**ST.JOSEPH’S COLLEGE (AUTONOMOUS), BANGALORE-27**

SPECIAL SUPPLEMENTARY EXAMINATION APRIL 2018

**B.Sc. PHYSICS – VI SEMESTER**

**PH 6112: Solid State Physics**

(**Attach the question paper with the answer script**)

**Time: 3 hours** **Maximum Marks: 100**

*This question paper has 2 printed pages and 3 parts*

PART – A

Answer any **five** questions. Each question carries 12 marks. [5x12=60]

1. a). What are Miller indices? Find the Miller indices of a plane which is parallel to the

          Z-axis and intercepts at 2a and 3b respectively along X and Y axes. Sketch the plane.

 b). Obtain an expression for the interplanar distance of a simple cubic crystal. [5+7]

2. a). With a neat diagram, explain the working of the Coolidge tube. How intensity and           energy of x-rays can be controlled in the Coolidge tube?

 b). State and explain Mosley’s law. Mention its importance. [8+4]

3. Give Einstein’s theory on specific heat of solids? Mention its success and failure to          account for the experimental observations. [12]

4. a). What is Hall effect? Obtain an expression for the Hall field in terms of Hall coefficient for a          metal.

 b). Write a note on light dependent resistor. [8+4]

5. a). Explain the terms, thermodynamic probability of a macrostate and most probable          macrostate.

 b). Derive Maxwell-Boltzmann distribution function. How it is different from B-E distribution            function? [2+10]

6. a). What is Fermi-Dirac distribution function and explain its variation with temperatures.

 b). Obtain an expression for the Fermi energy of a three dimensional free electron gas at zero        kelvin. What would be the Femi energy above zero kelvin? [4+8]

7. a).What is carrier concentration? Obtain an expression for the carrier concentration in the         conduction band of an intrinsic semiconductor as a function of temperature.

 b). Write a short note on Doppler broadening of spectral lines. [8+4]

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PART – B

Solve any **four** problems. Each problem carries 6 marks. [4x6=24]

8. A uniform silver wire has a resistivity of 1.58x10-8 Ωm at room temperature is subjected to an     electric field of 2V/cm. Calculate the drift velocity and mobility of free electrons. Given           electron density in silver is 5.8x1028/m3.

9. Monochromatic X-rays of wavelength 0.121Å undergo Compton scattering at an angle 1800from a carbon block. Calculate the energy imparted to the recoiling electron.

10. Calculate the intrinsic carrier density and conductivity in germanium at 270C. Given mobility       of electrons and holes are 0.4m2/ Vs and 0.2m2/ Vs respectively in germanium. The       forbidden energy gap of germanium is 0.7eV. (Assume m\*e =m\*h = 9.1x 10-31 kg)

11. A current of 50A is established in a slab of copper 0.5cm thick and 2cm wide. The slab is      placed in a transverse magnetic field 1.5T. Find the Hall voltage developed and Hall      coefficient of copper. The free electron concentration in copper is 8.48x1028 per m3.

12. Find the Fermi energy in Cu at zero kelvin on the assumption that each copper atom       contributes one electron to the electron gas. Given density =8.94x103 kg/m3 and atomic       mass =63.5u for Cu.1u=1.66x10-27 kg. Also find the Fermi momentum of the electron gas.

13. Three indistinguishable particles (bosons) are to be distributed in two compartments, the       first having 3 cells and the second 2 cells. What are the thermodynamic probability for the       macro- states (5,0) and (3,2).

PART – C

14. Answer any **eight** questions. Each question carries 2 marks. [8x2=16]

a). What are the basic lattice parameters?

b). If atomic radius of sodium is 1.86Å, then what is the edge of the unit cell in sodium?

c). Why Debye-Scherrer cameras are of diameter 57.3mm or multiples of that?

d). In metals, as the temperature increases, the conductivity increases or decreases? Explain

e). Is free electron theory in metals successful in accounting for the electrical conductivity of      metals? Explain.

f). How mobility of charge carriers varies with applied electric field in the semiconductor?

g). How energy bands are formed instead of energy levels in solids?

h). Under what conditions do B-E and F-D statistics yield to classical statistics?

i).Which statistics is followed by the following particles: electrons, ideal gas molecules,      protons, photons, helium atom and neutron?

 j). Can free electrons in a metal have zero energy at zero kelvin? Explain.

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