Lecture #1 20%. 30%. 50% final. ~~Electronics~~ 15 Feb Electronic Devices

Introduction → (Bohrs model) . electrons (Protons + neutrons nucleus) by Floyd (7th edition)
→ Hydrogen (1 proton + 1 electron) nucleus Author : Thomas L. Floyd
→ Ionization.

1.2 Semiconductors, Conductors and Insulators.
Bohrs ~~model~~

(Electronic devices such as diodes, transistors and integrated circuits are made of a semiconductive material)

Electrical properties can help us to divide the materials into three categories.

1. Conductors.
2. Semiconductors.
3. Insulators.

Conductors :-

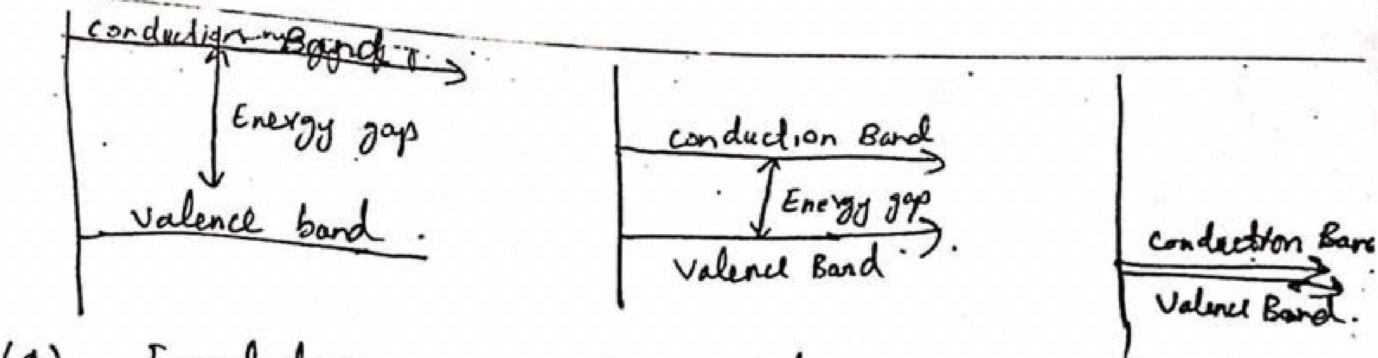
Conductor is a material that can easily conducts electrical current. e.g silver, copper, Gold.
one valence electron very loosely band to atom and free to move.

Insulators :-

An insulator is a material that does not conduct electrical current under normal conditions.
Valence electron are tightly bound to the atom.

Semiconductors :-

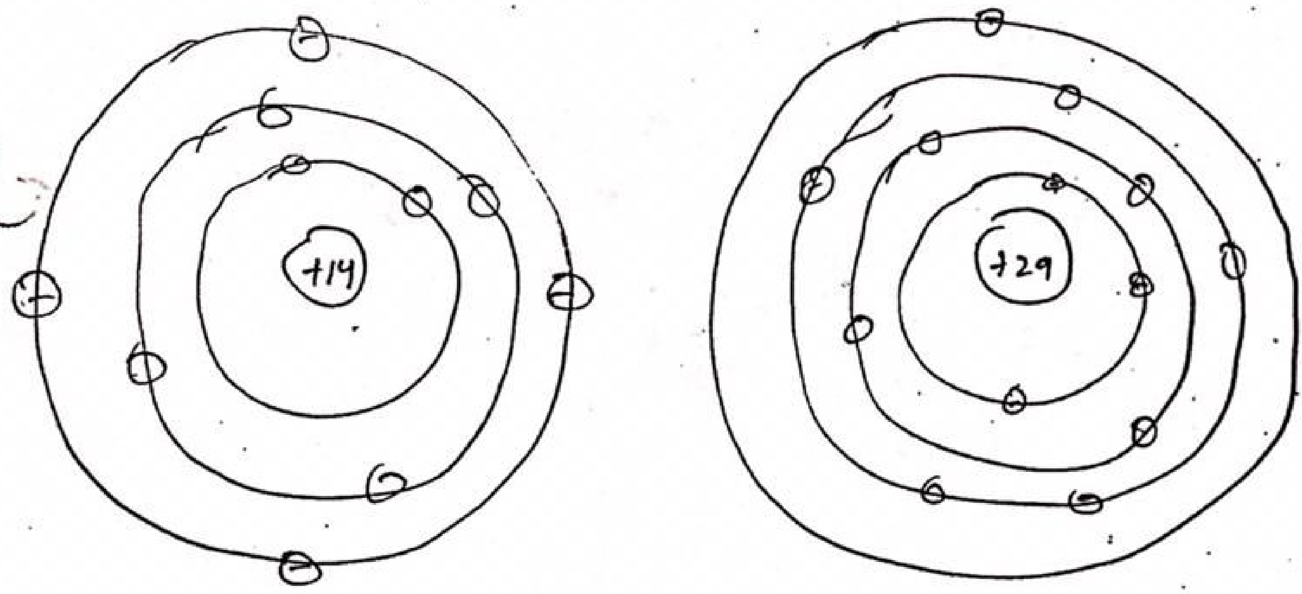
A Semiconductor is a ~~device~~ material that is between conductors and Insulators.
e.g silicon, germanium, carbon.



(a) Insulators. Semiconductor. conductor.

comparison of semiconductor and conductor.

Example. Comparsion of silicon and copper



Valence electron of silicon is in 3rd shell.

So it requires more energy to leave.

valence electron of copper is in 4^{th} shell.

it requires less ene... to leave.

Why we use semiconductors.

example of traffic signals to control. the tra... flow.

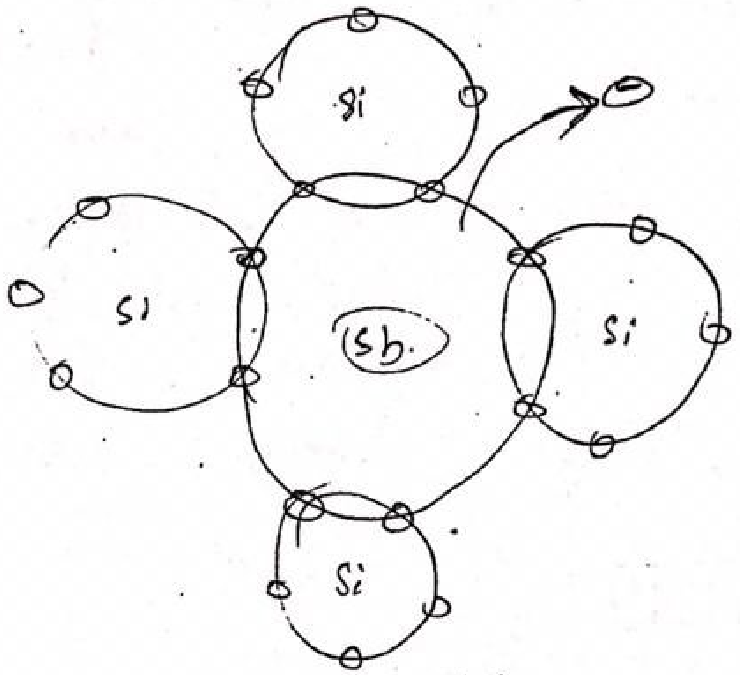
Lect 1.

N- Type semiconductor :-

It means to increase number of free electrons in conduction band.

Required pentavalent impurity atom.

e.g. arsenic (As), Phosphorus(P), antimony (Sb)



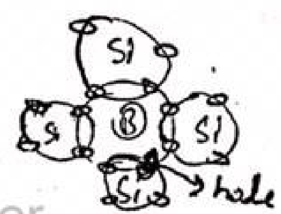
Majority carriers (~~holes~~ electrons). Minority carriers (holes)

P- Type semiconductor :-

It means to increase the holes in valence band.

Required trivalent impurity atoms.

e.g boron (B), gallium (Ga).



Majority carriers (holes)

Minority carriers (electr

't S

N-Type and P-Type Semiconductors.

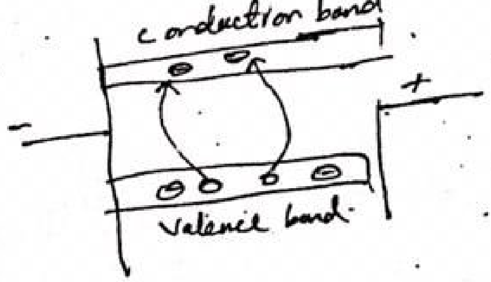
Lect 1

Semiconductors have limited number of free electrons in the conduction Band and holes in the valence band.

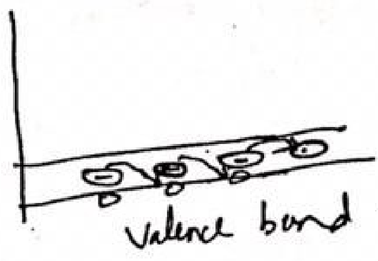
__At room temperature__ Electron jumps from silicon valence band to conduction band band a hole is created.

__Electrons current :-__

when ~~energy~~ voltage. applied across intrinsic silicon the free electrons attracted towards positive end. This movement of free electrons is one type of current in a semiconductive material and is called electron current.



__hole current :-__



SE.g Intrinsic silicon must be modified by. increasing the free elecrtons or holes to increase its conductivity. and make it useful in electronic devices.

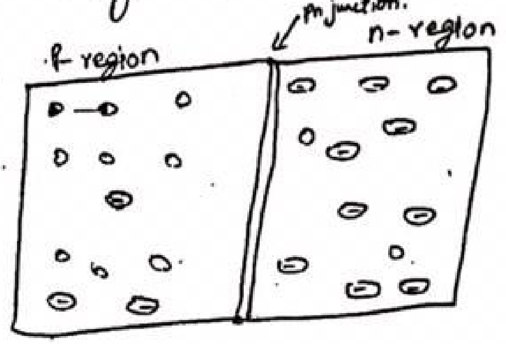
__Doping:-__ This increase in number of free electrons or holes is called doping.

16-Feb-2017. Lecture # 2. Electronics.

1) The Diode :-

If we dope some part of silicon with n-type and ~~[illegible]~~ some part with p-type, a boundary called the pn junction is formed. The resulting device is called basic diode.

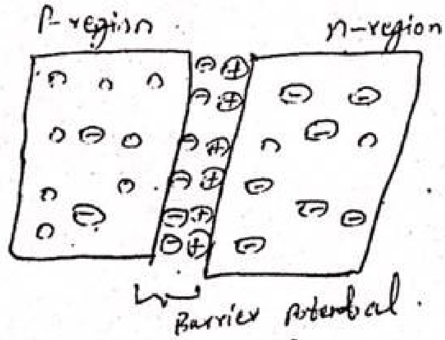
Property: A diode is a device that conducts current only in one direction.



Depletion Region :-

Once the Pn junction is formed, the electrons near to pn junction from n-region diffuses ~~into the p-region~~ junction ~~They combine~~ with holes by creating the layer of positive charges. As the electrons moves ~~from~~ across the junction, the p-region loses holes as the electrons and holes combined. This creates a layer of negative charge near the junction. These two layers of +ve and -ve charges form the depletion region.

1.2.



Depletion region formed quickly and is very thin compared to n and p region.

Equiblrium point reaches where total negative charge in the depletion region repels any further diffusion of electrons into p-region.

Barrier Potential :-

An electric field is created at junction because of positive and negative charges. This electric field stops farther diffusion of electrons with holes in the p-region. An external energy or voltage is required to move the electron across the depletion region. This amount of voltage is called barrier potential and is expressed in volts.

For silicon barrier potential 0.7V. } at
For germanium // // 0.3V } 25°C

1.7 Biasing a diode :- L2.

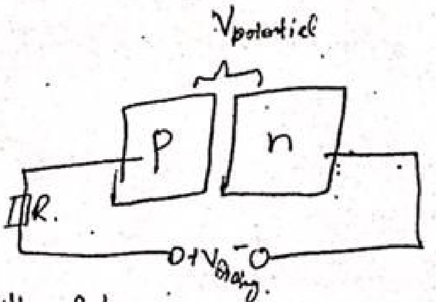
At equilibrium no electrons move through the pn junction.

Bias means to apply dc voltage to the device.

In diodes we will discuss

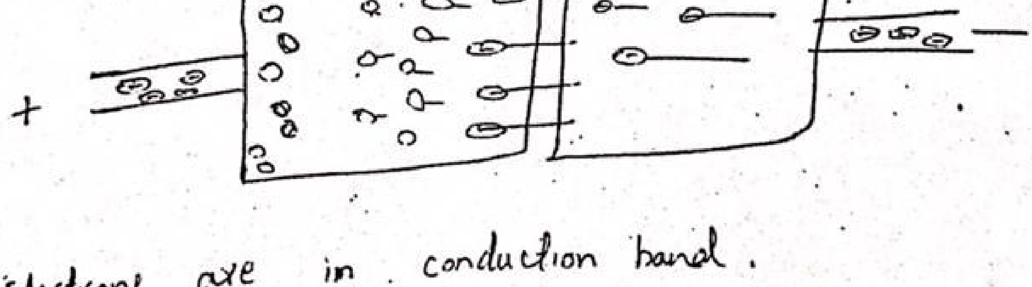
- Forward bias
- Reverse bias.

Forward bias :-



Conditions :-

1. +ve is connected with P-type
   -ve is " " n-type.
2. V_{Bias} should be greater then barrier potential.



Electrons are in conduction band.

holes are in valence band.

The negative side of biasing voltage pushes the electrons towards p-side. These electrons

(vii)

have sufficent energy to overcome the barrier potent
Once these electrons passes through the barrier they will be in valence band. Now these valence band electrons are in p-region. and attracted towards +ve potential of biasing voltage. The holes in the p-region provide the path to move these valence band electrons in to +ve side. The holes in the p-region moves towards right.

Electrons flow out of the p-region through the external connection they leaves holes behind in the p-region.

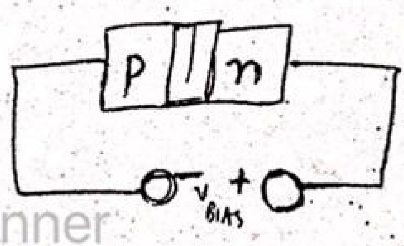
Effect of forward bias on depletion Region :-

More electrons flow into deplation region the number of +ve ions reduces and holes flow in to deplation region reduces -ve ions.

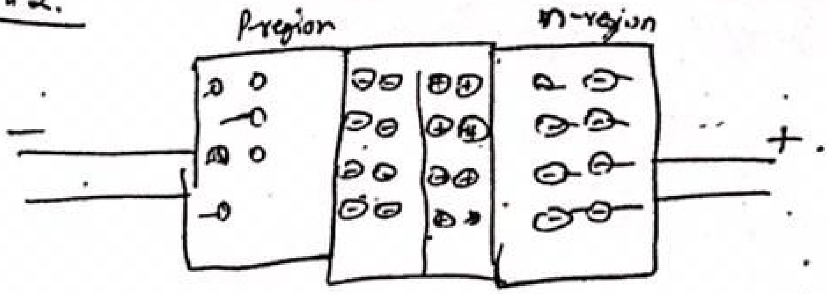
As a result depletion region become narrow.

Reverse bias :-

+ve side is connected with n-region
-ve " " " " p-region.



5-Feb-2017 Lecture #2.



electrons from the negative side of the voltage source. Holes in the p-region attracted towards ~~left~~ left region as a result additional negative ions are create on depletion region.

Electrons in the n-region attracted toward right as a result additional +ve ions are created on depletion region.

Reverse current :-

Electrons coming from biasing voltage source passes through the barrier and generates small reverse current.

Reverse breakdown :-

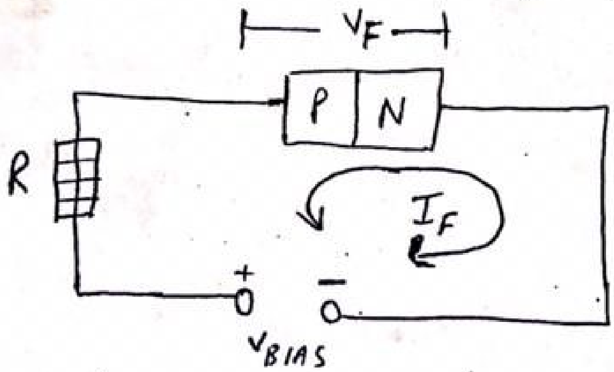
If reverse bias voltage is increased to a value called the breakdown voltage, the reverse current will increase.

Voltage current characteristics of a diode :-

Forward bias produces current through a diode. Reverse bias prevents current, except for a negligible reverse current. But if the reverse bias voltage equal or exceed the break down voltage of the junction then current will flow.

V-I characteristics for forward bias :-

When a forward bias voltage is applied across ~~the~~ a diode, current will flow. This current is called forward current and is designated by I_F.



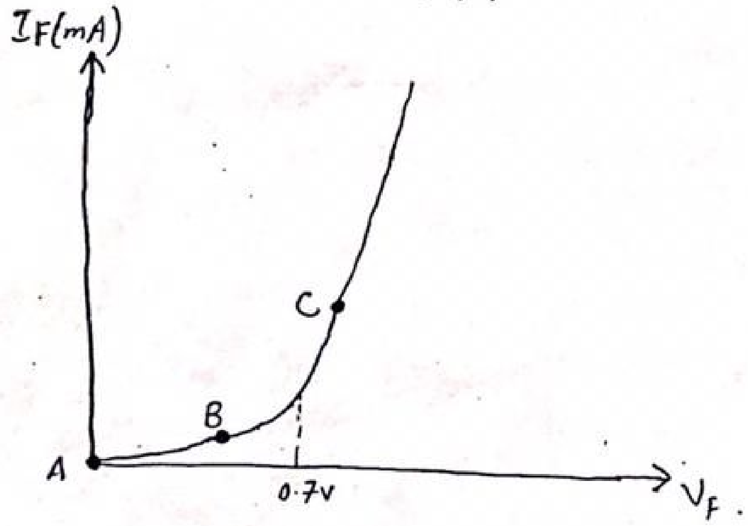
$V_{BIAS} = 0V$ $I_F = 0$. voltage across diode $V_F = 0V$

If we increase V_{BIAS} as $V_F = 0.7V$ then forward current I_F increases rapidly.

Graphing the V-I curve :-

diode forward voltage (V_F) on the horizontal axis.

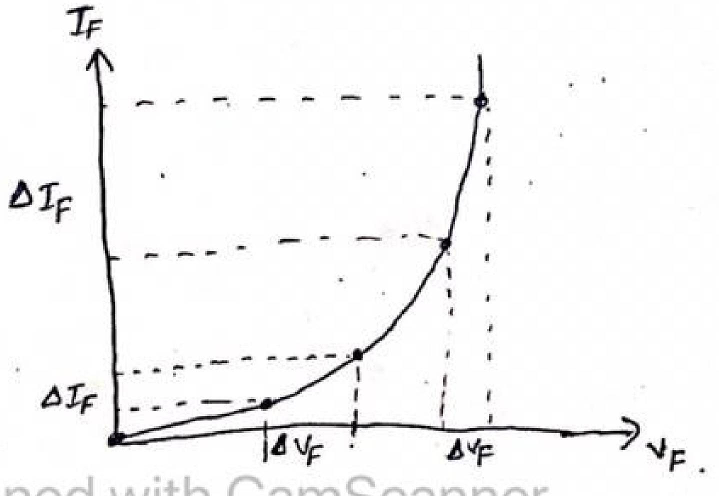
Forward current (I_F) on the vertical axis.



Point A where $V_{BIAS} = 0$ $V_F = 0$ $I_F = 0$

Point B where V_{BIAS} = increases but V_F less then 0.7V,.
I_F = slightly increases.

Point C. where V_{BIAS} = increases and V_F become equal to 0.7V. I_F = increases rapidly.



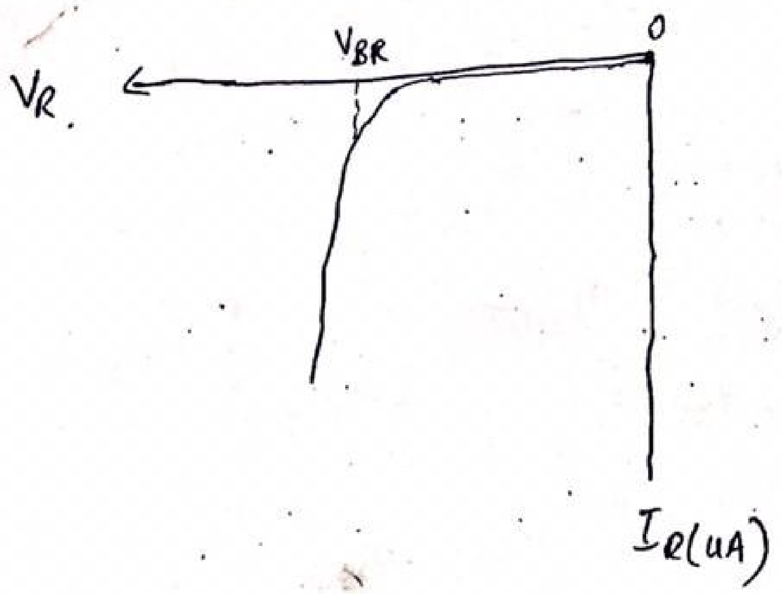
V-I characteristics for Reverse bias :-

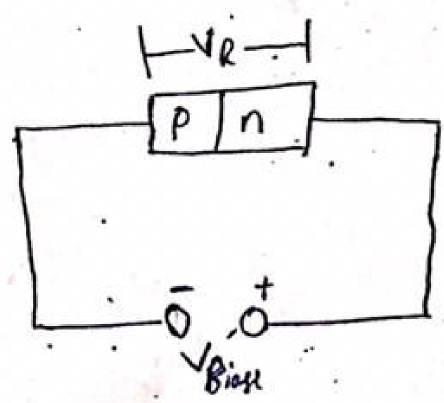
When a reverse bias voltage is applied across the diode a very small reverse current. (I_R) flow through the pn junction.

When the bias voltage is increased to a value where the reverse voltage across the diode (V_R) reaches the break down value then reverse current (I_R) begins to increase rapidly.

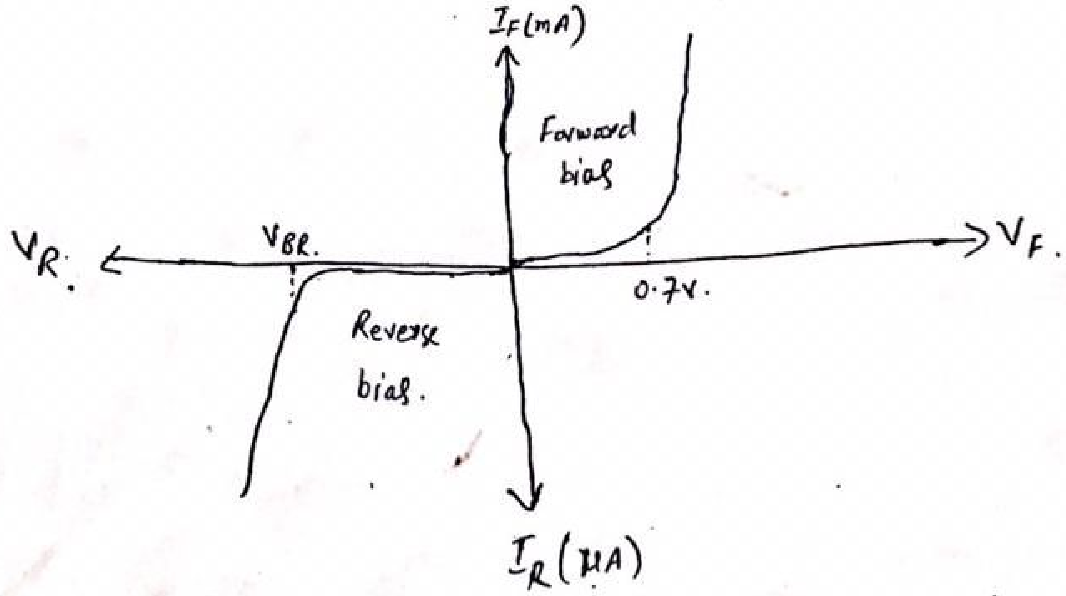
diode reverse voltage (V_R) on the horizontal axis.

diode reverse current (I_R) on the vertical axis.

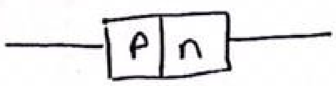




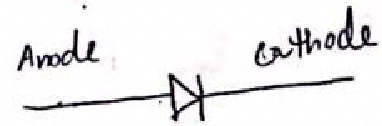
Complete V-I characteristic Curve :-



Diode symbol :-



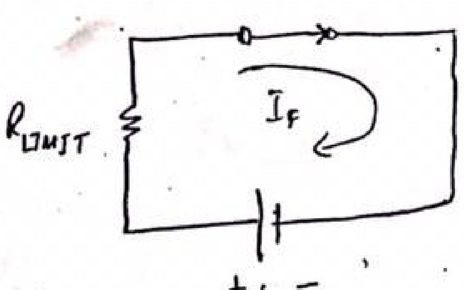
Basic diode structure.



schematic symbol.

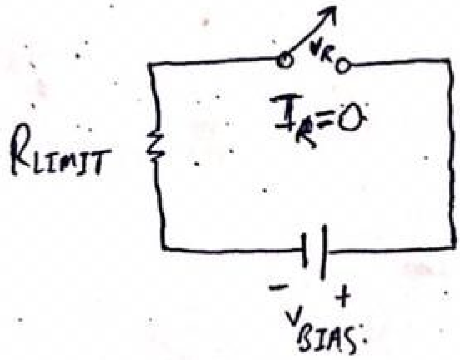
Ideal diode Model :-

Closed switch.



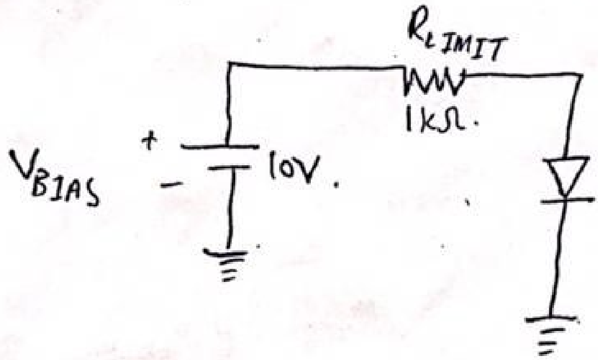
Forward bias.

open switch.



Rverse bias.

Example 1-1 (a) Determine the forward voltage and forward current for the diode in fig ? Also find $V_{R_{LIMIT}}$?

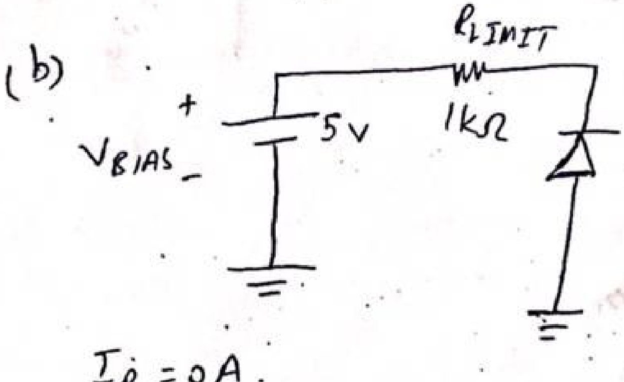


forward voltage $= V_F = 0V$.

$$I_F = \frac{V_{BIAS}}{R_{LIMIT}} = \frac{10V}{1k\Omega} = 10mA.$$

$$V_{R_{LIMIT}} = I_F R_{LIMIT} = (10mA)(1k\Omega) = 10V.$$

(b)



Find $V_R = ?$

$V_{R_{LIMIT}} = ?$

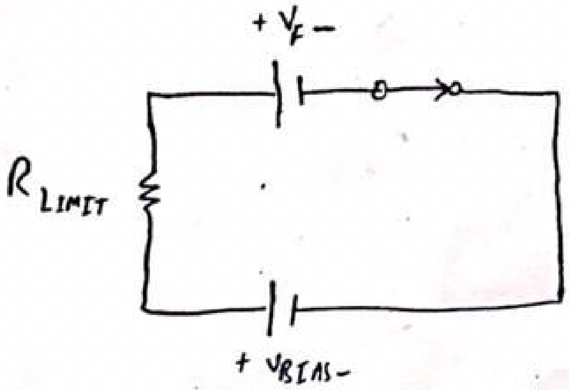
$I_R = ?$

$I_R = 0A$.

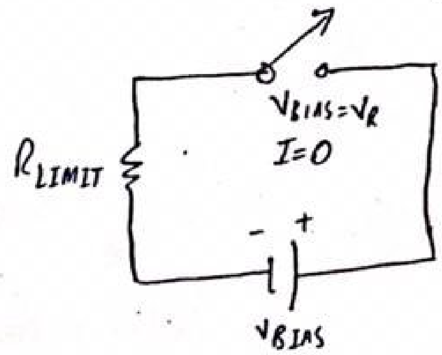
Reverse voltage $= V_R = V_{BIAS} = \cancel{0A}\ 5V$.

$V_{R_{LIMIT}} = 0V$.

Practical diode Model :-

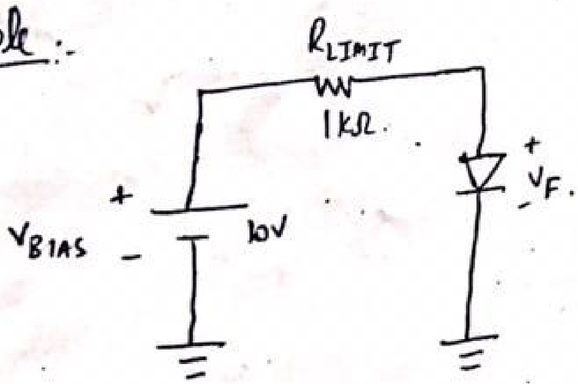


Forward bias

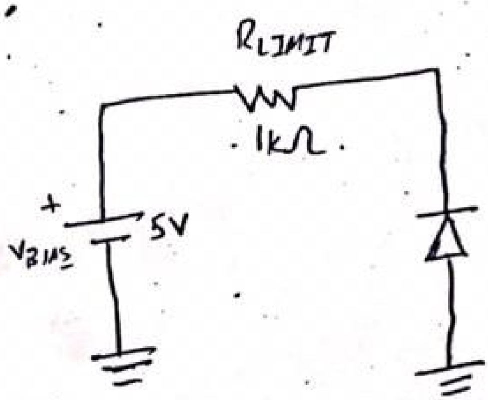


Reverse bias.

<u>Example</u> :-



Forward bias



Reverse bias.

Pro

$V_F = 0.7V$

$$I_F = \frac{V_{BIAS} - V_F}{R_{LIMIT}}$$

$$I_F = \frac{10V - 0.7V}{1k\Omega} = 9.3mA$$

$$V_{RLIMIT} = I_F R_{LIMIT}$$

$$V_{RLIMIT} = (9.3mA)(1k\Omega)$$

$$V_{RLIMIT} = 9.3V$$

$I_R = 0A$

$V_R = V_{BIAS} = 5V$

$V_{RLIMIT} = 0V$