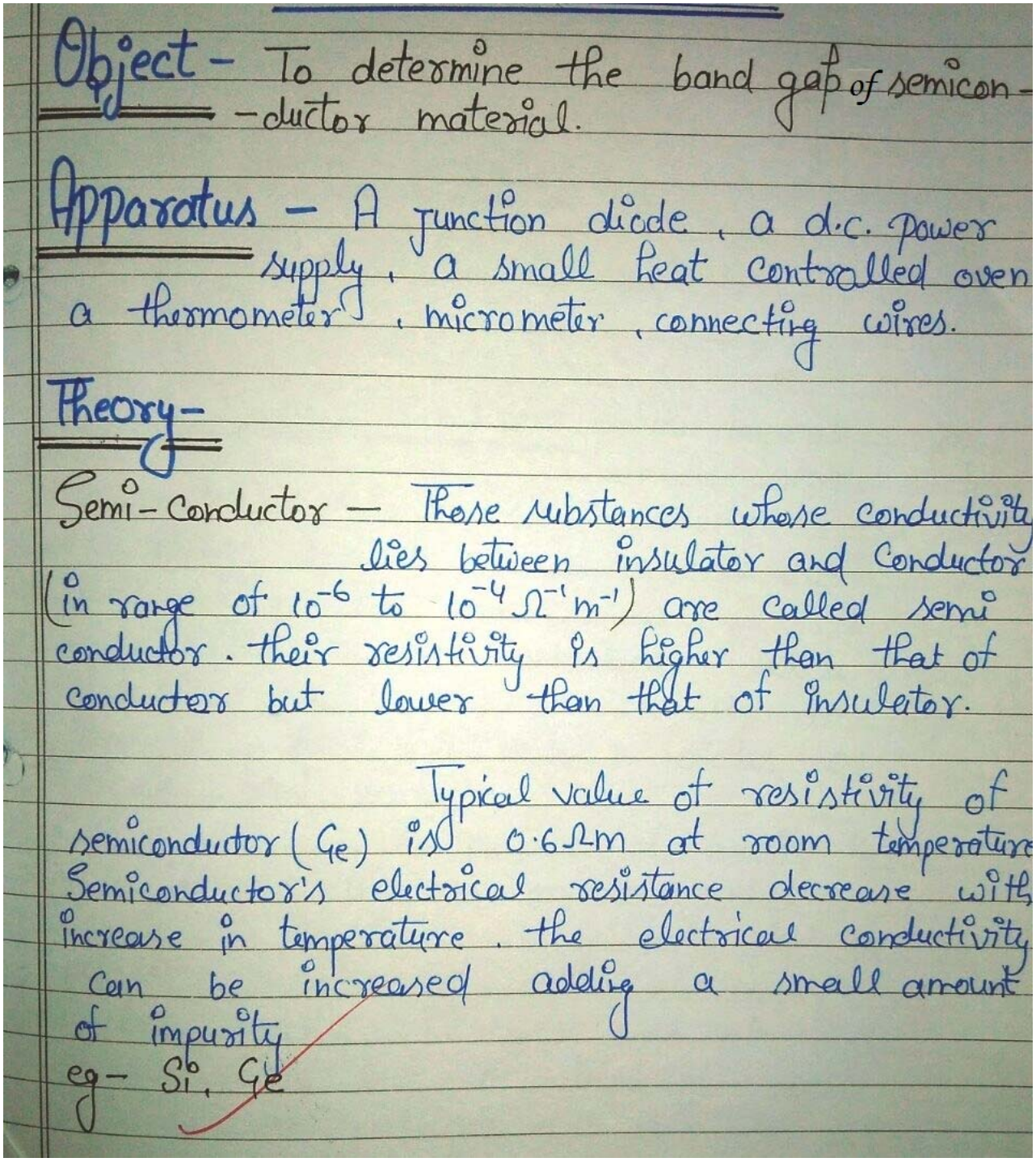
Band Gap Energy



Object – To determine the band gap of semiconductor material.

Apparatus – A junction diode, a d.c. power supply, a small heat controlled oven a thermometer, micrometer, connecting wires.

Theory–

Semi-Conductor – Those substances whose conductivity lies between insulator and Conductor (in range of 10^{-6} to $10^{-4}\ \Omega^{-1}m^{-1}$) are called semi conductor. their resistivity is higher than that of conductor but lower than that of insulator.

Typical value of resistivity of semiconductor (Ge) is 0.6 Ωm at room temperature Semiconductor's electrical resistance decrease with increase in temperature. the electrical conductivity can be increased adding a small amount of impurity

eg – Si, Ge

The relation of reverse saturation current with band gap energy and temperation can be written as,

$$2.303 \log_{10} I_S = \text{Constant} - \frac{\Delta E}{KT}$$

If I_s is in micro-ampere and ΔE is in eV then

$$2.303 \log_{10}(I_s \times 10^{-6}) = \text{Constant} - \frac{\Delta E \times 1.6 \times 10^{-19}}{2.303 \times 1.38 \times 10^{-23} T}$$

where,

$$K = 1.38 \times 10^{-23} \text{ J/K}$$

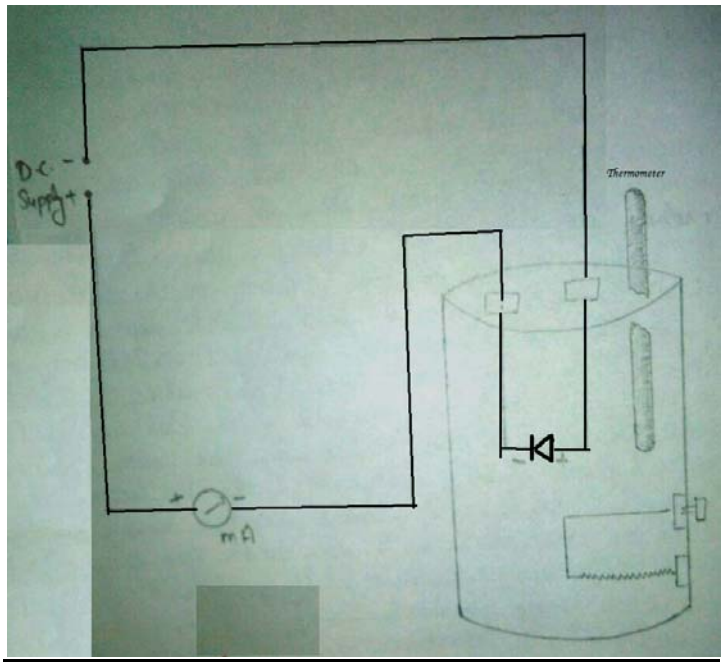
$$\log I_s = \text{a Constant} - \Delta E \times 5.036 \times \frac{10^3}{T}$$

Hence, a graph between $\log_{10} I_s$ and $10^3/T$ is a straight line of which the slope is $\log_{10} I_s / \frac{10^3}{T}$

Slop of the line $= -5.036\ \Delta E$

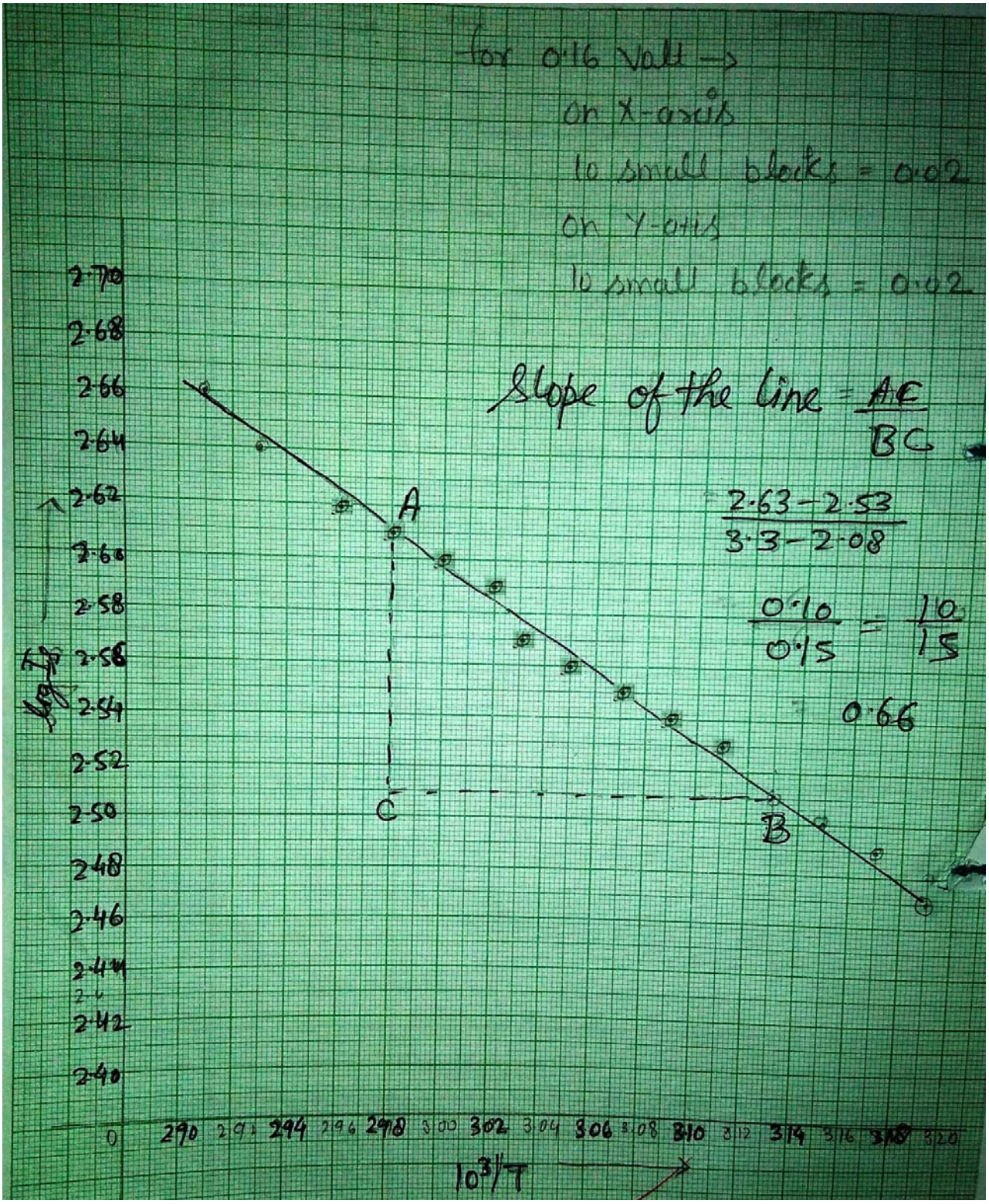
Band gap of semi-conductor $(\Delta E) = \frac{\text{Slope of the line}}{5.036}$

Circuit Diagram:



Observation Table –

S.No.	Current (I_s) μA	Temp °C	Temp T(K)	$10^3/T$	$\log_{10} I_s$
1	460	70	343	2.315	2.66
2	440	68	341	2.333	2.643
3	430	66	333	2.343	2.633
4	420	64	337	2.960	2.623
5	410	62	335	2.985	2.613
6	400	60	333	3.003	2.602
7	390	58	331	3.021	2.590
8	380	56	323	3.033	2.579
9	370	54	327	3.058	2.568
10	360	52	325	3.076	2.556
11	350	50	323	3.095	2.544
12	340	48	321	3.115	2.531
13	330	46	319	3.134	2.518
14	320	44	317	3.154	2.505
15	310	42	315	3.174	2.491
16	300	40	313	3.194	2.477



Graph $10^3/T$ and Log I_S

Calculation – from graph.

Slope of the line $= \frac{AC}{BC}$

$= \frac{2.63 - 2.53}{313 - 2.98} = \frac{0.10}{0.15} = 0.66$

Band gap $(\Delta E) = \frac{\text{Slope of the line}}{5.036}$

$\Delta E = \frac{0.66}{5.036} = 0.131 eV$

Result – The graph between $\log_{10} I_S$ and $10^3/T$ is straight line

Slope of the line = 0.66

Band gap = 0.131 eV

Precaution –

1. A reverse biased P-n junction diode must be used.
2. Reading of current must be taken when temp is decreasing.
3. Reading of temperature and current must be taken simultaneously.