Expt. No. 02

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Band Gap Determination using Post Office Box

AIM: To find the band gap of the material of the given thermistor using post office box.

APPARATUS REQUIRED:

Thermistor, thermometer, post office box, power supply, galvanometer, insulating coil and glass beakers.

PRINCIPLE AND FORMULAE:

① Wheatstone's Principle for balancing a network: $\frac{P}{Q} = \frac{R}{S}$

Of the four resistances, if three resistances are known and one is unknown, the unknown resistance can be calculated

② The band gap for semiconductors is given by,

$$E_g = 2k \left(\frac{2.303 \log_{10} R_T}{1/T} \right)$$

where; k = Boltzmann constant $= 1.38 \times 10^{-23}$ J/K

R_T = Resistance at T K

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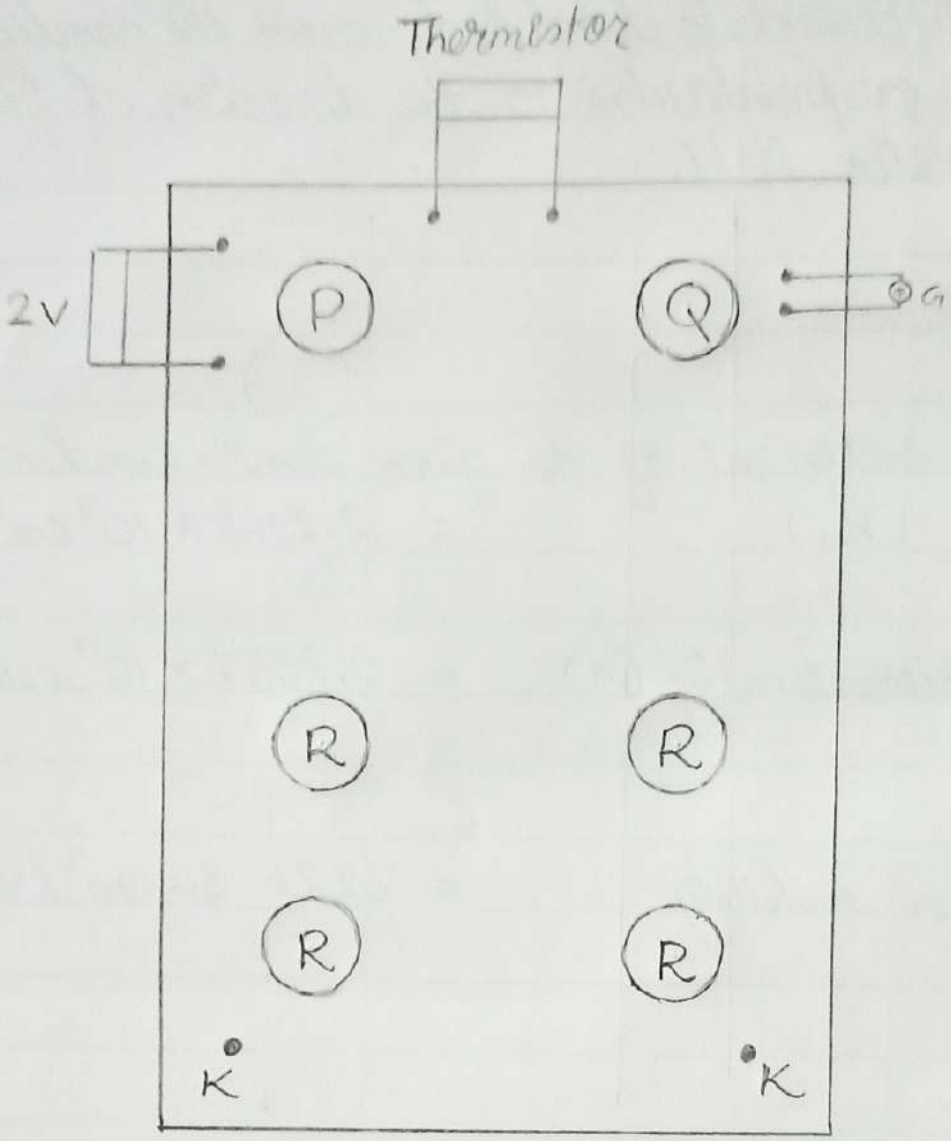


Circuit Diagram Of A post office box

TABLE: To Find The Resistance of Thermistor at Different Temperatures

Sl. No	Temperature of thermistor $T = t + 273$	$\frac{1}{T}$	Resistance in P	Resistance in Q	Resistance in R	Resistance of the thermistor $R_T = \frac{P}{Q} \times R$	$2.303 \log_{10} R_T$
	(K)	(K^{-1})	(ohm)	(ohm)	(ohm)	(ohm)	(ohm)
1	305	0.00327869	10	10	946	946	6.8535 (2.303 log 946)
2	310	0.00322581	10	10	740	740	6.6078 (2.303 log 740)
3	318	0.00314465	10	10	528	528	6.2702 (2.303 log 528)
4	328	0.00304878	10	10	400	400	5.9925 (2.303 log 400)
5	333	0.00300300	10	10	360	360	5.8872 (2.303 log 360)
6	343	0.00291545	10	10	300	300	5.7048 (2.303 log 300)
7	353	0.00283286	10	10	259	259	5.5578 (2.303 log 259)
8	358	0.00279330	10	10	200	200	5.2993 (2.303 log 200)
9	363	0.00275482	10	10	179	179	5.1883 (2.303 log 179)
10	371	0.00269542	10	10	173	173	5.1542 (2.303 log 173)

Calculations :-

1. When $R_T = 946\,\Omega$, $2.303 \log_{10} R_T = 2.303 \log_{10} 946 = 6.8535\,\Omega$

2. When $R_T = 740\,\Omega$, $2.303 \log_{10} R_T = 2.303 \log_{10} 740 = 6.6078\,\Omega$

3. When $R_T = 528\,\Omega$, $2.303 \log_{10} R_T = 2.303 \log_{10} 528 = 6.2702\,\Omega$

4. When $R_T = 400\,\Omega$, $2.303 \log_{10} R_T = 2.303 \log_{10} 400 = 5.9925\,\Omega$

5. When $R_T = 360\,\Omega$, $2.303 \log_{10} 360 = 2.303 \log_{10} 360 = 5.8872\,\Omega$

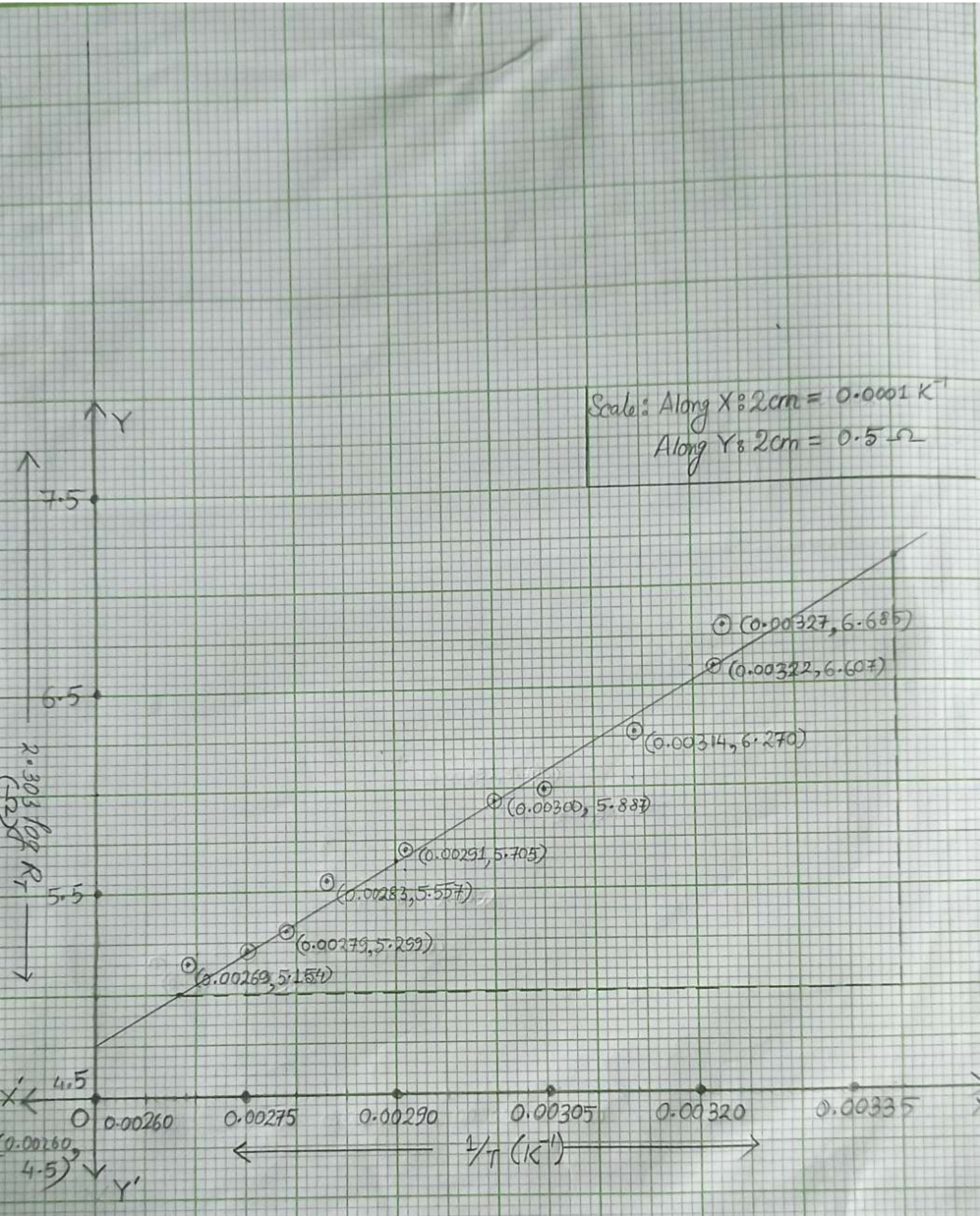
6. When $R_T = 259\,\Omega$, $2.303 \log_{10} R_T = 2.303 \log_{10} 259 = 5.5578\,\Omega$

7. When $R_T = 300\,\Omega$, $2.303 \log_{10} R_T = 2.303 \log_{10} 300 = 5.7048\,\Omega$

8. When $R_T = 200\,\Omega$, $2.303 \log_{10} R_T = 2.303 \log_{10} 200 = 5.2993\,\Omega$

9. When $R_T = 179\,\Omega$, $2.303 \log_{10} R_T = 2.303 \log_{10} 179 = 5.1883\,\Omega$

10. When $R_T = 173\,\Omega$, $2.303 \log_{10} R_T = 2.303 \log_{10} 173 = 5.1542\,\Omega$



[1/T vs 2.303 log R_T graph]

OBSERVATION :

A graph is drawn between $1/T$ in X axis and $2.303 \log_{10} R_T$ in Y axis where T is temperature in K and R_T is the resistance of the thermistor at T K

From graph, slope $= \frac{dy}{dx} = \frac{y_2 - y_1}{x_2 - x_1}$

$$= \frac{7.15 - 5.65}{0.00340 - 0.00268}$$

$$= 2083.3333 \ \Omega K^{-1}$$

Band gap (E_g) = 2k × slope of the graph

= 2k (k Boltzmann constant) × $\frac{dy}{dx}$

$= 2 \times 1.38 \times 10^{-23} \times 2083.3333$

$= 5.75 \times 10^{-20}$

$= \frac{5.76 \times 10^{-20}}{1.6 \times 10^{-19}} = 0.3594$ eV

Result:- The approximate band gap value of the given thermistor is 0.3594 eV (Ans)

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