

Vision

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Program Code:- First Semester – All Program

Course Name:- Basic Science (PHYSICS)

Course Code : - BSC (22102)

Course coordinator: Mr. S. K. Rawat

Course Name:- Basic Science (PHYSICS)



Unit No:2

Unit Name: Electricity, Magnetism & Semiconductors.

Unit Outcomes (UO2f): Explain the I-V characteristics and applications of the given p-n junction diodes.

Learning Outcomes (LOs):

LO11: Student will be able to explain the I-V characteristics p-n junction diode.



CONTENT

- ▶ VI characteristics of PN junction diode
- ▶ Forward bias characteristics
 - ▶ Knee voltage
- ▶ Reverse bias characteristics
 - ▶ Breakdown voltage
 - ▶ Peak inverse voltage



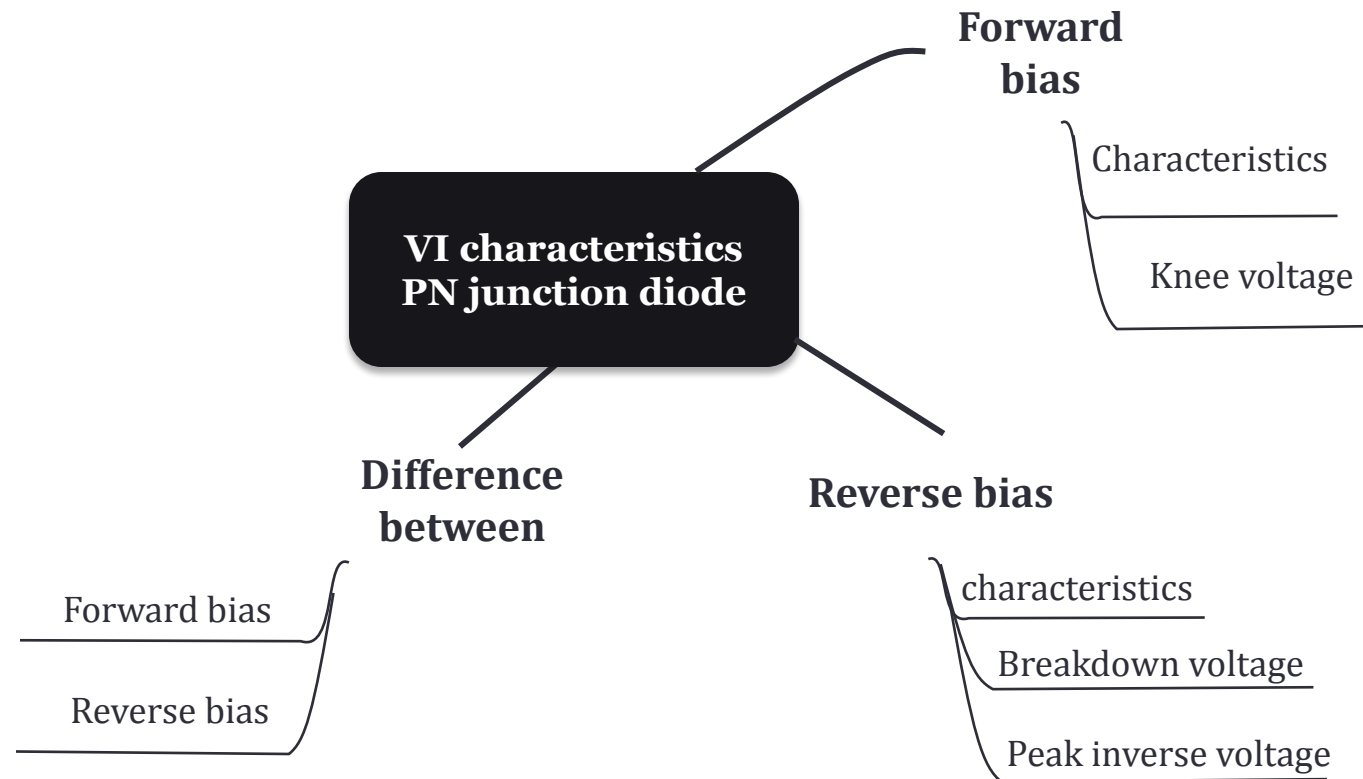
LEARNING OBJECTIVES



- ▶ Student will be able to explain the I-V characteristics p-n junction diode.



Concept Map

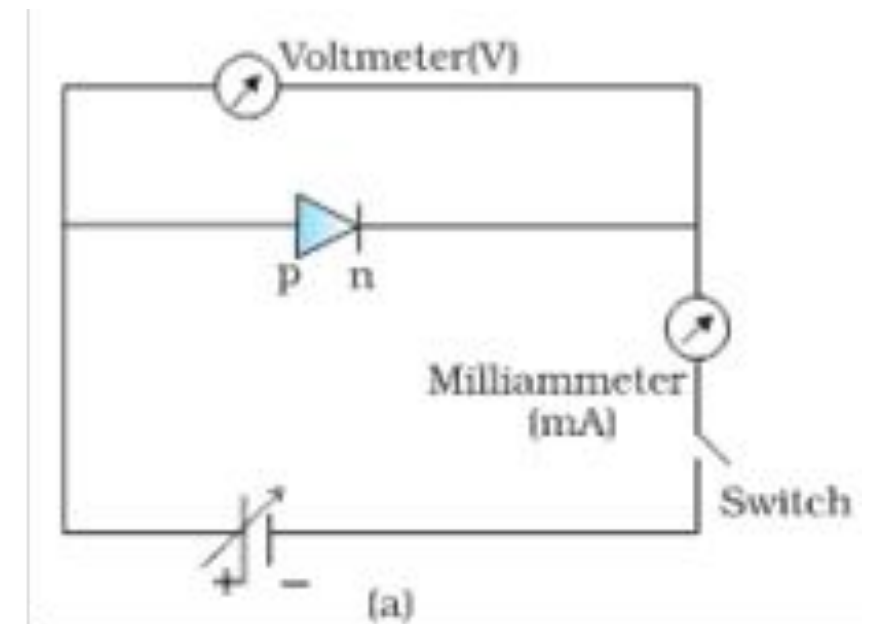


V-I characteristics: p-n junction diode

The circuit arrangement for studying the V-I characteristics of a diode, (i.e., the variation of current as a function of applied voltage) are shown in Fig. 1.

The battery is connected to the diode through a potentiometer (or rheostats) so that the applied voltage to the diode can be changed. For different values of voltages, the value of the current is noted.

In forward bias measurement, milliammeter is used since the expected current is large.



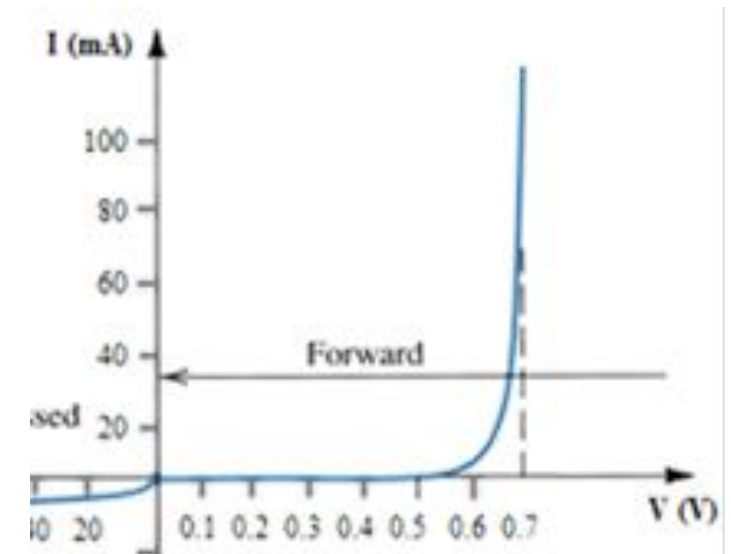
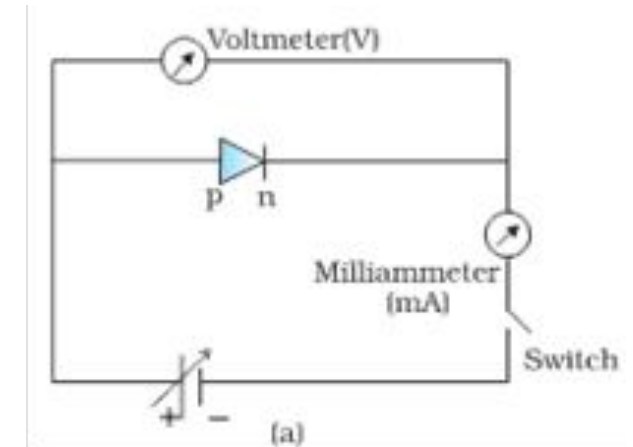
Forward bias vi characteristics

With forward bias condition, the potential barrier is reduced.

At some forward voltage (0.7V for Si or 0.3V for Ge diode), the potential barrier is completely reduced and current starts flowing in the circuit.

From forward bias characteristics as seen in Fig. 2, it is observed that at the starting (region OA), the current increases very slowly, almost negligibly, till the voltage across the diode crosses a certain value.

After the characteristic voltage, the diode current increases significantly (exponentially), even for a very small increase in the diode bias voltage.



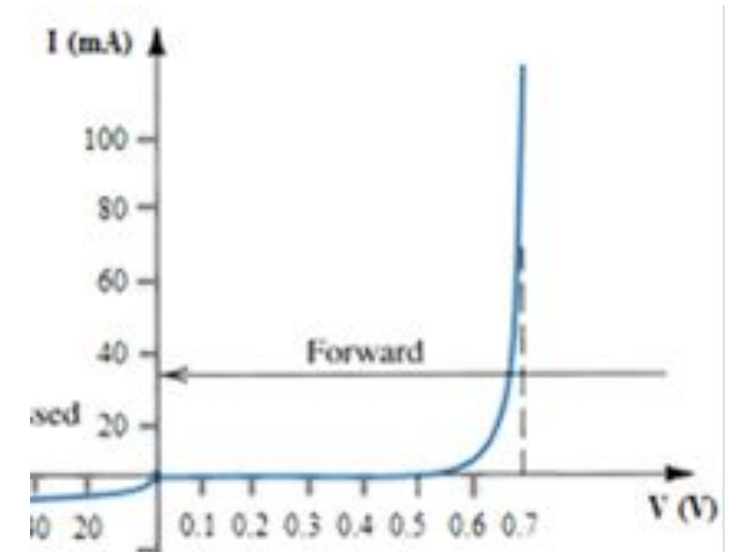
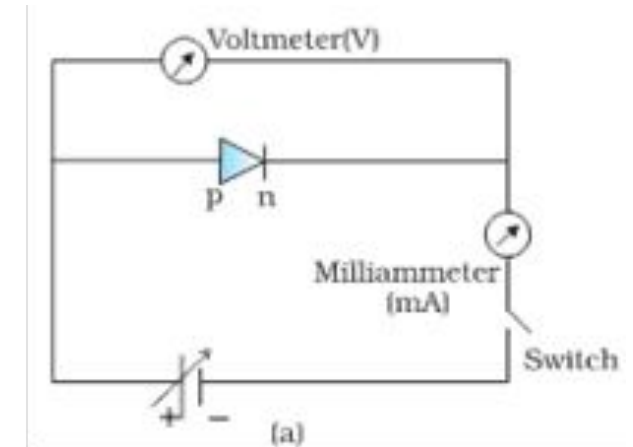
Forward bias vi characteristics

Thus the curve is non-linear (region AB), as the external applied voltage is used to overcome the potential barrier and the p-n junction diode conducts.

This voltage is called the knee voltage or threshold voltage or cut-in voltage ($\sim 0.2\text{V}$ for germanium diode and $\sim 0.7\text{V}$ for silicon diode).

Knee voltage: The forward voltage at which the current through the junction starts to increase rapidly is called knee voltage or threshold voltage or cut-off voltage.

The above discussion shows that the p-n junction diode primarily allows the flow of current only in one direction (forward bias).



Attempt Set 1 MCQs

Question No	Question No. 1	Question No. 2	Question No. 3
Statement of Question	The leakage current in a PN junction diode is of the order of _____	The barrier voltage at a PN junction diode for germanium is about _____	The forward voltage at which the current through the PN junction starts to increase rapidly is called _____
Level of Question	Remembering	Remembering	Understanding
Option (a)	a) A	a) 2V	a) knee voltage
Option (b)	b) mA	b) 3V	b) breakdown voltage
Option (c)	c) na	c) 5V	c) peak inverse voltage
Option (d)	d) μ A	d) 7V	d) reverse voltage
Correct Option	μ A	3V	knee voltage

START



REVERSE BIAS vi characteristics

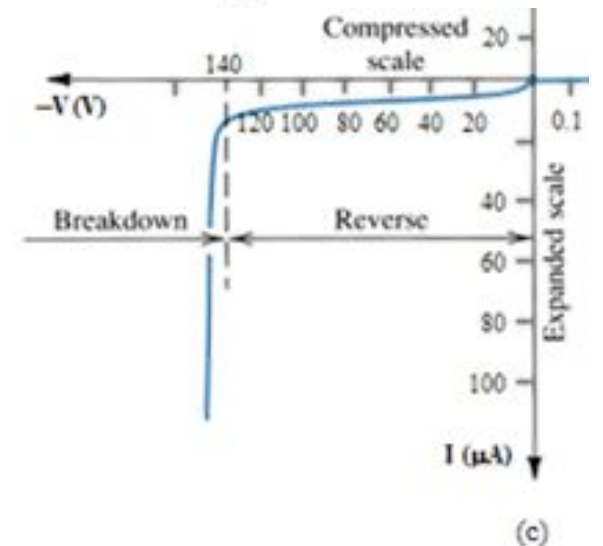
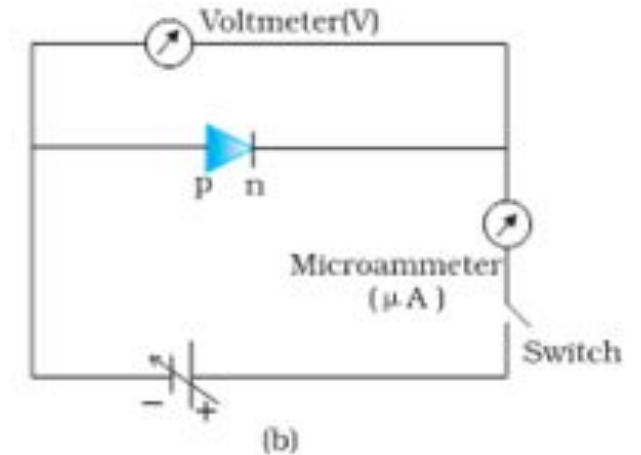
For the p-n junction diode in reverse bias, barrier potential at the junction is increased.

Therefore, the junction resistance becomes very high and practically no current flows through the circuit.

However in practice a very small current (\sim flows in the circuit and almost remains constant with change in bias.

As the flow of current is due to minority carriers, it is called reverse saturation current.

However, for special cases, at very high reverse bias (breakdown voltage), the current suddenly increases as seen in Fig. 1 (c).



REVERSE BIAS vi characteristics

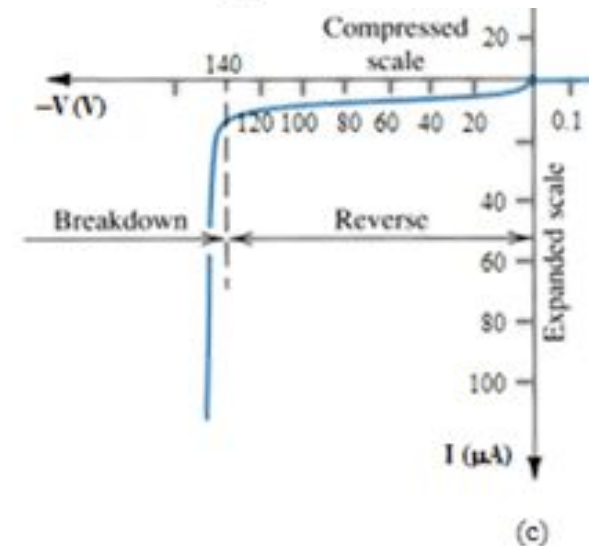
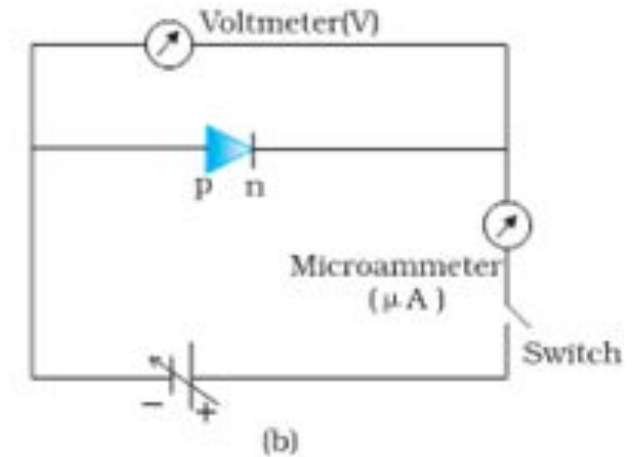
If reverse voltage is increased continuously at one stage breakdown of the junction occurs.

It is mainly because of sudden rise of reverse current and a sudden fall of the resistance of potential barrier.

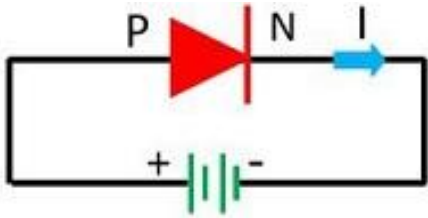
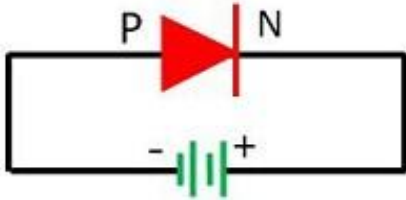
This may destroy the junction permanently due to excessive heat.

Breakdown voltage: The reverse voltage at which p-n junction breaks down with sudden rise in reverse current is called breakdown voltage.

Peak inverse voltage (PIV): The maximum reverse voltage that can be applied to the p-n junction without damage to the junction of diode is called peak inverse voltage.



Comparison: FORWARD BIAS and REVERSE BIAS

Points	Forward Biasing	Reverse Biasing
Definition	The external voltage which is applied across the PN-diode for reducing the potential barrier to constitute the easy flow of current through it is called forward bias.	The external voltage which is applied to the PN junction for strengthening the potential barrier and prevents the flow of current through it is called reverse bias.
Symbol		
Connection	The positive terminal of the battery is connected to the P-type semiconductor of the device and the negative terminal is connected to N-type semiconductor	The negative terminal of the battery is connected to the P-region and the positive terminal of the battery is connected to N-type semiconductor.
Barrier Potential	Reduces	Strengthen
Voltage	The voltage of an anode is greater than cathode.	The voltage of cathode is greater than an anode.

Comparison: FORWARD BIAS and REVERSE BIAS

Points	Forward Biasing	Reverse Biasing
Forward Current	Large	Small
Depletion layer	Thin	Thick
Resistance	Low	High
Current Flow	Allows	Prevents
Current Magnitude	Depends on forward voltage.	Zero
Operate	Conductor	Insulator

Attempt Set 2 MCQs

Question No	Question No. 1	Question No. 2	Question No. 3
Statement of Question	In reverse bias condition, the junction of P-N Junction diode may get destroyed completely due to	The max reverse voltage that can be applied to the diode without damage to the junction of is called	There is a small amount of current across the barrier of a reverse-biased diode. This current is called _____
Level of Question	Understanding	Understanding	Understanding
Option (a)	a) knee voltage	a) knee voltage	a) forward-bias current
Option (b)	b) fall in forward current	b) breakdown voltage	b) reverse breakdown current
Option (c)	c) rise in reverse current	c) peak inverse voltage	c) conventional current
Option (d)	d) fall in reverse current	d) reverse voltage	d) reverse leakage current
Correct Option	rise in reverse current	peak inverse voltage	reverse breakdown current

START

