Ajit Singhal '1'
Sec – 6
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ASSIGNMENT ON SOLID STATE PHYSICS

Q1. Explain Hall effect. Derive the formula of Hall constant in terms of mobility.

Ans. Hall Effect is defined as the difference in voltage generated across a current – carrying conductor, is transverse to an electrical current in the conductor and an applied magnetic field perpendicular to the current. It is the production of a voltage difference (the Hall voltage) across an electrical conductor that is transverse to an electric current in the conductor and to an applied magnetic field perpendicular to the current. It was discovered by Edwin Hall in 1879.

We know that,

$$R_H = \frac{\sigma_h^2 R_h + \sigma_e^2 R_e}{(\sigma_h + \sigma_e)^2} \qquad \text{-- (1)}$$

Where,

σ_h → conductivity of holes
σ_e → conductivity of electrons
R_h → Hall coefficient for holes
R_e → Hall coefficient for electrons
R_H → Hall coefficient

Now mobility,

$$\mu = \left|\frac{qT}{m}\right| \qquad \text{-- (2)}$$

Then,

$$\sigma = \mu_e |q_e| n_e + \mu_h |q_h| n_h$$

so,

$$R_H = \frac{1}{|q|} \frac{\mu_e{}^2 n_e - \mu_h{}^2 n_h}{(\mu_e n_e + \mu_h n_h)^2} \qquad \text{-- (3)}$$

On simplifying eq^n (3), we get

$$\boxed{\mu = \sigma R_H}$$

Q2. Define superconductivity. What is critical temperature and critical current?

Ans. Superconductivity is a set of physical properties observed in certain materials where electrical resistance vanishes and magnetic flux fields are expelled from the material.

Certain temperature of a substance is the temperature at and above which vapor of the substance cannot be liquified, no matter how much pressure is applied. Every substance has a critical temp.

The critical pressure of a substance is the pressure required to liquify a gas at its critical temperature.

Q3. Define Meissner effect.

Ans. The Meissner effect is the expulsion of a magnetic field from a superconductivity during its transition to the superconductivity state when it is cooled below the critical temperature.

A superconductor with little or no magnetic field within it is said to be in the Meissner state. The Meissner state breaks down when the applied field is too strong.

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Q4. What is difference between Type I and Type II semiconductors?

Ans.

Type I semiconductor	Type II semiconductor
Low critical temperature.	High critical temperature.
Low critical magnetic field.	High critical magnetic field.
Obeys Meissner effect.	Partly obeys Meissner effect.
Exhibits single critical magnetic field.	Exhibits two critical magnetic fields.
Easily lose the superconducting state by low-intensity magnetic field.	Does not easily lose the superconducting state by external magnetic field.

Q5. What are important applications of superconductivity?

Ans. Important applications of superconductivity are dominated by the use of LTS materials and include :

- Magnets for Magnetic Resonance imaging.
- Low and high field for NMR.
- Accelerators for high energy Physics.
- Industrial magnets for magnetic separation.