Experiment :

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Experiment-1

V-I Characteristics of a Diode

Site link - vlabs.iitkgp.ernet.in/be/exp5/index.html#

Aim - To study V-I characteristics of a diode

Apparatus - Fwd bias Si diode [1N4007], resistor, ammeter, etc

Theory - Structure of a P-N junction diode

The diode is a device formed from a function of n and p-type semiconductor material. Lead connected to p-type is anode and to n-type is cathode.

In fwd bias, diode +ve terminal of battery is connected to p side and -ve to n side. The holes in p-type and e^- in n-type are pushed towards junction reducing depletion zone width. In reverse bias, the depletion width increases.

Silicon - In order to conduct fwd biasing, voltage should be greater than the barrier potential it acts like closed switch with potential drop of 0.6V across. In reverse biasing depletion width increases and diode acts like open switch, thus is no current flow.

↳ The process is similar for Germanium diode, except that the potential drop is around 0.3V.

Diode Equation

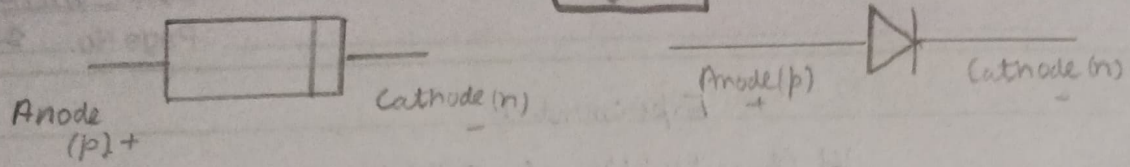
$$I_f = I_s \times \left(\exp \frac{V_f}{n \times V_T} - 1 \right)$$

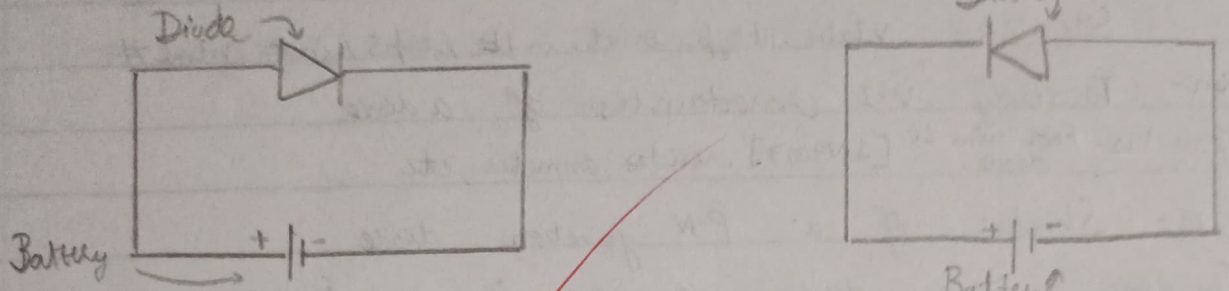
I_f : fwd current; I_s : leakage current; V_f : fwd voltage; V_T : thermal voltage

CLASSTIME

Diagrams →

Structure of P-N Junction Diode

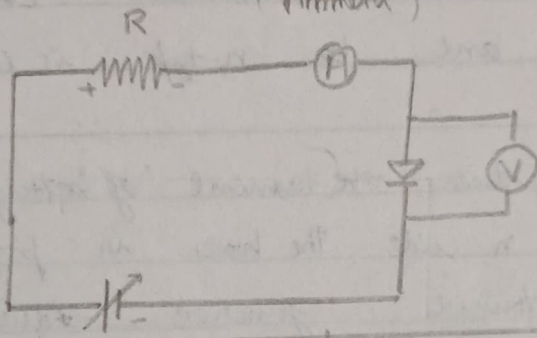




P-N junction diode function in (a) fwd bias (b) reverse bias

[FORWARD BIAS SILICON DIODE CKT Diagram]

R = 100Ω



→ Observation Table

S.No	$V_{Battery}$ (V)	V_R (V)	Forward Voltage (V)	Forward Current (mA)	IxR
1	0.6	0.6	0	0	0
2	0.7	0.172	0.528	0.0958	90.58
3	0.8	0.268	0.532	0.192	19.2
4	0.9	0.365	0.535	0.287	28.7
5	1	0.462	0.538	0.383	38.3
6	1.1	0.56	0.540	0.479	47.9
7	1.4	0.854	0.546	0.766	76.6
8	1.7	1.149	0.551	1.05	105
9	2.3	1.741	0.559	1.63	163
10	2.8	2.236	0.564	2.11	211

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Precautions -

1. Proper connection of the circuit (correct polarity, Tight connections)
2. Gradual variation of voltage, limiting current
3. Handling orientation of diode and avoiding overheating

Result / Conclusion -

1. When the forward bias voltage exceeds around 0.6V (cutoff voltage)
2. Current increases suddenly, when $V_R = 2.5V$ known as reverse breakdown.

R = 100Ω

(FORWARD BIAS SILICON DIODE)

S.No	$V_{Battery}$	V_R	Reverse Voltage (V)	Reverse Current (μA)	$V_R = I \times R$
1	0·2	0·3	0·170	0·1	10
2	1·3	0·12	1·18	0·1	10
3	3·7	0·22	3·48	0·1	10
4	5·7	0·26	5·44	0·1	10
5	6·95	0·28	6·6	0·1	10
6	9·15	0·29	8·86	0·1	10
7	11·7	0·30	11·4	0·1	10
8	14·3	0·20	14·1	0·1	10
9	17·95	0·15	17·8	0·1	10
10	20·3	0·10	20·2	0·1	10

V_R → Voltage across resistor
↳ $(V_B - V_D)$

R = 1000Ω

FORWARD BIAS

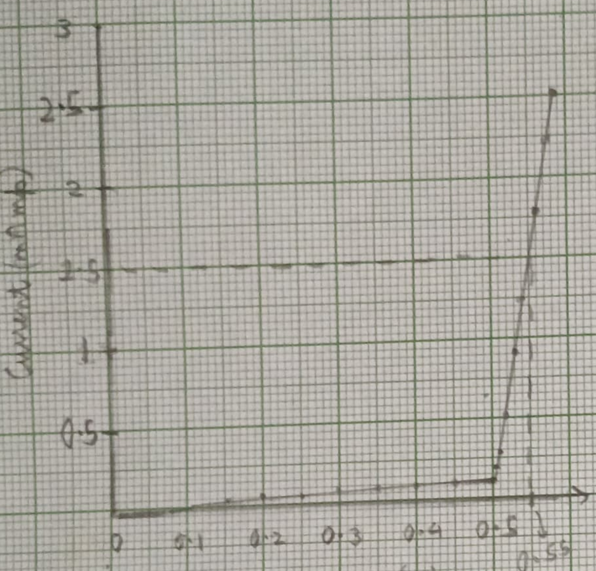
S.No	V_B (V)	V_D (V)	I_D (mA)	$V_R (V_B - V_D)$ (V)	V_R (I.R) (V)
1	0·2	0	0	0·2	0
2	0·7	0·630	0·1	0·17	0·1
3	1	0·539	0·4	0·461	0·4
4	1·3	0·546	0·7	0·714	0·7
5	1·6	0·051	1	1·049	1
6	1·9	0·555	1·3	1·345	1·3
7	2·2	0·588	1·6	1·641	1·6
8	2·5	0·866	1·9	1·937	1·9
9	2·8	0·566	2·2	2·234	2·2
10	3·1	0·571	2·8	3·129	2·8

V_B → Voltage of Battery
V_D → Voltage of Diode
I_D → Current of Diode
V_R → Voltage of resistor

FORWARD BIAS

SCALE
1 cm = 0.5 mA (Y-axis)
1 cm = 0.1 V (X-axis)

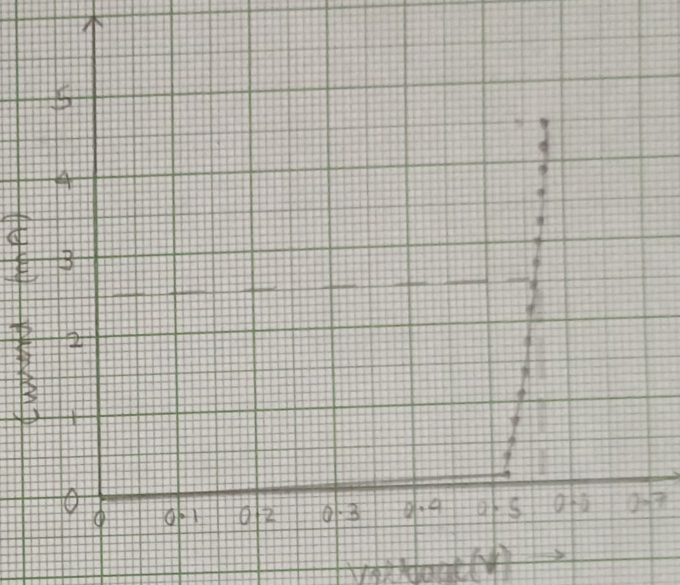
R = 100 Ω



Dynamic resistance → 2.72

SCALE
1 cm = 1 mA (Y-axis)
1 cm = 0.1 V (X-axis)

R = 1 kΩ



Dynamic resistance

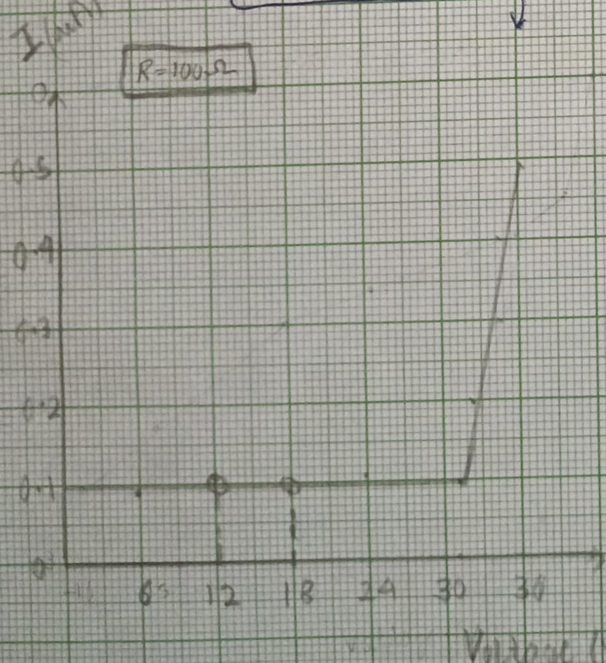
→ $\frac{V_2 - V_1}{I_2 - I_1}$ → $\frac{0.570 - 0.[illegible]}{4.5 - 0.3}$

→ 0.0709

→ 12.3207

REVERSE BIAS

R = 100 Ω



SCALE
① 1 cm = 0.1 μA (Y axis)
② 1 cm = 6 V (X-axis)

Dynamic Resistance

Y = 0.1

→ $\frac{0.1 - 0.1}{18 - 12}$ → 0