D-4

i) What are cooper pairs? Explain qualitatively the BCS theory of superconductivity.

Bardeen cooper & schriffer (BCS) theory of superconductivity :-

According to Bardeen cooper & schriffer, the basic interaction responsible for superconductivity is electron - lattice - electron interaction. This is explainingd as follows:.

Let an electron approches a +ve ion core. It suffers attractive coulomb interaction. Due to this attraction ion core is set in motion and consequently distorts the lattice. Smaller the mass of the ion core, greater will be distortion. Suppose towards that side another electron comes and sees the distorted lattice. Then the interaction between electron and distorted lattice occurs which in its effect lowers the energy of the second electron. Thus we interpret that the two electrons interact via the lattice distortion or the phonon field resulting in the lowering of energy for the electron. The lowering of energy for ~~the~~ implies that the force between the two electrons is attractive. This type of interaction is called electron - lattice - electron interaction. This interaction is strongest when the two electrons have equal and opposite momenta and spin.

Cooper pair :- The two such electrons which interact attractively via phonon are called cooper - pair. These cooper pairs have certain aspects of single particle. The energy of the

pair of electrons in the bound state is less than the energy of the pair of electrons in free state. The difference of energy in the two states of the pair is binding energy of the pair. At temp. less than critical temp. electron-phonon-electron interaction is stronger than electron-electron coulomb interaction and so the valence electron tends to form the pair. Pairing is complete at absolute zero and completely broken at critical temp.