Total No. of Questions : 8]

SEAT No. :

P1941

[Total No. of Pages : 3

[4922]-2002
M.Sc.
PHYSICS
PHY UT - 602 : Solid State Physics
(2014 Pattern) (4 Credits) (Semester - II)

Time : 3 Hours] *[Max. Marks : 50*

Instructions to the candidates:

1) ***Attempt any five questions.***
2) ***Draw neat and labelled diagrams wherever necessary.***
3) ***Figures to the right indicate full marks.***
4) ***Use of logarithmic tables and calculators is allowed.***

Constants:

Boltzmann constant	=	1.38×10^{-23} *J/K*
Planck's constant	=	6.623×10^{-34} *J-S*
Avogadro's number	=	6.023×10^{26} *per kg mole*
Mass of electron	=	9.1×10^{-31} *kg*
Electronic charge	=	1.6×10^{-19}*C*
Bohr magneton	=	9.27×10^{-24} *A.m*^{2}
Permeability of free space	=	$4\pi \times 10^{-7}$ *H/m*

Q1) a) Explain the reduced zone, extended zone and periodic zone schemes for representing energy bands with neat diagrams. **[4]**

b) Explain Type I and Type II superconductors with suitable examples.**[3]**

c) For Helium atom in ground state, the mean radius in the Langvin's formula is approximated by Bohr radius of 0.528 nm. Calculate the diamagnetic susceptibility of helium atom. Given : Density of helium = 0.178 kg/m^3.**[3]**

Q2) a) Prove that for Kronig - Penny potential with p < < 1, the energy of the lowest energy band at K = 0 is $E = \frac{h^2 p}{4\pi m a^2}$ **[4]**

b) Show that the flux coming from the hollow space of the super conducting ring is quantised. **[3]**

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c) An electromagnet with iron core can be magnetised typically upto 1 tesla. Compare the magnetic interaction energy $\mu_B B$ of an electron spin magnetic diapole moment with thermal energy $K_B T$ at room temperature. Hence show that at ordinary temperature, the approximation $K_B T/\mu_B B >>> 1$ holds good. **[3]**

Q3) a) Using equation $m\left[\frac{dv}{dt}+\frac{v}{\tau}\right]=-eE$ for electron drift velocity v, show that the d.c. electrical conductivity of metal is $\sigma=ne^2\tau$ m. Symbols have usual meanings. **[4]**

b) Explain the paramagnetism in iron group ions on the basis of quenching of orbital angular momentum. **[3]**

c) A magnetic material has a magnetisation of 3300 A/m and flux density of 0.0044 wb/m^2. Calculate the magnetising force and relative permeability of the material. **[3]**

Q4) a) Explain the formation of energy gap on the basis of nearly free electron model. **[4]**

b) For a simple 2-D square lattice, show that the Kinetic energy of a free electron at the corner of the first Brillouin Zone is higher than the electron at the midpoint of a side face of a zone by a factor of two. **[3]**

c) The critical temperature (T_C) for mercury with isotropic mass 199.5 is 4.185 K. Calculate its critical temperature when its isotropic mass changes to 203.4. **[3]**

Q5) a) Explain the phenomenon of hysteresis and hysteresis curve on the basis of domain theory. **[4]**

b) Describe the assumptions of BCS theory of super conductivity. **[3]**

c) The saturation magnetic induction of nickel is 0.65 wb/m^2. Calculate the magnetic moment of nickel atom in Bohr magneton. **[3]**

Given:

i) Density of nickel = 8906 kg/m^3.

ii) Atomic weight of nickel = 58.7.

Q6) a) Derive London equation for superconducting state. Hence obtain an expression for penetration depth. **[4]**

b) For a specimen of V_3Ga, the critical fields are respectively 1.4×10^5 and 4.2×10^5 A/m for 14K and 13K. Calculate the transition temperature and critical fields at 0K and 4.2K. **[3]**

c) A paramagnetic substance has 10^{28} atoms $/m^3$. The magnetic moment of each atom is 1.8×10^{-23} $A.m^2$. Calculate the paramagnetic susceptibility at 300K. **[3]**

Q7) a) Give an account of the Weiss molecular exchange theory of ferromagnetism. Hence derive Curie-Weiss law. **[5]**

b) Explain quantum theory of paramagnetism. Derive Curie law. **[5]**

Q8) a) Distinguish between metals, semiconductors and insulators on the basis of band theory of solids. **[5]**

b) Describe the motion of electron in 1-D periodic potential. Explain the concept of effective mass m*. Draw E-K, V-K and m* -K diagrams.**[5]**

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