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Manufacturers & Exporters of Laboratory and Research Equipments

BOLTZMAN CONSTANT KIT
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BOLTZMAN CONSTANT KIT

THEORY

Conventional method to determine Boltzman Constant (k) make use of the block body Radiation and its two famous laws i.e. Wien's displacement law and Stefan's law . These methods are time consuming and very often lead to comparatively less accurate results.

The V – I characteristics of a semiconductor diode can be used to determine Boltzman Constant accurately and with simple equipment that can be handled with ease and convenience . The diode equation is given by:

$$I = I_0\left\{\exp\left(\frac{eV}{\eta kT}\right)-1\right\} \qquad \ldots(1)$$

where V = voltage across the diode

I = forward current at voltage V

I_o = reverse saturation current

k = Boltzmann Constant

T = Temperature in Kelvin

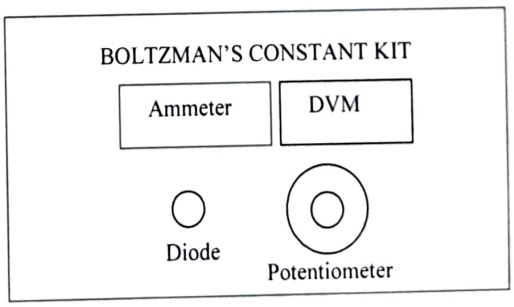
η = a constant , characteristic of the material from which the diode is made , for Ge diode, $\eta = 1$ while $\eta = 2$ for Si diode.

If $V >> kT/e$, the Boltzmann constant can be expressed as

$$k = \frac{e}{\eta T\left(\frac{\Delta \ln I}{\Delta V}\right)} \qquad \ldots\ldots\ldots\ldots\ldots\ldots (2)$$

where , $\left(\frac{\Delta \ln I}{\Delta V}\right)$ is the slope of the straight line drawn between **V** and **ln(I)** .

The top view of Kit is given below:



The experimental kit consists of following:

(a) A digital dc millivoltmeter (0 – 2 V) to measure the voltage across the diode.

(b) A highly stabilized variable power supply (0 – 5 V)

(c) A current meter (0 – 50 mA) to measure forward bias current in diode.

(d) Silicon diode.

PROCEDURE :

1. Connect the Si - diode (provided with the kit) to main unit.
2. Switch ON the Unit and keep voltage at minimum with the help of potentiometer.
3. Take the different voltage and current measurement of diode.

S.No.	Voltage (V)	Current (mA)

4. Draw the graph between ***ln* (I)** vs **V**, it would be a straight line.
5. Calculate Boltzmann Constant from the slope of the graph and using formula (2) i.e.

$$k = \frac{e}{\eta T\left(\frac{\Delta \ln I}{\Delta V}\right)}$$

6. Compare experimental value with the theoretical value. (k = 1.38×10^{-23} J/K).

Sample Readings: For Si diode

S.No.	Voltage V(volts)	Current I (mA)	*ln* (I)
1	0	0	-
2	0.6	1	-
3	0.63	1.5	0.4
4	0.66	4.0	1.4
5	0.68	7.5	2.0
6	0.7	10.5	2.4
7	0.72	14.5	2.6
8	0.73	22.5	3.1
9	0.75	32.6	3.5
10	0.76	41.5	3.73

Sample Calculations:

Boltzmann's constant $$k = \frac{e}{\eta T\left(\frac{\Delta \ln I}{\Delta V}\right)}$$

Where e = 1.6×10^{-19} C

$\eta = 2$

T= 300 K

$\left(\frac{\Delta \ln I}{\Delta V}\right) = 23.1$ (from slope of graph)

Substituting in equation , k = 1.15×10^{-23} J/K.