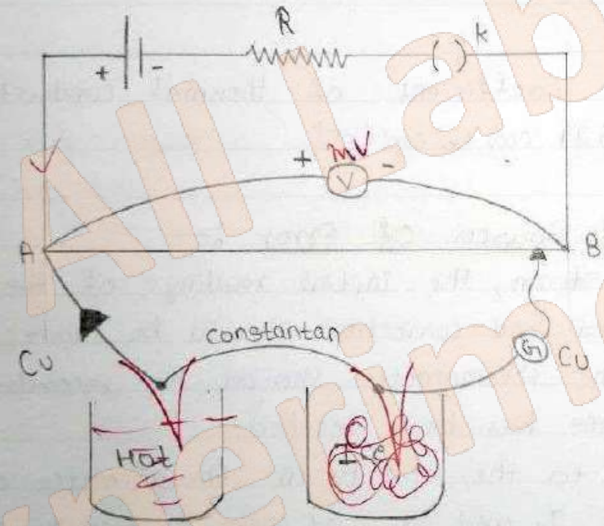
Aim – To Calibrate a thermocouple using a potentiometer.

Apparatus :–

A battery, a potentiometer, a key, a resistance box, a thermocouple, a sensitive galvanometer, heating arrangement two beakers, a funnel, a digital multimeter, ice and jockey and connecting wire

Circuit Diagram :–



Observation :–

Voltage shown by digital multimeter is 30 mV.

Total length of the wire = 10 × 100 = 1000 cm = L

So, V/L = 0.03 mv/cm.

Sr. No.	Temperature of hot Junction (°C)	Length of wire (l) at null point (cm)	Thermo emf = $\frac{V}{L} \times l$ (mv)
1.	230	345	10.35
2.	220	333	9.99
3.	200	328	9.84
4.	190	314	9.42

Aim :–

To calibrate a thermocouple using a potentio-meter.

Apparatus :–

A battery, a potentiometer, a key, a resistance box, a thermocouple, a sensitive galvanometer, heating arrangement two beakers, a funnel, a digital multimeter, ice and jockey and connecting wire.

Theory :–

Consider the circuit as shown in figure. If E is the emf of a battery, r is the resistance of potentiometer wire and R is the resistance in series with it, the current I in the circuit is, $I = \frac{E}{R+r}$

and the potential drop across the potentiometer wire AB is

$$V_{AB} = \frac{Er}{R+r} \quad \text{—— (1)}$$

the potential drop per centimeter of the wire is $P = \frac{Er}{R+r} \times \frac{1}{L}$

where L is the total length of wire.

If the thermo emf across the thermocouple is balanced by l centimeter of the potentiometer wire, its value is given by

$$e = \frac{Er}{R+r} + \frac{l}{L}$$

The thermoemf across the Cu-Constantan thermo couple when its hot junction is at 200 °C is of the order of 10mV. Therefore, we keep $V_{AB} = 10mV$. If $E = 2V$ eqn (1)

Sr.No	Temperature of hot junction (°C)	Length of wire (l) at null point (cm)	Thermo emf $= V/L \times l$ (mv)
5.	180	300	9
6.	170	294	8.82
7.	160	285	8.55
8.	150	260	7.8
9.	140	241.5	7.245
10.	130	225	6.75
11.	120	213	6.39
12.	110	201	6.03
13.	100	171	5.13
14.	90	159	4.77
15.	80	142	4.26
16.	70	124.5	3.735
17.	65	111	3.33
18.	60	102	3.06
19.	55	96.9	2.907
20.	50	83	2.49
21	45	70.2	2.106
22.	40	60.6	1.818

becomes, $10 \times 10^{-3} = \frac{2r}{R+r}$, $200r = R+r$

$R = 199r$

Procedure :—

(i) Connect the circuit as shown in figure and take out the resistance from resistance box as the multimeter shows 30 mV.

(ii) Keep one junction of thermocouple in heated oil and the other junction is crushed ice in a funnel so as to filter out the melted ice. Heat the oil containing in container till 230°C not above this. Note down the ~~ter thermocou-ple~~ temperature of the hot junction.

(iii) Connect the one end of thermocouple to the end A of the potentiometer and the other end to a sensitive galvanometer whose one end connected to a jockey.

(iv) With the help of jockey, find the length l of the potentiometer (measure from the end A) needed to bring the deflection in the galvanometer to zero. Note it down.

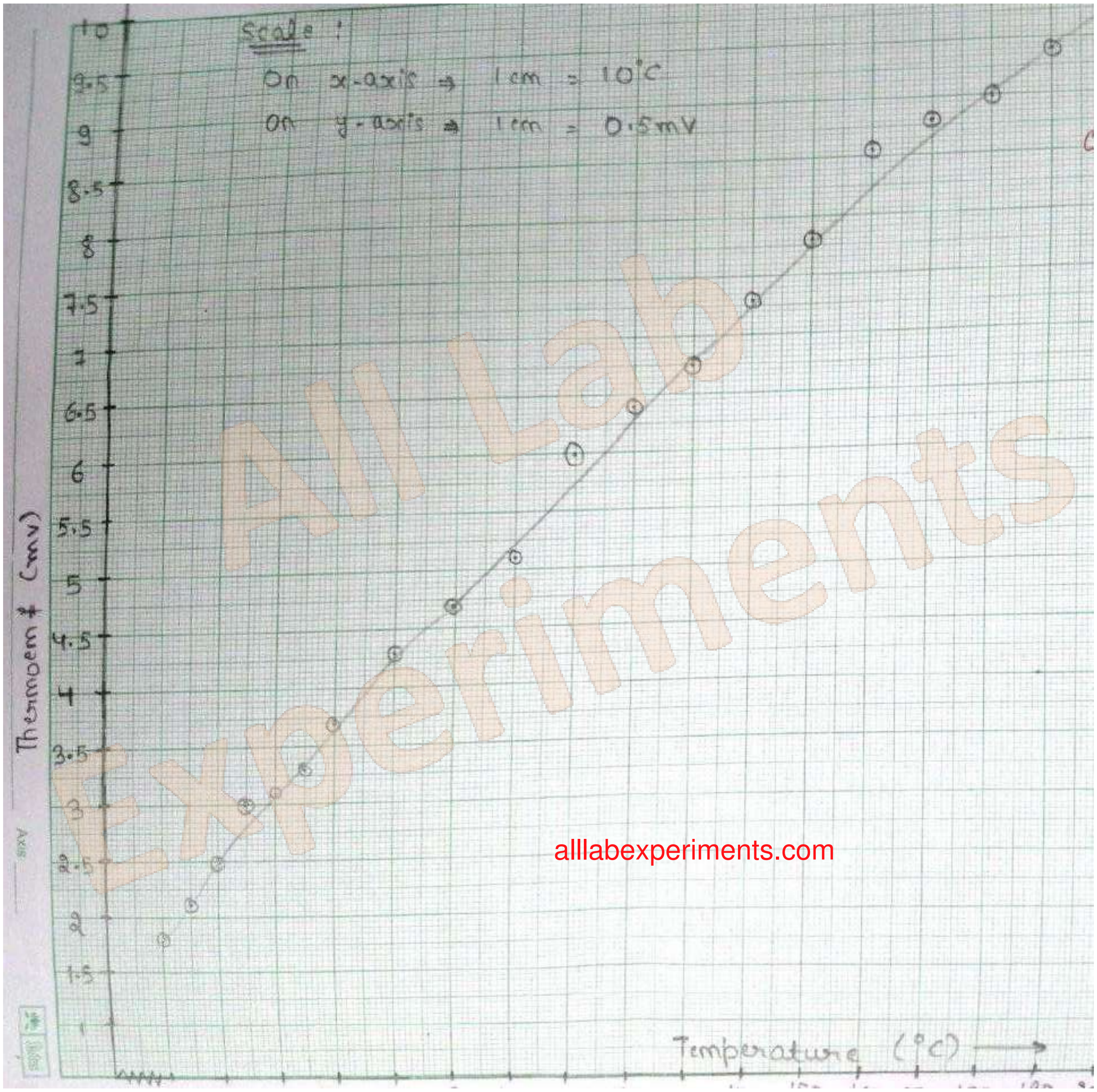
(v) Let the oil cool down. With every 10° or 5° fall of temper-ature note down the temperature and the length l of the potentiometer wire needed for balance.

(vi) Calculate the emf for each observation.

(vii) Draw a curve between the thermoemf 'e' and the temperature of the hot junction 'T'.

Result :—

The graph between the thermo emf and temperature difference for copper constantan thermocouple is a part of parabola as shown in graph.


Scale :
On x-axis ⇒ 1 cm = 10°C
On y-axis ⇒ 1 cm = 0.5mV
10
9.5
9
8.5
8
7.5
7
6.5
6
5.5
5
4.5
4
3.5
3
2.5
2
1.5
1
Thermoemf (mv)
Temperature (°C) →


All Lab Experiments

Precaution and Sources of Error :-

(i) The emf of the battery should remain constant during the experiment.

(ii) The keys should be closed only when observation are to be made.

(iii) The ends of the connecting wires should be properly cleaned with a sand paper. As the thermoemf to be measured is small, bad ~~contacts~~ connection will lead to trouble some difficulties.

(iv) The potential difference across the potentiometer wire should not be greater than the maximum emf of the thermocouple.

(v) In the thermocouple, the wires of the two metals should be in contact at the junction only and the contact should be good.

(vi) The galvanometer should be very sensitive.

(vii) The hot junction should be kept away from the rest of the contacts of the circuit.

(viii) The contact between the jockey and the wire should not be made while the former is being moved along. The contact should be momentary.

All Lab Experiments

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