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:

(1) Thermistor
(2) Thermometer
(3) Post Office Box
(4) Power Supply
(5) Galvanometer
(6) Insulating Coil
(7) Glass Beakers.

★ 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 resistance can be calculated.
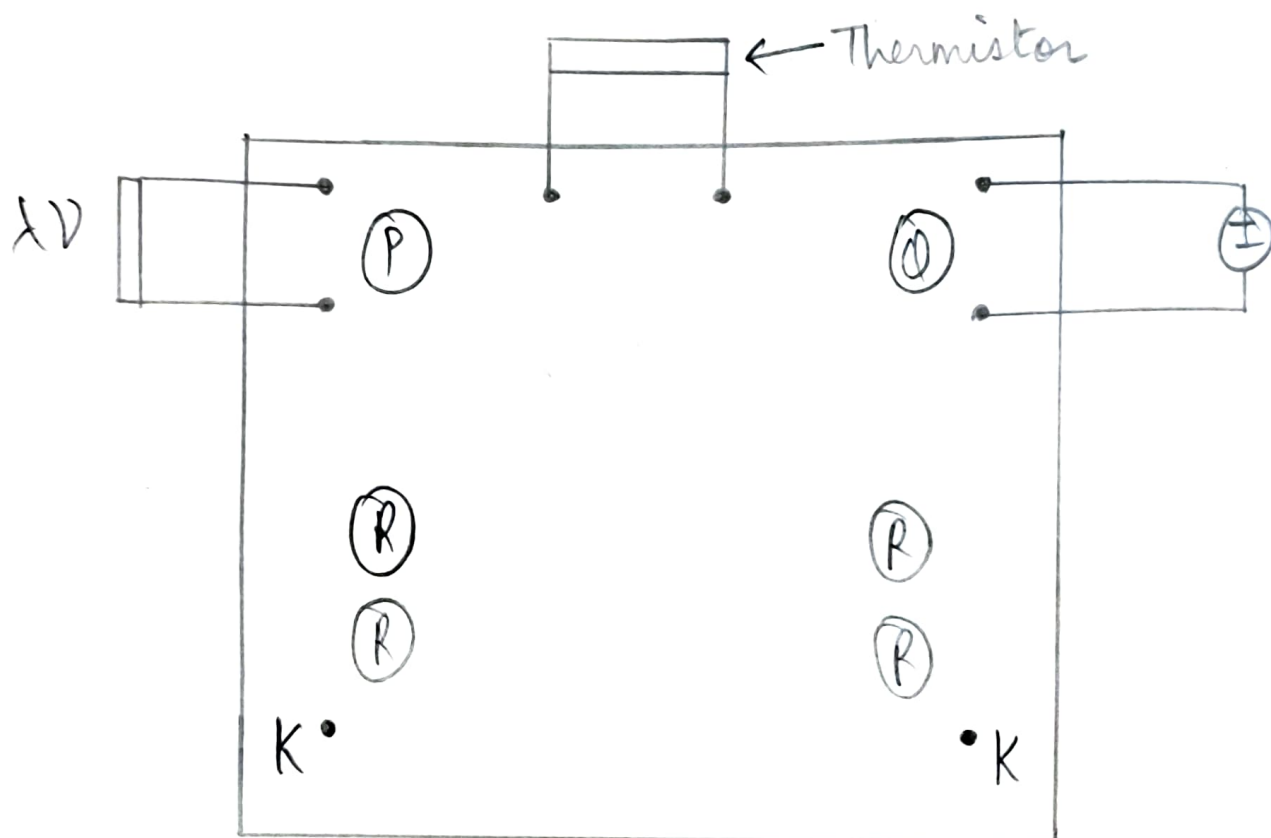
(2) The band gap for semiconductors is given by:

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

where, k = Boltzmann constant = 1.38×10^{-23} J/k
R_T = Resistance at T K.

→

PTO

Thermistor

P   O   E

λV

R R   R R

K   K

Post Office Box - Circuit Diagram

★ OBSERVATIONS:

Temperature of thermistor $T = t + 273$ (K)	$\frac{1}{T}$ (K^{-1})	Resistance in P. (Ω)	Resistance in Q. (Ω)	Resistance in R. (Ω)	Resistance of the thermistor $R_T = P/Q \times R$ (Ω)	2.303 $\log_{10} R_T$ (Ω)
305	0.0032769	10	10	946	946	6.8535
310	0.00322581	10	10	740	740	6.6078
318	0.00314465	10	10	528	528	6.2708
328	0.00304878	10	10	400	400	5.9925
333	0.00300300	10	10	360	360	5.8872
343	0.00291545	10	10	300	300	5.7048
353	0.00283286	10	10	259	259	5.5578
358	0.00279330	10	10	200	200	5.2993
363	0.00275482	10	10	179	179	5.1883
371	0.00269542	10	10	173	173	5.1542

★ CALCULATIONS:

→ Value of $2.303 \log_{10} R_T$:

(1) For $(RT)_1 = 2.303 \log_{10} R_T = 2.303 \log_{10} (946) = 6.8535 \ \Omega$.

(2) For $(RT)_2 = 2.303 \log_{10} R_T = 2.303 \log_{10} (740) = 6.6078 \ \Omega$.

(3) For $(RT)_3 = 2.303 \log_{10} (528) = 6.2702 \ \Omega$.

(4) For $(RT)_4 = 2.303 \log_{10} (400) = 5.9925 \ \Omega$.

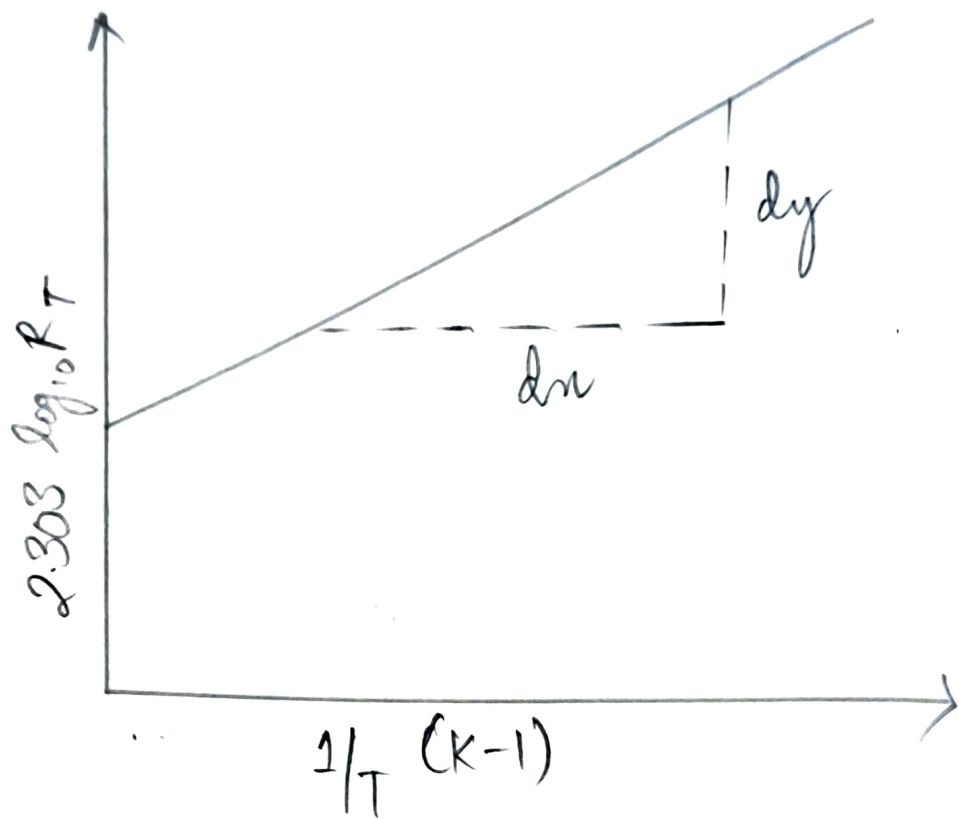(5) For $(RT)_5 = 2.303 \log_{10} (360) = 5.8872 \ \Omega$.

(6) For $(RT)_6 = 2.303 \log_{10} (259) = 5.5578 \ \Omega$.

(7) For $(RT)_7 = 2.303 \log_{10} (200) = 5.2993 \ \Omega$.

(8) For $(RT)_8 = 2.303 \log_{10} (179) = 5.1883 \ \Omega$.

(9) For $(RT)_9 = 2.303 \log_{10} (173) = 5.1542 \ \Omega$

Model Graph

→ Mean Value of $2.303 \log_{10} R_T = 5.8516 \ \Omega$

→ Mean Value of $1/T = 0.002969 \ K^{-1}$

→ Band Gap, $E_g = 2K (2.303 \log_{10} R_T) \div 1/T$

$$\Rightarrow 2 \times 1.38 \times 10^{-23} \times \frac{5.8516}{0.002969}$$

$$\Rightarrow 5.4391 \times 10^{-20} \ J$$

$$\Rightarrow E_g = 0.34 \ eV$$

★ GRAPH :

→ In ABC, $\dfrac{dy}{dn} = \dfrac{5.9925 - 5.578}{0.00304878 - 0.00283286} \Rightarrow 2013.24$

$$\therefore E_g = 2K \left(\frac{dy}{dn} \right) = 2 \times 1.38 \times 10^{-23} \times 2013.24 \Rightarrow 5.556 \times 10^{-20} \ J$$

$$\Rightarrow E_g = \frac{5.556 \times 10^{-20}}{1.6 \times 10^{-19}} \Rightarrow 0.35 \ eV$$

★ RESULTS:

→ The band gap of the material of the thermistor = 0.34 eV.

Scale on
x-axis, 1.5 cm = 1 unit
y-axis, 2 cm = 0.00015 units

y-axis: 2.303 log₁₀ P_T

Values on y-axis: 9.5, 8.5, 7.5, 6.5, 5.5

x-axis: 1/T (K⁻¹)

Values on x-axis: 0.00345, 0.00330, 0.00345, 0.00360, 0.00345, 0.00330, 0.00345