BHU (M.Sc.) 2018

No. of Questions: 120

Time: 2 Hours **Full Marks: 360**

Note: (1) Attempt as many questions as you can. Each question carries **3** marks. **One** mark will be deducted for each incorrect answer. **Zero** mark will be awarded for each unattempted question.

(2) If more than one alternative answers seem to be approximate to the correct answer, choose the closest one.

Q1. In Sommerfeld's model of atom, the orbits characterized by a particular principal quantum number, n and different azimuthal quantum number $n_\theta = 1, 2, 3, ..., n$ have

(a) same energy (b) energy in increasing order with n_θ

(c) energy in decreasing order with n_θ (d) no associated energy

Q2. Stern-Gerlach experiment s important because it gives experimental verification of

(a) quantization of energy of atom (b) orbital motion of electron

(c) electron spin (d) Sommerfeld model of atom

Q3. The ratio of orbital magnetic dipole moment μ_l to the orbital angular momentum L of an electron in an orbit is given by

(a) $\frac{\mu_L}{L} = \frac{\mu_b}{\hbar}$ (b) $\frac{\mu_L}{L} = -\frac{\mu_b}{\hbar}$ (c) $\frac{\mu_L}{L} = -\frac{\mu_b}{2\hbar}$ (d) $\frac{\mu_L}{L} = \frac{\mu_b}{2\hbar}$

Q4. Larmor Frequency is the frequency of precession of

(a) orbital angular momentum L about the external magnetic field, B

(b) spin angular momentum, S about the external magnetic field, B

(c) total angular momentum, J about the external magnetic field, B

(d) orbital angular momentum, L about the total angular momentum, J

Q5. On application of weak magnetic field the sodium line arising due to the transition ${}^2P_{3/2} \rightarrow {}^2S_{1/2}$ will split ideally into

(a) 2 components (b) 4 components

(c) 6 components (d) 10 components

Q6. The half-width of gain profile of a He-Ne laser is $2\times10^{-3}\ nm$. If the length of the cavity is $30\ cm$, how many longitudinal modes can be excited? The emission wavelength is $6328\ \overset{0}{A}$

(a) 1 (b) 2 (c) 3 (d) 4

Q7. At what temperature; pressure remaining unchanged, will the molecular velocity (root mean square velocity) of hydrogen will be double of its value at NTP?

(a) $1092\ ^{o}C$ (b) $819\ ^{o}C$ (c) $1092\ ^{o}F$ (d) $819\ ^{o}K$

Q8. The mean square speed for the following group of particles (N_i represents the number of particles with speed v_i) will be

N_i	v_i (m/sec)
2	1.0
4	2.0
8	3.0

(a) $11.33\, m/\sec$ (b) $16.43\, m^2/\sec^2$

(c) $2.67\, m/\sec$ (d) $3.36\, m/\sec$

Q9. The ratio between most probable speed and root mean square speed of a gas molecule is

(a) $\sqrt{\frac{3}{2}}$ (b) $\sqrt{\frac{3}{8\pi}}$ (c) $\sqrt{\frac{2}{3}}$ (d) $\sqrt{\frac{8}{3\pi}}$

Q10. The mean free path of molecules of a gas at pressure p and T temperature is 2×10^{-5} cm. The mean free path at pressure $\frac{p}{2}$ and temperature $2T$ will be

(a) $10^{-5}\ cm$ (b) $8\times10^{-5}\ cm$ (c) $10^{-5}\ m$ (d) $8\times10^{-5}\ m$

Q11. For the adiabatic expansion of a blackbody radiation enclosure, which of the following is correct?

(a) $V^{1/3}T=$ constant (b) $V.T=$ constant

(c) $V^{4/3}T=$ constant (d) $\frac{V}{T}=$ constant

where V is the volume and T is the temperature of the enclosure

Q12. In throttling process.

(a) the enthalpy remains constant (b) temperature remains constant

(c) Gibbs' free energy remains constant (d) entropy remains constant

Q13. Which one of the following is correct?

(a) $\frac{E_\lambda}{T^4} = \text{constant}$ (b) $\frac{E_\lambda}{T^5} = \text{constant}$

(c) $\frac{E_\lambda}{T^2} = \text{constant}$ (d) $\frac{E_\lambda}{T} = \text{constant}$

where E_λ is spectral emissive power.

Q14. The numerical value of the slope of an isenthalpic curve at any point on a TP-diagram is called

(a) Joule coefficient (b) Joule-Kelvin coefficient

(c) Van der Waals' constant (d) Virial coefficient

Q15. Which of the following can be used to produce lowest temperature?

(a) Liquefaction of N_2.

(b) Liquid He

(c) Adiabatic demagnetization of paramagnetic salts

(d) None of these

Q16. A mass m of water at T_1K is isobarically and adiabatically mixed with an equal mass of water at T_2K the entropy change of the universe is

(a) $2mC_p \ln\frac{(T_1+T_2)/2}{\sqrt{T_1T_2}}$ (b) $2m\ln\frac{(T_1+T_2)/2}{\sqrt{T_1T_2}}$

(c) $2C_p \ln\frac{(T_1+T_2)/2}{\sqrt{T_1T_2}}$ (d) $2mC_p$

Where C_p is specific heat at constant pressure.

Q17. Thermodynamic equation

$$TdS = C_V dT + \frac{\beta T}{\kappa} dV \text{ is called}$$

(a) 2nd TdS equation (b) 1st TdS equation (c) 3rd TdS equation (d) None of these

Where terms have their usual meanings.

Q18. Which of the following is correct?

(a) $C_P = \left(\frac{\partial V}{\partial T}\right)_P \left(\frac{\partial P}{\partial T}\right)_S$ (b) $C_P = T\left(\frac{\partial V}{\partial T}\right)_P \left(\frac{\partial P}{\partial T}\right)_S$

(c) $C_P = \left(\frac{\partial T}{\partial V}\right)_P \left(\frac{\partial P}{\partial T}\right)_S$ (d) $C_P = T\left(\frac{\partial T}{\partial V}\right)_P \left(\frac{\partial P}{\partial T}\right)_S$

Q19. In one-dimensional elastic collision of two particles, the ratio of velocities of separation and approach is equal to:

(a) coefficient of restitution (b) negative of coefficient of restitution

(c) zero, if collision is perfectly elastic (d) infinite

Q20. If in an elastic collision, a massive particle collides against a lighter One at rest:

(a) it can never bounce back along its original path

(b) it may bounce back along its original path

(c) the two particles move at right angles to each other after collision

(d) None of the above

Q21. In which of the following conditions, the total linear momentum of the system remains constant?

(a) If the resultant external force acting on the system of particles is zero

(b) If the resultant external force acting on the system of particles is positive

(c) If the resultant external force acting on the system of particles is -ve

(d) None of these

Q22. From the nozzle of a rocket $100\,kg$ of gases are exhausted per sec with a velocity of $1000 m/\sec$. What force (thrust) does the gas exert on the rocket?

(a) 100 kg/sec (b) 10^5 Newton (c) 10^3 Newton (d) 100 Newton

Q23. If a particle is at rest relative to an observer at rest at the centre of a rotating frame of reference

(a) centrifugal and Coriolis forces both act (b) only centrifugal force acts

(c) only Coriolis force acts (d) None of these

24. The length of a rod, of length $5m$ in a frame of reference which is moving with $0.6\ c$ velocity in a direction making 30^0 angle with the rod is nearly

(a) $4.3m$ (b) $3.4\ m$ (c) $2.43\ m$ (d) $2.34\ m$

Q25. π^+ meson decays into a μ^+ meson and a neutrino with a mean lifetime of about 2.5×10^{-8} sec in a frame in which it is at rest. If the velocity of the π^+ mesons in the laboratory frame be $0.9c$, then the expected lifetime in this frame is

(a) 5.7×10^{-8} sec

(b) $2.5\times10^{-8}\ m/\sec$

(c) 3.1×10^{-8} sec

(d) None of these

Q26. The speed of an electron having kinetic energy $2\,MeV$ will be

(a) $2.93\times10^{8}\ m/\sec$

(b) 3×10^{8} sec

(c) $10^{8}\ m/\sec$

(d) 1.5×10^{8} sec

Q27. Which of the following relations is correct for modulus of rigidity η bulk modulus K and Poisson's ratio σ?

(a) $\sigma=\dfrac{K-2\eta}{6K+2\eta}$

(b) $\sigma=\dfrac{3K-2\eta}{K+2\eta}$

(c) $\sigma=\dfrac{3K-2\eta}{6K+2\eta}$

(d) $\sigma=\dfrac{K-2\eta}{K+2\eta}$

Q28. Two wires A and B of the same material and equal length but of radii r and $2r$ are soldered coaxially, The free end of B is twisted by an angle Φ. The ratio of the twist at the junction and angle Φ is

(a) $\dfrac{16}{1}$ (b) $\dfrac{17}{16}$ (c) $\dfrac{16}{17}$ (d) $\dfrac{1}{16}$

Q29. Which of the following is true about liquid flow through a capillary tube?

(a)The velocity of the liquid layer in contact with the capillary tube is least

(b) The velocity of the liquid layer in contact with the capillary tube is maximum

(c) The velocity of the liquid layer at the centre of the capillary tube is minimum

(d) None of these

Q30. The depletion region is created by

(a) ionization

(b) diffusion

(c) recombination

(d) (a), (b) and (c)

Q31. A silicon diode is in series with a $1k\Omega$ resistor and a $5V$ battery. If the anode is connected to the +ve battery terminal, the cathode voltage with respect to the negative battery terminal is

(a) $0.7\ V$ (b) $0.3\ V$ (c) $5.7V$ (d) $4.3V$

Q32. Where will be the position of the Fermi level of the n-type material when $N_D = N_A$

(a) E_C (b) E_V (c) $\frac{E_C + E_V}{2}$ (d) None of the above

where terms have their usual meanings

Q33. The mobility of electrons in a material is expressed in unit of

(a) V/s (b) $\left(\frac{m^2}{V\sec}\right)$ (c) m^2/s (d) J/K

Q.34 A silicon sample is uniformly doped with 10^{16} phosphorous atoms/cm^3 and 2×10^{16} boron atoms/cm^3. If all the dopants are fully ionized, the material is

(a) n-type with carrier concentration of 3×10^{16}/cm^3

(b) p-type with carrier concentration of 10^{16}/cm^3

(c) p-type with carrier concentration of 4×10^{16}/cm^3

(d) intrinsic

Q35. The bias condition for a transistor to be used as a linear amplifier is called

(a) forward-reverse (b) forward-forward

(c) reverse-reverse (d) collector bias

Q36. Wien-bridge oscillators are based on

(a) positive feedback (b) negative feedback

(c) piezoelectric effect (d) high gain

Q37. Which of the following is a universal gate?

(a) OR gate (b)NOR gate (c) AND gate (d) NOT gate

Q38. For an ideal dielectric, polarization $\vec{P}$ is given by

(a) $\vec{P} = \varepsilon_0 \vec{E}$ (b) $\vec{P} = (K-1)\varepsilon_0 \vec{E}$

(c) $\vec{P} = (K+1)\varepsilon_0 \vec{E}$ (d) $\vec{P} = \frac{\varepsilon_0}{K-1}\vec{E}$

Q39. Clausius-Mossotti relation Es represented by the equation

(a) $\alpha = \frac{3\varepsilon_0}{n}\frac{K-1}{K+2}$ (b) $\alpha = \frac{\varepsilon_0}{n}\frac{K-1}{K+2}$

(c) $\alpha = \frac{\varepsilon_0}{3n}\frac{K-1}{K+2}$ (d) $\alpha = \frac{3\varepsilon_0}{n}\frac{K+2}{K-1}$

where symbols have their usual meanings

Q40. The dipole moment of water molecule is $6.2\times10^{-30}\,C-m$ at $20\,^0C$. The polarizability α is

(a) $3.17\times10^{-39}C-m^2/V$ (b) $3.17\times10^{-37}C-m^2/V$

(c) $3.17\times10^{-35}C-m^2/V$ (d) $3.17\times10^{-33}C-m^2/V$

Q41. The magnetic vectors are related as

(a) $\vec{B} = \mu_0\left(\vec{M}-\vec{H}\right)$ (b) $\vec{B} = \mu_0\left(\vec{M}+\vec{H}\right)$

(c) $\vec{B} = \mu_0^{-1}\left(\vec{M}+\vec{H}\right)$ (d) $\vec{B} = \mu_0^{-1}\left(\vec{M}-\vec{H}\right)$

Q42. For higher values of temperature, the susceptibility of paramagnetic substances is proportional to

(a) T (b) $\frac{1}{T}$ (c) T^2 (d) $\frac{1}{T^2}$

Q43. The loss of energy per hour in the iron core of a transformer, the hysteresis loop of which is equivalent in area to $2500\,ergs/cm^2$ is (given, frequency $=50\,Hz$, density of iron $=7.5\,g/cm^3$ weight of the iron core $=10\,kg$)

(a) $5.985\times10^2\ J$ (b) $5.985\times10^3\ J$

(c) $5.985\times10^4\ J$ (d) $5.985\times10^5\ J$

Q44. A current i is flowing in a toroidal coil of circular cross-section of radius R with N number of turns distributed uniformly over its circumference, If A is the cross-sectional area of the toroid, its self-inductance will be

(a) $L = \frac{\mu_0 N^2 A}{2\pi R}$ (b) $L = \frac{\mu_0 N^2 A}{\pi R}$

(c) $L = \frac{\mu_0 N^2 A}{4\pi R}$ (d) $L = \frac{\mu_0 N^2 A}{2R}$

Q45. Two inductors L_1 and L_2 are connected in series. The total inductance L will be

(a) $L = L_1 + L_2$
(b) $L = L_1 + L_2 + 2M$
(c) $L = L_1 + L_2 + M$
(d) $L = L_1 + L_2 - M$

where M is mtual inductance of two coils.

Q46. A circuit containing resistor R_1 inductor L_1 and capacitor C_1 connected in series gives resonance at the same frequency f as the second similar combination R_2L_2 and C_2. If the two circuits are connected in series, the whole circuit will resonate at the frequency

(a) $2f$
(b) $\frac{f}{2}$
(c) f
(d) $\frac{f}{4}$

Q47. A capacitor of $250\,pF$ is connected in parallel with a coil having inductance of $16\,mH$ and effective resistance $20\ \Omega$. The circuit impedance at resonance is

(a) $3.2\times10^4\ \Omega$
(b) $3.2\times10^3\ \Omega$
(c) $3.2\times10^2\ \Omega$
(d) $3.2\times10^5\ \Omega$

Q48. For dispersive medium, group velocity (v_g) and phase velocity (v_p) are related as

(a) $v_g = v_p + \lambda\frac{dv_p}{d\lambda}$
(b) $v_g = v_p - \lambda\frac{dv_p}{d\lambda}$
(c) $v_g = v_p + \frac{1}{\lambda}\frac{dv_p}{d\lambda}$
(d) $v_g = v_p - \frac{1}{\lambda}\frac{dv_p}{d\lambda}$

Q49. Photon of energy $1.02\ MeV$ undergoes Compton scattering through 180°. The energy of the scattered photon is

(a) $1.02\ MeV$
(b) $0.204\ MeV$
(c) $0.402\ MeV$
(d) $0.240\ MeV$

Q50. In Newton's ring experiment, the diameters of the bright rings are proportional to the

(a) natural number
(b) square root of natural numbers
(c) square root of odd numbers
(d) odd numbers

Q51. A thin sheet of a transparent material of refractive index, $\mu = 1.50$ is placed in the path one of the interfering beams in a biprism experiment with a monochromatic source of wavelength,

$\lambda = 5000\,\overset{0}{A}$. The central fringe shifts to a position originally occupied by 10th bright fringe. the thickness of the sheet is

(a) $1\times10^{-5}\ m$ (b) $1.5\times10^{-5}\ m$ (c) $2\times10^{-5}\ m$ (d) $2.5\times10^{-5}\ m$

Q52. Interference pattern is produced by two point sources S_1 and S_2 on a plane perpendicular to the line joining S_1 and S_2. What will be the shape of interference fringes?

(a) straight line (b) circular

(c) Parabolic (d) Hyperbolic

Q53. In order to make a glass plate of refractive index, μ_g non-reflecting over a wide wavelength range around λ, a thin film is deposited on it. The refractive index μ_f and the thickness d of the film should be

(a) $\mu_f = \sqrt{\mu_g \mu_a}, d = \dfrac{3\lambda}{4\mu_f}$ (b) $\mu_f = \sqrt{\mu_g \mu_a}, d = \dfrac{\lambda}{4\mu_f}$

(c) $\mu_f = \sqrt{\mu_g / \mu_a}, d = \dfrac{\lambda}{4\mu_f}$ (d) $\mu_f = \sqrt{\mu_g / \mu_a}, d = \dfrac{3\lambda}{4\mu_f}$

Q54. When the distance between two mirrors in Michelson interferometer decreased is

(a) the fringe pattern appears to collapse at the centre

(b) the fringe pattern expands

(c) the fringe pattern remains stable

(d) the shape of the fringe changes

Q55. The spread of the central maximum in the Fraunhofer diffraction by a single slit is approximately given by

(a) $\dfrac{\lambda}{b} \le \theta \le \dfrac{\lambda}{b}$ (b) $\dfrac{2\lambda}{b} \le \theta \le \dfrac{2\lambda}{b}$

(c) $\dfrac{\lambda}{2b} \le \theta \le \dfrac{\lambda}{2b}$ (d) $\dfrac{\lambda}{b} \le \theta \le \dfrac{\lambda}{2b}$

where θ is diffraction angle, b is width of the slit and λ is the wavelength of the light used.

Q56. A $2mW$ laser beams of wavelength $\lambda = 6\times10^{-5}\ cm$ is focussed on the retina by a human eye lens of focal length $f = 2.5\ cm$ and pupil diameter $2\,mm$. The intensity on the retina will be of the order of

(a) $10^4 W/m^2$ (b) $10^6 W/m^2$ (c) $10^8 W/m^2$ (d) $10^2 W/m^2$

Q57. To increase the resolving power of a grating total number of lines on the grating is increased such that the grating element becomes 2.5λ How many orders will be seen on the screen?

(a) First order only

(b) First and second orders only

(c) First, second and third orders only

(d) First, second, third and fourth orders only

Q58. The radii of the circles of a zone plate is given by $r_n = 0.1\sqrt{n}\ cm$ The most intense focal point for wavelength $\lambda = 5\times10^{-5}$ cm will be at a distance

(a) $50\,cm$ (b) $100\ cm$ (c) $150\ cm$ (d) $200\ cm$

Q59. What is the minimum thickness of the base of a prism that can just resolve the two lines of sodium light centred at $5890\,\mathring{A}$ and $5896\,\mathring{A}$. The given value of refractive index of prism material is 1.6545 at wavelength $6563\,\mathring{A}$ and 1.6635 at wavelength $5270\,\mathring{A}$

(a) $8\,mm$ (b) $10\,mm$ (c) $12\,mm$ (d) $14\ mm$

Q60. An unpolarized light is incident on a glass plate placed in air at polarizing angle. The reflected light is

(a) plane polarized with electric vector perpendicular to the plane of incidence

(b) plane polarized with electric vector parallel to the plane of incidence

(c) partially polarized having more electric field vectors perpendicular to the plane of incidence

(d) partially polarized having more electric field vectors parallel to the plane of incidence

Q61. A rigid body is constrained to move on plane. Number of degrees of freedom for it will be

(a) 2 (b) 1 (c) 5 (d) 3

Q62. Number of generalized coordinates required. to describe the motion of a solid cylinder rolling without slipping on an inclined plane is

(a) 5 (b) 2 (c) 3 (d) 4

Q63. The constraints of a rigid body is

(a) conservative and scleronomic (b) conservative and rheonomic

(c) holonomic and rheonomic (d) non-holonomic and scleronomic

Q64. Which one of the following represents the equation of motion for the system described by the Hamiltonian $H(q,p)$?

(a) $\dot{q}=\frac{\partial H}{\partial p},\dot{p}=\frac{\partial H}{\partial q}$ (b) $-\dot{q}=\frac{\partial H}{\partial p},\dot{p}=\frac{\partial H}{\partial q}$

(c) $\dot{q}=\frac{\partial H}{\partial p},\dot{p}=-\frac{\partial H}{\partial q}$ (d) $\dot{q}=\frac{\partial H}{\partial q},-\dot{p}=\frac{\partial H}{\partial p}$

Q65. A particle of unit mass moves in a potential $V(x)=x^3-3x+2$. The angular frequency of small oscillation about the minimum of the potential is

(a) $\sqrt{6}$ (b) $\sqrt{3}$ (c) $\frac{1}{\sqrt{6}}$ (d) $\frac{1}{\sqrt{3}}$

Q66. A system is described by the Lagrangian $L(r,\theta,\dot{r},\dot{\theta})=\frac{1}{2}m\dot{r}^2+\frac{1}{2}mr^2\dot{\theta}^2+\frac{1}{r}$.

Which one of the following is not true?

(a) Total energy of the system is conserved

(b) Angular momentum of the system is conserved

(c) θ is cyclic coordinate

(d) Linear momentum of system is conserved

Q67. If q_1 and q_2 are generalized coordinates and p_1 and p_2 are corresponding generalized momenta, then the Poisson bracket $\{q_1^2+q_2^2,2p_1+p_2\}$ is

(a) 0 (b) $(q_1+2q_2)2p_1$

(c) $3(q_1^2+q_2^2)$ (d) $2(2q_1+q_2)$

Q68. Lagrangian for simple harmonic oscillator with frequency ω, mass m in one dimension is given by

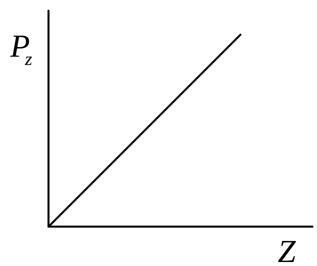
(a) $\frac{1}{2}m(\dot{x}^2-\omega^2x^2)$ (b) $\frac{1}{2}m(\dot{x}^2+\omega^2x^2)$

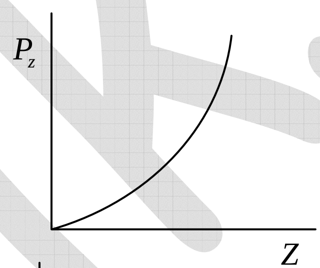
(c) $\frac{1}{2}m\left(\ddot{x}+\omega^2 x\right)$ (d) $\frac{p^2}{2m}+\frac{1}{2}m\omega^2 x^2$

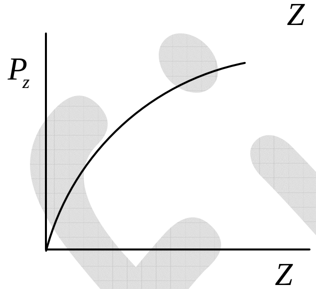
Q69. The probability distribution of variable x in the range $-\infty$ to $+\infty$ is given by $P(x)=10e^{-\left[2x^2-4x-6\right]}$. The maximum probability will correspond to

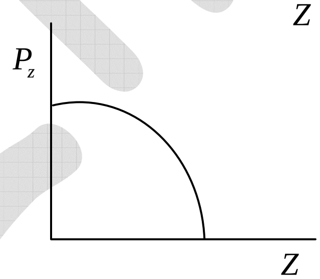
(a) $x=1$ (b) $x=0$ (c) $x=3$ (d) $x=-1$

Q70. The phase space trajectory of a single particle, falling freely from a height will be

(a)


(b)


(c)


(d)


Q71. Number of microstates for a monoatomic ideal gas with N molecules in a volume V and with total energy E is proportional to

(a) E^N (b) $E^{3N/2}$ (c) $E^{N/2}$ (d) E^{3N}

Q72. If Q be the partition function of a system of particles in canonical ensemble, the avenge energy of the system is given by

(a) $\bar{E}=\frac{\partial Q}{\partial \beta}$ (b) $\bar{E}=-\frac{\partial Q}{\partial \beta}$ (c) $\bar{E}=\frac{\partial}{\partial \beta}\ln Q$ (d) $\bar{E}=-\frac{\partial}{\partial \beta}\ln Q$

Q73. Consider a system consisting of two particles each of which can be in any one of three quantum states $0, \varepsilon, 2\varepsilon$. The number of total configurations when the particles are identical bosons

(a) 9 (b) 6 (c) 5 (d) 3

Q74. Consider a gas of photons in a cubical container of edge length L and volume $V = L^3$. The mean pressure in terms of mean energy E is given by

(a) $\frac{E}{V}$ (b) $\frac{2}{3}\frac{E}{V}$ (c) $\frac{1}{3}\frac{E}{V}$ (d) 0

Q75. The statistical systems in which both energy and number of particles change are best described by

(a) micro-canonical ensemble theory

(b) canonical ensemble theory

(c) grand-canonical ensemble theory

(d) both canonical as well as grand-canonical ensemble theory

Q76. Relative root mean square fluctuation of energy in canonical ensemble theory is

(a) $\propto T^{1/2}$ (b) $\propto T$ (c) $\propto T^2$ (d) $\propto T^{3/2}$

Q77. Given three isobars, namely;; ${}^{25}_{11}Na, {}^{25}_{12}Mg$ and ${}^{25}_{13}Al$

(a) ${}^{25}_{11}Na$ is stable and the other two are beta emitters

(b) ${}^{25}_{12}Mg$ is stable and the other two are beta emitters

(c) ${}^{25}_{13}Al$ is stable and the other two are beta emitters

(d) All nuclei are stable

Q78. Radiocarbon dating is done by estimating in the specimen

(a) the ratio of amount of ${}^{14}C$ to ${}^{12}C$ still present

(b) the ratio of amount of ${}^{13}C$ to ${}^{12}C$ still present

(c) the amount of radiocarbon still present

(d) the amount of ${}^{13}C$ still present

Q79. The rate of electron emission from $4\,mg$ of ${}^{210}_{80}Pb$ with half-life 5 days is

(a) 1.84×10^{16} (b) 1.84×10^{13} (c) 9.2×10^{11} (d) 9.2×10^{16}

Q80. A proton with $16\,MeV$ energy s bombarded on ${}^{216}_{84}Po$ nucleus. The proton is

(a) scattered (b) reflected back

(c) captured (d) transmitted through the nucleus

Q81. The fission rate of ${}^{235}U$ to produce energy of $200\,MW$ is

(a) 6.25×10^{15} fission/sec (b) 6.25×10^{16} fission/sec

(c) 6.25×10^{18} fission/sec (d) 3.12×10^{20} fission/sec

Q82. The minimum temperature required to initiate fusion of deuteron and triton is of the order of

(a) $10^9\ K$ (b) $10^6\ K$ (c) $10^{13}\ K$ (d) $10^{15}\ K$

Q83. The average velocity of nucleons inside the nucleus s of the order of

(a) $3\times10^8\ m/s$ (b) $6\times10^7\ m/s$ (c) $3\times10^6\ m/s$ (d) $6\times10^6\ m/s$

Q84. The magnetic dipole and electric quadrupole moment data of deuteron imply that the that the nuclear force is

(a) purely central

(b) central and spin dependent

(c) mixture of central and non-central components

(d) velocity dependent

Q85. In a crystal, a lattice plane cuts intercepts of $2a, 3b$ and $6c$ along the axes where a, b, c are primitive vectors of the unit cell. The Miller indices the given plane are

(a) (321) (b) (231) (c) (123) (d) (213)

Q86. The total number of Bravais lattice are

(a) 7 (b) 14 (c) 21 (d) 26

Q87. Origin of characteristic X -rays is

(a) photoelectric effect (b) inverse photoelectric effect

(c) electronic transitions within atoms (d) Compton effect

Q88. The K_α line from Molybdenum has a wavelength of $0.7078\overset{0}{A}$. The wavelength of the K_α line of copper (given atomic number of Molybdemum $=42$, atomic number of copper $=29$)

(a) $1.517\overset{0}{A}$ (b) $1.157\overset{0}{A}$ (c) $1.175\overset{0}{A}$ (d) $1.715\overset{0}{A}$

Q89. The relation of the reciprocal basis vector $\vec{A}$ to the direct basis vector $\vec{a}$ is given by

(a) $\vec{A}.\vec{a}=0$ (b) $\vec{A}.\vec{a}=2\pi$ (c) $\vec{A}.\vec{a}=\pi$ (d) $\vec{A}.\vec{a}=\frac{\pi}{2}$

Q90. If current carriers are electrons, the Hall coefficient R_H is

(a) $R_H=-\frac{1}{ne}$ (b) $R_H=+\frac{1}{ne}$ (c) $R_H=\frac{n}{e}$ (d) $R_H=ne$

Q91. The electron velocity v_F, at the Fermi surface is

(a) $\hbar\left(\frac{3\pi^2 N}{V}\right)^{1/3}$ (b) $\frac{\hbar}{m}\left(\frac{3\pi^2 N}{V}\right)^{1/3}$

(c) $\frac{\hbar}{m}\left(\frac{3\pi N}{V}\right)^{1/3}$ (d) $\frac{\hbar}{m}\left(\frac{\pi^2 N}{V}\right)^{1/3}$

Q92. The Langevin function, $L(\alpha)$ represented by

(a) $L(\alpha)=\cot h\alpha$ (b) $L(\alpha)=\left[\cot h\alpha+\frac{1}{\alpha}\right]$

(c) $L(\alpha)=\left[\cot\ h\alpha-\frac{1}{\alpha}\right]$ (d) $L(\alpha)=(\cot h\alpha-\alpha)$

where the symbols have their usual meaning

Q93. The curl of the electromagnetic intensity is

(a) conservative (b) rotational (c) divergent (d) static

Q94. The direction of propagation of electromagnetic wave is given by

(a) $\vec{E}.\vec{B}$ (b) $\vec{E}$ (c) $\vec{E}\times\vec{B}$ (d) $\vec{B}$

Q95. For good conductors the skin depth varies inversely with

(a) ω (b) ω^2 (c) $\sqrt{\omega}$ (d) ω^4

Q96. The divergence of the curl of a vector field is

(a) a scalar (b) a vector (c) zero (d) infinity

Q97. The charge build up in the capacitor is due to which quantity?

(a) Conduction current (b) Displacement current

(c) Convection current (d) Direct current

Q98. In conductors, which condition will be true?

(a) $\sigma\omega\varepsilon > 1$ (b) $\frac{\sigma}{(\omega\varepsilon)} > 1$

(c) $\frac{\sigma}{(\omega\varepsilon)} < 1$ (d) $\sigma\omega\varepsilon < 1$

Q99. the relation between the speed of light, permeability and permittivity is

(a) $c = \mu\varepsilon$ (b) $c = \frac{\mu}{\varepsilon}$ (c) $c = \frac{1}{\sqrt{\mu\varepsilon}}$ (d) $c = \frac{1}{\mu\varepsilon}$

Q100. The phenomenon employed in the waveguide operation is

(a) reflection (b) refraction

(c) total internal reflection (d) absorption

Q101. The metric of spherical polar coordinates are

(a) $h_{11} = r, h_{22} = 1, h_{33} = r\sin\theta$ (b) $h_{11} = 1, h_{22} = r, h_{33} = r\sin\theta$

(c) $h_{11} = r, h_{22} = r\sin\theta, h_{33} = 1$ (d) $h_{11} = r^2, h_{22} = r^2\sin^2\theta, h_{33} = r^2\sin^2\theta$

Q102. Given the transformation $u = x + y, v = x - y$ and $du\ dv = kdx\ dy$, the value of k is

(a) 1 (b) -1 (c) 2 (d) $\frac{1}{2}$

Q103. Given $A = \begin{pmatrix} 0 & 1 \\ 0 & 0 \end{pmatrix}(aI + bA)^n$ is (where I is 2×2 unit vector)

(a) $a^n I + b^n A$ (b) $a^n I + nab^{n-1} A$

(c) $a^n I + nabA$ (d) $a^n I + na^{n-1} bA$

Q104. Eigenvectors of the matrix $\begin{pmatrix} 0 & i \\ -i & 0 \end{pmatrix}$ are

(a) $\begin{pmatrix} 1 \\ 0 \end{pmatrix}, \begin{pmatrix} 0 \\ 1 \end{pmatrix}$ (b) $\frac{1}{\sqrt{2}}\begin{pmatrix} 1 \\ -i \end{pmatrix}, \frac{1}{\sqrt{2}}\begin{pmatrix} 1 \\ i \end{pmatrix}$

(c) $\frac{1}{\sqrt{2}}\begin{pmatrix} 1 \\ 1 \end{pmatrix}, \frac{1}{\sqrt{2}}\begin{pmatrix} 1 \\ 1 \end{pmatrix}$ (d) $\frac{1}{\sqrt{2}}\begin{pmatrix} i \\ 1 \end{pmatrix}, \frac{1}{\sqrt{2}}\begin{pmatrix} -i \\ 1 \end{pmatrix}$

Q105. Given the matrix $\begin{pmatrix} -2 & 2 & -3 \\ 2 & 1 & -6 \\ -1 & -2 & 0 \end{pmatrix}$ with one of the eigenvalues equal to -3, the other two eigenvalues are

(a) $0,1$ (b) $0,-1$ (c) $0,2$ (d) $-3,5$

Q106. In the equation $x^2\frac{d^2y}{dx^2}+x\frac{dy}{dx}+\left(q^2x^2-m^2\right)y=0$

(a) $x=0$ and $x=\infty$ are ordinary points

(b) $x=0$ and $x=\infty$ are regular singular points

(c) $x=0$ is a regular singular point and $x=\infty$ is an irregular singular points

(d) $x=0$ and $x=\infty$ are irregular singular points

Q107. One of the solutions of the equation $\left(1-x^2\right)\frac{d^2y}{dx^2}-2x\frac{dy}{dx}+12y=0$ is

(a) $H_4(x)$ (b) $P_3(x)$ (c) $L_4(x)$ (d) $J_4(x)$

Q108. The Delta function $\delta\left(x^2-a^2\right)$ is equal to

(a) $\delta(x+a)\delta(x-a)$ (b) $\delta(x+a)+\delta(x-a)$

(c) $\frac{1}{2|a|}\left[\delta(x+a)+\delta(x-a)\right]$ (d) $\delta(x+a)-\delta(x-a)$

Q109. The Fourier coefficients of the function

$$f(x)=\begin{cases}0 & \text{for } -L\le x\le 0\\ 1 & \text{for } 0\le x\le L\end{cases}$$

expanded in Fourier series are

(a) $a_0=1, a_n=0, b_n=\frac{1}{n\pi}\left[1-(-1)^n\right]$ (b) $a_0=1, a_n=\left[1-(-1)^n\right], b_n=0$

(c) $a_0=1, a_n=0, b_n=0$ (d) $a_0=1, a_n=1, b_n=\frac{1}{n\pi}\left[1-(-1)^n\right]$

Q110. The operator $i\hbar\frac{d}{d\hat{x}}-\hat{x}$ in momentum basis is

(a) $i\hbar\frac{d}{d\hat{p}}-\hat{p}$ (b) $-i\hbar\frac{d}{d\hat{p}}-\hat{p}$

(c) $-i\hbar\frac{d}{d\hat{p}}+\hat{p}$ (d) $i\hbar\frac{d}{d\hat{p}}+\hat{p}$

Q111. If a^+ and a are creation and annihilation operators for SHO, then which of the following is not a Hermitian operator

(a) $aa^+ + a^+a$ (b) $aa^+ + a^+a$ (c) $i(a^+ - a)$ (d) $i(a^+ + a)$

Q112. If the expectation value of the momentum operator in the normalized state $\psi(x)$ is $\langle p\rangle$, then expactation value of the momentum operator in the state $\psi_1(x)=e^{\frac{i}{\hbar}p_0x}\psi(x)$ will be

(a) $\langle p\rangle + p_0$ (b) $\langle p\rangle - p_0$ (c) $\langle p\rangle$ (d) 0

Q113. The ground state wave function for a $1-d$ system described by the potential

$$V(x)=0 \quad \text{for} -\frac{L}{2}\le x\le\frac{L}{2} \text{ is}$$
$$=\infty \quad \text{elsewhere}$$

(a) $A\cos\frac{\pi x}{L}$ (b) $A\sin\frac{\pi x}{2L}$ (c) $A\sin\frac{\pi x}{L}$ (d) $A\cos\frac{\pi x}{2L}$

Q114. A simple harmonic oscillator in one dimension has an eigenfunction (of the Hamiltonian) which vanishes 3 times in the interval $0<x<\infty$ and is odd under parity. The energy eigenvalue for this state is

(a) $\frac{7}{2}\hbar\omega$ (b) $\frac{9}{2}\hbar\omega$ (c) $\frac{13}{2}\hbar\omega$ (d) $\frac{15}{2}\hbar\omega$

Q115. The raising and lowering of angular momentum operators are defined as $L_\pm = L_x \pm iL_y$. The commutator $|L_-, L_\pm|$ is equal to

(a) $-2\hbar L_-$ (b) $\hbar L_-$ (c) $\hbar L_+$ (d) $-\hbar L_-$

Q116. The bound state energy for the state $\psi_{5,4,2}(r,\theta,\phi)$ in a H-atom problem is given by

(a) $-\frac{13.6}{5}eV$ (b) $-\frac{13.6}{25}eV$ (c) $-13.6\times 5eV$ (d) $-13.6\times 25eV$

Q117. In a H-atom problem if $L_z\psi_{3,2,-2}(r,\theta,\phi)=a\hbar\psi_{3,2,-2}(r,\theta,\phi)$, then a is

(a) 2 (b) -2 (c) $2\sqrt{3}$ (d) $\sqrt{6}$

Q118. ψ_1 and ψ_2 are the wave functions of two orthogonal states of a system belonging to the energy eigenvalues E and $-E$, respectively. In a measurement of energy of another state ψ of the system, the expectation value of energy is found to be $\frac{E}{2}$. ψ in terms of ψ_1 and ψ_2 is

(a) $\frac{\sqrt{3}}{2}\psi_1+\frac{1}{2}\psi_2$ (b) $\frac{1}{2}(\psi_1-\psi_2)$

(c) $\frac{1}{\sqrt{2}}(\psi_1-\psi_2)$ (d) $\frac{3}{4}\psi_1+\frac{1}{4}\psi_2$

Q119. In any Bohr orbit of hydrogen atom, the ratio of the kinetic energy to the potential energy of the electron is

(a) $\frac{1}{2}$ (b) 2 (c) $\frac{-1}{2}$ (d) -2

Q120. Considering the nuclear mass finite, the Rydberg constant is maximum for

(a) hydrogen atom (b) deuterium atom

(c) singly ionized helium atom (d) doubly ionized lithium atom