CHAPTER NO. 18 (ELECTRONICS)

Question 18.1:- How does the motion of an electron in an n-type substance differ from the motion of holes in a p-type substance?

Answer:- In a n-type material, the electrons are majority charge carriers and moves from low potential (negative terminal of the battery) towards high potential (positive terminal of the battery).

In a p-type material, the holes (deficiency of free electrons in valence band) are majority charge carrier and move from high potential (positive terminal of the battery) to low potential (negative terminal of the battery).

Question 18.2:- What is the net charge of a n-type or a p-type substance?

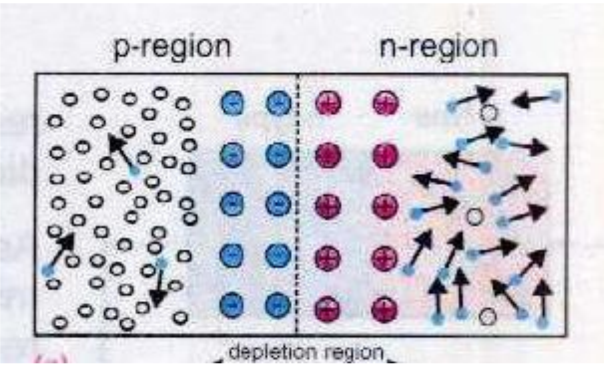
Answer:- A n-type or a p-type substance is made up of doping a pentavalent or a trivalent impurity to a pure semiconductor respectively. The net charge on n-type or p-type substance is always zero because they are made up of neutral atoms i.e. they are electrically neutral.

Question 18.3:- The anode of a diode is 0.2 V positive with respect to its cathode. Is it forward biased?

Answer:- When anode of a diode is 0.2 V positive i.e. at high potential with respect to its cathode, the diode is in forward biased conduction.

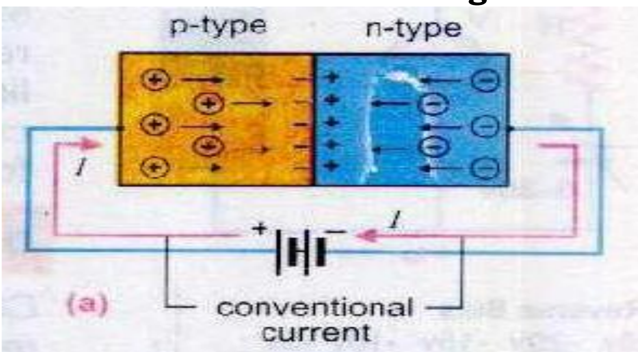
However, in case of practical diodes made up of Ge or Si, the potential barriers are 0.3 V and 0.7 V respectively, the conduction in these diodes will be very small due to small forward voltage i.e. 0.2 V.

Question 18.4:- Why charge carriers are not present in the depletion region?

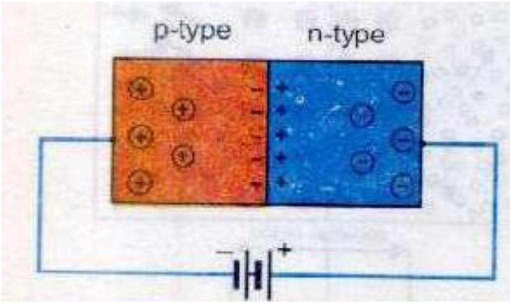


Answer:- When a piece of silicon is doped such that its one half is doped with pentavalent impurity (n-type) and other is doped with trivalent impurity (p-type), the electrons from n-type region diffuse across the junction towards p-type region an neutralize holes. This diffusion of electrons leaves behind a layer of positive ions of impurity atoms in n-type region and creates a layer of negative ions of impurity atoms in p-type region, creates a potential barrier and stops further diffusion of electrons. No mobiles charges (charge carriers) are present inside this region, therefore, it is called depletion region.

Question 18.5:- What is the effect of forward and reverse biasing of a diode on the width of depletion region?



Answer:- (a) During forward biasing, the width of depletion region is decreased because electrons have sufficient amount of energy to cross the potential barrier.



(b) During reverse biasing, the width of depletion region is increased as electrons are brought farther apart from the junction.

Question 18.6:- Why ordinary silicon diodes do not emit light?

Answer:- Emission of light is not possible from ordinary silicon diode because it is an indirect band gap element and electron-hole recombination in such material is not accompanied by any radiative emission.

(Discussion: Some notes specify that silicon diode do not emit light because it is an opaque material.

Some notes specify that band gap in silicon lies in infrared (invisible) region, so such light cannot be detected with the help of naked eye.

Answer: It is stated that in solid state physics, materials are divided into two categories **(i)** Direct band gap **(ii)** Indirect band gap.

Electron-hole recombination in direct band gap materials is always accompanied by radiative emission with the radiations having energy equal to difference in energy levels of conduction band and valence band.

Electron-hole recombination in indirect band gap materials such as crystalline silicon and germanium, is not accompanied by any radiative emission. Even, some compound semiconductors are also indirect band gap such as AlSb**).**

Question 18.7:- Why a photo diode is operated in reverse biased state?

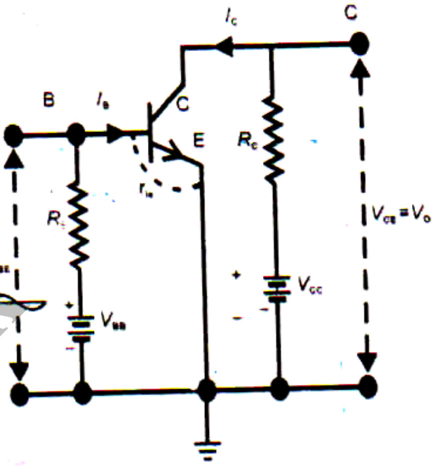
Answer:- The photodiode is operated in reverse biased state because it is used for detection of light. When no light is incident on the junction, the reverse current is almost negligible. When the junction is exposed to light, the reverse current increases with the intensity of light. Thus, reverse biasing of photodiode is useful for detection of light.

Question 18.8:- Why is the base current in a transistor very small?

Answer:- The base region of a transistor is very thin i.e. of the order of 10^{-6} m and is doped very lightly. In normal biasing, the voltage of base biasing battery V_{BB} is much smaller than collector biasing battery V_{CC}. Due to extremely small thickness, low doping level and small base biasing battery V_{BB}, the current flowing out of base lead is very small.

Question 18.9:- What is the biasing requirement of the junctions of a transistor for its normal operation? Explain how these requirements are met in a common emitter amplifier?

Answer:- For normal operation of a transistor, its base-emitter junction is made forward biased and collector-base junction is made reverse biased.



In a common emitter amplifier, base-emitter junction is made forward biased by power supply V_{BB} and collector-base junction is made reverse biased by using power supply V_{CC} as shown in figure.

Question 18.10:- What is the principle of virtual ground? Apply it to find the gain of an inverting amplifier.

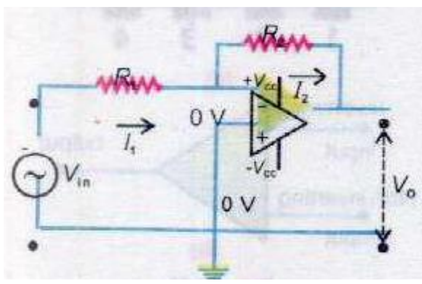
Answer:- Due to very high open loop voltage gain A_{OL} of operational amplifier, the potential difference between both the input terminal reduces to very low voltage practically of the order of 10^{-5} V considered as zero i.e. $V_+ - V_- \approx 0$ which implies that $V_+ \approx V_-$ so if $V_+ = 0$ V (actual ground) then $V_- = 0$ V (virtual ground).

If one of the input terminals is actually grounded, the potential of other input terminal reduces to zero due to high open loop voltage gain, which is called virtual ground.

<u>Inverting Amplifier</u>:- The circuit diagram for inverting amplifier is shown in figure. The current I_1 which originates from input source V_{in} passes through the resistor R_1. The same current passes through resistor R_2 towards output terminal as no current enters the inverting terminal due to high input resistance of op-amp.

$$I_1 = \frac{V_{in} - V_-}{R_1}$$

$$I_2 = \frac{V_- - V_o}{R_2}$$



Since $V_- = 0$ V and $I_1 = I_2$

We can write as $\frac{V_{in} - V_-}{R_1} = \frac{V_- - V_o}{R_2}$, Put $V_- = 0$ V and rearrange to find the voltage gain as follows:-

$G = \frac{V_o}{V_{in}} = -\frac{R_2}{R_1}$

Question 18.11:- The inputs of a gate are 1 and 0. Identify the gate if its output is (a) 0, (b) 1.

Answer:- (a) XNOR gate

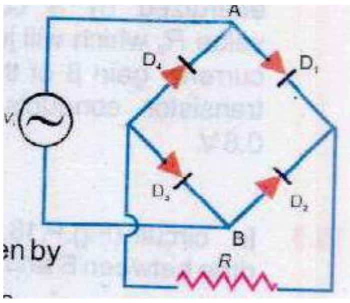
(b) XOR gate

Question 18.12:- Tick the correct answer.

Answer:- (i) A diode characteristic curve is a plot between **(c) voltage and current.**

(ii) The colour of light emitted by a LED depends on **(d) the type of semiconductor material used.**

(iii) In a half-wave rectifier the diode conducts during **d. one half on the input cycle.**



(iv) In bridge rectifier of figure when V_i is positive at point B with respect to point A, which diodes are ON?

b. D_1 and D_3

(v) The common emitter amplification factor β is given by **a.** $\frac{I_C}{I_E}$

(vi) The table of logic function **c. displays all its input/output possibilities.**

(vii) The output of two inputs OR gate is 0 only when its **a. both inputs are 0.**

(viii) A two inputs NAND gate with inputs A and B has an output 0 if **d. both A and B are 1.**

(ix) The truth table shown below is for **a. XNOR gate.**

A	B	X
0	0	1
0	1	0
1	0	0
1	1	1