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EE24BTECH11021 - Eshan Ray

14) There are four electrons in $3d$ shell of an isolated atom. The total magnetic moment of the atom in units in Bohr magneton is ...

15) Which of the following transitions is NOT allowed in the case of an atom, according to the electric dipole radiation selection rule?

a) $2s - 1s$
b) $2p - 1s$
c) $2p - 2s$
d) $3d - 2p$

16) In the $SU(3)$ quark model, the triplet of mesons $\left(\pi^+, \pi^0, \pi^-\right)$ has

a) Isospin=0, Strangeness =0
b) Isospin=1, Strangeness =0
c) Isospin=$\frac{1}{2}$, Strangeness =+1
d) Isospin=$\frac{1}{2}$, Strangeness =-1

17) The magnitude of the magnetic dipole moment associated with a square shaped loop carrying a steady current I is m. If this loop is changed to a circular shape with the same current I passing through it, the magnetic dipole moment becomes $\frac{pm}{\pi}$. The value of p is ...

18) The total power emitted by a spherical black body of Radius R at a temperature T is P_1. Let, P_2 be the total power emitted by another spherical black body of radius $\frac{R}{2}$ kept at an temperature $2T$. The ratio, $\frac{P_1}{P_2}$ is .... (*Give your answer upto two decimal places*)

19) The entropy S of a system of N spins, which may align either in the upward or in the downward direction, is given by $S = -k_B N\left[p \ln p + (1-p)\ln(1-p)\right]$. Here, k_B is the Boltzmann constant. The probability of alignment in the upward direction is p .The value of p, at which the entropy is maximum, is .... (*Give your answer upto one decimal place*)

20) For a system at constant temperature and volume, which of the following statements is correct at equilibrium?

a) The Helmholtz free energy attains a local minimum.
b) The Helmholtz free energy attains a local maximum.
c) The Gibbs free energy attains a local minimum.
d) The Gibbs free energy attains a local maximum.

21) N atoms of an ideal gas are enclosed in a container of volume V. The volume of the container is changed to $4V$, while keeping the total energy constant. The change in the entropy of the gas, in units of $Nk_n \ln 2$, is ..., where k_B is the Boltzmann constant.

22) Which of the following is an analytic function of z everywhere in the complex plane?

a) z^2
b) $(z^{\cdot})^2$
c) $|z|^2$
d) $\sqrt{z}$

23) In a Young's double slit experiment using light, the apparatus has two slits of unequal widths. When only $slit-1$ is open, the maximum observed intensity on the screen is $4I_0$. When only $slit-2$ is open, the maximum observed intensity is I_0. When both the slits are open, an interference pattern appears on the screen. The ratio of the intensity of principal maximum to that of the nearest minimum is ...

24) Consider a metal which obeys the Sommerfeld model exactly. If E_F is the Fermi energy of the metal at $T = 0\,K$ and R_H is the Hall coefficient , which of the following statements is correct ?
a) $R_H \propto E_F^{\frac{3}{2}}$
b) $R_H \propto E_F^{\frac{2}{3}}$
c) $R_H \propto E_F^{-\frac{3}{2}}$
d) R_H is independent of E_F

25) A one-dimensional linear chain of atoms contains two types of atoms of masses m_1 and m_2 ($where\, m_2 > m_1$), arranged alternately. The distance between successive atoms is the same. Assume that the harmonic approximation is valid. At the first Brillouin zone boundary , which of the following statements is correct?
a) The atoms of mass m_2 are at rest in optical mode, while they vibrate in acoustical mode.
b) The atoms of mass m_1 are at rest in optical mode, while they vibrate in acoustical mode.
c) Both types of atoms vibrate with equal amplitudes in the optical as well as in the acoustical modes.
d) Both types of atoms vibrate, but with unequal, non-zero amplitudes in the optical as well as in the acoustical modes.

26) Which of the following operators is Hermitian?
a) $\frac{d}{dx}$
b) $\frac{d^2}{dx^2}$
c) $i\frac{d^2}{dx^2}$
d) $\frac{d^3}{dx^3}$