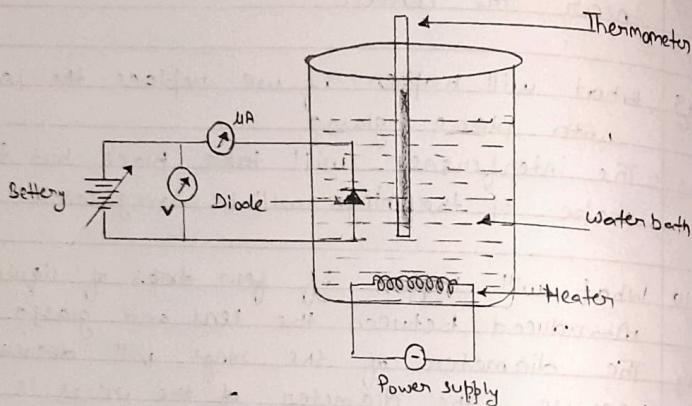


Diagram:-



Band gap Apparatus

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Experiment No. 6

Object:- To determine the width of the forbidden energy band gap in a semiconductor diode.

Apparatus:- Point contact diode, heating arrangement to heat the diode, ammeter, voltmeter, thermometer etc.

Theory and Formula:- A semiconductor doped or intrinsic always possesses energy gap between its conduction and valence bands. For conduction of electricity, a certain amount of energy is to be given to the electron, so that it goes from the valence band to the conduction band. This energy so needed is the measure of the energy gap ΔE between the top and bottom of valence and conduction bands respectively. When a P-N junction is reversed biased as shown figure. The current through the junction is due to minority carriers i.e. due to electrons in P section and holes in N section. The concentration of these carriers depends upon the energy gap ΔE . For small range of temperature, relation between I_s and T can be put as,

Teacher's Signature:

Teacher's Signature:

Calculation:-

(1) Calculation of slope by graph:-

$$\text{Slope of line} = \frac{dy}{dx} = \frac{3.246 - 3.194}{-5.468 + 5.677} = 0.24$$

(2) Calculation of energy band gap:

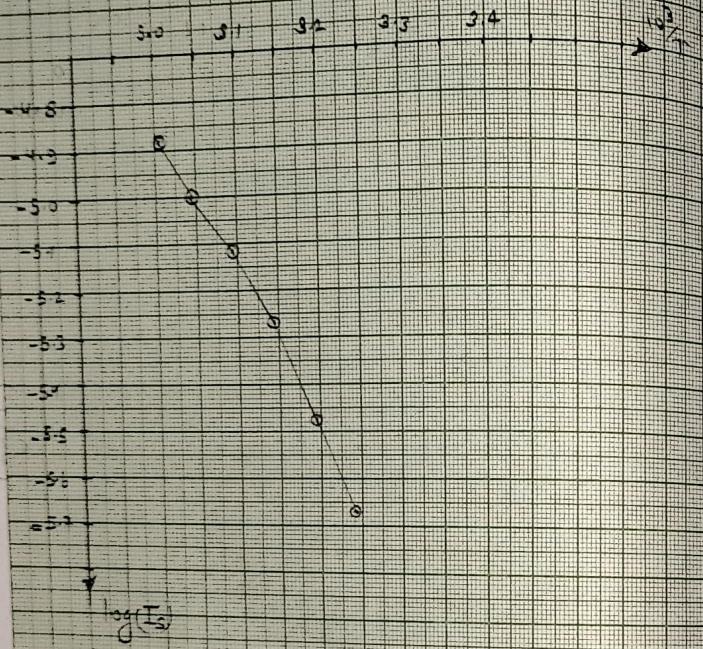
$$\Delta E = \frac{\text{slope of line}}{5.036} = \frac{-0.24}{5.036} = -0.049$$

Error :-

$$\% \text{ error} = \frac{\text{std value} - \text{calculated value}}{\text{std value}} \times 100$$

$$\% \text{ error} = \frac{0.72 - 0.49}{0.72} \times 100$$

$$= 31.9\%$$



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$$\log I_s = \text{Constant} - 5.036 \Delta E [10^3/T]$$

Therefore, if a graph is plotted between $\log I_s$ and $10^3/T$, a straight line would be obtained, where the slope of this line = $5.036 \Delta E$

$$\Delta E = \frac{\text{Slope of line}}{5.036}$$

Hence ΔE is in electron volts.

Observation :-

- (1) Room temperature = 25°C
- (2) Current = $1.6 \mu\text{A}$

Observation Table :-

S.No.	Temp $T = (t + 27.3)\text{K}$	Current I_s (10^{-6} Amp)	$10^3/T$ (K^{-1})	$\log(I_s)$ Amp
1.	60	333	13.2	-4.879
2.	55	328	10.0	-5.000
3.	50	323	7.6	-5.119
4.	45	318	5.4	-5.267
5.	40	313	3.4	-5.468
6.	35	308	2.1	-5.677

Result :- The width of the forbidden energy in a semiconductor diode is =
Standard value forbidden energy in Germanium is = 0.72 eV
Error in percentage =

Precaution:-

1. The maximum temperature should not exceed 60°C
2. Bulb of the thermometer should be inserted well in the oven.

Industrial Application :-

PN Junction have been used as rectifiers in power supplies, detectors in RF circuits, zener diodes which are voltage regulators, clippers, LED's, PIN diodes are RF switches.

Viva Questions

Q1. What is diode?

Ans: A diode consists of two electrodes one is cathode and another is anode. The cathode emits electrons and the anode will attract the emitted electrons when it is supplied by positive potential.

Q2. What is energy band gap?

Ans: The gap between conduction band and the valence band is called Energy band Gap. To move the electrons from the valence band to conduction band the supplied external voltage must be equal to energy gap.

Q3. The range of energy is

Q3. What is valence band?

Ans: The range of energy which is possessed by valence electron is known as valence band. Here the electrons which are situated at outer most orbits are called valence electrons. The valence band consists of valence electrons which are having highest energy.

Q4 What is conduction band?

Ans The range of energies possessed by conducting electrons is known as conduction band. The conduction electrons are responsible for the conduction of current in a conducting material. So, these electrons are called as conduction electrons.

Q5 How many types of solid materials are there and what are those materials?

Ans Based on the energy gap the solid materials are classified into 3 types they are : conductors, insulators and semi-conductors.

Q6 What is a conductor?

Ans Those substances whose atoms have their outermost orbits incomplete are known as conductors (ex. Sodium $1s^2 2s^2 2p^6 3s^1$) In these conductors the valence electrons are very closely bounded to the nucleus and hence they can easily move from valence band to conduction band. So the Energy gap is very less or zero.

Q7 What is insulator?

Ans Those substances which have more and more energy band gap between valence & conduction band they are called insulators.

Q8 What are Semi Conductors?

Ans Those substances which have conductivity and resistivity properties in between conductors & insulators are called semi conductors (ex: Ge, Si)
Energy gap of these semiconductors i.e. between 0.5 ev to 1.1 ev [For Ge - 0.5-0.7 ev]