Unit IX: Electronic Devices **12 Periods**

Chapter–14: Semiconductor Electronics: Materials, Devices and Simple Circuits

Energy bands in conductors, semiconductors and insulators (qualitative ideas only)

Semiconductor diode - I-V characteristics in forward and reverse bias, diode as a rectifier;

Special purpose p-n junction diodes: LED, photodiode, solar cell and Zener diode and their characteristics, zener diode as a voltage regulator.

PHYSICS CLASS-XII –SEMICONDUCTOR

901. Give the ratio of the number of holes and number of conduction electrons in an intrinsic semiconductor.
[Ans. $n_h / n_e = 1$ **CBSE (F)-2003**

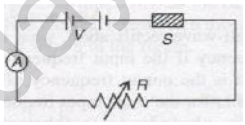
902. What is meant by the term doping of an intrinsic semiconductor ? How does it affect the conductivity of a semiconductor ?
[Ans. Doping : **CBSE (AIC)-2001**
Deliberate adding of desired impurity to a semiconductor to increase its conductivity is called doping.
Conductivity of a semiconductor increases due to doping

903. How does the energy gap of an intrinsic semiconductor vary, when doped with a trivalent impurity/ pentavalent impurity?
[Ans. Decreases **CBSE (AI)-2002,(D)-2002**

904. How does the forbidden energy gap of an intrinsic semiconductor vary with increase in temperature?
[Ans. no effect **CBSE (AI)-2002,(D)-2002**

905. Name the two factors on which electrical conductivity of a pure semiconductor at a given temperature depends.
[Ans. (i) The width of the forbidden band **CBSE (AIC)-2005**
(ii) Intrinsic charge carrier concentration

906. The diagram shows a piece of pure semiconductor 'S' in series with variable resistor R and a source of constant voltage V. Would you increase or decrease the value of R to keep the reading of ammeter (A) constant when semiconductor 'S' is heated ? Give one reason. **CBSE (DC)-2005**
[Ans. Increase the value of R
Reason : on heating, conductivity of the semiconductor increases



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907. Give reason, why, a p-type semiconductor crystal is electrically neutral, although $n_h >> n_e$
[Ans. because impurity atoms added to the semiconductor are electrically neutral **CBSE (F)-2013,(D)-2008**

908. An n-type semiconductor has a large number of electrons but still it is electrically neutral. Explain the reason.
[Ans. because impurity atoms added to the semiconductor are electrically neutral] **CBSE (AI)-2008**

909. Is the ratio of the number of holes and number of electrons in a p-type semiconductor more than, less than or equal to 1 ?
[Ans. $n_h / n_e > 1$ **CBSE (AIC)-2003**

910. Why is the conductivity of n-type semiconductor greater than that of the p-type semiconductor even when both of these have same level of doping ? **CBSE (AIC)-2005**
[Ans. because mobility of electrons is higher than that of holes

911. How does the conductivity of a semiconductor change with the rise in its temperature ? **CBSE (DC)-2010**
[Ans. Conductivity of a semiconductor increases exponentially with the temperature

912. Why does the conductivity of a semiconductor increase with the rise in its temperature ? **CBSE (DC)-2005**
[Ans. $\sigma = e [n_e \mu_e + n_h \mu_h]$
On increasing the temperature μ_e & μ_h decreases (due to increase in the collision frequency). But n_e & n_h increases (as $n \propto e^{-\frac{E_g}{KT}}$). Since n_e & n_h is so large that decrease of μ_e & μ_h does not affect too much. So overall conductivity of the semiconductor increases

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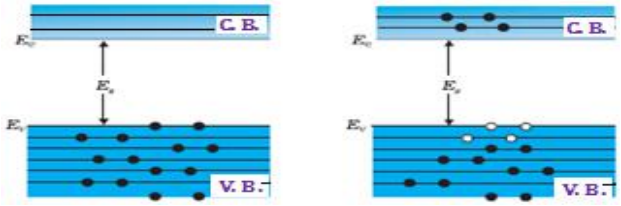
913. What are energy bands ? How are these formed ? **CBSE (AI)-2016,2008,2006,(D)-2010,2006,2005,(F)-2003**
[Ans. Energy bands : A group of large number of closely spaced energy levels spread in a very short energy range, is called an energy band
Formation of energy bands :
Due to interaction of electrons in outermost orbits of atoms in a crystal, different energy levels with continuous energy variation splits and energy bands are formed.

914. What is a valance band & conduction band ?
[Ans. Valence Band : The highest energy band filled with valence electrons is called the valence band
Conduction Band : The lowest unfilled allowed energy band above the valence band is called conduction band

915. Define forbidden energy gap ?
[Ans. Forbidden energy gap (E_g) **:** The energy gap between the valence band and the conduction band in which no allowed energy levels can exists is called the energy band gap (E_g)

916. Draw the energy band diagram of an intrinsic semiconductor. **CBSE (AIC)-2006,2005,2003**

[Ans. Energy band diagrams of an intrinsic semiconductor $\left(\frac{n_e}{n_h} = 1\right)$



(a) at T = 0 K **(b) at T > 0 K**

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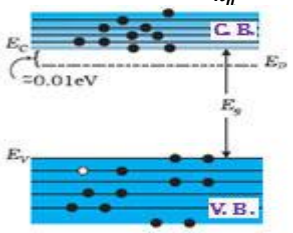
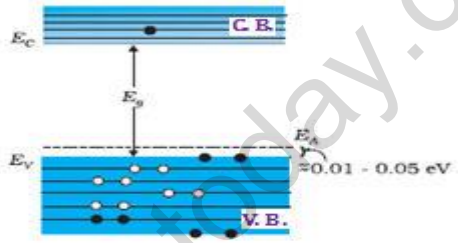
917. Draw the energy band diagram of $n-type$ & $p-type$ semiconductor.

[Ans. **CBSE (AI)-2012,2006,2005,2003,2001,(D)-2005,2004,2002**

n-type semiconductor ($\frac{n_e}{n_h}$ >1)



p-type semiconductor ($\frac{n_e}{n_h}$ <1)



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918. Distinguish between intrinsic and extrinsic semiconductors. **CBSE (F)-2017,(D)-2015,2008**

[Ans.

Intrinsic Semiconductor	Extrinsic Semiconductor
1. It is a pure semiconductor.	1. It is a semiconductor with added impurity.
2. $n_e = n_h$	2. $n_e \neq n_h$
3. Low conductivity at room temperature	3. High conductivity at room temperature
4. Its electrical conductivity depends on temperature only.	4. Its electrical conductivity depends on temperature and the amount of doping.

919. Distinguish between intrinsic and a p-type semiconductor. **CBSE (F)-2013**

[Ans.

n-type semiconductor	p-type semiconductor
1. It is obtained by adding controlled amount of pentavalent impurity to a pure semiconductor.	1. It is obtained by adding controlled amount of trivalent impurity to a pure semiconductor.
2. $n_e \gg n_h$	2. $n_h \gg n_e$
3. Its electrical conductivity is due to free electrons.	3. Its electrical conductivity is due to holes.

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920. Name the two important processes that occur during the formation of a p-n junction. **CBSE (AI)-2016,(D)-2017**

[Ans. (i) Diffusion (ii) drift

921. What happens when a forward bias is applied to a p-n junction ? **CBSE (AI)-2015**

[Ans. p-n junction conducts current when a forward bias is applied to it

922. Name any semiconductor device which operates under the reverse bias in the breakdown region. **CBSE (AI)-2013**

[Ans. Zener diode

923. Name the p-n junction diode, which emits spontaneous radiation when forward biased. **CBSE (DC)-2004**

[Ans. Light Emitting Diode (LED)

924. Why is the current under reverse bias almost independent of the applied potential up to a critical voltage ? **CBSE (AI)-2013**

[Ans. As the number of minority charge carriers is very small, so the current is almost independent of the applied voltage up to reverse breakdown voltage

PHYSICS CLASS-XII –SEMICONDUCTOR

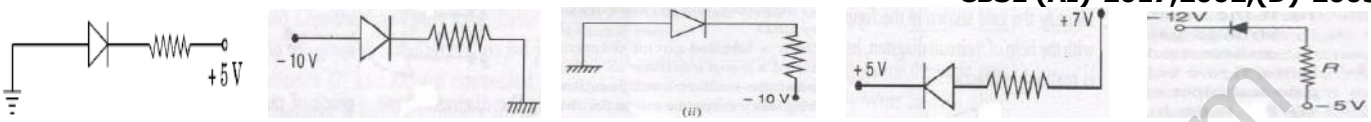
925. Why does the reverse current shows a sudden increase at the critical voltage ? **CBSE (AI)-2013**

[Ans. At the critical voltage, i,e, reverse breakdown voltage, the applied voltage is large enough to break covalent bonds producing more minority charge carriers which conduct causing a sudden increment in the current

926. Explain how the width of depletion region in a p-n junction diode change, when the junction is-
(i) forward biased (ii) reverse biased. **CBSE (AI)-2011, 2002,(D)-2010,2003**

[Ans. (i) decreases (ii) increases

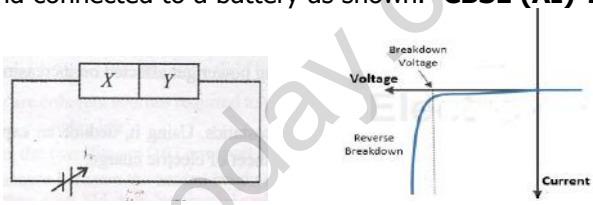
927. In the following circuit diagram, is the junction diode forward biased or reverse biased ? **CBSE (AI)-2017,2002,(D)-2005**



[Ans. (i) reverse bias (ii) reverse bias (iii) Forward bias (iv) forward bias (v) forward bias

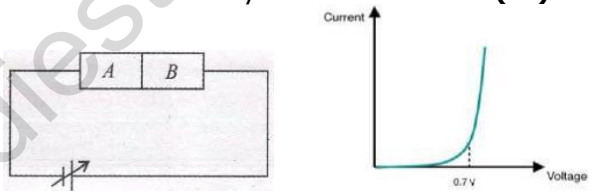
928. Two semiconductor materials X and Y shown in given figure are made by doping germanium crystal with Indium and Arsenic respectively. The two are joined end to end and connected to a battery as shown. **CBSE (AI)-2007**
(i) Will the junction be forward biased or reverse biased ?
(ii) sketch V-I graph for this arrangement.

[Ans. (i) Reverse bias



929. Two semiconductor materials A and B shown in given figure are made by doping germanium crystal with Arsenic and Indium respectively. The two are joined end to end and connected to a battery as shown. **CBSE (AI)-2007**
(i) Will the junction be forward biased or reverse biased ?
(ii) sketch V-I graph for this arrangement.

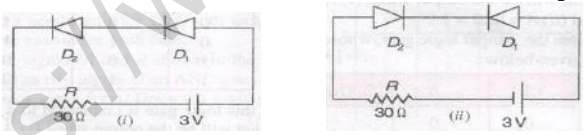
[Ans. (i) Forward bias



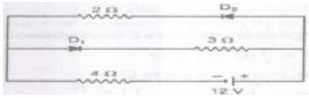
930. Draw and explain the output wave forms across the load resistor R, if the input waveform is as shown in the figure.

[Ans. **CBSE (D)-2006**

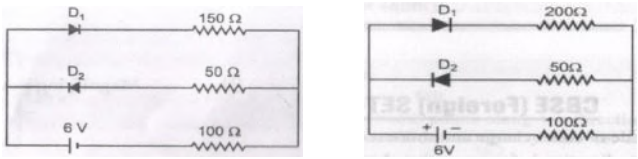
931. Determine the currents through the resistance R of the circuits (i) and (ii), when similar diodes D_1 and D_2 are connected as shown. **[Ans. (i) 0.1 A (ii) zero** **CBSE (DC)-2002**



932. The circuit shown in the figure has two oppositely connected ideal diodes connected in parallel. Find the current flowing through each diode in the circuit. **[Ans.** through D_1, I=0, through D_2, I = 2A] **CBSE (F)-2013**



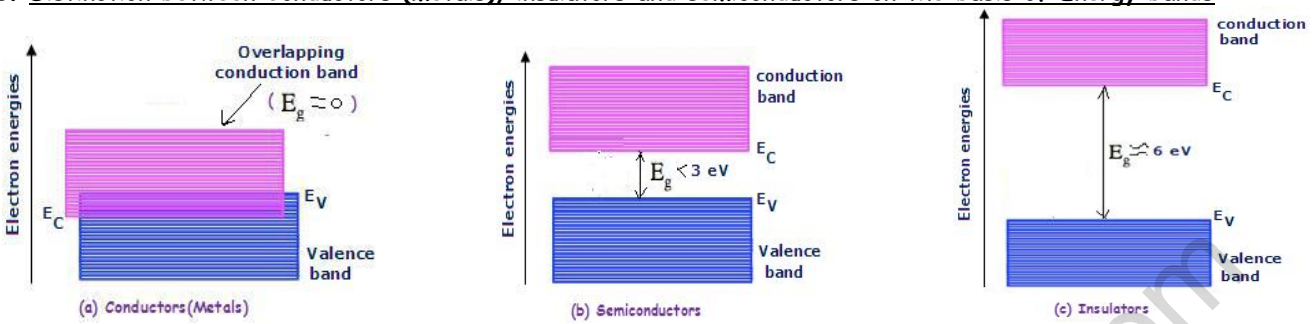
933. The circuit shown in the figure consists of two diodes each with a forward resistance of 50 Ω and infinite backward resistance. Find the current through 100 Ω resistance. **[Ans.** 6/300 A, 6/350 A] **CBSE (F)-2013**



934. Distinguish between a conductor, an insulator and a semiconductor on the basis of energy band diagrams.

CBSE (AI)-2016,2008,2006,(D)-2010,2006,2005,(F)-2003

[Ans. Distinction between Conductors (metals), insulators and semiconductors on the basis of Energy bands



1. **Conductors (Metals) :**

In conductors either conduction and valence band partly overlap each other or the conduction band is partially filled. Forbidden energy gap does not exists ($E_g \approx 0$). This makes a large number of free electrons available for electrical conduction. So the metals have high conductivity.

2. **Semiconductors :**

In semiconductors, conduction band is empty and valance band is totally filled. E_g is quite small (< 3 eV). At $0\ K$, electrons are not able to cross this energy gap and semiconductor behaves as an insulator. But at room temperature, some electrons are able to jump to conduction band and semiconductor acquires small conductivity

3. **Insulators**

In insulators, conduction band is empty and valance band is totally filled. E_g is very large (≈ 6 eV). It is not possible to give such large amount of energy to electrons by any means. Hence conduction band remains total empty and the crystal remains as insulator

935. What is p-n junction ? Explain briefly, with the help of suitable diagram, how a p-n junction is formed. Define the term Potential barrier and depletion region.

CBSE (D)-2017,2014,2010,2006,(AI)-2016,2015,2012,2009,2003,(F)-2015,2009,2006

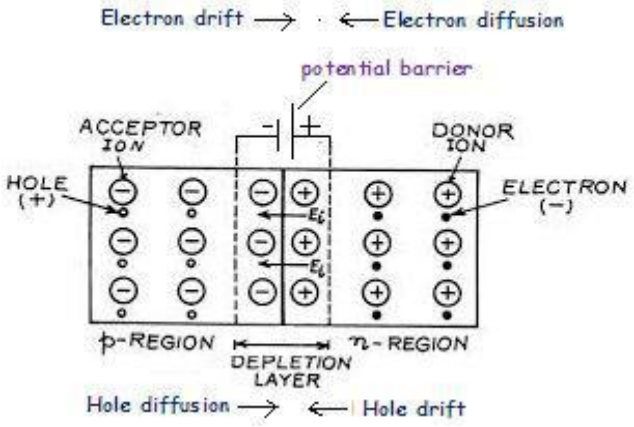
[Ans. p-n junction : When a semiconductor crystal is so prepared that, it's one half is p-type and other is n-type, then the contact surface dividing the two halves, is called p-n junction

Formation of p-n junction : potential barrier & depletion region

Diffusion and drift are the two important processes involved during the formation of a p-n junction

Due to different concentration gradient of the charge carriers on two sides of the junction, electrons from $n-side$ starts moving towards $p-side$ and holes start moving from $p-side$ to $n-side$. This process is called ***Diffusion***.

Due to diffusion, positive space charge region is created on the $n-side$ of the junction and negative space charge region is created on the $p-side$ of the junction. Hence an electric field called Junction field is set up from $n-side$ to $p-side$ which forces the minority charge carriers to cross the junction. This process is called **Drift**.



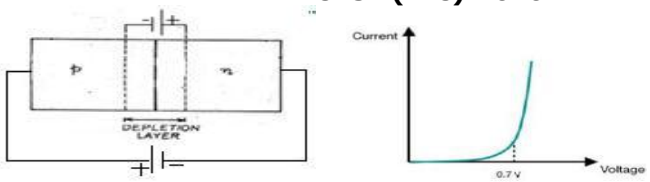
The potential difference developed across the p-n junction due to diffusion of majority charge carriers, which prevents the further movement of majority charge carriers through it, is called potential barrier. For Si, V_B = 0.7 V and for Ge, V_B =0.3 V

The small space charge region on either side of the p-n junction, which becomes depleted from mobile charge carriers is known as depletion region (10^{-6}m)

936. What is meant by forward and reverse biasing of a p-n junction ? Draw the circuit diagram of a forward and reverse biasing of a p-n junction. **CBSE (AIC)-2010**

[Ans. (i) Forward biasing :

When the positive terminal of external battery is connected to p-side and negative terminal to the n-side, then the p-n junction is said to be forward biased



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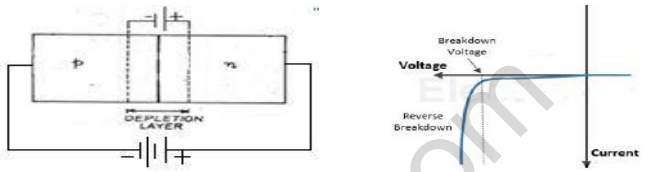
(ii) Reverse biasing :

When the positive terminal of external battery is connected to n-side and negative terminal to the p-side, then the p-n junction is said to be reverse biased



937. Describe briefly: (i) 'minority carrier injection' in forward bias (ii) 'Breakdown voltage' in reverse bias. **CBSE (AI)-2015**

[Ans. (i) Minority carrier injection in forward bias :

During forward bias, electrons from n-side cross the junction and reach p-side. (where they are minority carries). Similarly, holes from p-side cross the junction and reach the n-side (where they are minority carries). This process is known as minority carrier injection

(ii) Breakdown voltage in reverse bias : At very high reverse voltage, the current suddenly increases and becomes independent of applied voltage. This critical voltage is called breakdown voltage

938. Define the terms 'depletion region' and 'potential barrier' in a p-n junction. Explain how the width of depletion region in a p-n junction diode change, when the junction is- (i) forward biased (ii) reverse biased. **CBSE (AI)-2016,2011,2010,2002**

[Ans. Depletion region : The small space charge region on either side of the p-n junction which becomes depleted from mobile charge carriers. is known as depletion region

Potential barrier : The potential difference developed across the p-n junction due to diffusion of majority charge carriers, which prevents the further movement of these charge carriers through it, is called potential barrier

(i) Width of depletion region decreases in forward bias

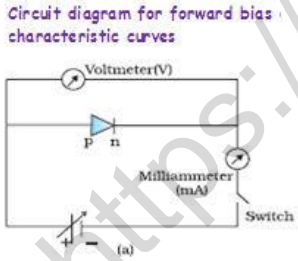
Reason : In the forward bias, external battery pushes the majority charge carriers towards the junction.

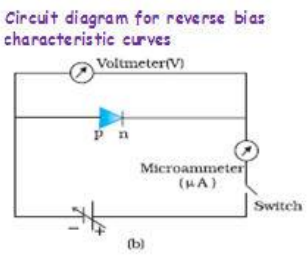
(ii) Width of depletion region increases in reverse bias

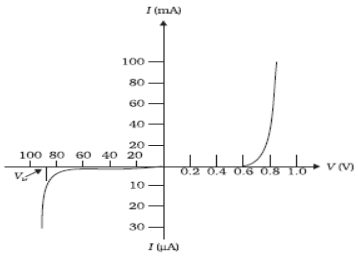
Reason : In the reverse bias, external battery attracts the majority charge carriers away from the junction.

939. Draw the circuit diagram for studying the V-I characteristics of a p-n junction diode in (i) forward bias and (ii) reverse bias. Draw the typical V-I characteristics of a silicon diode. **SE (AI)-2015,2014,2013,2010,2009,(D)-2014**

[Ans. V-I characteristics : A graph showing the variation of current through a p-n junction with the voltage applied across it, is called the voltage – current (V-I) characteristics of that p-n junction.







For different values of voltages, the value of the current is noted. A graph between *V* and **I** is obtained as in fig. This V-I graph shows that -

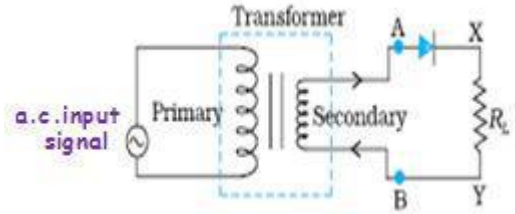
(i) At a certain forward bias voltage, current increases rapidly showing the linear variation. This voltage is known as knee voltage or threshold voltage or cut-in voltage.

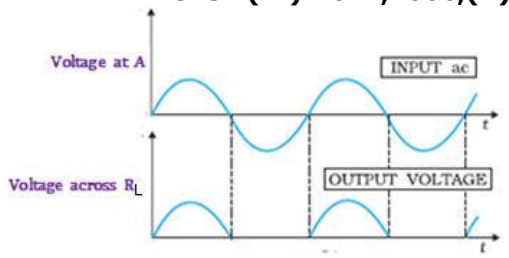
(ii) The ratio of change in forward voltage to the change in forward current is called dynamic resistance (r_d)

i,e, $r_d = \frac{\Delta V}{\Delta I}$ Ω

(iii) Under reverse bias, the current is very small (~μA) and remains almost constant. However, when reverse bias voltage reaches a high value, reverse current suddenly increases. This voltage is called Zener breakdown voltage.

940. Explain with the help of a circuit diagram, the working of p-n junction diode as half wave rectifier.
[Ans. Half wave rectifier : **CBSE (AI)-2014,2006,(D)-2009**





During the positive half cycle of ac input signal, the diode is forward biased and it conducts. Hence, there is current in the load resistance R_L and we get an output voltage.

During the negative half cycle of ac input signal, diode is reverse-biased and it does not conduct. Hence, there is no current in the load resistance and there is no output.

Thus, we get the output only for half cycle of a.c. input signal.

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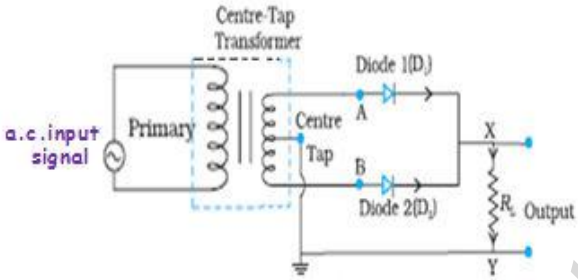
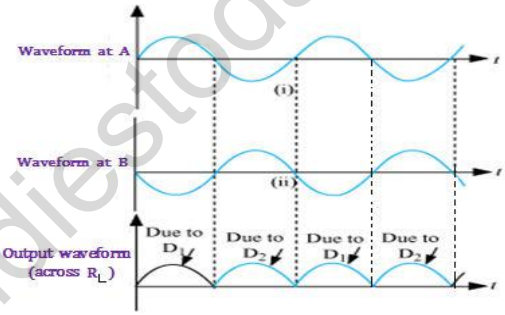
941. Draw a labelled circuit diagram of a junction diode as a full wave rectifier. Explain its underlying principle and working. Depict the input and output wave forms. **CBSE (AI)-2017,2015,2011,2006,(D)-2012,2009,(F)-2009,2005**
[Ans. Full wave rectifier





During the positive half cycle of a.c. input signal, diode D_1 gets forward biased and conducts while D_2 being reverse biased does not conducts. Hence, there is a current in R_L due to diode $D_1$and we get an output voltage.

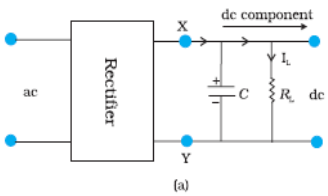
During the negative half cycle of ac input signal, diode D_1 gets reverse biased and does not conduct while D_2 being forward biased conducts. Hence, now there is a current in R_L due to diode D_2 and again we get an output voltage.

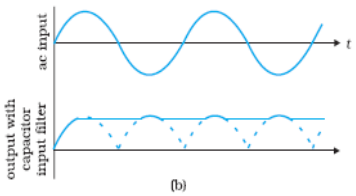
Thus, we get output voltage for complete cycle of a.c. input signal in the same direction

942. Which characteristic property makes the junction diode suitable for rectification ? **CBSE (AI)-2015**
[Ans. A p-n junction diode allows current to pass only when it is forward biased

943. Frequency of an a.c. input signal is 50 Hz. What is the output frequency of a - **CBSE (AIC)-2010**
(i) Half wave rectifier (ii) Full wave rectifier
[Ans. (i) 50 Hz **(ii)** 100 Hz

947. Describe briefly the role of a capacitor in filtering. **CBSE (AI)-2015**
[Ans. A capacitor connected across the output terminals of a rectifier offers a low resistance path for a.c. and blocks dc. So all dc will pass through load resistance R_L and we get steady current.



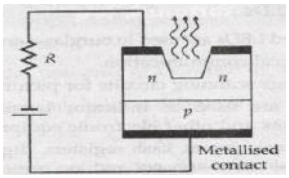


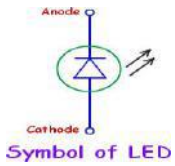
948. How are the V-I characteristics of a p-n junction diode made use of in rectification ? **CBSE (D)-2014**
[Ans. It is obvious from V-I characteristics that diode allows the current to pass only when it is forward biased. So, when an alternating voltage is applied across a junction diode, the current will flow only in that part of the cycle when diode is forward biased. This property is used to rectify the alternating voltages

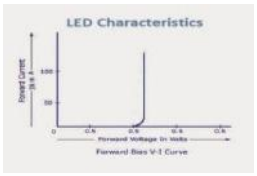
949. What is a light emitting diode ? How is a light emitting diode fabricated ? Draw a circuit diagram showing the biasing of a LED. Explain briefly the process of emission of light by a light emitting diode (LED).
CBSE (D)-2016,2004,(AI)-2015, 2010,(F)-2008,(DC)-2005

[Ans. Light Emitting Diode (LED) : It is a special heavily doped p-n junction diode, which emits spontaneous light, when forward biased. It converts electrical energy in to light energy.

LED is fabricated by- (i) heavily doped p-n junction made from a semiconductor like GaAs having $E_g \approx 1.8$ eV.
(ii) Providing a transparent cover so that light can come out







Working : When p-n junction is forward biased, electrons and holes moves across the junction from n to p and p to n-side respectively. As a result, the concentration of minority carriers increases rapidly at the junction. These excess minority carriers on either side of the junction, recombine with majority carriers and energy is released in the form of photons ($h\nu = E_g$)

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981. Give two advantages of using LEDs over conventional incandescent lamps. **CBSE (AI)-2015,2007,2004**
[Ans. low operational voltage/less power consumption/Long life/ fast on-off switching capability/no warm-up time required

982. Mention two uses of LEDs. **CBSE (AIC)-2010,2004**
[Ans. in remote controls/in electronic watches & calculators /in burglar alarm systems/ in optical communication

983. Which semiconductors are preferred to make LEDs and why ? **CBSE (AI)-2015,2010**
[Ans. GaAs and GaAsP
Reason: these materials have energy gap $E_g \geq 1.8$ eV which is suitable to produce visible light of desired wavelengths

984. What criterion is kept in mind while choosing the semiconductor material for a LED ? **CBSE (D)-2013,2007**
[Ans. semiconductor used must have an energy band gap of 1.8 eV

985. The band gap of the semiconductor used for fabrication of visible LED's must at least be 1.8 eV. Why ? **CBSE (SP)-2015**
[Ans. The photon energy of visible light photons varies about 1.8 eV to 3 eV. Hence for visible LED's the semiconductor used must have a band gap of at least 1.8 eV

986. State the factor which controls (i) wavelength/frequency of light (ii) intensity of light emitted by LED. **CBSE (F)-2008**
[Ans. (i) nature of material of diode/band gap (ii) forward biasing of LED

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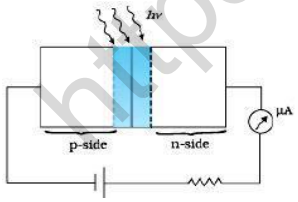
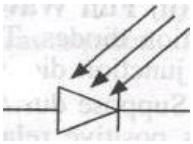
987. What is Photodiode ? How is photodiode fabricated ? Describe the working of photodiode by drawing the circuit diagram. Also draw the characteristics of a photodiode for different illumination intensities.
CBSE (AI)-2016,2015,2005,(D)-2015,2012,2005,(F)-2014,2010,2005

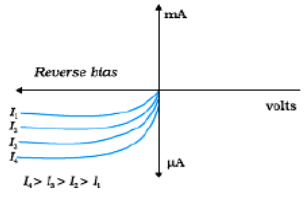
[Ans. Photodiode : It is a reverse biased p-n junction diode, in which current carriers are generated by photons through photoconduction by light

Fabrication of Photodiode : It is a special reverse biased p-n junction diode fabricated with a transparent window to allow the light of suitable frequency ($h\nu > E_g$) to fall on the junction of diode



Biasing of a photodiode


Symbol of a photodiode



Characteristics of a photodiode

Working : (i) when light of energy ($h\nu > E_g$) falls on photodiode, electron-holes pairs are generated in the depletion region due to absorption of photons
(ii) due to electric field at the junction, electrons and holes are separated before they recombine
(iii) electrons are collected on n-side and holes are collected at p-side, giving rise to an emf and current flows in the load. Photocurrent is proportional to the incident light intensity

988. Give any two uses of photodiode. **CBSE (DC)-2010**

[Ans. in detection of optical signals / in light operated switches/ in electronic counters

989. A photodiode is operated under reverse bias although in the forward bias the current is known to be more than the current in the reverse bias. Explain giving reason. **CBSE (D)-2015,2012,2005,(F)-2010,2005,(AI)-2005**

[Ans. The fractional change, due to photo effects, in the reverse bias current, is much more than the fractional change in the forward bias current. Hence, photodiode is used in reverse bias.

Explanation : Let us consider n-type semiconductor ($n \gg p$).

When illuminated with light, both type of carriers increase equally in number.

⇨ $n' = n + \Delta n$ & $p' = p + \Delta p$

Now as $n \gg p$ & $\Delta n = \Delta p$, ⇨ $\frac{\Delta n}{n} \ll \frac{\Delta p}{p}$

990. Write briefly how a photodiode can be used as a photo detector to detect optical signals. **CBSE (D)-2013**

[Ans. It is easier to observe change in the current, with change in the light intensity, when reverse bias is applied. Hence photodiode can be used as a photo detector to detect optical signals

991. A photodiode is fabricated from a semiconductor with a band gap of 2.8eV.Can it detect a wavelength of 6000nm? Justify. **CBSE (AI)-2005,(D)-2005,(F)-2005**

[Ans. $E = \frac{hc}{\lambda} = \frac{6.6\ X\ 10^{-34}\ X\ 3\ X\ 10^{8}}{6000\ X\ 10^{-9}} = 0.207\ eV$

As $E < E_g$, photodiode **cannot** detect the radiation of wavelength 6000 nm

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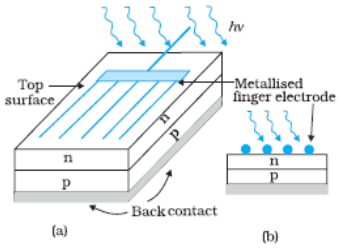
992. What is a Solar Cell ? How a solar cell is fabricated ? State the working principle of a solar cell. Mention three Basic processes involved in the generation of emf. **CBSE (F)-2016,(AI)-2015,2008**

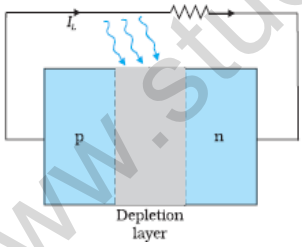
[Ans. Solar Cell : It is a p-n junction diode, which converts light energy in to electrical energy.

Principle : It is based on the principle of **photovoltaic effect**

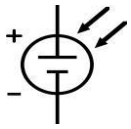
Fabrication : A simple p-n junction solar cell consists of a very thin p-Si wafer. On one side of this wafer, a thin layer of n-Si is grown by diffusion process and on the other side there is a metal coating which acts as back contact. On the top of n-Si layer, metallic grid is deposited, which acts as a front contact.



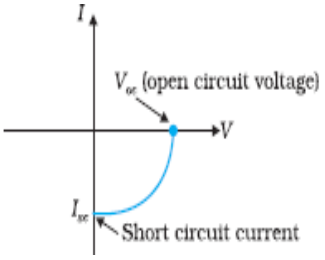
Solar cell



Circuit diagram



Symbol



characteristic curve

Working : Generation of emf by a solar cell, when light falls on, it is due to the following three basic processes:

(i) generation of electron hole pairs due to incident light (with $h\nu > E_g$) close to the junction

(ii) separation of electrons and holes due to electric field of the depletion region

(iii) the electrons reaching the n-side are collected by the front contact and holes reaching p-side are collected by the back contact. Thus p-side becomes positive and n-side becomes negative giving rise to photo voltage.

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993. Write any two uses of solar cells. **CBSE (AIC)-2010**

[Ans. (i) to power electronic devices in satellites and space vehicles

(ii) in power supply for watches, calculators

(iii) in charging solar batteries

994. Why are Si and GaAs preferred materials for solar cells ? **CBSE (F)-2016, (AI)-2008**

[Ans. Solar radiation has maximum intensity of photons of energy = 1.5 eV. Hence, semiconducting materials Si and GaAs, with $E_g \approx 1.5$ eV, are preferred materials for solar cell

995. Write two important criteria required for the selection of a material for solar cell fabrication. **CBSE (AI)-2015**

[Ans. (i) Band energy gap E_g must be of range 1.0 to 1.8 eV (ii) strong electrical conductivity

≈ *cr*(iii) high optical absorption (10^4 $^{-1}$) (iv) availability and low cost of the raw material

PHYSICS CLASS-XII –SEMICONDUCTOR

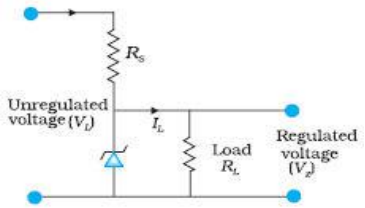
996. What is Zener diode ? How is a Zener diode fabricated ? What causes the setting up of high electric field even for small reverse bias voltage across the diode ? With the help of a circuit diagram explain the use of a Zener diode as a voltage stabilizer. **CBSE (AI)-2015,2009,2008,2004,(F)-2007,2001**

[Ans. Zener Diode: It is a heavily doped p-n junction diode specially designed to operate in the reverse breakdown region Continuously

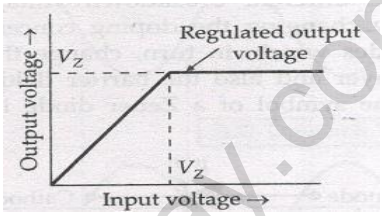
Principle : At reverse breakdown voltage, the voltage across Zener diode remains constant for a large change in reverse current.

Fabrication : Zener diode fabricated by heavily doping both p and n- side of the junction. Heavy doping makes the depletion region very thin. This makes the electric field of the junction extremely high ($\approx 5 \times 10^6$ V/m), even for a small reverse voltage ($\approx$ 5V). This in turn helps the Zener diode to act as voltage regulator

Zener diode as a Voltage stabilizer :




Symbol of Zener diode



Working :

If input voltage increases/ decreases, current through Zener diode will also increase/ decreases. It increases/ decreases voltage drop across Rs without any change in voltage across R_L as potential across Zener diode does not change in breakdown region giving the regulated output voltage

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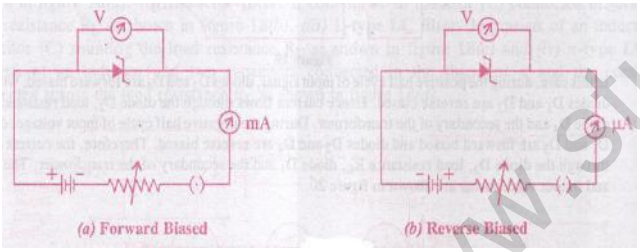
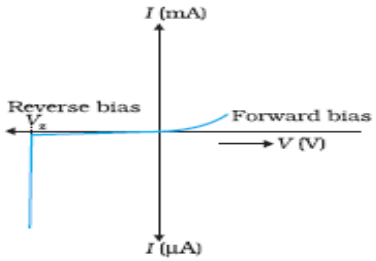
997. Draw the circuit diagram to study the characteristic curves of a Zener diode and draw its typical I-V characteristics. **CBSE (F)-2012,2010**

[Ans. Circuit diagram to draw characteristic curves :



I-V characteristic curves



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997a. Write two important considerations used while fabricating a Zener diode. **CBSE (AI)-2015,2012**

[Ans. (i) heavily doping of both p and n-sides of the junction (ii) Proper breakdown voltage under reverse biasing

997b. Why Zener diode is called a special purpose diode ?

[Ans. Because operates in reverse breakdown region and acts as a voltage regulator

997c. Why is Zener diode fabricated by heavily doping both p and n- side of the junction ? **CBSE (F)-2014**

OR

How is a Zener diode fabricated ? What causes the setting up of high electric field even for small reverse bias voltage across the diode ? **CBSE (AI)-2015**

[Ans. Zener diode fabricated by heavily doping both p and n- side of the junction. Heavy doping makes the depletion region very thin. This makes the electric field of the junction extremely high ($\approx 5 \times 10^6$ V/m), even for a small reverse voltage ($\approx$5V). This in turn helps the Zener diode to act as voltage regulator

998. Zener diodes have higher dopant densities as compared to ordinary p-n junction diodes. How does it affect the- (i) width of depletion layer (ii) junction field ? **CBSE (Sample Paper)-2010**

[Ans.(i) width of depletion layer decreases (ii) junction field increases

999. How the reverse current suddenly increases at the breakdown voltage ? Explain. **CBSE (F)-2012,2010**

[Ans. At V = *Vz*, electric field is high enough (10^6 V/m) to pull valence electrons from the host atoms on the p-side which are accelerated to n-side. These electrons account for high current observed at the breakdown. The emission of electrons from the host atoms due to the high electric field is known as internal field emission or field ionization. The breakdown of diode due to internal field emission is called Zener breakdown