INSULATOR:

An insulator is a material that does not conduct electrical current under normal conditions. Most good insulator are compounds rather than single-element materials. Valence electrons are tightly bound to atom; Therefore there are few free electrons in an insulator. E.g. rubber, plastics, glass etc.

CONDUCTOR:

A conductor is a material that does conduct electrical current under normal conditions. Most metals are good conductors. The best conductors are single element ~~element~~ materials. Eg. copper, iron, silver, GOLD. Metals ~~~~ which are characterized by atoms with only one valence electron very loosely bound to the atom. These loosely bound electrons become free electrons. Therefore, in a conductive material the free electrons are valence electrons

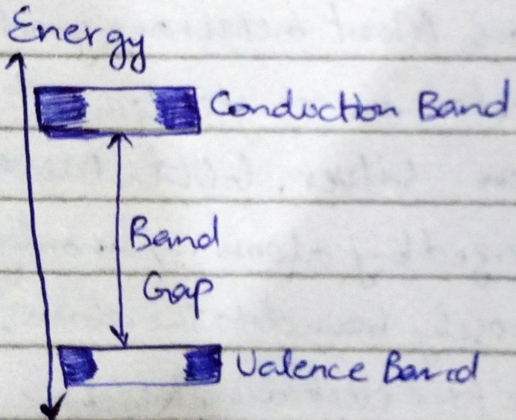
SEMI CONDUCTOR:

Semiconductors is a material that is between conductors & insulators in its ability to conduct electric current. A semiconductor in its pure (intrinsic) state is neither a good conductor nor a good insulator. Single element semiconductors are silicon, germanium

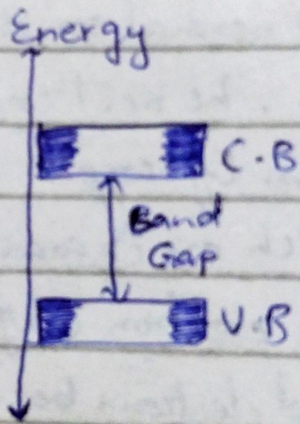
No. ______

Arsenic (As), Antimony (Sb), Boron (B) etc.
Compound ~~element~~ semiconductors are gallium arsenide, indium phosphide, gallium nitride, silicon carbide etc.
Silicon is most ~~conductor~~ commonly used semiconductor.

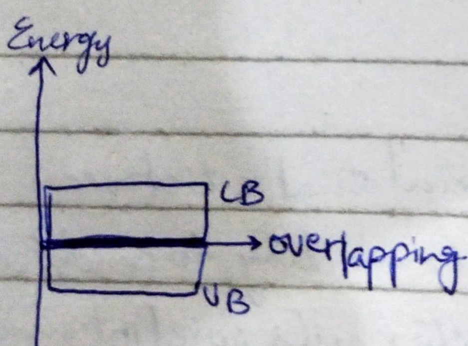
The difference in energy between the valence band and the conduction band is called band gap or energy gap.



Insulator



Semiconductor



Conductor.

An (intrinsic) pure silicon crystal at room temp.

DOPING:

Semiconductors are generally poor conductors, their conductivity can be drastically increased by controlled addition of impurities to the intrinsic ~~conductors~~ semiconductive material. The prosess is called Doping. Two categories of impurities are n-type & p-type.

P-Type Semiconductors:

To increase the number of holes in intrinsic silicon a trivalent impurity atom is doped. These are atoms with three valence electrons Boron (B), Indium (In) and Gallium (Ga). Since holes ~~numbers~~ outnumbers free electrons. The holes are referred to as the majority carriers and free electrons are minority carriers.

n-Type Semiconductors:

Silicon that has been doped with pentavalent impurity is called n-type semiconductor, where n-stands for negative. These are atoms with five valence electrons such as arsenic (As), phosphorous (P) and antimony (Sb). Since free electrons outnumbers holes in n-type semiconductor, the free electrons are majority carriers and holes are minority carriers.

pn Junction Diode:

The word diode is a contraction of two electrodes where "di" stands for "two".

The border between p-type and n-type is called pn-junction.

Barrier Potential:

Each dipole has an electric field.

The potential difference required for the electrons to be passed across the electric field is called Barrier potential.

At 25°C, the barrier potential equals approximately 0.3V for germanium diodes & 0.7V for silicon diodes.

Forward Bias:

The negative source terminal is connected to n-type material, and positive terminal is connected to p-type material. ~~~~ The connection produces is called forward bias.

- Current flows easily in forward biased diode.
- As long as applied voltage is greater than barrier potential, there will be a large continuous current in the circuit.

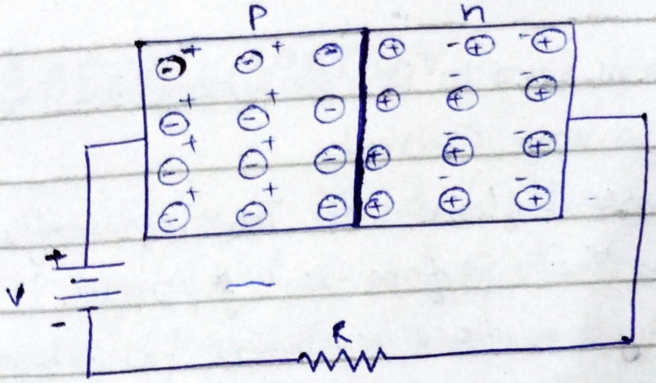
actual

$e \rightarrow p^+$ $V = 0.7V$

$p^+ \rightarrow e^-$

conventional

Date



Reverse Bias:

The negative source terminal is connected with ptype and positive terminal is connected with n-type. The connection produces is called reverse bias.

The negative ~~layer~~ terminal attracts the holes and positive battery terminal attracts free electrons. Because of this holes and electrons move away from junction and therefore depletion layer widens. The greater the depletion layer, the higher will be the barrier potential.

Is there any current after the depletion layer stabilizes?

Yes, a small current exists with reverse bias. The thermal energy continuously creates a pair of free electrons and holes. This means that a few minority carriers exists on both sides of junction. Most of these recombines with majority carriers. But those inside in depletion layer exists long enough to get across the junction. When this happens a small current flows in external circuit.

forward → 0.7 voltage of depletion layer
Reverses → depletion layer = Battery Voltage

Date

Current is approx zero in Reverse bias diode.

Surface-leakage Current:
A small current flows on the surface of crystal known as the surface-leakage current. It is caused by surface impurities and imperfection in crystal structure.

Breakdown Voltage:
Breakdown voltage is a characteristic that defines the max voltage difference that can be applied accross the material.

0.02+0.01=0.03

Third Approximation:

0.5-0.3=0.2

V=IR

Half wave Rectification / Full wave rectifiation.

DIC

Th

a

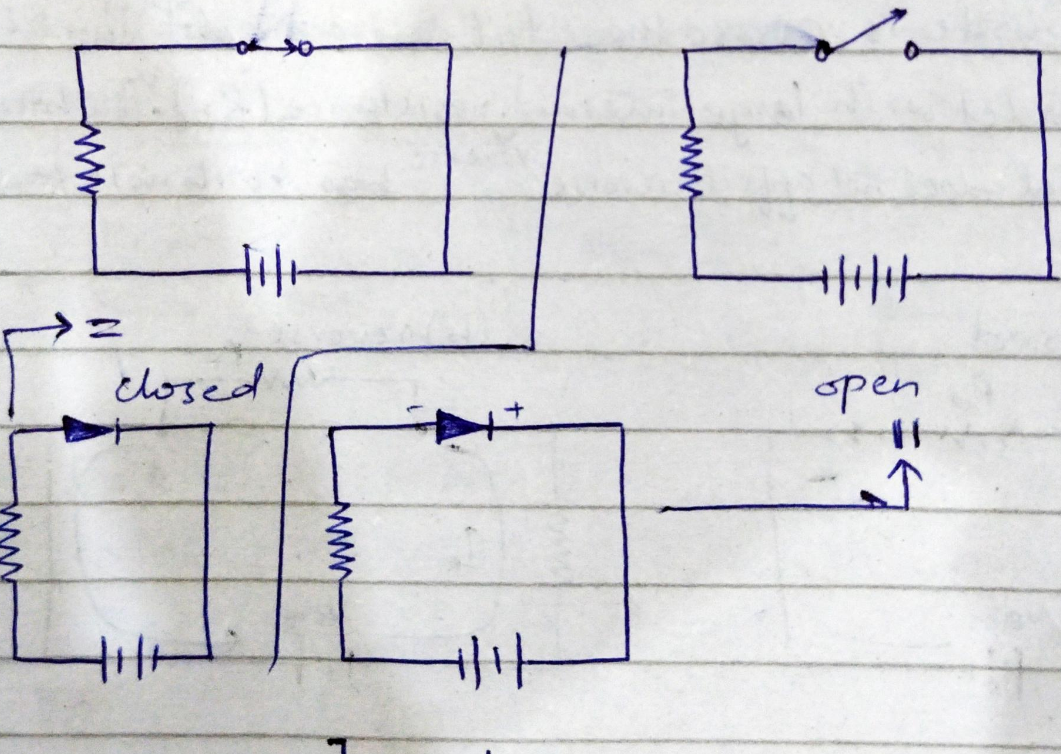
DIODE APPROXIMATION:

The Ideal Diode Model:

The ideal model of diode is the least accurate approximation and can be represented by a simple switch.

When the diode is forward biased; it ideally acts like a closed (on) switch.

When the diode is reversed biased it ideally acts like a open (off) switch.



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

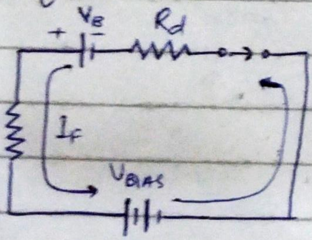
The Complete Diode Model:

The complete diode model is the most accurate approximation and includes the barrier potential, the small forward dynamic resistance (R_d) and the large internal reverse ~~d~~ resistance (R_r). The reverse resistance is taken into account because it provides a path for the reverse current, which is included in this diode model.

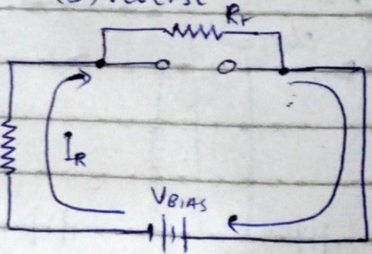
When diode is forward-biased, it acts as a closed switch in series with equivalent barrier potential Voltage (V_B) and the small forward dynamic resistance (R_d).

When diode is reverse biased, it acts as a ~~clos~~ open switch in parallel with large internal, reverse resistance (R_r). The barrier potential does not affect reverse bias, so its not a factor.

(a) forward

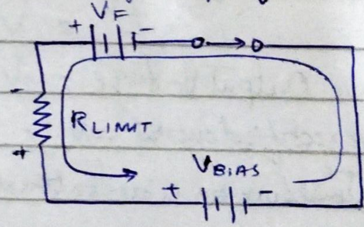


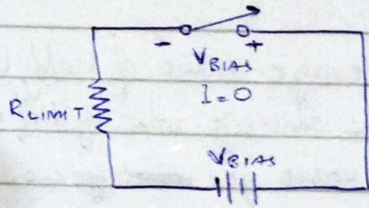
(b) reverse



The Practical Diode Model:

The Practical Model includes the barrier potential. When the diode is forward-biased, it is equivalent to a closed switch in series with a small equivalent voltage source (V_F) equal to barrier potential (0.7V) with the positive side toward the anode. This equivalent voltage source represents the barrier potential that must be exceeded by the bias voltage before the diode will conduct and is not an active source of voltage. When conducting a voltage drop of 0.7 V appears across the diode.





By Kirchoff's Voltage Law.

$$V_{BIAS} - V_F - V_{R_{LIMIT}} = 0 \Rightarrow V_{R_{LIMIT}} = V_{BIAS} - V_F$$

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

$$I_F = \frac{V_{R_{LIMIT}}}{R_{LIMIT}}$$

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

The diode is assumed to have zero reverse current

$I_R = 0A$

$V_R = V_{BIAS}$

HALF WAVE RECTIFIERS:

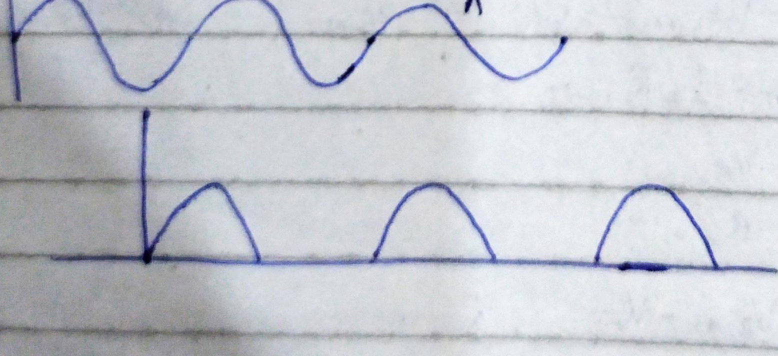
A rectifier that converts only allows one half cycle ~~the~~ AC input Voltage to a pulsating DC voltage called a half wave rectified voltage

A diode is connected to an AC source and to a load resistor R_L forming Half wave rectifier.

Average Value of Half Wave Output Voltage:

The average value of Half wave rectified output voltage is the value you ~~need~~ ~~go~~ would measure an a dc voltmeter.

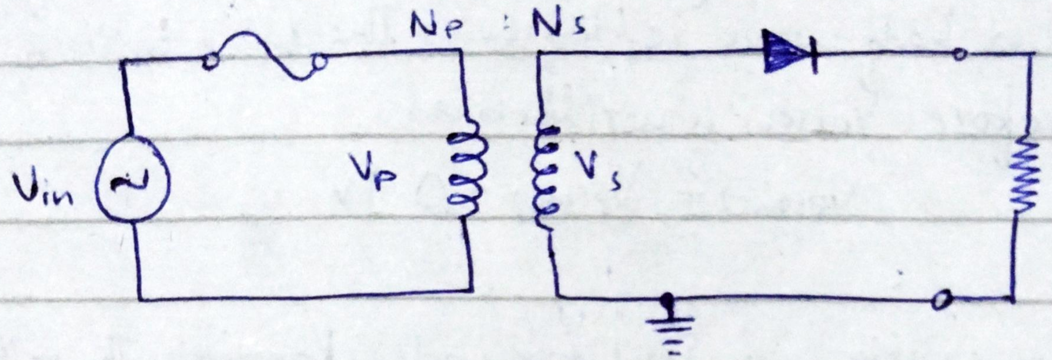
$$V_{AVG} = \frac{V_P}{\pi}$$



Peak Voltage

The peak inverse voltage (PIV) equals the peak value of the input voltage and the diode must be capable of withstanding this amount of repititive reverse voltage

TRANSFORMER:



A transformer is used to couple the ac input voltage from the source to the rectifier. Transformer coupling provides two advantages. First, it allows the source voltage to be stepped down as needed. second, the AC source is electrically isolated from the rectifier, thus preventing a shock hazard in the secondary circuit.

Turns Ratio is the amount that the voltage is stepped down of transformer. The number of turns in the secondary (N_s) divided by number of turns in the primary (N_p). Thus, a transformer with a turns ratio less than 1 is step-down and one with a turns ration greater than 1 is a stepup type.

The sec voltage of transformer equals the turns ratio, n, times the primary voltage

$$V_s = n V_p$$

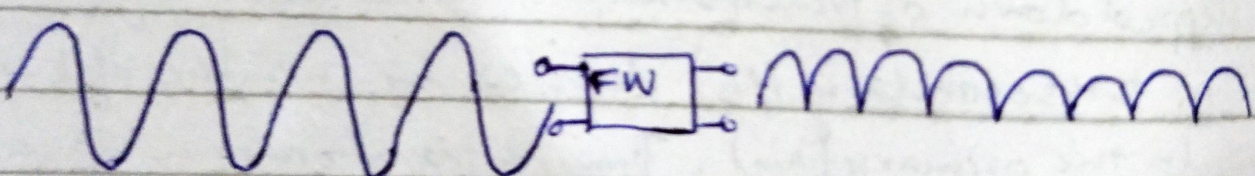
The peak secondary voltage, $V_{P(sec)}$ in a transformer coupled half-wave rectifier is the same as $V_{P(in)}$. Therefore $V_{P(sec)}$ is written as

$$V_{P(out)} = V_{P(sec)} - 0.7V$$

Turns ratio is useful for understanding the voltage transfer from primary to secondary. A transformer is generally specified based on the sec voltage rather than turns ratio.

FULL WAVE RECTIFIER:

A full wave rectifier allows unidirectional (one way) AC current through the load during the entire 360° of input cycle into pulsating DC

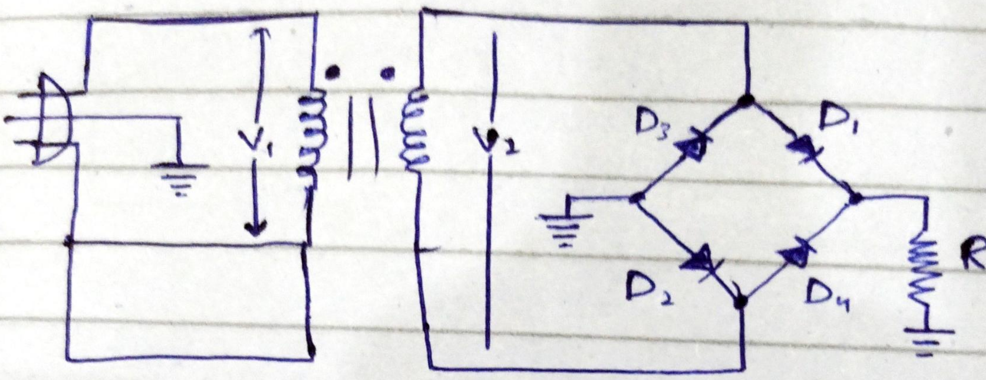


The avg value which is the value measured on a DC voltmeter for a full wave rectified sinusoidal voltage is twice that of the half wave

$$V_{AVG} = \frac{2V_P}{\pi}$$

BRIDGE FULL-WAVE RECTIFIER:

A bridge rectifier uses four diodes connected. ~~When the~~



The bridge rectifier is similar to a full wave rectifier because it produces a full wave output voltage. Diodes D_1 & D_2 conduct on positive half cycle and D_3 and D_4 conduct on the negative half cycle. As a result, the rectified load current flows during both half cycles.

The positive half cycle shows, D_1 and D_2 are forward Biased. This produces a positive load voltage as indicated