BHU-M.Sc. 2015

Q1. If the probability in a total number of N steps making n_1 steps to the right and n_2 steps to the let is described by a binomial distribution, the mean number (n_1) is proportional to

(a) N (b) N^{-1} (c) $N^{\frac{1}{2}}$ (d) none of these

Q2. The specific internal energy of an ideal gas is dependent on its

(a) volume only (b) temperature only

(c) pressure only (d) None of these

Q3. Which of the following best describes the relation between isothermal compressibility (k_T) and adiabatic compressibility (k_s) is

(a) $k_T > k_s$ (b) $k_s \leq k_T$ (c) $k_T < k_s$ (d) $k_T \leq k_s$

Q4. $\left(\frac{\partial P}{\partial T}\right)_V$ can be given in terms of volume expansivity (β) and isothermal compressibility (k_T) as

(a) $\frac{\beta}{k_T}$ (b) $\frac{-\beta}{k_T}$ (c) $\frac{k_T}{\beta}$ (d) $\frac{-k_T}{\beta}$

Q5. In a throttling expansion of a real gas through a porus plug, the following quantity is the same in the initial and the final states of the gas

(a) Temperature (b) Pressure

(c) Entropy (d) Enthalpy

Q6. One kilogram of water at $273\ K$ is brought into contact with a hoat reservoir at $373\ K$. When the temperature of water becomes $373\ K$, the change in the entropy (in SI units) of the Universe is (for water $C_P = 4200\ Jkg^{-1}K^{-1}$)

(a) 1310 (b) 185 (c) 0 (d) 1210

Q7. The change in entropy (in SI units) in an adiabatic free expansion of one mole of an ideal gas, to double its initial volume is

(a) 5.762 (b) 0 (c) 8.314 (d) 1.38

Q8. Entropy has the same unit as

(a) heat capacity (b) enthalpy

(c) temperature (d) internal energy

Q9. The Clausius mathematical statement of the second law of thermodynamics, for an irreversible process is

(a) $\oint \frac{\delta Q}{T} \leq 0$ (b) $\oint \frac{\delta Q}{T} > 0$ (c) $\oint \frac{\delta Q}{T} < 0$ (d) $\oint \frac{\delta Q}{T} = 0$

Q10. In a gas at room temperature, the ratio of the root mean square velocity and the speed of sound in the gas is (for $\gamma = \frac{C_P}{C_V}$)

(a) $\sqrt{\frac{3}{\gamma}}$ (b) $\sqrt{\frac{\gamma}{3}}$ (c) $\sqrt{3\gamma}$ (d) None of these

Q11. The phase velocity v_p and group velocity v_g of an EM wave through a dispersive medium are given by

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

(c) $v_g = v_p - \frac{dv_p}{d\lambda}$ (d) $v_g = v_p - \frac{d^2 v_p}{d\lambda^2}$

Q12. curl $E = \frac{-\delta E}{\delta t}$ is representing

(a) Ampere's law (b) Gauss's law

(c) Ohm's law (d) Faraday's law

Q13. The pointing vector S of an electromagnetic wave is

(a) $S = E \times H$ (b) $S = E \times B$

(c) $S = \frac{E}{B}$ (d) $S = \frac{E}{H}$

Q14. The ratio of electric field vectors E and magnetic field vector H (i.e., $\frac{E}{H}$) has the dimensions of

(a) resistance (b) inductance

(c) capacitance (d) product of inductance and capacitance

Q15. Which of the following Maxwell's equations implies the absence of magnetic monopole?

(a) $divD = P$ (b) $\text{div} B = 0$

(c) curl $E = -\delta \frac{B}{\delta t}$ (d) curl $H = J + \frac{\delta D}{\delta t}$

Q16. The displacement vector D and electric field strength E are related by

(a) $D = \frac{E}{\varepsilon}$ (b) $D = \varepsilon E$ (c) $D = \varepsilon E^2$ (d) $D = \varepsilon E^{\frac{1}{2}}$

Q17. The dimension of $E \times E$ is

(a) $\frac{\text{energy}}{\text{area}} \times \text{time}$ (b) $\frac{\text{energy}}{\text{time}}$

(c) $\frac{\text{energy}}{\text{area}}$ (d) $\frac{\text{energy}}{\text{length}} \times \text{time}$

Q18. Propagation of EM wave in a medium the dependence of phase velocity with frequency is called

(a) reflection (b) refraction (c) polarization (d) dispersion

Q19. For a good conductor, the skin depth varies

(a) inversely as frequency ω (b) directly as ω

(c) inversely as $\sqrt{\omega}$ (d) directly as $\sqrt{\omega}$

Q20. The relative dielectric constant ε_r of water is 80. This does not justify its refractive index $n = 1.33$ violating the expression $n^2 = \varepsilon_r$. This is because

(a) the water molecule has no permanent dipole moment

(b) the boiling point of water is $100^0 C$

(c) the two quantities are measured by different experiments

(d) water is transparent to viable light

Q21. An a.c. voltage is applied to a parallel plate capacitor. The ratio of displacement current and conduction current through the capacitor in the external circuit is

(a) larger than 1 (b) less than 1

(c) equal to 1 (d) None of the above

Q22. A plane EM wave travelled in a vacuum with a velocity is given by

(a) $c=\sqrt{\varepsilon_0}/\mu_0$ (b) $c=1/\sqrt{\varepsilon_0\mu_0}$ (c) $c=\sqrt{\mu_0}/\varepsilon_0$ (d) $c=\sqrt{\varepsilon_0\mu_0}$

Q23. What is the main parameter for determining whether a medium is free space, lossless dielectric, lossy dielectric or good conductor

(a) attenuation constant (b) consecutive parameter (σ,ε,μ)

(c) loss tangent (d) reflection coefficient

Q24. For a material medium characterized by conductivity σ and permittivity ε exposed to sinusoidally varying field E of frequency ω. The ratio of conduction current density to displacement current density is

(a) $\frac{\sigma}{E\varepsilon}$ (b) $\frac{\sigma}{\omega\varepsilon}$ (c) $\frac{\varepsilon}{(\omega\sigma)}$ (d) $\frac{E\varepsilon}{\omega}$

Q25. For Cu $\sigma=10^{-2}S/m$ and $\varepsilon=3\varepsilon_0$. The conduction current and displacement current will be equal at the frequency

(a) $160\,Hz$ (b) $60\,kHz$ (c) $60\,MHz$ (d) $160\,MHz$

Q26. For sinusoidally varying electric field the conduction current and the displacement current differ in phase by

(a) 180 degrees (b) 0 degrees (c) 90 degrees (d) 45 degrees

Q27. In a dielectric material having $\varepsilon_r=12$ the displacement current is 25 times greater than the conduction current at $100\,MHz$. The conductivity of the dielectric is

(a) $0.00267\ S/m$ \(b) $0.0267\ S/m$ (c) $2.67\ S/m$ (d) $0.267\ S/m$

Q28. For a plane e.m. wave propagation in a non-conducting, non-magnetic medium, the square of index of refraction is given as

(a) $\frac{1}{(\varepsilon, \mu_r)^{1/2}}$ (b) $(\mu_r)^{1/2}$ (c) $(\varepsilon_r)^{1/2}$ (d) $\frac{1}{(\varepsilon_r)^{1/2}}$

Q29. A plane e.m. wave is travelling in an lossless dielectric medium having $\mu_r = 2,\ \varepsilon_r = 3$ and has peak value electric field intensity of $6V/m$. The velocity of wave is

(a) $3\times 10^8\ m/s$ (b) $0.37\times 10^8\ m/s$

(c) $1.73\times 10^8\ m/s$ (d) $1.5\times 10^8\ m/s$

Q30. A medium has conductivity $\sigma = 10^2\ mho/m,\ \mu_r = 2,\ \varepsilon_r = 3$. The depth of penetration at $2\,MHz$ is

(a) 115.7 mm (b) 11.57 mm (c) 1.157 mm (d) 0.1157 mm

Q31. Bubbled (input inverted) OR gate is equivalent to

(a) NOE gate (b) NAND gate (c) NOT gate (d) XNOR gate

Q32. The minimum number of two input NAND gates required to realize the function of 3 input OR gate is

(a) 4 (b) 5 (c) 6 (d) 3

Q33. Which one of the following is not the Boolean expression for XOR gate?

(a) $A\overline{B} + \overline{A}\cdot B$ (b) $(\overline{A} + \overline{B})\cdot(A + B)$

(c) $(\overline{A} + B)\cdot(A + \overline{B})$ (d) $(A + B)\cdot(\overline{A\cdot B})$

Q34. The simplified Boolean expression for the given Boolean expression $AB + (A + B)\cdot(B + C)$ is

(a) $B + AC$ (b) $C + AB$ (c) $A + BC$ (d) $AB + AC$

Q35. The Boolean expression $AB\overline{C}+BC\overline{A}+CA\overline{B}+ABC$ is equivalent to the simplified Boolean expression in POS form

(a) $(A+B)\cdot(B+C)\cdot(C+A)$ (b) $(A+\overline{B})\cdot(B+\overline{C})\cdot(C+\overline{A})$

(c) $(\overline{A}+\overline{B})\cdot(\overline{B}+\overline{C})\cdot(\overline{C}+\overline{A})$ (d) $(\overline{A}+B)\cdot(\overline{B}+C)\cdot(\overline{C}+A)$

Q36. Indicate the false statement about doped semiconductors

(a) The product of majority and minority carriers is independent of doping concentration

(b) On heating these semiconductors, their conductivity always increases

(c) On heating these semiconductors, their conductivity initially increases but after reaching a maximum value it begins to decrease with increase of temperature

(d) The product of majority and minority carriers increases with increase in temperature

Q37. To obtain P type silicon, it must be doped with

(a) Barium (b) Antimony (c) Arsenic (d) Indium

Q38. The conductivity of Ge doped with phosphorous with impurity concentration $4.41\times10^{14}/cm^3$. (Given that for Ge the intrinsic carrier concentration is $2.5\times10^{13}/cm^3$, electron mobility $\mu_e=3800\,cm^2/V-\sec$ and hole mobility $\mu_p=1800\,cm^2/V-\sec$) is

(a) $0.27(\Omega-cm)^{-1}$ (b) $0.03(\Omega-cm)^{-1}$ (c) $0.05(\Omega-cm)^{-1}$ (d) $0.42(\Omega-cm)^{-1}$

Q39. The net current density in a p- type semiconductor, when both a potential gradient and concentration gradient exist simultaneously within the semiconductor is given by

(a) $J=-q\mu_p p\left(\frac{dV}{dx}\right)+qD_p\frac{dp}{dx}$ (b) $J=-q\mu_p p\left(\frac{dV}{dx}\right)-qD_p\frac{dp}{dx}$

(c) $J=qp\mu_p\frac{dV}{dx}-qD_p\frac{dp}{dx}$ (d) $J=qp\mu_p\frac{dV}{dx}+qD_p\frac{dp}{dx}$

Q40. The value of the ideality factor η in the diode equation for current flowing in $P-N$ junction made from Si is

(a) $\eta=1$ for all currents

(b) $\eta=2$ for all currents

(c) $\eta=1$ for small current but $\eta=2$ for large current

(d) $\eta=2$ for small current but $\eta=1$ for large current

Q41. On heating the current in reverse biased $p-n$ junction diode increases because of

(a) increase in its carrier concentration and carrier mobilities both

(b) increase in its carrier concentration only

(c) increase in its carrier mobilities only

(d) decrease in its carrier concentration but increase in its carrier mobilities

Q42. $P-N$ junction diode cannot be used as

(a) modulator (b) demodulator (c) redefier (d) amplifier

Q43. The frequency of second harmonic component in the output of full wave rectifier (Given AC mains frequency is $50\,Hz$) is

(a) $50\,Hz$ (b) $100\,Hz$ (c) $200\,Hz$ (d) $25\,Hz$

Q44. Indicate the false statement from the following statements for a Zener diode whose breakdown voltage is 4.7 volts

(a) It has been constructed from highly doped materials to decrease the depletion width

(b) Breakdown is due to high velocity of minority carriers causing thermal ionization of impurities in the depletion region

(c) Breakdown is due to high electric field ionization of impurities in depletion region

(d) Tunneling of minority carriers from one side of the junction to the other side of junction

Q45. Why does the collector current increases with increasing collector to base reverse bias voltage V_{CB} for constant forward bias emitter base voltage V_{EB} in common base configuration

(a) It is due to increase in effective base width

(b) It is due to decrease in concentration gradient of minority carriers in base region

(c) It is due to decrease in effective base width and increase in concentration gradient of minority carriers in base region

(d) It is due to increase in effective base width and decrease in concentration gradient of minority carriers in base region

Q46. For a given Ge transistor, the common base current gain is 0.98 and the reverse saturation current is $50\,\mu A$, then the collector current will be

(a) $2.45\,mA$ (b) $2.40\,mA$ (c) $2.50\,mA$ (d) $2.55\,mA$

Q47. Indicate the false statement about the common collector transistor amplifier

(a) Its input impedance is very high

(b) Its output impedance is very low

(c) Its voltage gain is slightly less than 1

(d) Its voltage gain is slightly more than 1

Q48. On increasing the value of bypass capacitor in RC coupled CE amplifier its

(a) voltage gain increases but lower cutoff frequency decreases

(b) voltage gain as well as lower cutoff frequency decreases

(c) voltage gain as well as lower cutoff frequency increases

(d) voltage gain decreases but lower cutoff frequency increases

Q49. A bridge rectifier is preferred over an ordinary full-wave rectifier because

(a) it uses four diodes

(b) it uses transformer which has no centre tap

(c) it has higher rectification efficiency

(d) it has lower ripple factor

Q50. In series L-C-R circuit $R = 100\,\Omega$, $X_L = 300\,\Omega$ and $X_C = 200\,\Omega$ the current lags the applied voltage by an angle

(a) 45^0 (b) 60^0 (c) 90^0 (d) 0^0

Q51. If $\vec{r}$ is position vector of a point, for what value of n, the vector $r^n\vec{r}$ is solenoidal?

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

Q52. If $\vec{r}$ is position vector of a point, the vector $r^n\vec{r}$ is an irrotational vector for

(a) $n = 3$ (b) any value of n (c) $n = 2$ (d) $n = 1$

Q53. Divergence of the vector $r^{n-1}\vec{r}$, where $\vec{r}$ is position vector of a point, vanishes for

(a) $n = 3$ (b) $n = 2$ (c) $n = -2$ (d) $n = -3$

Q54. If $\vec{r}$ is position vector of a point and r is its magnitude, the value of $\vec{\nabla}\cdot\vec{\nabla}\left(r^n\right)$ vanishes for

(a) $n=3$ (b) $n=-2$ (c) $n=0$ only (d) $n=0$ and $n=-1$

Q55. Eigenvalues of $\begin{pmatrix} 1 & 0 & 1 \\ 0 & 1 & 0 \\ 1 & 0 & 1 \end{pmatrix}$ are

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

Q56. The function $e^{\frac{x\left(t^2-1\right)}{2t}}$ is a generating function of

(a) Hermite polynomials (b) Legendre polynomials

(c) Laguerre polynomials (d) Bessel functions

Q57. The value of $J_{1/2}(x)$ is

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

Q58. Which of the following is true?

(a) $J_{5/2}(x)=\frac{3}{x}J_{3/2}(x)-J_{1/2}(x)$ (b) $J_{5/2}(x)=\frac{x}{3}J_{3/2}(x)-J_{1/2}(x)$

(c) $J_{5/2}(x)=\frac{3}{x}J_{3/2}(x)+J_{1/2}(x)$ (d) $J_{5/2}(x)=\frac{x}{3}J_{3/2}(x)+J_{1/2}(x)$

Q59. Legendre polynomial $P_n(x)$ for $n=0$ has, for any value of x, value

(a) 0 (b) ∞ (c) 1 (d) none of these

Q60. For $P_n(x)$, which of the following is true?

(a) $P_n(x)=\frac{1}{2^n n!}\frac{d^n}{dx^n}\left(x^2+1\right)^n$ (b) $P_n(x)=\frac{1}{2^n n!}\frac{d^n}{dx^n}\left(1-x^2\right)^n$

(c) $P_n(x)=\frac{1}{2^n n!}\frac{d^n}{dx^n}\left(x^2-1\right)^n$ (d) $P_n(x)=\frac{1}{2^n n!}\frac{d^n}{dx^n}\left(x-1\right)^n$

Q61. The de Broglie wavelength associated with a photon of wavelength $6580\,\overset{0}{\text{A}}$ would be

(a) $6000\,\overset{0}{\text{A}}$ (b) $7000\,\overset{0}{\text{A}}$ (c) $4580\,\overset{0}{\text{A}}$ (d) $6580\,\overset{0}{\text{A}}$

Q62. An atom absorbs and emits orange light whose frequency is $5.00\times10^{14}\,Hz$. The energy quantum of this light is

(a) $2.08\,keV$ (b) $2.08\,eV$ (c) $2.08\,MeV$ (d) $2.08\times10^{2}\,eV$

Q63. A wave function has the form $\psi_1 = Ae^{-\alpha x}x$ for $x>0$ for the positive value of α. However, it has the form $\psi_2 = e^{+\alpha x}$ for $x<0$. The normalized form of this function is

(a) $\psi_1(x) = \sqrt{\alpha}e^{\alpha x}$ for $x>0$
$\psi_2(x) = \sqrt{\alpha}e^{-\alpha x}$ for $x<0$

(b) $\psi_1(x) = \sqrt{\alpha}e^{+\alpha x}$ for $x<0$
$\psi_2(x) = \sqrt{\alpha}e^{-\alpha x}$ for $x>0$

(c) $\psi_1(x) = \frac{1}{\sqrt{\alpha}}e^{\alpha x}$ for $x>0$
$\psi_2(x) = \frac{1}{\sqrt{\alpha}}e^{-\alpha x}$ for $x<0$

(d) $\psi_1(x) = \frac{1}{\sqrt{\alpha}}e^{-\alpha x}$ for $x>0$
$\psi_2(x) = \frac{1}{\sqrt{\alpha}}e^{+\alpha x}$ for $x<0$

Q64. For a linear harmonic oscillator, the potential is $V = \frac{1}{2}m\omega^2x^2$. Using Schrödinger equation with $\psi(x) = xe^{-m\omega x^2/2\pi}$ one obtains the energy eigenvalue as

(a) $E = \frac{5}{2}\hbar\omega$ (b) $E = \frac{3}{2}\hbar\omega$ (c) $E = \frac{1}{2}\hbar\omega$ (d) $E = \hbar\omega$

Q65. For a rigid rotator with moment of inertia (I) which is fixed in the XY - plane only, the Schrödinger equation would be

(a) $\frac{\partial^2\psi}{\partial\phi^2} + \frac{\partial^2\psi}{\partial\theta^2} + \frac{2IE}{\hbar^2}\psi = 0$

(b) $\frac{\partial^2\psi}{\partial\phi^2} - \frac{\partial^2\psi}{\partial\theta^2} + \frac{2IE}{\hbar^2}\psi = 0$

(c) $\frac{\partial^2\psi}{\partial\phi^2} + \frac{2IE}{\hbar^2}\psi = 0$

(d) $\frac{\partial^2\psi}{\partial\phi^2} - \frac{2IE}{\hbar^2}\psi = 0$

Q66. For rigid rotor fixed in the XY - plane, the energy eigenvalues change as

(a) $E_m = \frac{3}{2}\frac{\hbar^2}{2I}m^2, m = 0, \pm1, \pm2, ...$

(b) $E_m = \frac{2}{3}\frac{\hbar^2 m^2}{2I}, m = 0, \pm1, \pm2, ...$

(c) $E_m = \frac{m^2\hbar^2}{2I}, m = 0, \pm1, \pm2, ...$

(d) $E_m = \frac{\hbar^2}{2I}\left(1+m^2\right), m = 0, \pm1, \pm2, ...$

Q67. The ground state of the H - atom corresponds to the following quantum numbers

(a) $n = 0, m = 0, l = 0$

(b) $n = 1, m = 0, l = 0$

(c) $n = 2, m = 1, l = 1$

(d) $n = 1, m = 1, l = 1$

Q68. If the Hamiltonian is Hermitian, two degenerate eigenstates

(a) would be orthogonal to each other

(b) would be non-orthogonal to each other

(c) may not be orthogonal

(d) may not be non-orthogonal

Q69. The smallest possible uncertainty in the position of an electron moving with velocity $3\times10^7 m/\sec$ is given by

(a) $0.048\overset{0}{\mathrm{A}}$ (b) $0.058\overset{0}{\mathrm{A}}$ (c) $0.038\overset{0}{\mathrm{A}}$ (d) $0.068\overset{0}{\mathrm{A}}$

Q70. An anti-Hermitian operator corresponds to the eigenvalue that is

(a) complex (b) real (c) imaginary (d) zero

Q71. Two photons A and B are moving in the opposite direction. The relative velocity of A w.r.t. B would be

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

Q72. The inertial reference frame is used in the description of special theory of relativity. An example of an inertial reference frame is

(a) rotating frame with a uniform angular velocity w.r.t. a stationary frame

(b) two frames stationary with respect to each other

(c) a freely falling frame under uniform gravitation

(d) two frames having uniform acceleration with respect to each other

Q73. An electron is moving with a speed of $0.85c$ in a direction opposite to that of a photon. The relative velocity of the electron w.r.t. the photon is

(a) $0.85c$ (b) $0.65c$ (c) $0.75c$ (d) c

Q74. The energy equivalent of the rest mass of an electron is

(a) $1.12\,MeV$ (b) $0.51\,MeV$ (c) $0.91\,MeV$ (d) $0.85\,MeV$

Q75. The Lorentz invariant length between two space-time points (x, y, z, ct) and (x', y', z', ct') is as follows

(a) $(x'-x)^2+(y'-y)^2+(z'-z)^2-c^2(t'-t)^2$

(b) $(x'-x)^2+(y'-y)^2-(z'-z)^2+c^2(t'-t)^2$

(c) $(x'-x)^2-(y'-y)^2+(z'-z)^2+c^2(t'-t)^2$

(d) $(x'-x)^2+(y'-y)^2+(z'-z)^2+c^2(t'-t)^2$

Q76. Total energy of a relativistic particle, (which is the sum of kinetic energy and rest mass energy) is

(a) m_0c^2 (b) $\dfrac{m_0c^2}{\sqrt{1-\dfrac{v^2}{c^2}}}$ (c) $m_0c^2\sqrt{1-\dfrac{v^2}{c^2}}$ (d) $\dfrac{m_0v^2}{\sqrt{1-\dfrac{v^2}{c^2}}}$

where m_0 is the rest mass if the particle moving with velocity v and c is the speed of light.

Q77. In the laboratory frame of reference, a particle moving with speed $2.8\times10^{10}\,cm/\sec$, has the life-time 2.5×10^{-7} sec. The proper life-time of the particle is

(a) $\approx 5\times10^{-10}$ sec (b) $\approx 6\times10^{-11}$ sec (c) $\approx 7\times10^{-8}$ sec (d) $\approx 7\times10^{12}$ sec

Q78. The proper length of a rod is $100\,cm$. If the rod starts moving with speed $0.8c$, its length would be

(a) $110\,cm$ (b) $90\,cm$ (c) $60\,cm$ (d) $120\,cm$

Q79. A monochromatic light falls on a glass surface at Brewster's angle, then

(a) the refracted beam is partially polarized

(b) the refracted beam is completely polarized

(c) the refracted ray is partially polarized

(d) reflected and refracted rays both are completely polarized

Q80. A $0.25\,mm$ thick crystal plate cut parallel to optic axis serves as a quarter wave plate for refractive index difference $n_e - n_o = 0.009$, constant for all wavelengths. The number of wavelengths for which the plate behaves as a quarter wave plate in the visible region is

(a) 6 (b) 3 (c) 2 (d) 1

Q81. On applying electric field to certain materials, their refractive index changes. If change in refractive index Δn is proportional to the electric field E, the effect is called

(a) Faraday effect (b) Pockels effect (c) Kerr effect (d) birefringence

Q82. Kerr effect is the change in refractive index Δn on application of electric field $\vec{E}$. The change Δn is given by

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

Q83. An optically inactive crystal becomes optically active under the application of magnetic field. The effect is known as

(a) Kerr effect (b) Faraday effect (c) Pockels effect (d) birefringence

Q84. Which of the molecules given below will show optical activity?

(a) Methane (b) Chloroform

(c) Carbon tetrachloride (d) Chloro-bromo methanol

Q85. An optically active material

(a) rotates the direction of the light beam passing throw it

(b) rotates the direction of polarization of the plane polarized beam passing through it.

(c) splits the unpolarized beam passing through it into two linearly polarized beam with direction of polarization perpendicular to each other

(d) splits the unpolarized beam passing through it into two unpolarized light beam equal intensity

Q86. Typical white light has range $4000-7000\overset{0}{A}$. The coherence length for such a light beam is of the order of

(a) $100\overset{0}{A}$ (b) $100\ mm$ (c) $100\ cm$ (d) $100\ m$

Q87 $He-Ne$ Laser emits light of wavelength $6328\overset{0}{A}$ with spectral width $\Delta\lambda = 10^{-7}\overset{0}{A}$. Its coherence time and coherence length are

(a) $133\mu s$ and $40m$ (b) $133\mu s$ and $40km$

(c) $133ms$ and $40m$ (d) $133ms$ and $40km$

Q88. A perfectly monochromatic light wave

(a) cannot be observed (b) can be observed with special device

(c) has finite coherence length (d) has finite coherence time

Q89. Anti-reflection coating is based on the principal of

(a) polarization (b) diffraction

(c) interference (d) total internal reflection

Q90. Resolving power of Fabry-Perot interferometer depends on

(a) plate separation only

(b) reflectivity of plates only

(c) wavelength of light only

(d) plate separation, reflectivity of plates and wavelength of light

Q91. The gyromagnetic ratio for electron spin is r times the corresponding ratio for the electron orbital motion, where r is

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

Q92. Ground state of K is

(a) ${}^1S_0$ (b) ${}^3S_0$ (c) ${}^1P_1$ (d) ${}^2S_{1/2}$

Q93. According to spin-relativity quantum-mechanical theory, the number of components of H_α line of H-atom is

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

Q94. When S level is lower level out of the transitions ${}^2P_{1/2} \to {}^2S_{1/2}$ and ${}^2P_{3/2} \to {}^2S_{1/2}$

(a) former is always weaker

(b) latter is always weaker

(c) both are equally strong

(d) former is forbidden while latter is allowed

Q95. Spin-orbit interaction in one valence electron atom causes each energy level of a given l to split into

(a) $2l+1$ components (b) 2 components

(c) $2j+1$ components (d) 3 components

Q96. The fine structure level ${}^3D_1, {}^3D_2, {}^3D_3$, have separations ${}^3D_1 - {}^3D_2$ and ${}^3D_2 - {}^3D_3$ in the ratio

(a) $1:2$ (b) $1:3$ (c) $2:3$ (d) $1:1$

Q97. The total number of terms arising due to one $4p$ and one $4d$ electrons i.e., outer configuration if an atom as $4p\,4d$ is

(a) 6 (b) 12 (c) 9 (d) 3

Q98. The sodium lines $5890\,\overset{0}{A}$ and $5896\,\overset{0}{A}$ originate due to transitions, respectively

(a) ${}^2P_{3/2} \to {}^2S_{1/2}$ and ${}^2P_{1/2} \to {}^2S_{1/2}$

(b) ${}^2P_{1/2} \to {}^2S_{1/2}$ and ${}^2P_{3/2} \to {}^2S_{1/2}$

(c) ${}^2S_{1/2} \to {}^2P_{3/2}$ and ${}^2S_{1/2} \to {}^2P_{1/2}$

(d) ${}^2S_{1/2} \to {}^2P_{1/2}$ and ${}^2S_{1/2} \to {}^2P_{3/2}$

Q99. The number of components due to transition ${}^1D_2 \to {}^1P_1$ on account of Zeeman splitting is

(a) 9 (b) 3 (c) 2 (d) 6

Q100. A Laser beam is passed through a strong magnetic field. One observes

(a) Zeeman splitting
(b) Paschen-Back splitting
(c) Stark splitting
(d) No splitting

Q101. Principal series arises due to transitions

(a) $nf \rightarrow 3d,\ n > 3$
(b) $nd \rightarrow 3p,\ n > 2$
(c) $ns \rightarrow 3p,\ n > 3$
(d) $np \rightarrow 3s,\ n > 2$

Q102. Which of the following is true?

(a) Principal series appears in emission and absorption both
(b) Sharp series appears in emission and absorption both
(c) Diffuse series appears in emission and absorption both
(d) Fundamental series appears in emission and absorption both

Q103. A metal surface has work function equivalence to energy of wavelength of light $4500\,\overset{0}{A}$.

When a beam of light with $\lambda\ 4000\,\overset{0}{A}$ falls on it

(a) photoelectrons will not be emitted
(b) photoelectrons will be emitted with certain speeds
(c) photoelectrons will be emitted with zero speeds
(d) photoelectrons may or may not be emitted

Q104. Due to Compton scattering, the change in wavelength is

(a) dependent on electron charge
(b) dependent on electron mass and charge
(c) dependent on electron mass and scattering angle both
(d) dependent on scattering angle only

Q105. Which of the following is true?

(a) Dirac's theory explains fine structure of H-atom Balmer series lines
(b) The $2\,^2S_{1/2}$ level and $2\,^2P_{1/2}$ level of H- atom have different energies due to Dirac
(c) $2\,^2S_{1/2}$ level of H-atom is a metastable level
(d) $2\,^2P_{1/2}$ level of H-atom is a metastable level

Q106. What is the shortest wavelength emitted by an X - ray tube if 40 kilovolts is applied across it

(a) 0.0496 (b) 0.0310 (c) 0.0248 (d) 0.0155

Q107. X - ray spectrum of a cobalt largest $(Z = 27)$ contains strong K_α line of wavelength 0.1785 nm and a weak line having wavelength of 0.1537 nm due to impurities.

(a) 29 (b) 24 (c) 23 (d) 30

Q108. For a simple cubic lattice, the ratio of $d_{100} : d_{110} : d_{111}$ is

(a) $\sqrt{2} : \sqrt{3} : \sqrt{6}$ (b) $\sqrt{6} : \sqrt{3} : \sqrt{2}$

(c) $\sqrt{2} : \sqrt{6} : \sqrt{3}$ (d) $\sqrt{3} : \sqrt{2} : \sqrt{6} :$

Q109. Given that the cube edge of diamond is $0.356 nm$. The number of atoms per metre cube is

(a) 0.88×10^{29} (b) 5.31×10^{29} (c) 2.77×10^{29} (d) 1.77×10^{29}

Q110. Sodium chloride has the following crystal structure

(a) hexagonal (b) face-centred cubic

(c) simple cubic (d) body-centred cubic

Q111. The spacing d_{hkl} of the planes (hkl) in a hexagonal crystal is

(a) $\left[\frac{4}{3}\left(\frac{h^2 + hk + k^2}{a^2}\right) + \frac{l^2}{c^2}\right]^{-1/2}$ (b) $a\left(h^2 + k^2 + l^2\right]^{-1/2}$

(c) $\left[\frac{h^2}{a^2} + \frac{k^2}{b^2} + \frac{l^2}{c^2}\right]^{-1/2}$ (d) $\left[\frac{h^2 + k^2}{a^2} + \frac{l^2}{c^2}\right]^{-1/2}$

Q112. A crystal system whose unit cell is specified by $a = b \neq c, \alpha = \beta = \gamma = 90$ is known as

(a) simple cubic (b) hexagonal (c) monoclinic (d) tetragonal

Q113. In the periodic potential model, discontinuities in E versus κ curve occur for

(a) $k = \frac{n\pi}{a}$ (b) $k = \frac{8n\pi}{a}$ (c) $k = \frac{n^2\pi}{a}$ (d) $k = \frac{n\pi}{4a}$

Q114. Which of the following statements is true about the velocity of electron in an energy band?

(a) It is constant throughout the band

(b) It is maximum at the bottom of the band

(c) It is maximum at the inflection point of the $E(k)$ curve

(d) It is maximum at the top of the band

Q115. The Miller indices of a set of parallel planes which makes intercepts in the ratio of $1:\frac{1}{2}:\frac{1}{4}$ is given by

(a) (421) (b) (124) (c) (122) (d) (142)

Q116. The angle of diffracted X -rays is 90^0 from the incident direction of X - rays. The interplaner separation of the planes responsible for the diffraction is given by

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

Q117. Which of the statements about the spectrum of continuous X -rays false?

(a) There is no long wavelength cutoff limit

(b) Continuous X -rays are produced due to decleration of electrons

(c) The maximum intensity of continuous X -rays depends upon potential difference across the X -ray tube

(d) Short wavelength limit of X -rays depends upon the nature of filament

Q118. The de Broglie wavelength λ, mass m and charge e of an electron are related to the accelerating potential V by

(a) $V = \frac{\lambda^2}{2meh^2}$ (b) $V = \frac{h}{2me\lambda^2}$ (c) $V = \frac{h^2}{2me\lambda^2}$ (d) $V = \frac{h^2\lambda^2}{2me}$

Q119. The number of ions in the unit cell of NaCI crystal is

(a) 1 (b) 2 (c) 4 (d) 8

Q120. According to the Wiedemann-Franz law, the ratio of thermal to electrical conductivity of any metal is give by

(a) $\left(\frac{\pi kT}{2e}\right)^2$ (b) $\frac{\pi^2}{3}\left(\frac{k}{e}\right)^2 T$ (c) $\frac{\pi^2}{3}\left(\frac{kT}{e}\right)^2$ (d) $\left(\frac{\pi k}{e}\right)^2 T$

Q121. The number of lattice points in a BCC unit cell is

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

Q122. The lattice specific heat at constant volume C_V of a solid at lower temperatures depends on temperature T as

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

Q123. The reciprocal lattice of a FCC crystal is

(a) orthorhombic (b) simple cubic (c) hexagonal (d) BCC

Q124. Because of which property of the crystals X-rays can be diffracted from the crystals

(a) colour of the crystals (b) sharp edges of the crystals

(c) periodic array of atoms (d) random arrangement of atoms

Q125. Indicate the false statement about the semiconductors

(a) All intrinsic semiconductors are insulators at $T = 0^0 K$

(b) At very high temperature all semiconductors become intrinsic semiconductors

(c) The conductivity of all semiconductors always increases with temperature

(d) N -type semiconductors are obtained by doping phosphorus into silicon

Q126. The density of carriers in a pure semiconductor is proportional to

(a) $\exp\left[-\frac{E_g}{kT}\right]$ (b) $\exp\left[-\frac{2E_g}{kT}\right]$ (c) $\exp\left[-\frac{E_g}{kT^2}\right]$ (d) $\exp\left[-\frac{E_g}{2kT}\right]$

Q127. The reverse saturation current in geranium p-n diode is of the order of

(a) nA (b) μA (c) mA (d) ampere

Q128. The Fermi level in an n-type semiconductor at $0^0 K$

(a) lies below the donor level

(b) lies in the conduction band

(c) lies half-way between the conduction band and donor level

(d) coincides with intrinsic Fermi level

Q129. If the Fermi energy of a metal at $0^0 K, 10\,eV$, the mean energy of the electrons in the metal at $0^0 K$ is

(a) $6\,eV$ (b) $5\,eV$ (c) $1.5\,eV$ (d) $2\,eV$

Q130. X-rays can be deflected by

(a) magnetic field only

(b) electric field only

(c) simultaneously applying electric and magnetic field

(d) Neither by electric or magnetic field

Q131. A nuclear reaction is exoergic if the Q-value of the reaction process is

(a) negative

(b) zero

(c) positive

(d) positive as well as negative depending on the nature of reacting nuclei

Q132. Nuclear fusion reaction is the one where light nuclei combine to form a heavy nucleus. The mass number of the light nuclei should have the limits

(a) $A \geq 10$ (b) $A \geq 15$ (c) $A \leq 8$ (d) $A \geq 8$

Q133. For carbon dating, the isotope of the carbon that is used is

(a) carbon-12 (b) carbon-13 (c) carbon-14 (d) carbon-15

Q134. The Q- value of an endoergic nuclear reaction process is

(a) positive

(b) negative

(c) zero

(d) zero aas well as positive depending the nature of participating nuclei

Q135. Nuclear fission can be explained by one of the following models of nucleus

(a) shell model (b) deformed-shell model

(c) liquid-drop model (d) rotating model(rotor)

Q136. Binding energy curve of nuclei with respect to their mass number can be explained by

(a) shell model of nucleus (b) rotating model of nucleus

(c) deformed rotating model (d) liquid-drop model

Q137. Nucleus is approximately 10^5 times smaller than the size of an atom because of

(a) universal electromagnetic interaction (b) short-range nuclear interaction

(c) quantum effects of gravity (d) van der Waals interaction

Q138. The helium isotope ${}_2^5He$ is unstable. The possible decay mode of it is

(a) positive β-decay (b) negative β - decay

(c) γ - decay (d) α -decay

Q139. The unit of activity in the process of radioactive decay in Becquerel(Bq). One unit of (Bq) is

(a) 10 decays/sec (b) 5 decays/sec (c) 100 decays/sec (d) 1 decay/1sec

Q140. In the nuclear reactors, the process that is controlled is

(a) nuclear fusion reaction (b) nuclear fission

(c) natural radioactive decay (d) artificial nuclear transmutation

Q141. α - decay of radioactive nuclei can be explained by exploiting he concepts of

(a) classical theory of particles (b) electromagnetic theory

(c) quantum tunneling (d) weak interactions

Q142. The range of energy carried by the γ - rays of the order of

(a) keV (kilo electronic volt) (b) MeV (Mega electronic volt)

(c) eV (Electron volt) (d) GeV (Giga electron volt)

Q143. Given that ${}^{113}Cd$ has density $n = 5.58\times10^{27}$ $atoms/m^3$ and its capture cross-section $\sigma = 2\times10^{-24}m^2$ for thermal neutrons, the mean- free path of these neutrons in ${}^{113}Cd$ is

(a) $8.93\times10^{-7}m$ (b) $8.93\times10^{-5}m$ (c) $8.93\times10^{-9}m$ (d) $8.93\times10^{-10}m$

Q144. In an atomic bomb, the energy released cannot be controlled. The process involved in the making of an atomic bomb is

(a) atomic chain reaction (b) nuclear chain reaction

(c) thermal chain reaction (d) chemical chain reaction

Q145. Existence of magic numbers can be explained by

(a) liquid-drop model of nucleus (b) shell model of nucleus

(c) rotating model of nucleus (d) deformed model of nucleus

Q146. One of the isotopes of hydrogen is radioactive. This isotope is known as

(a) deuterium (b) tritium (c) charmonium (d) postironium

Q147. The relationship between Bohr magneton and nuclear magneton is

(a) nuclear magneton is always greater than Bohr magneton

(b) Bohr magneton may be equal to the nuclear magneton in specific limit

(c) nuclear magneton is always less than Bohr magneton

(d) nuclear magneton can be less, equal and greater than Bohr magneton depending on the physical situation

Q148. For the even-odd or odd- even nuclei, the pairing energy is always

(a) positive

(b) negative

(c) zero

(d) sometimes negative and sometimes positive

Q149. The binding energy of the neon isotope ${}_{10}^{20}Ne$ is 160.65 MeV. Thus, its atomic mass, in atomic unit(u), would be

(a) $19.99u$ (b) $18.99u$ (c) $17.99u$ (d) $16.99u$

Q150. Nuclear Magnetic Resonance (NMR) is used to determine

(a) mass of nucleon (b) magnetic moment of nucleon

(c) charge of the nucleon (d) quadrupole moment of the nucleon