2017

M.Sc.

3rd Semester Examination

PHYSICS

PAPER – PHS-303

Full Marks : 50

Time : 2 Hours

(Solid State Physics-Spl-I – PHS 303)

Answer Q1 and any three from the rest

1. Answer any five bits: 5X2 = 10

(a) Find the bandwidth for FCC crystal along [100] direction according to Tight Binding Approximation.

(b) For copper n_o = 8.5 x 10^{22} cm^{-3}, E_{Fo} = 3.2 eV. Calculate the Thomas Screening length.

(c) What is polariton?

(d) Calculate the deHaas-Van Alphen period $\Delta(\frac{1}{B})$for potassium on the basis of free electron model. The radius of free electron Fermi sphere is K_F = 0.75 x 10^8 cm^{-1}.

(e) What is equilibrium concentration of the vacancies at 800K in Copper? The energy for formation of vacancy is 120 x 10^3 Joule/mole. Gas constant R = 8.314 Joule/mole/K.

(f) In case of dislocation defects in solids what is preferred direction of slip? In case of BCC structure, in which direction slip occur?

(g) Explain the mechanism of formation of F center in an ionic crystal.

(Turn Over)

(h) What is meant by Dielectric relaxation?

2. (a) What is meant by reduced Zone scheme? (2)

(b) In case of nearly free electron model of electrons in metals, what is the main assumption behind the model compared with the Fermi gas model? (1)

(c) What is the origin of energy gap in this model? (1)

(d) Derive the energy dispersion relation for an electron in solid according to the nearly free electron approximation subject to a weak potential of $U(x) = U_0 \text{Cos}(2\pi x/a)$, where *a* is lattice constant. (5)

(e) What is crystal momentum? (1)

3. (a) What is Mott's metal-insulator transition? (2)

(b) What is soft optical phonon mode? (2)

(c) Derive Thomas Fermi dielectric function considering electrostatic screening in metal. (6)

4. (a) Find an estimation of critical shear stress in perfect solid according to Frenkel estimate. Why this value of the critical shear stress is much higher than the experimentally observed value? (3)

(b) Find the expression of elastic energy per unit length of screw dislocation considering a region of crystal of radius *r* about the screw dislocation with Burgers vector $\vec{b}$. (4)

(c) Write down and explain the various terms in Boltzmann transport equation under relaxation time approximation. (3)

5. (a) Explain the ionic conductivity and find the expression of ionic mobility and ionic conductivity. Which features of the ionic crystals could govern the ionic conductivity? (6)

(b)What information can you obtain from the peak of F-centre absorption spectra? (2)

(Continued)

(c) Treat F-centre as free electron of mass *m* moving in the field of a point charge *e* in NaCl crystal with the dielectric constant of 2.25. What is the 1s-2p energy difference of F-centre in NaCl? (2)

6. Define reflectivity coefficient r(ω) and reflectance (R). Derive Kramers-Kroning relations. How reflectivity coefficient can be determined through Kramers-Kroning relation assuming reflectivity coefficient as response function? (1+1+5+3)

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Internal Assessment-10