflected from the ionosphere layers
B) Microwaves get reflected from the ionosphere
C) Radio waves get reflected from the ionosphere layers
D) It does not play any particular role

114. An LED is constructed from a pn junction based on a certain semiconducting material whose energy gap is 1.9 eV. The wavelength of the emitted light is
A) 653 m B) 6530 nm C) 653 A D) 653 nm.

115. The ripple factor of a rectifier is

A) $\gamma = 2\sqrt{\left(\frac{I_m}{I_{dc}}\right) - 1}$ B) $\gamma = \sqrt{(\frac{I_{rms}}{I_{dc}})^2 - 1}$

C) $\gamma = (\frac{I_{rms}}{I_{dc}})^2$ D) $\gamma = \sqrt{\left(\frac{I_{rms}}{I_{dc}}\right)}$

116. Consider an operational amplifier with A = 10^5, $Z_1(s) = R_1 = 2000$ ohms and $Z_1(f) = R_f = 10000$ ohms. For non-inverting terminal, the gain is

A) -10 B) 10 C) 6 D) -12

117. In a clamping circuit, the time constant RC of the circuit should be

A) Comparable with respect to the period of the input wave
B) Large with respect to the period of the input wave
C) Small with respect to the period of the input wave
D) Equal to the period of the input wave

118. The parameter that measures the performance of FET is

A) Transconductance B) Transresistance
C) Amplification factor D) Drain current

119. The truth table given below corresponds to

A	B	F
0	0	0
0	1	0
1	0	0
1	1	1

A) OR B) AND C) XOR D) NOR

120. A voltage comparator that develops a regenerative trigger is known as

A) Flip-flop B) Multivibrator
C) Schmitt trigger D) Shift register

****