Thermoelectricity

objectives:

Determining thermoelectricity voltage as a function of the temperature differential.

Theory:

In 1821 a German physicist named Seebeck discovered the thermoelectric effect which forms the basis of modern thermocouple technology. He observed that an electric current flows in a closed circuit of two dissimilar metals if their two junctions are at different temperatures. The thermoelectric voltage produced depends on the metals used and on the temperature relationship between the junctions. If the same temperature exists at the two junctions, the voltages produced at each junction cancel each other out and no current flows in the circuit. With different temperatures at each junction, different voltages are produced and current flows in the circuit. A thermocouple can therefore only measure temperature differences between the two junctions, a fact which dictates how a practical thermocouple can be utilized .

Another way to explain this conduction phenomenon is by considering the Fermi levels of the metals, that is when two metal wires with different Fermi energies E_F touch, electrons move from one to the other. The metal with the lower electronic work function W_A emits electrons and becomes positive. The transfer does not stop until the contact voltage

$$U = \frac{W_{A1} - W_{A2}}{e}$$

e=elementary charge

is reached. If the wires are brought together in such a way that they touch at both ends, and if the two contact points have a temperature differential $T = T_1 - T_2$, an electrical potential, the thermoelectric voltage

$$U_r = U(T_1) - U(T_2)$$

is generated. Here, the differential thermoelectric voltage

$$\alpha = \frac{dU_r}{dT}$$

depends on the combination of the two metals.

Apparatus:

Thermocouples ,clamping plug, Thermometer(-10-110) ^{0} c,hotplate ,Beaker,microvoltmeter

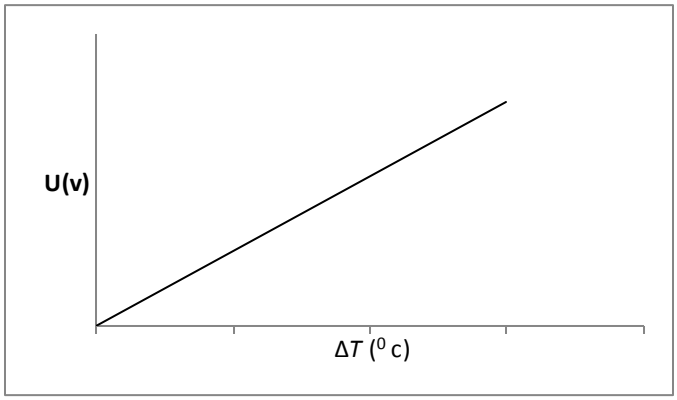
Procedure:

1-Connect one end of the thermocouple to the microvoltmeter and insert the other in a water bath.
2-Reset the microvoltmeter and choose an appropriate scale .change the scale while reading if necessary.
3-heat the water till it reaches 100 ^{0} c and Record the temperature and corresponding voltage readings.
4-Repeat the last step while water is cooling.

Measurements:

Room temperature=

T(^{0} c)	ΔT (^{0} c)	U(v)



Graph:

Plot U versus ΔT

Results:

-Find α= slope.

-Find the error.