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

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Tomson effect

When a temperature gradient is maintained between the different parts of the same metal and a current is passed through the metal, there exists a variation of potential along the metal i.e. e.m.f. is developed in the metal due to the gradient of temperature. This effect is known as Thomson effect.

As heat is either absorbed or evolved when current passes between two points having a difference of potential, therefore the passage of electric current through such a metal (having temperature gradient) results in an absoroption or evolution of heat in the body of the metal.

In case of copper or antimony the potential increases from cold to hot end and decreases from hot to cold end; therefore heat is absorbed when the current j flows from the cold to the hot end and is evolved when the current flows from the hot to cold end. In the case of iron or bismuth the potential decreases from cold to the hot

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end and increases from hot to the cold end; Therefore heat is evolved when the current flows from the cold to the hot end and is absorbed when the current flows from the hot to the cold end.

Thomson Coefficient :-

The Thomson Co-efficient σ of a metal is defined as the amount of heat energy absorbed or evolved when one Coulomb charge flows in the metal between two points which differ in temperature by 1°C.

Thus if a charge q coulomb flows in a metal between two points having a temperature difference of 1°C, Then heat energy absorbed or evolved = σq joules.

But if E volts be the Thomson e.m.f developed between these points then this energy must be equal to Eq joules.

Therefore $\sigma q = Eq$

or $\sigma = E$.

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Hence Thomson coefficient of a metal is numerically equal to the e.m.f set up between two point differing in temperature by $1^{\circ}C$.

Thus the unit of Thomson coefficient σ is joule per coulomb per °C or volts per °C. The Thomson coefficient of a metal is +ve when e.m.f. is directed from lower to higher temperature as in copper and antimony and −ve when e.m.f. is directed from higher to lower temperature as in iron and bismuth. Its value for lead is however practically zero.

If σ is the Thomson coefficient, then the e.m.f. developed between the points at temp. T and $T+dT$ is σdT. Therefore the resultant Thomson e.m.f in a metal A whose ends are at temp. T_1 and T_2 ($T_1 < T_2$) is given by

$$\int_{T_1}^{T_2} \sigma dT.$$

By analogy with specific heat Thomson coefficient has been called the specific heat of electricity of the material.