# UNIT - 9.

# Semiconductors.

- Semiconductor
- Electronic devices.

## Chapter ⇒ 1.

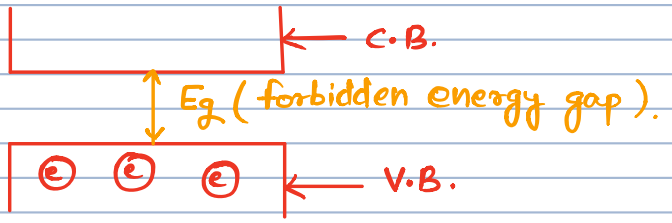
## Semiconductors

### Types of Substances :-

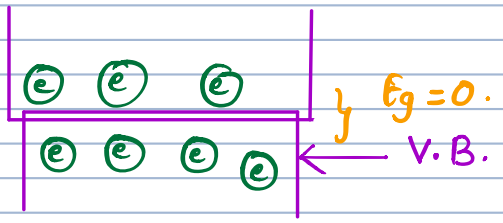
| Conductors | Insulators | Semiconductors |
|---|---|---|
| They conduct electricity | They do not conduct electricity. | They do not conduct electricity at room temp. but start conducting if they are heated! <br> e.g. → Si and Ge |

| gp.13 | gp.14 | gp.15 |
|---|---|---|
| B | C | N |
| Al | Si | P |
| Ga | Ge | As |
| In | Sn | Sb |
| Th | Pb | Bi |

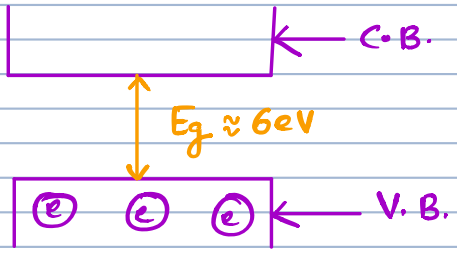
### Valence - band theory :-



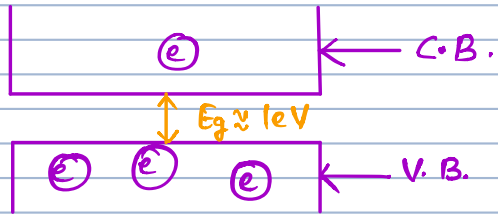
for Conductors :-




for Insulators :-




for Semiconductors :-




Semiconductors

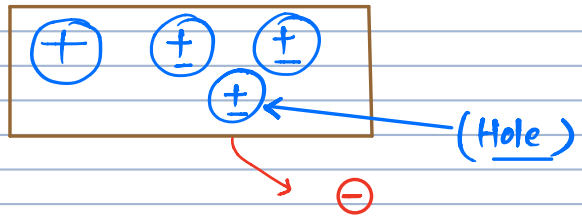
- Intrinsic
  - They are pure semiconductors with no impurity atom added.
- Extrinsic
  - They are impure semiconductors with suitable impurity atom added to them.

Extrinsic

n-type  P-type.

Q1⇒ What do we mean by holes in semiconductors?

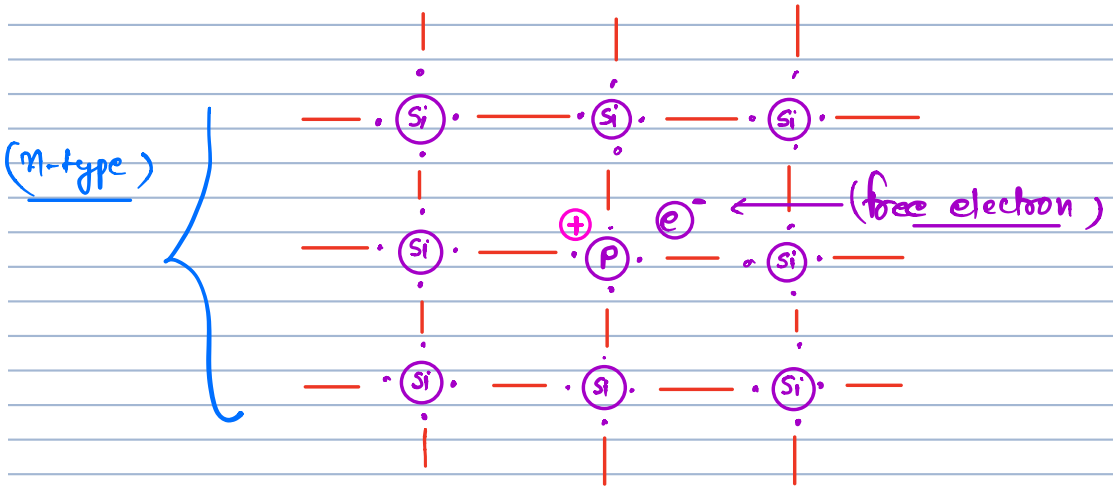
Sol°-




Holes do not move but they cause shifting of e⁻.

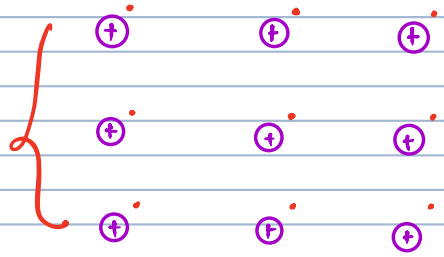
n-type semiconducter °- They are the semiconductors which are formed by doping pure semiconductors with gp. 15 elements.

(*) free Electrons are more.




(*) n-type semiconductors are neutral.

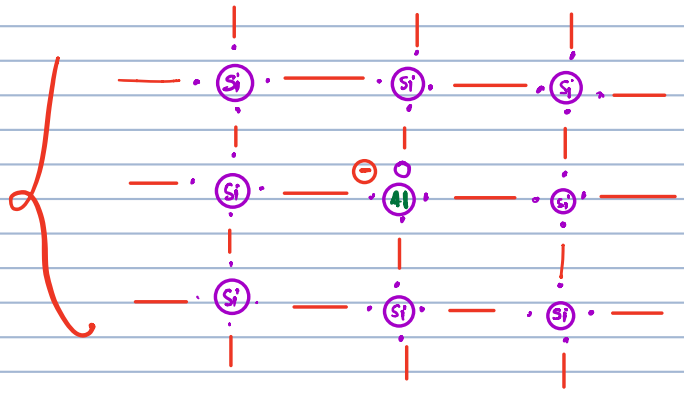
(n-type)



P-type semiconductor :- They are the semiconductors which are made by doping pure semiconductors with gp. 13 elements.

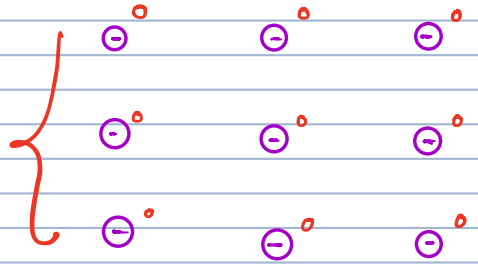
(*) Holes are more.

(P-type)




(*) P-type semiconductors are neutral.

(P-type)



formula for doping :-

$$n_e n_h = (n_i)^2$$

$n_e$ → no. of $e^-$

$n_h$ → no. of holes

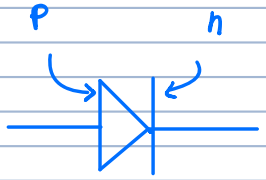
$n_i$ → no. of intrinsic charge carriers.

# CHAPTER - 2

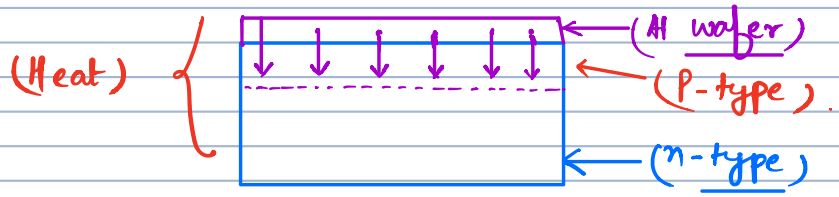
# ELECTRONIC DEVICES

## P - N Junction diode :-

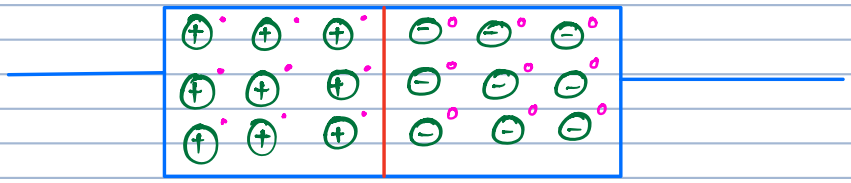
Symbol :-




## How is it made ?



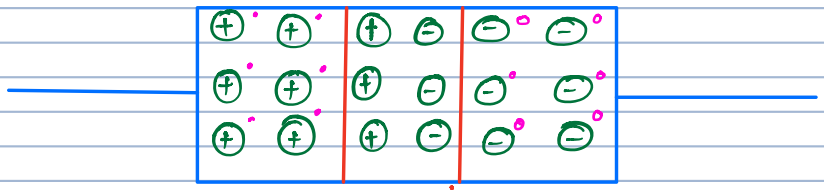

## formation of diode :-



Two important processes take place during the formation of a diode :-

i) Diffusion of magority charge carriers that leads to the formation of diffusion current.

ii) Drift of minority charge carriers that leads to the formation of drift current.




**Depletion region :-** It is defined as the space in which the ions are depleted of their charges.

**Potential barrier :-** It is the potential difference b/w the two ends of depletion region.

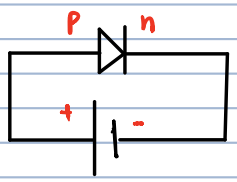
(*) Initially diffusion current is high but after some time diffusion current becomes equal to drift current.

(Way of connecting)

## BIASING OF A DIODE:

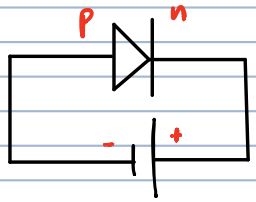
### (FORWARD)

→ When P-end is connected to high potential and n-end is connected to low potential.




### (REVERSE)

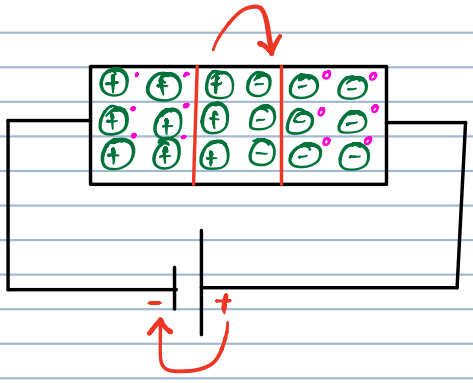
→ When n-end is connected to high potential and P-end is connected to low potential.



→ Diode conducts in forward biasing.

→ Resistance decreases during forward biasing.

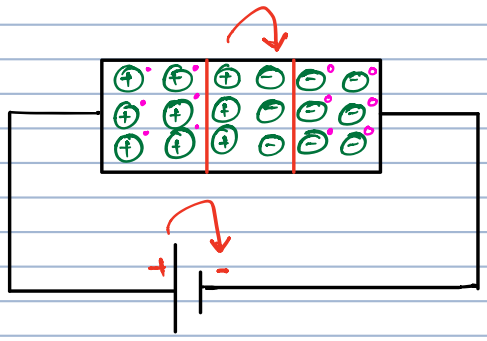
→ Width of depletion layer decreases during f.B.



→ Diode does not conduct in R.B.

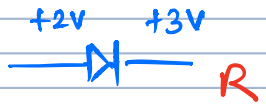
→ Resistance increases during R.B.

→ Width of depletion layer increases during R.B.

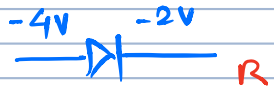


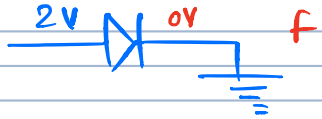
**Q:1 ⇒** Identify the type of biasing in the following figures :-

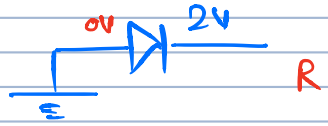
a) 

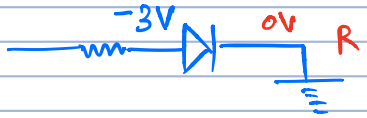

b) 

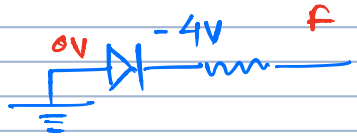

c) 


d) 


e) 

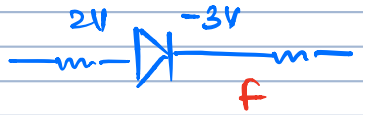

f) 


g) 


h) 

i) 

No biasing

j) 


## 10(A) RECTIFIER.

**Introduction :-** It is a device which is used to convert a.c. into d.c.

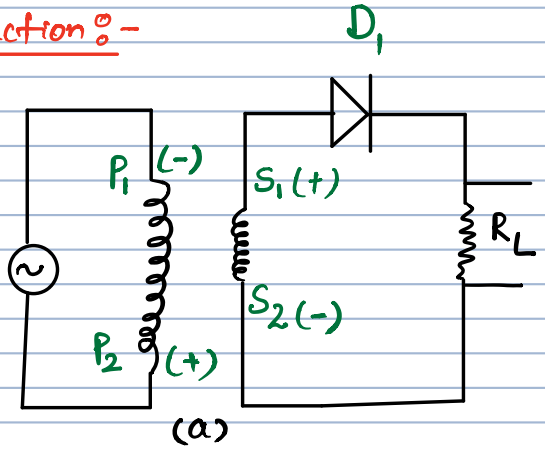
**Principle :-** It works on the fact that a p-n junction diode conducts in f.B. and does not conduct in R.B.

Rectifier

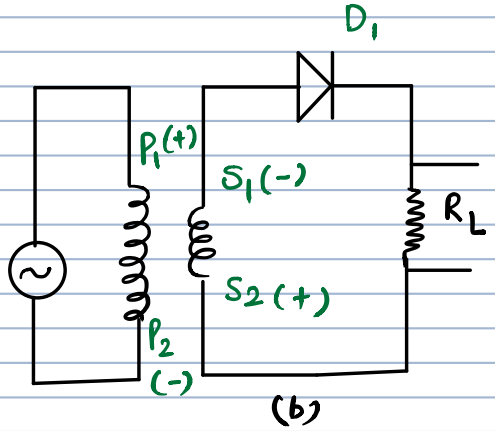
- (Half wave)
- (full wave)
- (Bridge) (x)

**Half wave :-**

**Construction :-**



(a)



(b)

$P_1P_2$ and $S_1S_2$ are the primary and secondary coils of a step-down transformer.

$D_1$ → Diode and $R_L$ → Load Resistor.

**Working:-**

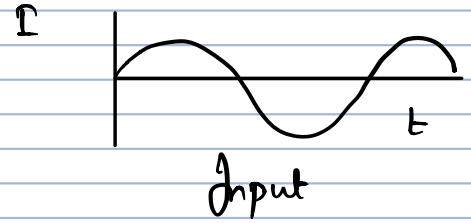
i) Suppose Initially $P_1$ is -ve and $P_2$ is +ve. Due to mutual induction, $S_1$ is +ve and $S_2$ is -ve.

ii) In this condition diode is forward biased and hence it will conduct.

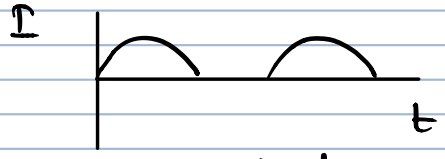
iii) When the next cycle comes, $P_1$ becomes +ve and $P_2$ becomes -ve. Due to mutual induction, $S_1$ is -ve and $S_2$ is +ve.

iv) In this condition diode is reverse biased and hence it will not conduct.

v) The input and output cycles are shown below:-

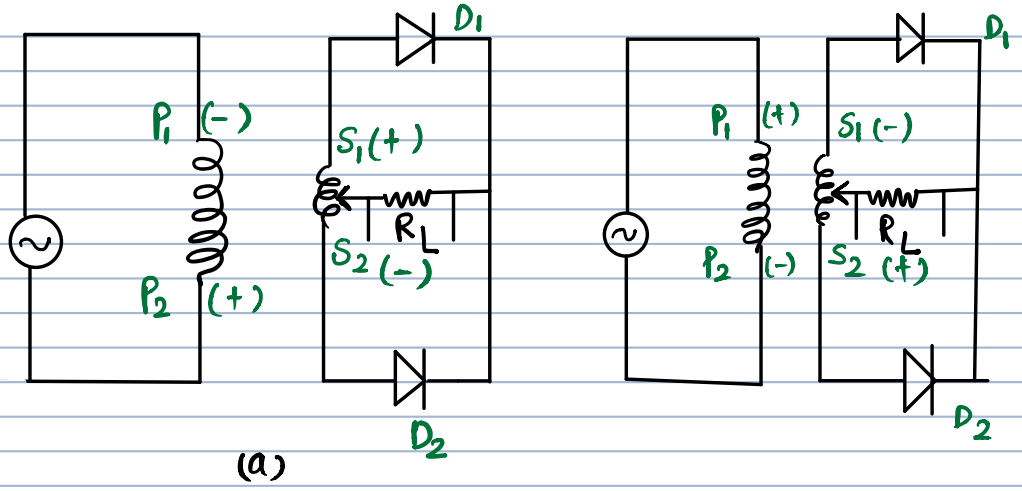



Input




output.

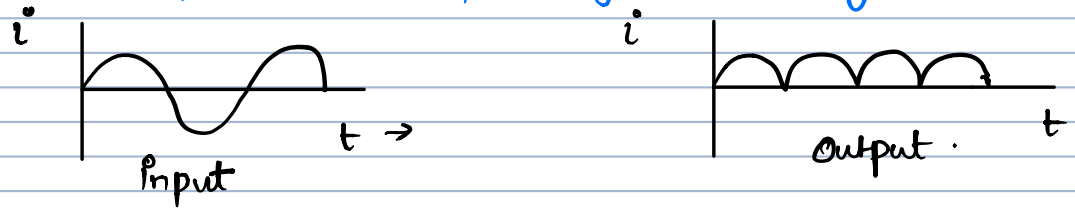
**full wave :-**




(a)

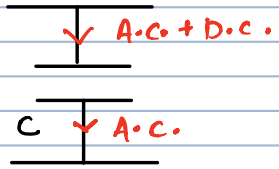
Working :-

4) The input and output cycles are given below :-




filter circuit :- It is a circuit which is used to separate A.C. from D.C.

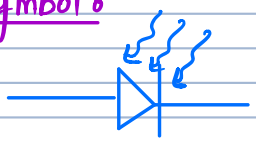
A Capacitor is used in a filter circuit.




## Types of Diodes.

### Photo diode

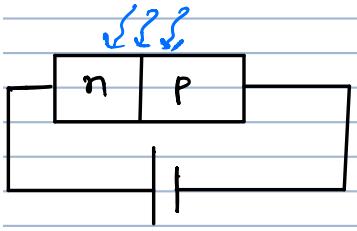
Symbol :-



Introduction :- It is a heavily doped p-n junction diode made up of photo-sensitive material which starts conducting when light falls over it.

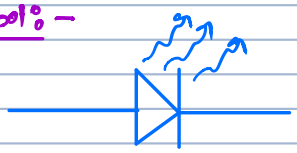
Biasing :- Reverse biasing.

Circuit diagram :-




### Light emitting diode

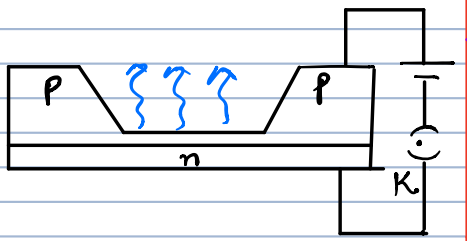
Symbol :-



Introduction :- It is a heavily doped P-n junction diode which emits spontaneous radiations when forward biased.

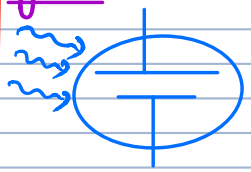
Biasing :- forward biasing.

Circuit diagram :-




### Solar cell

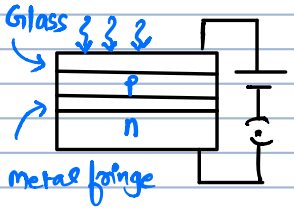
Symbol :-



Introduction :- It is a heavily doped P-n junction diode made up of photo-sensitive material which starts conducting when light falls over it.

Biasing :- Not biased.

Circuit diagram :-



**Uses :-**

i) for switching lights on and off.

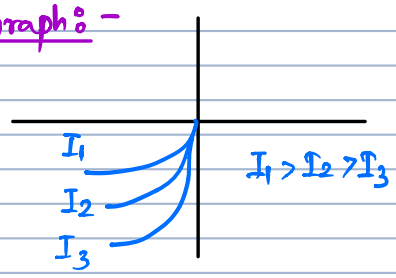
ii) In automatic headlamps

iii) To count people if they come in queue.

iv) In Burglar alarm systems.

**Dark current :-** When no light is falling on the diode, still some current is left in it. This is called Dark current.

**Graph :-**




**Uses :-**

i) In TV, Torches, Bulbs, Tubelights.

ii) for decoration purpose

iii) for display purpose

**Advantages of LED over Incandenscent lamps :-**

i) They require less power to operate.

ii) It does not require heating time.

iii) They are easily portable.

iv) They are cheap

**Uses :-**

i) watches, calculators.

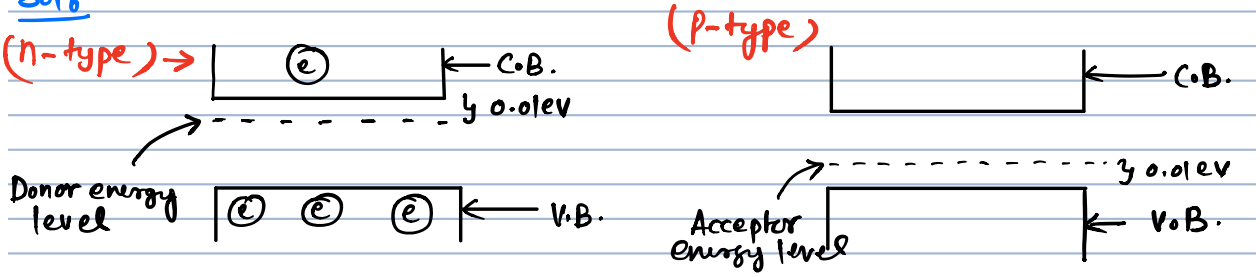
ii) Street lights as solar cell panels

iii) Solar cell panels can be used to provide electricity in hilly areas.

**Related Questions :-**

Q.20 Draw energy band diagram of a p-type and n-type semiconductor? ( DELHI 2005C, AI 2005, 01)

**Sol :-**

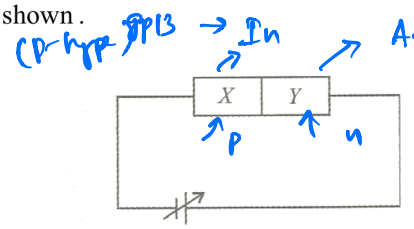


range : ( DELHI 2015C)

Q.6 The current in forward bias is known to be more than reverse biasing. What is the reason that photo diode is connected in reverse-biasing? ( DELHI 2012)

Sol:- The change in minority charge carriers is greater in R.B. as compared to F.B. Hence photo diode is connected in R.B.

Q.13 Two semiconductor materials X and Y shown in the given figure are made by doping germanium crystal with indium and arsenic respectively. The two are joined end to end and connected to a battery as shown .

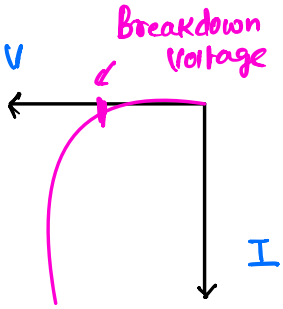



(P-type) gp 13 → In  Ar → gp 15 (n-type)

Reverse .

(i) Will the junction be forward or reverse biased?

(ii) Sketch a V-I graph for this arrangement? ( AI 2007)




Sol:-