Assignment 9

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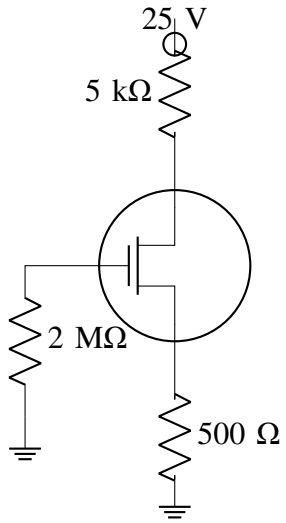
GATE-2015:PH

1) In the given circuit, the voltage across the source resistor is 1 V. The drain voltage (in V) is _____

(PH:2015)



2) A point charge is placed between two semi-infinite conducting plates which are inclined at an angle of 30° with respect to each other. The number of image charges is _____

(PH:2015)

3) A beam of X-ray of intensity I_0 is incident normally on a metal sheet of thickness 2 mm. The intensity of the transmitted beam is $0.025I_0$. The linear absorption coefficient of the metal sheet (in m^{-1}) is _____ (upto one decimal place)

(PH:2015)

4) The lattice parameters a, b, c of an orthorhombic crystal are related by $a = 2b = 3c$. In units of a, the interplanar separation between the (110) planes is _____ (upto three decimal places)

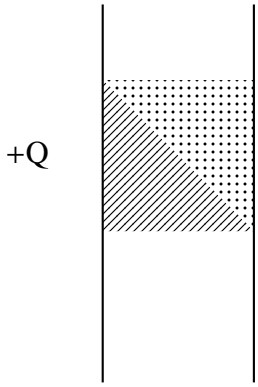
(PH:2015)

5) In a Hall effect experiment, the Hall voltage for an intrinsic semiconductor is negative. This is because (symbols carry usual meaning)

(PH:2015)

a) $n \approx p$ b) $n > p$ c) $\mu_e > \mu_h$ d) $m_e^* > m_h^*$

6) The space between two plates of a capacitor carrying charges $+Q$ and $-Q$ is filled with two different dielectric materials, as shown in figure. Across the interface of the two dielectric materials, which one of the following statements is correct?



(PH:2015)

a) $\overrightarrow{E}$ and $\overrightarrow{D}$ are continuous
b) $\overrightarrow{E}$ is continuous and $\overrightarrow{D}$ is discontinuous
c) $\overrightarrow{D}$ is continuous and $\overrightarrow{E}$ is discontinuous
d) $\overrightarrow{E}$ and $\overrightarrow{D}$ are discontinuous

7) The energy dependence of the density of states for a two dimensional non-relativistic electron gas is given by, $g(E) = CE^n$, where C is constant. The value of n is _____

(PH:2015)

8) The dispersion relation for phonons in a one-dimensional monatomic Bravais lattice with lattice spacing a and consisting of ions of masses M is given by, $\omega(k) = \sqrt{\frac{2C}{M}\,[1 - \cos(ka)]}$, where ω is the frequency of oscillation, k is the wavevector, and C is the spring constant. For the long wavelength modes ($\lambda \gg a$), the ratio of the phase velocity to the group velocity is _____

(PH:2015)

9) Four forces are given below in Cartesian and spherical polar coordinates.
(i) $\mathbf{F}_1 = K \exp\left(-\frac{r^2}{R^2}\right)\hat{r}$
(ii) $\mathbf{F}_2 = K(x^3\hat{y} - y^3\hat{z})$
(iii) $\mathbf{F}_3 = K(x^3\hat{x} + y^3\hat{y})$
(iv) $\mathbf{F}_4 = K\left(\frac{\hat{\phi}}{r}\right)$
where K is a constant. Identify the correct option.

(PH:2015)

a) (iii) and (iv) are conservative but (i) and (ii) are not
b) (i) and (ii) are conservative but (iii) and (iv) are not
c) (ii) and (iii) are conservative but (i) and (iv) are not
d) (i) and (iii) are conservative but (ii) and (iv) are not

10) Consider a system of eight non-interacting, identical quantum particles of spin$-\frac{3}{2}$ in a one dimensional box of length L. The minimum excitation energy of the system, in units of $\frac{\pi^2\hbar^2}{2mL^2}$ is _____

(PH:2015)

11) The excitation wavelength of laser in a Raman effect experiment is $546\,nm$, then the wavenumber of the anti-Stokes' line (in cm^{-1}) is _____

(PH:2015)

12) The binding energy per molecule of NaCl (lattice parameter is $0.563\,nm$) is $7.95\,eV$. The repulsive term of the potential is of the form $\frac{K}{r^9}$, where K is a constant. The value of the Madelung constant

is _____ (upto three decimal places)
(Electron charge $e = -1.6 \times 10^{-19}\,C$; $\epsilon_0 = 8.854 \times 10^{-12}\,C^2N^{-1}m^{-2}$)

(PH:2015)

13) Given that the Fermi energy of gold is $5.54\,eV$, the number density of electrons is _____ $\times 10^{28}\,m^{-3}$ (upto one decimal place)
(Mass of electron= $9.11 \times 10^{-31}\,kg$; $h = 6.626 \times 10^{-34} J \cdot s$; $1\,eV = 1.6 \times 10^{-19}\,J$)

(PH:2015)