OPERATING INSTRUCTIONS

FOR

EXPERIMENTAL SET-UP

ON

STUDY OF THERMO E.M.F. USING POTENTIOMETER AND SAND BATH

OMEGA TYPE ES-231

Manufacturer:

OMEGA ELECTRONICS

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OMEGA TYPE ES-231 Experimental Set Up has been designed specifically for the study of Thermo E.M.F. The aims are to plot thermo emf versus temperature graph and to find the melting point of Paraffin Wax using digital D.C. microvoltmeter and sand bath. The set up is absolutely self contained and requires no other apparatus. Practical experience on this set up carries great educative value for Science and Engineering Students, particularly for students of B.Sc. and 10 + 2 classes.

OBJECT

- ❑ Study of a thermocouple and plot a graph between thermo emf and temperature of hot junction.
- ❑ Determine the melting point of Paraffin Wax.

FEATURES

❑ The Set up consists of the following :

1. Digital D.C. Microvoltmeter is very versatile multipurpose instrument for the measurement of low dc voltage. It has 5 decade ranges from 1mV to 10V with 100% over-ranging. For better accuracy and convenience, readings are directly obtained on 3½ digit LED display. IC amplifier used offers exceptionally low offset voltage and input bias parameters, combined with excellent speed characteristics OMEGA TYPE DMV-022
2. A Copper-Constantan Thermocouple.
3. Retort stand with ring.
4. Thermometer 0-360°C
5. Sand bath
6. Beaker 250 ml
7. Funnel 4"
8. Tripot stand
9. Test Tube 1"
10. Glycerine
11. Paraffin Wax.
12. Wooden stand.

❑ Adequate no. of connecting wires.

THEORY OF THERMO ELECTRICITY

Seeback effect :

If two rods of different substances, say constantan and copper, be soldered at the ends and if one of the junctions be kept at a constant temperature, say, in melting ice (at 0°C) while the other be placed in a beaker of water whose temperature is gradually raised, a sensitive galvanometer included in the circuit indicates an increasing current. This is the thermo-electric current and the two rods form a *Thermo-couple*. This is illustrated in Fig. 1. The strength of the current depends upon the materials forming the couple and on the difference of temperatures between the two junctions.

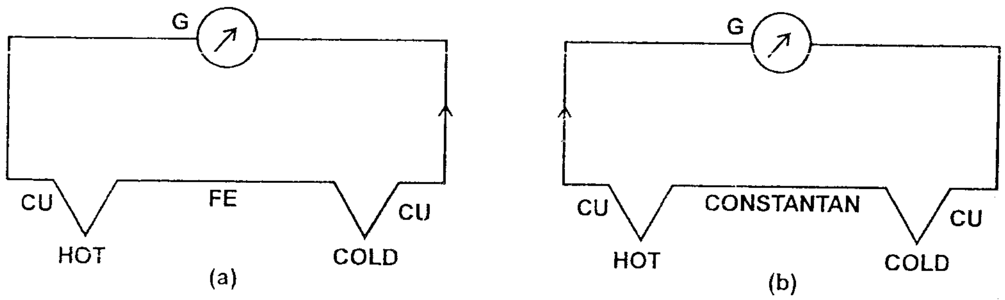

FIG. 1 PRINCIPLE DIAGRAM

As this temperature-difference is gradually increased, the current first increases, becomes a maximum for a given temperature of the hot junction, and then begins to decrease, with a further rise in its temperature. The temperature of hot junction for maximum current is called the *Neutral temperature* it is independent of the temperature of the cold junction. This illustrated in Fig. 2

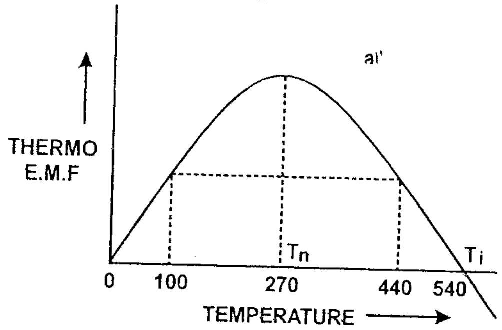

FIG. 2 GRAPH BETWEEN TEMPERATURE AND THERMO E.M.F. FOR COPPER CONSTANTAN

As the current depends upon the resistance of the circuit and resistance changes with a change in temperature, it is usual to measure the e.m.fs. developed in the circuit and not the currents.

When measuring temperatures with a thermo-couple care should be taken to see that the neutral temperature for the pair is remote from the temperature-range in use. With a couple of copper-constantan temperatures upto 300°C can be measured. The couple develops an e.m.f. about 15 millivolts at 300°C and the temperature e.m.f. curve is practically linear.

For measuring temperatures, the hot junction is brought to various temperatures and the corresponding thermo e.m.f. is determined for every temperature. A curve is plotted between temperature and e.m.f. Any unknown temperature (within this range) can be determined from the curve.

Peltier effect:

If instead of establishing a difference of temperatures between the junctions, a current be sent through the circuit, in the same direction in which the thermoelectric current was flowing, the hot junction cools down while the cold junction is heated up, due to the evolution of heat there. While in joule heating heat is produced throughout the circuit and the process is irreversible, in Peltier-heating heat is produced (or absorbed) only at the two junctions and the process is reversible.

Thomson effect:

A difference of potentials exists along the length of an unequally heated metal rod, due to the unequal concentration of the free electrons at the various points of the heated rod. In copper the hotter parts are at higher potentials while in iron they are at lower potentials. Thormson effect is zero for lead. That is why lead is taken as the second element or base in studying the thermo-electric behaviour of various metals.

EXPERIMENT – 1

OBJECT

Study of a thermocouple and plot a graph between thermo emf and temperature of hot junction.

PROCEDURE

1. Make the arrangement as shown in Fig. 3

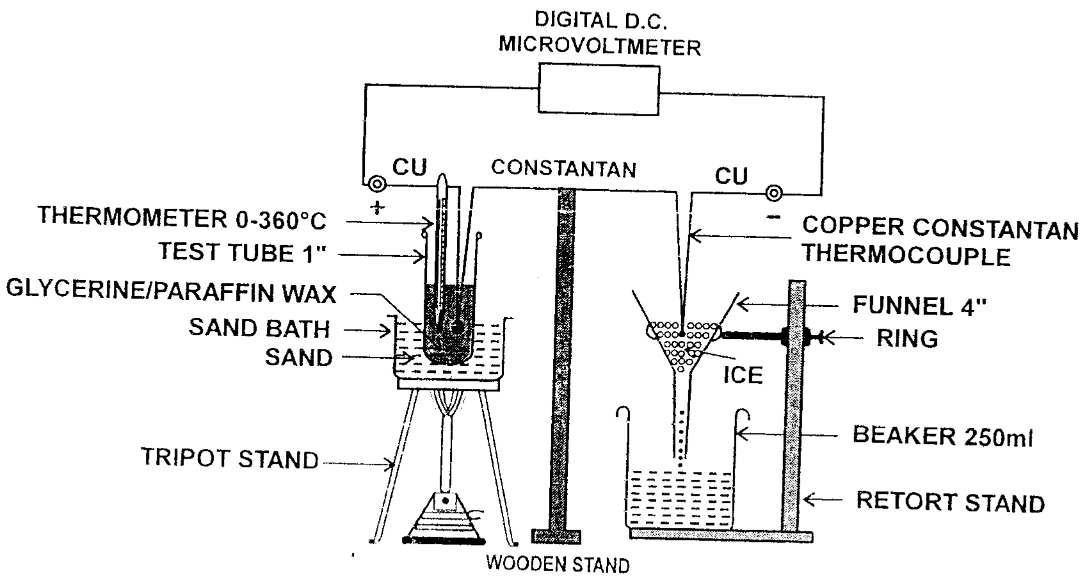

FIG. 3

2. Connect Hot Junction terminal of thermocouple to +ve lead of Digital Microvoltmeter & Cold Junction terminal of thermocouple to –ve lead of Digital Microvoltmeter.
3. Put one junction (–ve) of the copper constantan thermocouple in funnel full of ice & other junction (+ve) of thermocouple in test tube containing glycerin, put the test tube on sand bath thermometer in test tube. Further put partition cum wooden stand in the middle as shown in Fig. 3.
4. Heat the sand bath with burner and note down the reading of temperature (say interval of 5° or 10°) corresponding also note down the readings of Digital Microvoltmeter.
5. Put out the burner and note the readings while cooling.
6. Take mean of Digital Microvoltmeter reading during increasing temperature & decreasing temperature at various temperatures.
7. Plot a curve between temperature (along X-axis) corresponding to thermo e.m.f. developed at various temperature (along the X-axis). It should be straight line. This is illustrated in Fig. 4

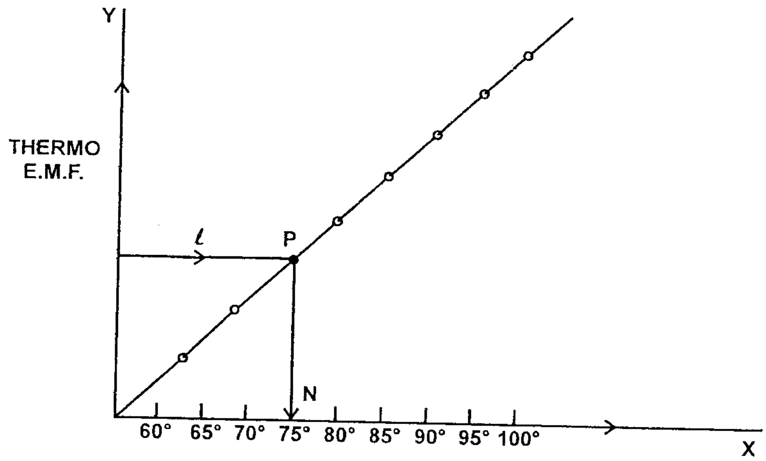

FIG. 4

OBSERVATION

Temperature of cold junction = ...°C

Sr. No.	Temperature of Hot Junction		Thermo emf. = volts
	As shown by thermo-meter °C	Above cold Junction °C	

EXPERIMENT – 1

OBJECT

Determine the melting point of Paraffin Wax.

(i) Take out Glycerin from the test tube Put some Paraffin Wax in it and dip the hot junction of the thermocouple in the middle of the Wax.

(ii) Heat the stand bath. When the Wax starts melting, put out the burner and determine temperature and calculate the thermo e.m.f.

(iii) Draw a line parallel to X-axis at the thermo e.m.f. cutting the curve at P. Draw a perpendicular PN to the X-axis. N is the melting point of Paraffin wax.

RESULT

The melting point of Paraffin Wax as determined from the calibration curve of the thermocouple = ...°C

Melting point as determined by mercury thermometers =. . . . . .°C

Difference = ...°C

ORAL QUESTIONS

1. What is thermo emf ?
2. How can you explain the phenomenon of production of thermo emf ?
3. On what factors the direction of thermo e.m.f. depends ?
4. How thermo emf varies with temperature ?
5. What are the uses of thermo couple ?
6. What is the basic principle of the potentiometer ?
7. What are the main sources of error in this experiment ?
8. What do you mean by Peltier effect ?
9. What do you mean by Thomson effect ?
10. What is the order of thermo emf generated in Cu-constantan?

REFERENCES :

Bsc. Practical Physics by Harnam Singh
Bsc. Practical Physics by C.L. Arora
Practical Physics IIG by Gupta & Kumar

ACCESSORIES : NIL.

ENCLOSURES : NIL.