Assignment 19

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30. A constant and uniform magnetic field $\overrightarrow{B} = B_0\hat{k}$ pervades all space. Which one of the following is the correct choice for the vector potential in Coulomb gauge? (2018)
    (A) $-B_0\,(x+y)\,\hat{i}$
    (B) $B_0\,(x+y)\,\hat{j}$
    (C) $-B_0\left(x\hat{j}\right)$
    (D) $-\frac{1}{2}B_0\left(x\hat{i}-y\hat{j}\right)$
31. If H is the Hamiltonian for a free particle with mass m , the commutator $[x,[x,H]]$ is (2018)
    (A) $\frac{\hbar^2}{m}$
    (B) $-\frac{\hbar^2}{m}$
    (C) $-\frac{\hbar^2}{2m}$
    (D) $\frac{\hbar^2}{2m}$
32. A long straight wire, having radius a and resistance per unit length r , carries a current I . The magnitude and direction of the Poynting vector on the surface of the wire is (2018)
    (A) $\frac{I^2r}{2\pi a}$, perpendicular to axis of the wire and pointing inwards
    (B) $\frac{I^2r}{2\pi a}$, perpendicular to axis of the wire and pointing outwards
    (C) $\frac{I^2r}{\pi a}$, perpendicular to axis of the wire and pointing inwards
    (D) $\frac{I^2r}{\pi a}$, perpendicular to axis of the wire and pointing outwards
33. Three particles are to be distributed in four non-degenerate energy levels. The possible number of ways of distribution: (i) for distinguishable particles, and (ii) for identical Boson, respectively, is (2018)
    (A) (i) 24, (ii) 4
    (B) (i) 24, (ii) 20
    (C) (i) 64, (ii) 20
    (D) (i) 60, (ii) 16
34. The term symbol for the electronic ground state of oxygen atom is (2018)
    (A) $^1S_0$
    (B) $^1D_2$
    (C) $^3P_0$
    (D) $^3P_2$
35. The energy dispersion for electrons in one dimensional lattice with lattice parameter a is given by $E(k) = E_0 - \frac{1}{2}W\cos ka$, where W and E_0 are constants. The effective mass of the electron near the bottom of the band is (2018)
    (A) $\frac{2\hbar^2}{Wa^2}$
    (B) $\frac{\hbar^2}{Wa^2}$

(C) $\frac{\hbar^2}{2Wa^2}$
(D) $\frac{\hbar^2}{4Wa^2}$

36. Amongst electrical resistivity ρ , thermal conductivity κ, specific heat C , Youngâs modulus Y and magnetic susceptibility χ , which quantities show a sharp change at the superconducting transition temperature? (2018)

(A) ρ, κ, C, Y
(B) ρ, C, χ
(C) ρ, κ, C, χ
(D) κ, Y, χ

37. A quarter wave plate introduces a path difference of $\frac{\lambda}{4}$ between the two components of polarization parallel and perpendicular to the optic axis. An electromagnetic wave with $\vec{E} = (\hat{x} + \hat{y}) E_0 e^{i(kz-\omega t)}$is incident normally on a quarter wave plate which has its optic axis making an angle 135° with the x - axis as shown. (2018) The

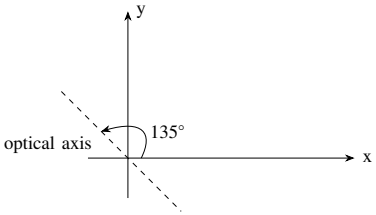

Fig. 0.1: 1

emergent electromagnetic wave would be

(A) elliptically polarized
(B) circularly polarized
(C) linearly polarized with polarization as that of incident wave
(D) linearly polarized but with polarization at 90° to that of the incident wave

38. A p - doped semiconductor slab carries a current $I = 100mA$ in a magnetic field $B = 0.2T$ as shown. One measures $V_y = 0.25$ mV and $V_x = 2$mV . The mobility of holes in the semiconductor is .....$m^2V^{-1}s^{-1}$ (2018)

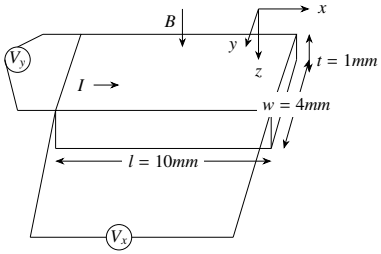

Fig. 0.2: 2

39. An n - channel FET having Gate-Source switch-off voltage $V_{GS(OFF)=-2V}$ is used

to invert a 0-5 V square-wave signal as shown. The maximum allowed value of R would be .....$k\Omega$ (2018)

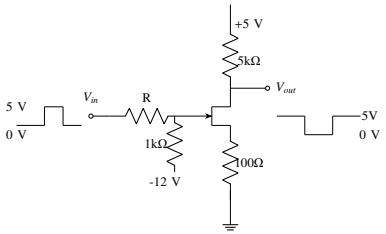

Fig. 0.3: 3

40. Inside a large nucleus, a nucleon with mass $939MeVc^{-2}$ has Fermi momentum $1.40fm^{-1}$ at absolute zero temperature. Its velocity is Xc , where the value of X is..... (up to two decimal places). (2018)
41. 4MeV γ - rays emitted by the de-excitation of ^{19}F are attributed, assuming spherical symmetry, to the transition of protons from $1d_{3/2}$ state to $1d_{5/2}$ state. If the contribution of spin-orbit term to the total energy is written as C$\langle \vec{l}.\vec{s} \rangle$ the magnitude of C is .....MeV (up to one decimal place). (2018)
42. An α particle is emitted by a $^{230}_{90}Th$ nucleus. Assuming the potential to be purely Coulombic beyond the point of separation, the height of the Coulomb barrier is..... MeV (up to two decimal places). (2018)