DU MSc Physics 2020

Q1. An atomic transition line with wavelength $350\,nm$ is observed to be split into three components in a spectrum of light from a sunspot. Adjacent components are separated by $1.7\,pm$. Determine the strength of the magnetic field in the sunspot

(a) $3T$ (b) $0.03T$ (c) $3.3T$ (d) $0.3T$

Ans. : (d)

Q2. Which one of the following is correct in respect of an electron and a proton having a same de-Broglie wavelength of $2\overset{0}{\text{A}}$

(a) Both have same kinetic energy

(b) Both have same velocity

(c) Both have same momentum

(d) The kinetic energy of proton is more than that of electron

Ans. : (c)

Q3. If r_p & r_H are the radius and E_p & E_H are the energy of an electron in the n^{th} orbit of positronium atom and hydrogen atom respectively, then

(a) $r_p = 2r_H$ and $E_p = E_H/2$ (b) $r_p = 2r_H$ and $E_p = 2E_H$

(c) $r_p = 2r_H$ and $E_p = E_H/4$ (d) $r_p = r_H$ and $E_p = 2E_H$

Ans. : (a)

Q4. An X - ray beam of wavelength $0.16\,nm$ is incident on a set of planes of a certain crystal. The first Bragg reflection is observed for an incidence angle of 30^0. What is the corresponding inter planar spacing?

(a) $0.16\ nm$ (b) $0.67\,nm$ (c) $1.02\,nm$ (d) $0.89\,nm$

Ans. 4: (a)

Q5. What is the velocity of conduction electron of silver having Fermi energy $5.52\,eV$

(a) $1.39\times10^6\ m/s$ (b) $2.39\times10^6\ m/s$

(c) $0.89\times10^6\ m/s$ (d) 0

Ans. : (a)

Q6. Given that a piece of n- type silicon contains $8\times10^{21}\,m^{-3}$ phosphorus impurity atoms, calculate the carrier concentration of silicon at room temperature. Given that the intrinsic electron concentration of silicon at room temperature is $1.6\times10^{16}\,m^{-3}$

(a) $3.2\times10^{10}\,m$ (b) $2.3\times10^{11}\,m$ (c) $1.5\times10^{10}\,m$ (d) $3.2\times10^{11}\,m$

Ans. : (a)

Q7. The dispersion relation for a one-dimensional monoatomic lattice chain is given by the equation, $\omega=\frac{2}{a}v_s\left|\sin\left(\frac{ka}{2}\right)\right|$ where, 'a' is the interatomic spacing, $K=\frac{2\pi}{\lambda}$ and v_s has the dimension of velocity. The relation between the phase velocity V_P and group velocity V_g in the long wavelength limit is given by

(a) $V_P=V_g$ (b) $V_P=2V_g$ (c) $V_P=V_g/2$ (d) $V_P\neq V_g$

Ans. : (a)

Q8. The largest wavelength of light falling on double slits separated by $1.5\,\mu m$, for which there is a first order maximum is in the

(a) ultraviolet range (b) visible range

(c) infrared range (d) X-ray range

Ans. : (c)

Q9. In a multi-stage R-C coupled amplifier, the coupling capacitor

(a) limits the low frequency response

(b) limits the high frequency response

(c) reduces the amplitude of input signal

(d) blocks d.c. component without affecting the frequency response

Ans. : (d)

Q10. An AM transmitter is coupled to an aerial. The input current is found to be $5A$. With modulation the current value increases to $5.9\,A$. The depth of modulation is

(a) 83.4% (b) 88.6% (c) 78.2% (d) 74.3%

Ans. : (b)

Q11. Hexadecimal equivalent of a digital number 10011101 is

(a) $H913$ (b) $9D$ (c) AE (d) 157

Ans. : (b)

Q12. If the doping concentration in a Si - Zener diode is increased, the Zener breakdown voltage

(a) Decreases (b) Increases

(c) Remains unchanged (d) Becomes broader

Ans. : (a)

Q13. Which one of the following is an example of doubly magic nuclei?

(a) ^{18}O (b) ^{48}Ca (c) ^{124}Sn (d) ^{204}Pb

Ans. : (b)

Q14. Which radiation has maximum ionization power?

(a) Alpha (b) Beta (c) Neutron (d) Gamma

Ans. : (a)

Q15. For beta-minus decay, which statement is **TRUE**?

(a) Daughter nuclide atomic mass (A_D) is more than that of the parent nuclide atomic mass (A_P)

(b) Daughter nuclide atomic number (Z_D) is same that of the parent nuclide atomic number (Z_P)

(c) Daughter nuclide neutron number (N_D) is less than that of the parent nuclide neutron number (N_P)

(d) Daughter nuclide neutron number (N_D) is same that of the parent nuclide neutron number (N_P)

Ans. : (c)

Q16. The probability that student A solves the problem is $1/2$, and that of B is $2/3$. What is the probability that the problem is solved?

(a) $4/6$ (b) $1/3$ (c) $5/6$ (d) none of these

Ans. : (c)

Q17. Are the three points whose position vectors are $2i+3j-4k$, $i-2j+3k$ and $-7j+10k$ collinear?

(a) Yes (b) No

(c) Cannot be determined (d) None of these

Ans. : (a)

Q18. The number of independent fundamental solutions in n-th order ordinary differential equation is

(a) $n-1$ (b) n (c) $n+1$ (d) $2n$

Ans. : (b)

Q19. If $z_1 = 2-3i$ and $z_2 = 4+6i$ then find $\frac{z_1}{z_2}$

(a) $-\frac{5}{26}-\frac{6i}{13}$ (b) $-\frac{5}{26}+\frac{6i}{13}$ (c) $8+18i$ (d) $8-18i$

Ans. : (b)

Q20. The rank of the following matrix $\begin{pmatrix} 1 & 5 & 1 \\ 2 & 1 & 1 \\ 3 & 6 & 2 \end{pmatrix}$ is

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

Ans. : (b)

Q21. Two Carnot engines X and Y are operating in series. The engine X receives heat at $1200\,K$ and rejects to a reservoir at a temperature T. The second engine Y receives the heat rejected by X and in turn rejects to a heat reservoir at $300\,K$.

Calculate the temperature T (in Kelvin) for the situation when the efficiency of the engines is same

(a) $600\,K$ (b) $750\,K$ (c) 0 (d) $450\,K$

Ans. : (a)

Q22. A square conducting loop of mass m, side l and resistance R is dropped into a region with a uniform horizontal magnetic field B whose direction is perpendicular to the plane of the falling loop. The loop will reach a terminal velocity v given by

(a) $v=\dfrac{mgR}{(Bl)^2}$ (b) $v=\dfrac{2mgR}{B^2l^2}$ (c) $v=\dfrac{mgR}{2B^2l^2}$ (d) None of these

Ans. : (a)

Q23. An ideal inductor, a resistor of resistance R Ohms and a capacitor with adjustable capacitance are connected in series to an alternating voltage with an effective value of V Volts and with frequency of f Hz. The current flowing through the circuit when the capacitance of the capacitor is set to C_1 is the same as when the capacitance of the capacitor is set to C_2, $C_2 > C_1$. The inductance of the inductor L is given by

(a) $\dfrac{1}{8\pi^2 f^2}\dfrac{C_1+C_2}{C_1C_2}$ (b) $\dfrac{1}{8\pi^2 f^2}\dfrac{C_1C_2}{C_1+C_2}$

(c) $\dfrac{1}{2\pi f}\dfrac{C_1C_2}{C_1-C_2}$ (d) $\dfrac{1}{2\pi^2 f^2 R(C_1-C_2)}\dfrac{C_1C_2}{C_1+C_2}$

Ans. : (a)

Q24. A cylinder of length L is made up of an inner core of steel of radius r_1 and an outer sheath of copper of thickness r_1. The resistivities of steel and copper are ρ_1 and ρ_2 respectively. The total resistance of the cylinder is

(a) $\dfrac{(\rho_1\rho_2)L}{\pi r_1^2(3\rho_1+\rho_2)}$

(b) $\dfrac{(3\rho_1+\rho_2)L}{\pi r_1^2}$

(c) $\dfrac{(\rho_1+\rho_2)L}{4\pi r_1^2}$

(d) Cannot be determined from the information provided above

Ans. : (a)

Q25. A meter stick is at an angle of 45^0 to the x- axis in its rest frame. The rod moves with a speed of $\frac{1}{\sqrt{2}}C$ along the $+x$- direction w.r.t. a frame S. The length of the rod in S is

(a) $\frac{\sqrt{3}}{2}$ meters (b) $\frac{\sqrt{5}}{3}$ meters (c) $\frac{\sqrt{2}}{3}$ (d) $\frac{2}{3}$

Ans. : (a)

Q26. An AC generator with output and frequency f is connected to the plates of an air filled parallel plate capacitor of plate area A and plate separation d. The maximum value of the displacement current is

(a) $\frac{2\pi \in_0 fVA}{d}$

(b) $\frac{\in fV}{d}$

(c) $\frac{2\pi f \in_0 A}{Vd}$

(d) Cannot be determined from the information provided

Ans. : (a)

Q27. An electron enters a uniform magnetic field of flux density $1.2 Wb/m^2$. Find the energy difference in (eV), between electrons having spins parallel and anti-parallel to the field. (Given: $\mu_B = 9.3\times10^{-24} J/T$)

(a) $3.95\times10^{-5} eV$ (b) $13.95\times10^{-5} eV$

(c) $23.95\times10^{-5} eV$ (d) $33.95\times10^{-5} eV$

Ans. : (b)

Q28. Using the vector atom model, determine the possible values of the angular momentum of an electron in f - shell

(a) $\frac{3\sqrt{7}}{2}\hbar, \frac{\sqrt{35}}{2}\hbar$ (b) $\frac{2\sqrt{7}}{2}\hbar, \frac{\sqrt{25}}{2}\hbar$ (c) $\frac{5\sqrt{7}}{2}\hbar, \frac{\sqrt{15}}{2}\hbar$ (d) $\frac{\sqrt{7}}{2}\hbar, \frac{\sqrt{5}}{2}\hbar$

Ans. : (a)

Q29. The two eigenvalues of the matrix $\begin{pmatrix} 1 & 1 \\ 1 & 1 \end{pmatrix}$ are

(a) $2,0$ (b) $1,1$ (c) $1,2$ (d) $0,1$

Ans. : (a)

Q30. The commutator, $\pi\left[x^2, p_x\right]$, is equal to

(a) ihx (b) $2ihx$ (c) $2ihp_x$ (d) Zero

Ans. : (a)

Q31. A particle of mass m is confined in the ground state of a one dimensional box extending from $x=-2L$ to $x=+2L$. The wave function of the particle in this state is $\Psi(x)=\psi_0\cos\left(\frac{\pi x}{4L}\right)$, where ψ_0 is a constant. The energy eigenvalue corresponding to this state is

(a) $\frac{\hbar^2\pi^2}{32mL^2}$ (b) $\frac{\hbar^2\pi^2}{2mL^2}$ (c) $\frac{\hbar^2\pi^2}{4mL^2}$ (d) $\frac{\hbar^2\pi^2}{16mL^2}$

Ans. : (a)

Q32. The normalized wave functions ψ_1 and ψ_2, correspond to the ground state and the first excited states of particle in a potential. The operator $\hat{A}$ acts on the wave functions as $\hat{A}\psi_1=\psi_2$ and $\hat{A}\psi_2=\psi_1$. The expectation value of the operator $\hat{A}$ for the state $\psi=(3\psi_1+4\psi_2)/5$ is

(a) 0.96 (b) –0.32 (c) 0 (d) 0.75

Ans. : (a)

Q33. The primitive translation vector of a two-dimensional lattice are $a=2\hat{i}+\hat{j}, b=2\hat{j}$. The primitive translation vector of its reciprocal lattice in x - direction is given by

(a) $a^*=\pi\hat{i}$ (b) $a^*=2\pi\hat{i}$ (c) $a^*=\hat{i}$ (d) $a^*=\pi\hat{j}$

Ans. : (a)

Q34. The mean drift speed v_d of an electron in an applied electric field E with electron density 'n' can be expressed as

(a) $v_d = |\sigma E / ne|$ (b) $v_d = |\sigma E / e|$ (c) $v_d = |\sigma e / nE|$ (d) None of these

Ans. : (a)

Q35. An un-damped oscillator has time period $\tau_0 = 1.0$ sec. Now a little damping is added so that its time period changes to $\tau_1 = 1.001$ sec. By what factor will the amplitude of oscillation decrease after 10 cycles?

(a) ≈ 17 (b) ≈ 1 (c) $\approx 1/17$ (d) None of these

Ans. : (a)

Q36. A kilogram of water has a constant heat capacity of $4.2 kJ/K/kg$ over the temperature range $0^0 C$ to $100^0 C$. The water was initially at $0^0 C$ and is brought into contact with a heat reservoir at $100^0 C$. When the water is in thermal equilibrium with the heat reservoir, calculate the change in entropy of the universe (Water + Reservoir).

(a) $184.8 J/K$ (b) $2437.8 J/K$ (c) $0 J/K$ (d) $1310.8 J/K$

Ans. : (a)

Q37. Two identical finite bodies of constant volume and of constant heat capacity at constant volume C_V, are used to drive a heat engine. Their initial temperatures are T_1 and T_2. The maximum amount of work which can be obtained from the system is

(a) $C_V \left\{2(T_1T_2)^{1/2} - (T_1 + T_2)\right\}$ (b) $C_V (T_1 + T_2)$

(c) $C_V (T_1T_2)^{1/2}$ (d) 0

Ans. : (a)

Q38. For a system of bosons, we can write the Bose-Einstein distribution function as $f(E_i) = \dfrac{1}{\exp(\alpha + \beta E_i) - 1}$, where $\beta = \dfrac{1}{k_B T}$ and $\alpha = \dfrac{\mu}{k_B T}$ ($k_B =$ Boltzmann constant). If μ represents the chemical potential, then which one of the following is true?

(a) $\mu \le 0$ (b) $\mu \ge 0$ (c) $\mu \le 1$ (d) $\mu \ge 1$

Ans. : (b)

Q39. An ideal capacitor C is charged to a voltage V_o and connected at $t=0$ across an ideal inductor L (The circuit now consists of a capacitor and an inductor only). If the resonant frequency $\omega_0 = \frac{1}{\sqrt{LC}}$, the voltage across the capacitor at time $t>0$ is given by

(a) V_0 (b) $V_0 \cos(\omega_0 t)$ (c) $V_0 \sin(\omega_0 t)$ (d) $V_0 e^{-\omega_0 t} \cos(\omega_0 t)$

Ans. : (b)

Q40. Magnetic moment of proton (μ_p) in terms of nuclear magneton (μ_N) is

(a) $\mu_p = 1.9\,\mu_N$ (b) $\mu_p = 2.7\,\mu_N$ (c) $\mu_p = 3.8\,\mu_N$ (d) $\mu_p = 5.4\,\mu_N$

Ans. : (b)

Q41. Find the eigenvalues of $A+4I$, where I is identity matrix and $A = \begin{pmatrix} 2 & -1 \\ -1 & 2 \end{pmatrix}$

(a) $1,3$ (b) $5,7$ (c) $4,4$ (d) None of these

Ans. : (b)

Q42. The limit $\lim_{n\to\infty}\left(\frac{1}{n}\right)^{\frac{1}{n}}$ is

(a) $\frac{1}{e}$ (b) 1 (c) 0 (d) e

Ans. : (b)

Q43. $\left(\frac{1+i}{\sqrt{2}}\right)^{49}$ is equal to

(a) $\left(\frac{1+i}{\sqrt{2}}\right)$ (b) $\left(\frac{2+98i}{\sqrt{2^{49}}}\right)$ (c) $\left(\frac{1-i}{\sqrt{2}}\right)$ (d) $\left(\frac{2-98i}{\sqrt{2^{49}}}\right)$

Ans. : (a)

Q44. $\sin\left(\frac{\pi}{4}+i\right)$ is equal to

(a) $\frac{\sqrt{2}}{4}\left(e-\frac{1}{e}\right)+\frac{\sqrt{2}}{4}\left(e-\frac{1}{e}\right)i$

(b) $\frac{\sqrt{2}}{4}\left(e+\frac{1}{e}\right)+\frac{\sqrt{2}}{4}\left(e-\frac{1}{e}\right)i$

(c) $\frac{\sqrt{2}}{4}\left(e+\frac{1}{e}\right)+\frac{\sqrt{2}}{4}\left(e+\frac{1}{e}\right)i$

(d) $\frac{\sqrt{2}}{4}\left(e-\frac{1}{e}\right)+\frac{\sqrt{2}}{4}\left(e+\frac{1}{e}\right)i$

Ans. : (b)

Q45. Two students are working on a math problem. The first student has probability $\frac{1}{2}$ of solving it and the second student has probability $\frac{3}{4}$ of solving it. What is the probability that at least one of them solves the problem?

(a) $\frac{3}{8}$ (b) $\frac{5}{8}$ (c) $\frac{7}{8}$ (d) $\frac{9}{8}$

Ans. : (c)

Q46. Expansion of the function $f(z)=\frac{1}{z^2-3z+2}$ in the region defined by $|z|>2$ is

(a) $z^{-2}+3z^{-4}+7z^{-6}+....$

(b) $z^{-2}+3z^{-3}+7z^{-4}+....$

(c) $z^{-1}+3z^{-2}+7z^{-3}+....$

(d) $z^{-3}+3z^{-4}+7z^{-5}+....$

Ans. : (b)

Q47. The Fourier transformation of the function $f(x)=1$ for $|x|<a=0$ for $|x|>a$ is

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

Ans. : (a)

Q48. The Laplace transformation of the function $f(t)=2^t$ is

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

Ans. : (b)

Q49. Consider a collection of non-interacting particles, each of mass m in a volume where the gravitational force is a negative (z - direction). Consider the system is in thermal equilibrium at a temperature T . Find the partition function

(a) $Q_N = \left[\dfrac{(kT)^3}{2\pi mg\hbar^2}\right]^{N/2}$

(b) $Q_N = \left[\dfrac{2\pi mg\hbar^2}{(kT)^3}\right]^{N/2}$

(c) $Q_N = \left[\dfrac{(kT)^3}{2\pi mg\hbar^2}\right]^{N}$

(d) $Q_N = \left[\dfrac{2\pi mg\hbar^2}{(kT)^3}\right]^{N}$

Ans. : (a)

Q50. The quantum distribution function for any gas atom which follows MB, BE and FD statistics is given as a generalized single form

$$f_i = \frac{g_i}{\left[\exp(\in_i - \mu)/(kT + J)\right]}$$

If the distribution function follows the MB statistics in a classical limit then what will be the condition of the following. Symbols have their usual meanings

(a) $\dfrac{f_i}{g_i} \ll 1;\ J = 1$

(b) $\dfrac{f_i}{g_i} \ll 1;\ J = 0$

(c) $\dfrac{g_i}{f_i} \ll 1;\ J = 1$

(d) $\dfrac{g_i}{f_i} \ll 1;\ J = -1$

Ans. : (b)