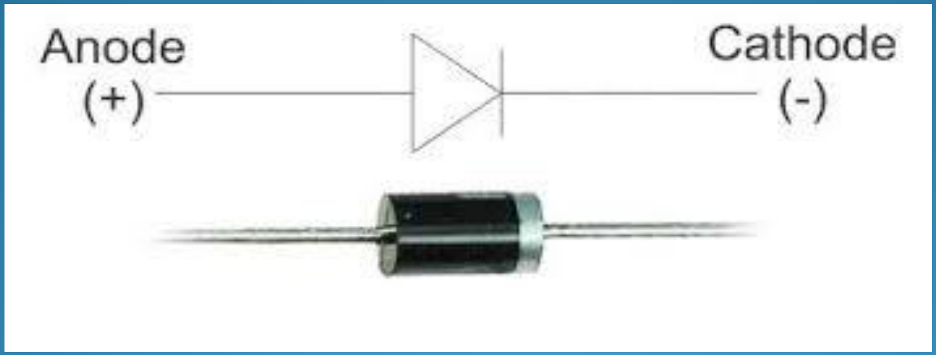
PN junction diode (Practical)

A lecture in online workshop for B.Sc. III organised by Uttrakhand Open University Haldwani from 06 July to 19 July 2020



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Experiment : To draw characteristics of PN junction diode

1. Objectives
2. Introduction
3. Apparatus Used
4. Theory
5. About apparatus
6. Procedure
7. Observation
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9. Precaution and source of error

Objectives

What are semiconductor device.

Formation of PN junction diode.

Characteristics of PN junction diode.

Use of PN junction diode.

Introduction

Classification of Materials

Classification according to the way materials react to the current when a voltage is applied across them:

Insulators

- Materials with very high resistance - current can't flow
- mica, rubber

Conductors

- Materials with very low resistance – current can flow easily
- copper, aluminum

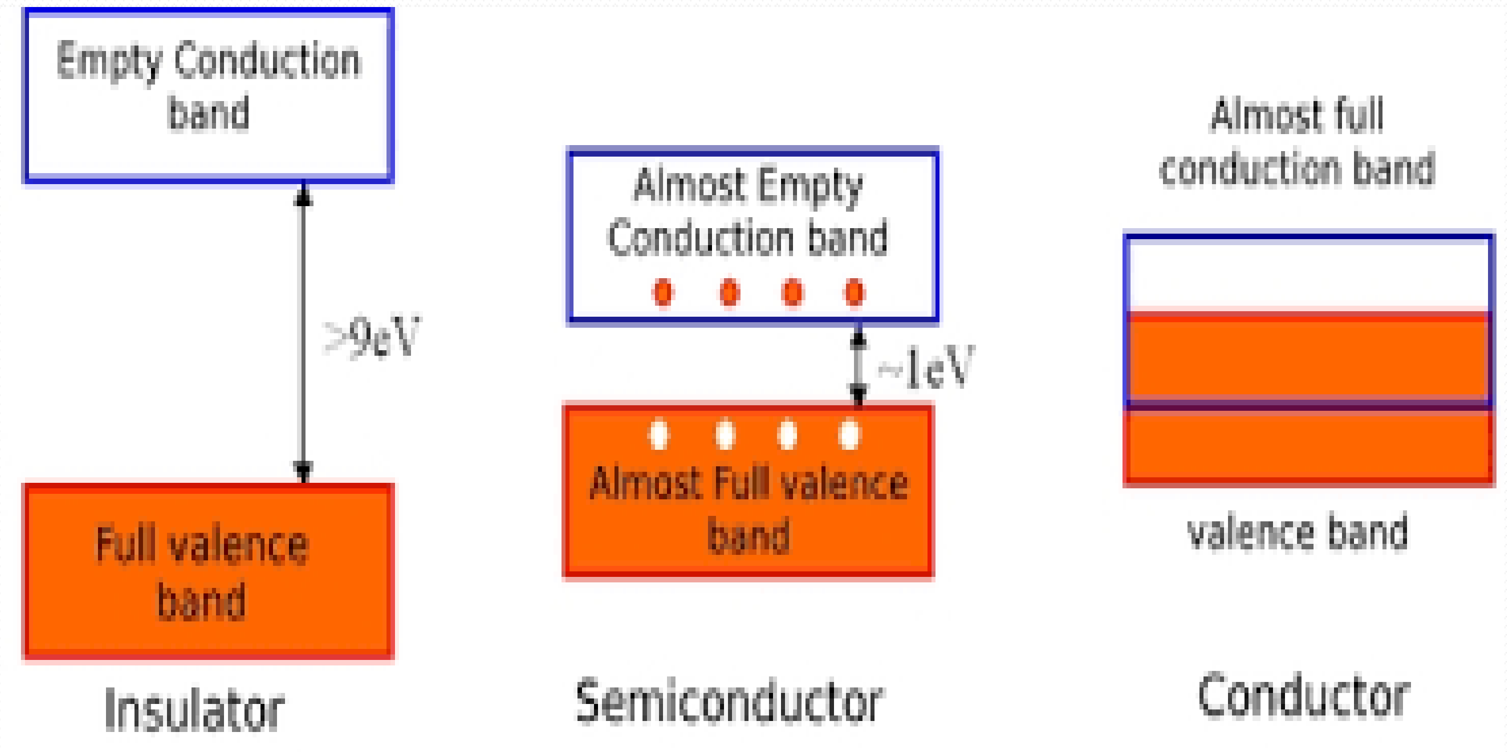
Semiconductors

- Neither good conductors nor insulators (silicon, germanium)
- Can be controlled to either insulators by increasing their resistance or conductors by decreasing their resistance

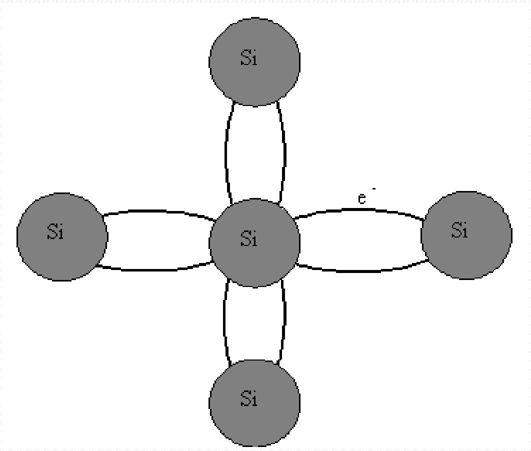
Materials resistivities

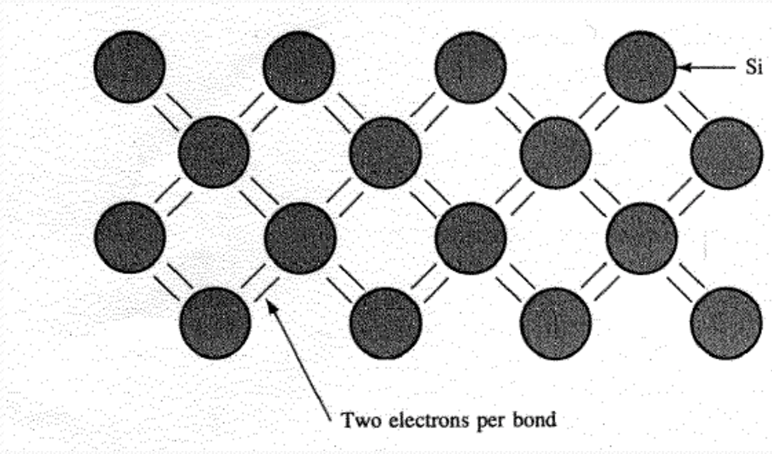
Classification	Material	ρ (Ω m)
conductors	silver	1.6×10^{-8}
	copper	1.7×10^{-8}
	aluminium	2.7×10^{-8}
	iron	10×10^{-8}
Semiconductors	germanium	0.46
	silicon	2300
Insulators	glass	$10^{10} - 10^{14}$
	wood	$10^{8} - 10^{11}$
	quartz	10^{13}
	rubber	$10^{13} - 10^{16}$

How to explain



Bonding of Si atoms

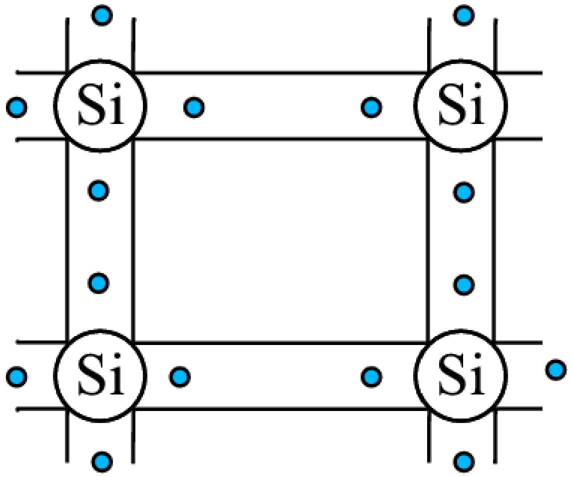


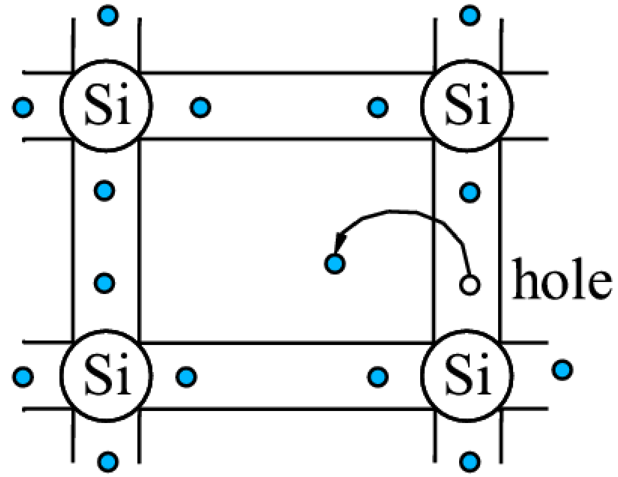


A Covalent Bond Formed by the Sharing of Electrons in an Outer Energy Level

Electrons and Holes

Si and Ge are tetravalent elements – each atom of Si (Ge) has 4 valence electrons in crystal matrix





T=0 all electrons are bound in covalent bonds

no carriers available for conduction.

For T> 0 thermal fluctuations can break electrons free creating electron-hole pairs

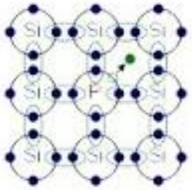
Both can move throughout the lattice and therefore conduct current.

Extrinsic semiconductor

Doping in 2 types of semiconductors

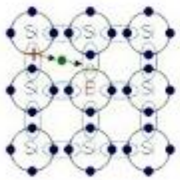
n-type semiconductor

- Elements with 5 valence electrons are introduced as impurities to silicon: n-type doping.

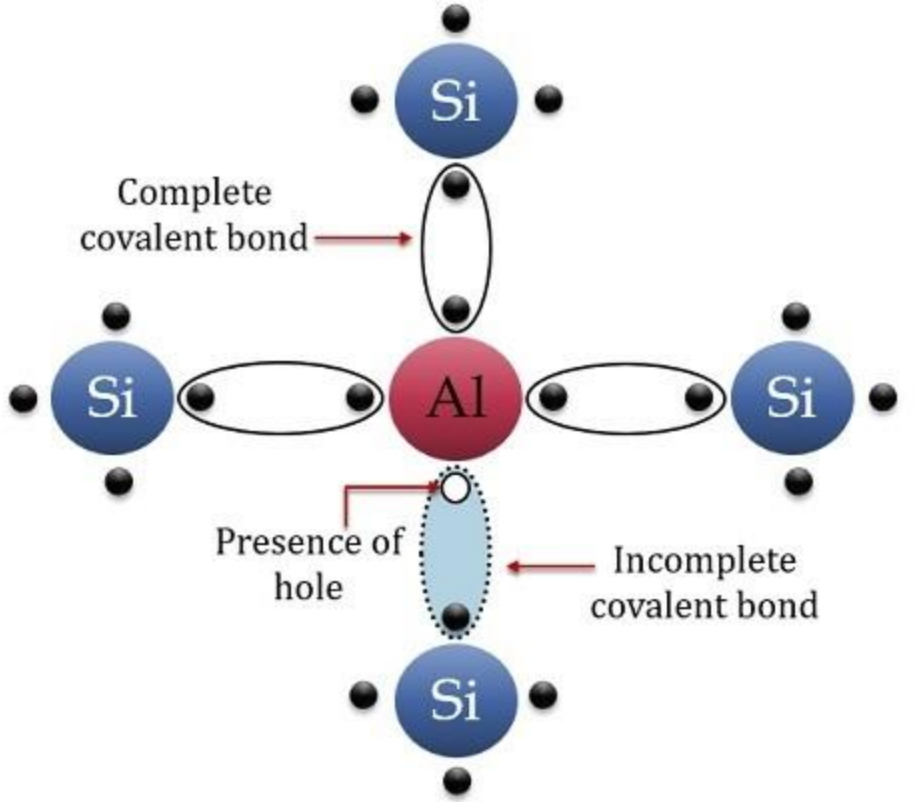


p-type semiconductor

- Elements with 3 valence electrons are introduced as impurities to silicon: p-type doping.

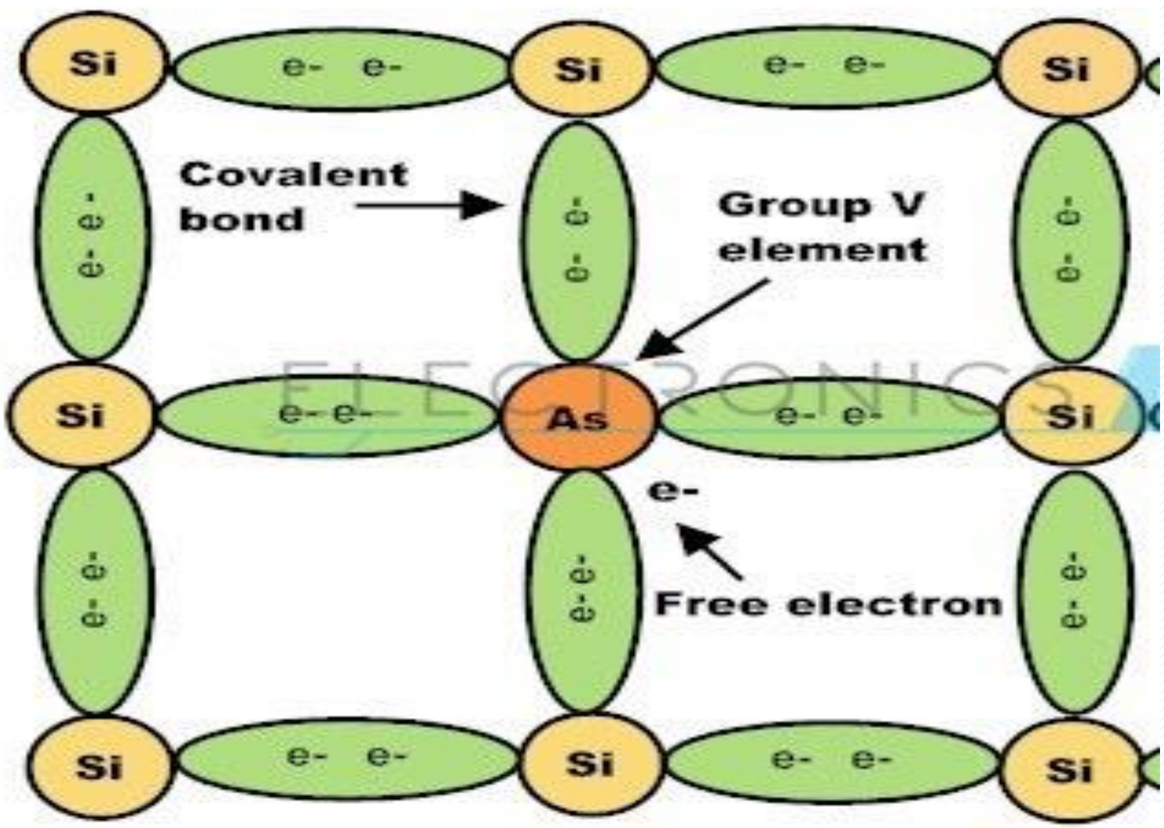


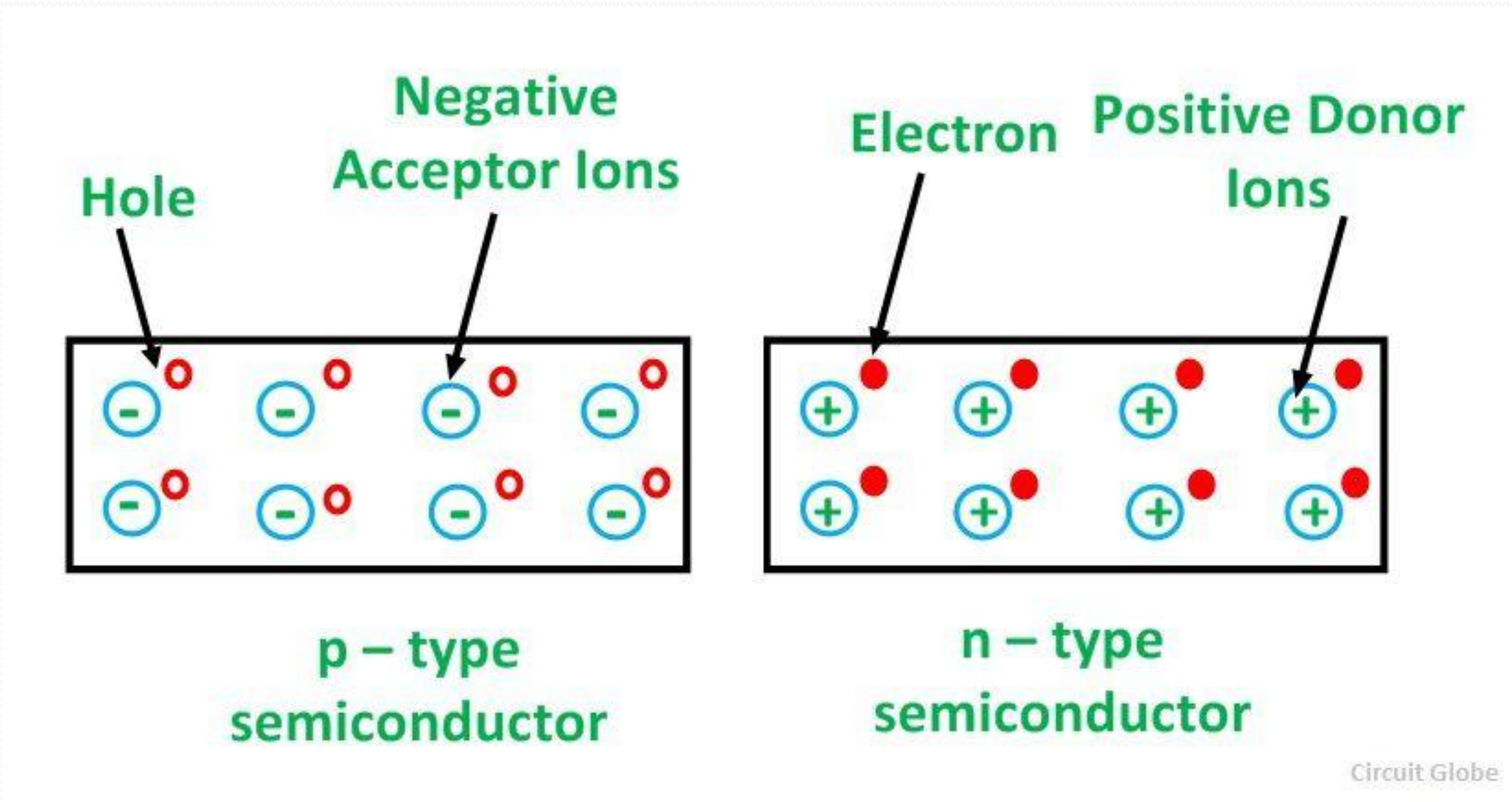
Formation of P type Extrinsic semiconductor



- Si = Intrinsic semiconductor atom
- Al = Trivalent impurity atom

Formation of N type Extrinsic semiconductor





Hole
Negative
Acceptor Ions
Electron
Positive Donor
Ions
p – type
semiconductor
n – type
semiconductor
Circuit Globe

REVIEW
P-type and N-type

P-type: A P-type material is one in which holes are majority carriers i.e. they are positively charged materials (++++)

N-type: A N-type material is one in which electrons are majority charge carriers i.e. they are negatively charged materials (-----)

Apparatus Used

P-N junction diode

Milliammeter (measuring forward current)

Microammeter (measuring forward current)

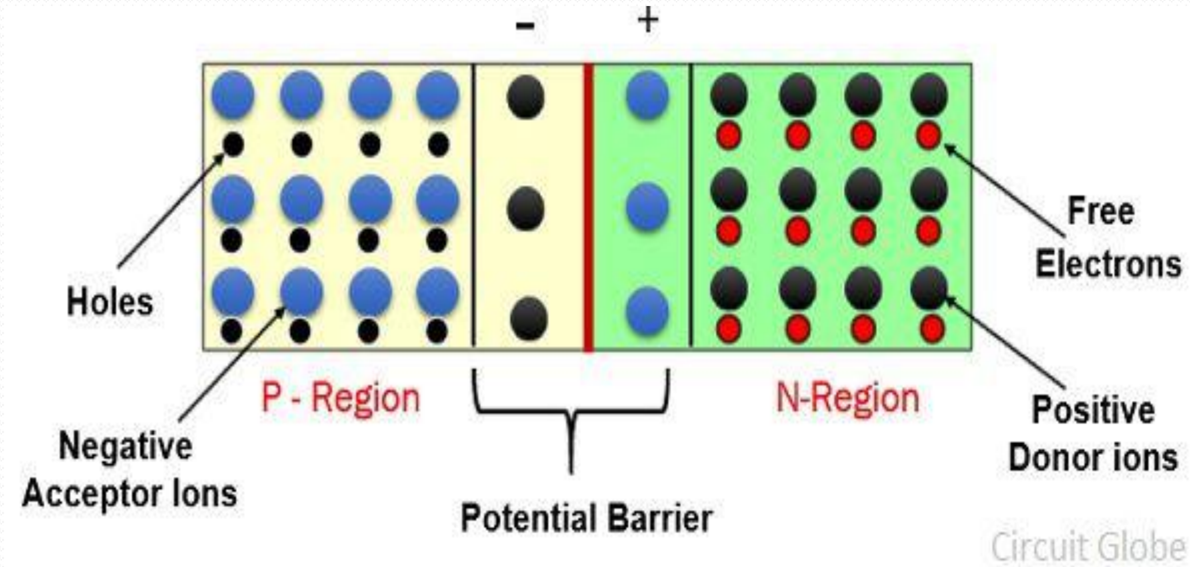
Rheostat

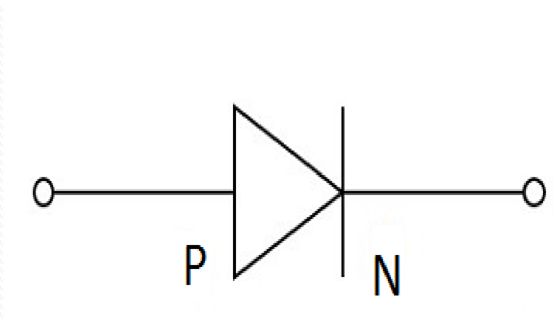
Voltmeter

Battery

Connection wires.

Theory
Formation of P-N Junction diode





PN Junction trainer box

Forward bias

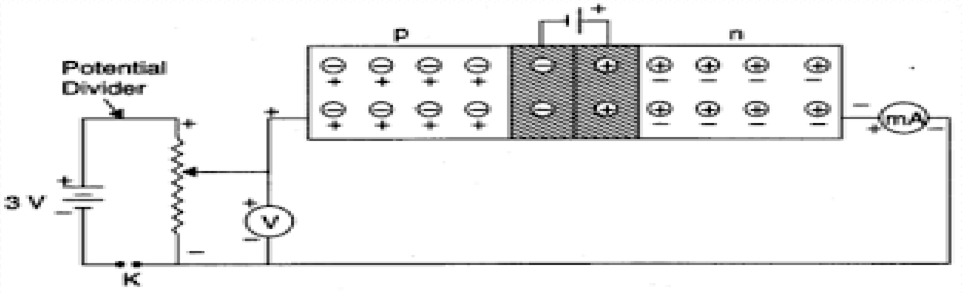
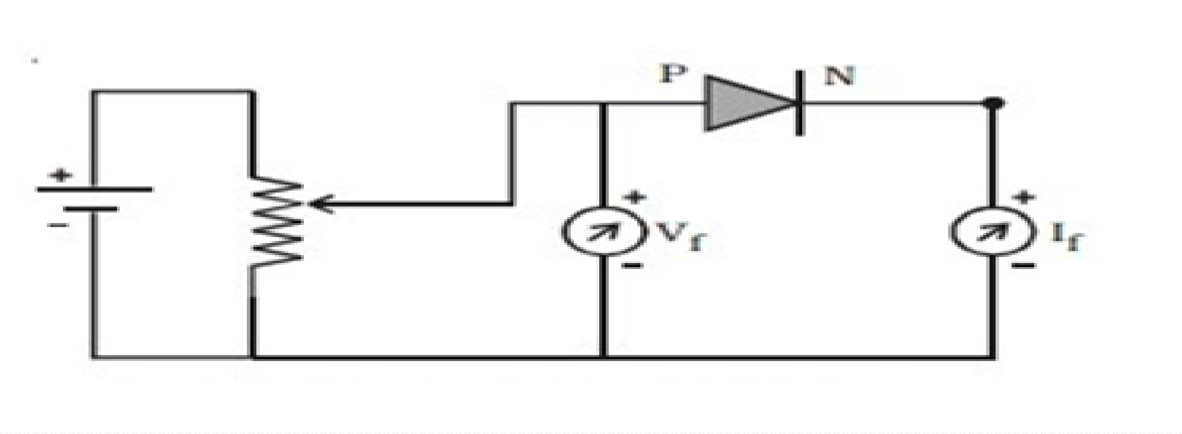
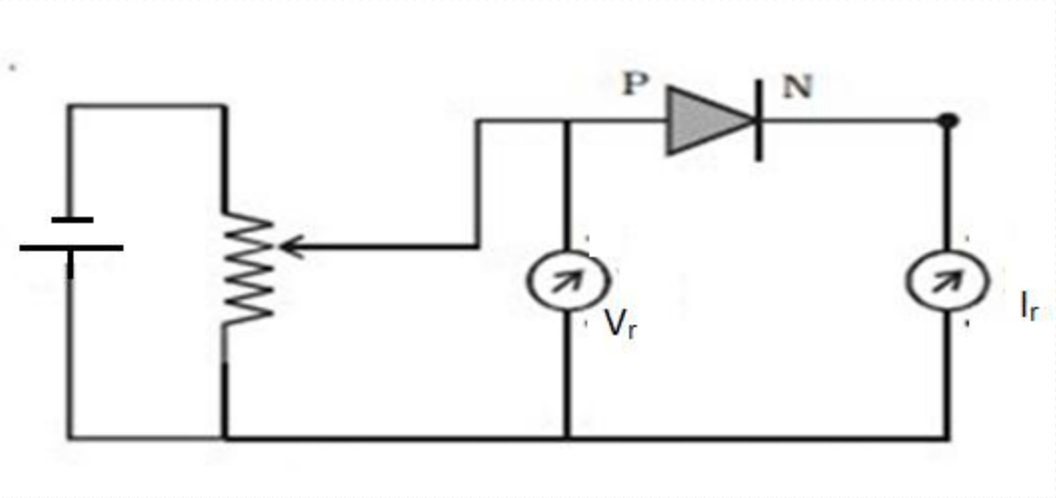


Fig. *p-n* junction diode—forward biased.



Reverse bias



Observation

SN	Forward Voltage (In V)	Forward Current (In mA)	Reverse Voltage (In V)	Reverse Current (In μA)
1.				
2.				
3.				
4.				
5.				

Observation

(Forward bias)

SN	Forward Voltage (In V)	Forward Current (In mA)	SN	Forward Voltage (In V)	Forward Current (In mA)
1.	0.0	0.0	7	0.8	3.0
2.	0.2	0.0	8	1.0	5.0
3.	0.3	0.0	9	1.2	7.5
4.	0.4	0.5	10	1.4	10.0
5.	0.6	1.0	11	1.6	15.0
6	0.8	2.0	12	1.8	20.0

Observation

(Reverse bias)

SN	Reverse Voltage (In V)	Reverse Current (In µA)	S N	Reverse Voltage (In V)	Reverse Current (In µA)
1.	0.0	1	7	14.0	7
2.	6.0	2	8	16.0	9
3.	8.0	3	9	18.0	10
4.	10.0	4	10	20.0	13
5.	12.0	5	11	22.0	25
6	0.8	2.0	12	1.8	20.0

Forward and Reverse characteristics of PN junction diode

Draw the graph between voltage V and current I in graph paper for

1. Forward bias and

2. Reverse bias

I-V Characteristics of Practical Diode

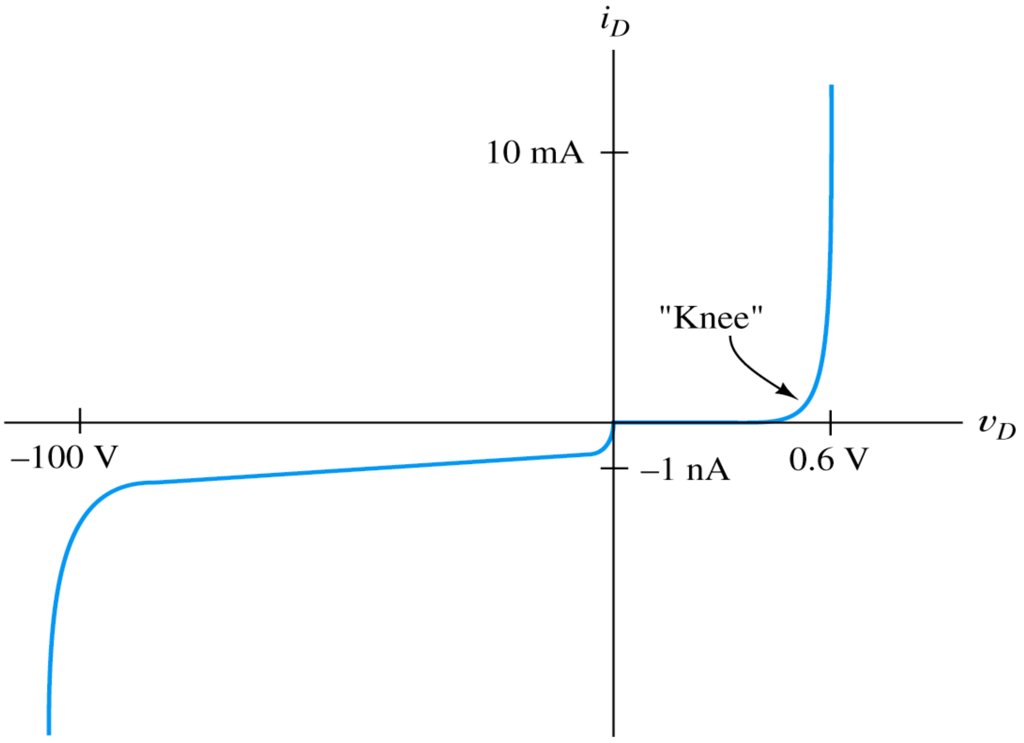


Figure 10.2 Volt–ampere characteristic for a typical small-signal silicon diode at a temperature of 300 K. Notice the change of scale for negative current and voltage.

Result

The forward and reverse characteristics of PN junction diode is presented the graph.

Precaution and source of error

1. Sensitive voltmeter and sensitive ammeter should be used.
2. The direction about maximum plate voltage given by manufacturer should be strictly followed.
3. The graphs should drawn smoothly.
4. There should not be any fluctuation on the power.
5. To avoid over heating of PN junction, current should not passed for long time.

THANKING YOU