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B. Sc. Part II Paper-IV
Physics Hons
Current electricity

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Demonstration of Thomson Effect :-

S.G. Starling's experiment to demonstrate the Thomson effect is illustrating in fig (7) and its ends A and B are immersed in mercury bath A and B. Two fine copper coils P and Q of equal resistances are wound over the two arms of the rod and packed round with asbestos wool and then connected in the two opposite gaps of a Wheatstone bridge.

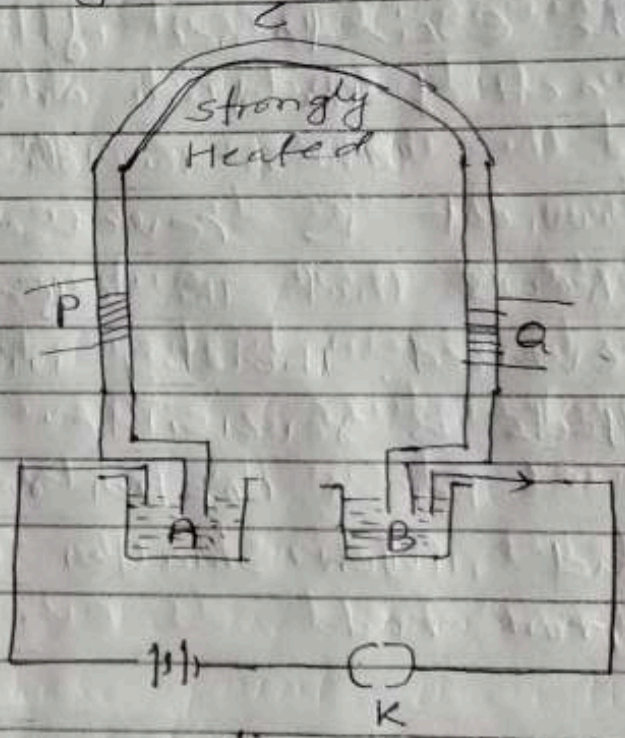

fig-7

The end C of the rod is heated by a Bunsen burner strongly while the ends A and B are kept cold in the mercury bath, so that there is a steep gradient of temp. from C to A and C to B.

Now a balance is obtained by varying the other two resistances R and S (Not shown in fig) of the bridge.

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Now a heavy current is passed from A to B. It is found that the balance is disturbed and the galvanometer shows a deflection indicating that the resistance of P has increased while that of Q has decreased. It shows that heat is evolved in the arm AC in which the current flows from cold to hot end and absorbed in the arm CB in which current flows from hot to cold end. This experiment demonstrates the existence of Thomson effect in each of the two arms of the iron rod.

When the direction of the current is reversed, the galvanometer shows that the effects have also been reversed, thereby indicating that Thomson effects is reversible.

For a copper rod the effect is opposite and much smaller than that for the iron rod.

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Explanation of Thomson effect

According to electron Theory the free electrons inside the metal move freely like the Molecules of a gas. Therefore the free electrons are said to form a gas known as electron gas. The electron gas is uniformly distributed inside the entire Volume of metal. When the temperature of a metal is same everywhere then the density and the Pressure of the electron gas inside the metal is also same everywhere. When one end of a metal rod is heated keeping the other end at constant low temp., then the Pressure of the electron gas at heated end increases and so a number of electrons start moving from the hot to the cold end. Due to different electron densities in the hot and cold ends of the metal rod an e.m.f. is sufficient to stop the further movement of the electrons from the hot to the cold end, then the state of the dynamical equilibrium is reached. In the state of the dynamic equilibrium, there exists a certain e.m.f. between the ends of the rod which is known as

Thomson e.m.f. The Thomson e.m.f. between two points of the rod differing in temperature by 1°C is called Thomson coefficient. It is now obvious that the Thomson e.m.f. is due to the diffusion of electrons between different parts of the same metal which are at different temperatures. In the case of copper or antimony rod, the Thomson e.m.f. acts from the part of the metal at lower temperature to the part of higher temperature. Therefore when a current flows from the cold to the hot end, it flows in the direction of the Thomson emf and heat is absorbed from the rod. On the other hand in the case of iron antimony, the Thomson e.m.f. acts from higher temperature to lower temperature. Therefore when current flows from the cold to the hot end it flows against the Thomson e.m.f. and hence heat is evolved.