Duration: 2 ½ hrs. **Total Marks: 60**

N.B. (1) Figures to the right indicate full marks.
(2) All questions are compulsory.
(3) Use of non-programmable calculator is allowed.
(4) Symbols have their usual meaning unless stated otherwise.

Q.1 a) Attempt any **one**

(i) In the elastic scattering monochromatic plane by a monoatomic sample, determine the expression for the structure factor for a crystal of N cells of when the diffraction condition is satisfied for any plane. **8**

(ii) Briefly explain Powder method of x-ray diffraction **8**

b) Attempt any **one**

(i) Write a short note on Ewald construction. **4**

(ii) Draw a labelled diagram of a Laue diffractometer. **4**

Q.2 a) Attempt any **one**

i) Explain quantization of lattice vibration and inelastic scattering of neutron by photon. **8**

ii) What is harmonic approximation? Obtain the dispersion relation for acoustical branch in crystal with two atoms per basis. **8**

b) Attempt any **one**

(i) What are the factors affecting the thermal conductivity in insulators. Show graphically how thermal conductivity varies with temperature. **4**

(ii) Write short note on phonon momentum. **4**

Q.3 a) Attempt any **one**

i) Discuss the quantum theory of paramagnetism and deduce the Curie Law. **8**

ii) Describe the method of adiabatic demagnetisation of paramagnetic salt. **8**

b) Attempt any **one**

i) Write a note on magnetic properties of rare earth elements. Explain the term lanthanide contraction. **4**

ii) State and explain Curie-Weiss law. **4**

Q.4 a) Attempt any **one**

i) Explain temperature dependence of saturation magnetization in ferromagnetic materials with the help of graphical solution. **8**

ii) What is 'Bloch wall'? Determine the total wall energy per unit area. **8**

b) Attempt any **one**

i) Write a short note on neutron magnetic scattering. **4**

ii) Write a short note on saturation magnetization at absolute zero temperature. **4**

Q.5 Attempt any **four** **12**

(i) Find the fundamental reciprocal lattice vectors for a simple cubic lattice with cube edge a.

(ii) With suitable diagram explain the construction of the first Brillouin zone in a one dimensional lattice.

(iii) What is harmonic theory? State the consequences of it.

(iv) Find the maximum normal mode angular frequency in a linear monoatomic chain where the mass of each atom is 6.09x10^-26 kg and the speed of sound is 1040m/s. assume harmonic interactions.

(v) State and explain Hund's first rule with suitable example.

(vi) Explain nuclear demagnetization method to obtain lower temperatures.

(vii) Write a note on ferrites.

(viii) Write a short note on Iron Garnets.

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