(MP3-7) Seebeck's Effect

Aim of experiment

Determination of Seebeck's coefficient of a thermocouple.

Apparatus

Thermocouple - Metal Hot Plate - Voltmeter - Thermometer.

Theory of experiment

When two different metals are in contact, electrons tend to pass from the metal with the higher concentration of free electrons into the metal with lower concentration. This results in a temperature dependent voltage difference; contact voltage, *figure 1*. This phenomenon is known as Seebeck effect.

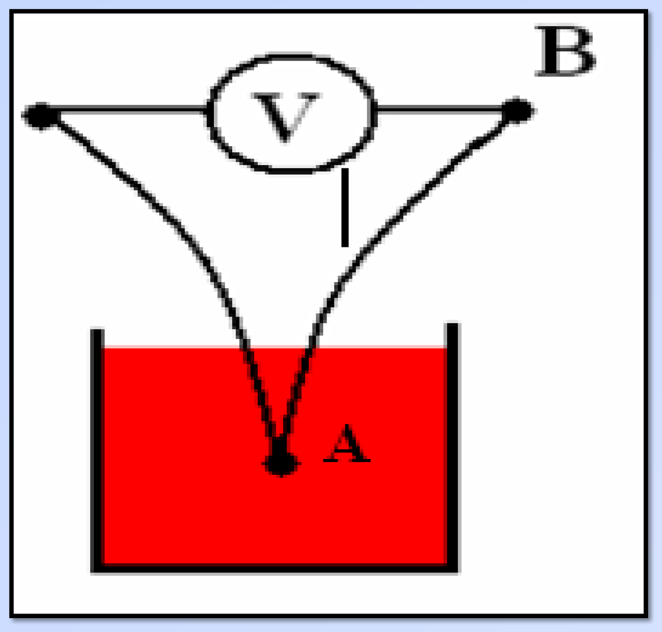

*Figure 1***.** A thermocouple with junction at A set in an environment; red medium.

A typical thermocouple consists of two electrical conductors made of two different materials with two junctions A and B, and connected together into complete conducting circuit, *figure 2*. The junction A represents the temperature probe, while the junction B represents the reference point which is maintained at constant temperature.

When the circuit is closed, the contact voltages at the junctions A and B compensate each other as long as the junctions are at the same temperature. If the two junctions are at different temperatures

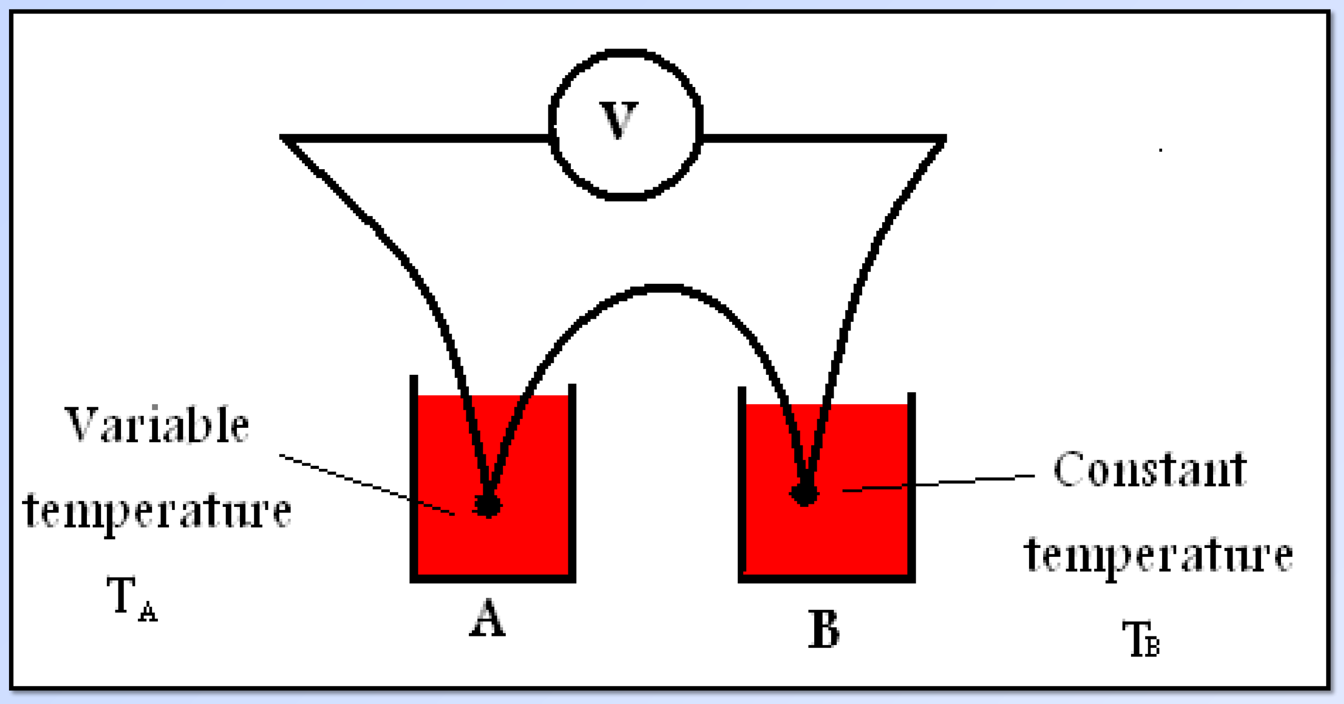

Figure 2. Ideal circuit diagram for a thermocouple set up to measure Seebeck's coefficient.

a residual contact voltage, the thermoelectric voltage V_T, appears. The magnitude of this voltage is proportional to the temperature difference ΔT;

$V_T \,\alpha\, \Delta T$ then $V_T = S\,\Delta T = S\,(T_A - T_B)$

where, S is Seebeck's coefficient.

The thermoelectric voltage V_T between the two points A and B, which are at different temperatures, can be directly measured by means of a voltage sensitive measuring amplifier, or by a micro-voltmeter

If only one junction is used, the reference point B is that of the environment T_o. If the temperature of junction A is increased a potential difference changes by ΔV, Figure 1.

Then

$$V_T = S\Delta T = S\,(T_A - T_o)$$

A graph between V_T and $(T_A - T_o)$ will result in a straight line of slope equals *S*; Seebeck's coefficient.

Procedure

1. Connect the circuit as shown in *figure 1*
2. Measure the environmental temperature T_o °C, with the thermometer, and the corresponding voltage V_o
3. Increase the temperature of the A plate in steps of 5°C and record the corresponding voltage *V*, then record the data in the next table.
4. Draw a graph between ΔT on x-axis and ΔV on y-axis. Seebeck's coefficient can be calculated from the equation:

$$Slope = S = \Delta V / \Delta T$$

Results

T (°C)	$\Delta T = (T - To)$ (°C)	V (V)	$\Delta V = (V - Vo)$ (V)

T_o=………….. °C V_o=………..*Volt*

Slope = S= ………………..   *(V. K*$^{-1}$*)*

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