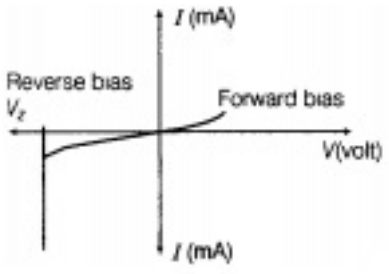
CBSE Test Paper-02

Class - 12 Physics (Electronic Devices)

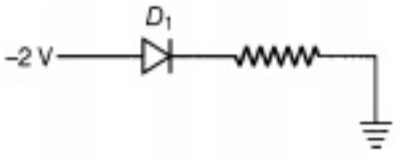
1. Depletion region (space charge) is formed because
   a. majority carriers while drifting to the other side leave behind immobile ionized atoms
   b. majority carriers while diffusing to the other side leave behind immobile ionized atoms
   c. minority carriers while diffusing to the other side leave behind immobile ionized atoms
   d. majority carriers while diffusing to the other side leave behind highly mobile ionized atoms
2. Suitable impurities are added to a semiconductor depending upon its use. This is done to
   a. increase its electrical resistivity.
   b. enable it to withstand high voltage
   c. increase its electrical conductivity
   d. increase its life
3. P-N junction can be used as
   a. a rectifier
   b. an oscillator
   c. a modulator
   d. an amplifier
4. In a semiconductor, the forbidden energy gap between the valance band and the conduction band is of the order of
   a. 1 MeV
   b. 1 ev
   c. 1 GeV
   d. 5 eV
5. In the case of metals the valence and conduction bands have
   a. no overlap, energy gap =0

b. no overlap, energy gap is large
c. no overlap, energy gap is small
d. overlap, energy gap =0

6. Figure shows the I-V characteristics of a given device. Name the device and write where it is used.

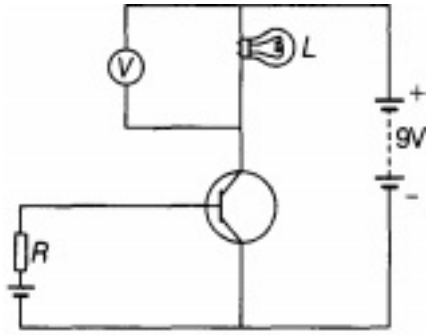


7. Which type of biasing is there in the following diode.



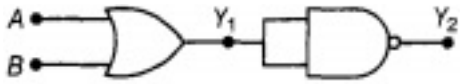
8. In the given circuit diagram, a voltmeter Vis connected across a lamp L. How would

i. the brightness of the lamp and
ii. voltmeter reading V be affected, if the value of resistance R is decreased? Justify your answer.



9. Mention the important considerations required while fabricating a p-n junction diode to be used as a Light Emitting Diode (LED). What should be the order of band gap of an LED, if it is required to emit light in the visible range?

10. i. For the digital circuit given below, write the truth table showing outputs Y_1 and Y_2 for all possible inputs of A and B.



ii. Show output waveform for all possible inputs of A and B.

11. Two amplifiers are connected one after the other in series (cascaded). The first amplifier has a voltage gain of 10 and the second has a voltage gain of 20. If the input signal is 0.01 V, calculate the output a.c. signal.

12. i. Describe the working of Light Emitting Diodes (LEDs).
    ii. Which semiconductors are preferred to make LEDs and why?
    iii. Give two advantages of using LEDs over conventional incandescent low power lamps.
13. i. Why is a photodiode operated in reverse bias mode?
    ii. For what purpose is a photodiode used?
    iii. Draw its I-V characteristics for different intensities of illumination.

14. The black box, shown here, converts the input voltage waveform into the output voltage waveform as is shown in the figure:

Draw the circuit diagram of the circuit present in the black box and give a brief description of its working.

15. i. Draw I-V characteristics of a Zener diode.
    ii. Explain with the help of a circuit diagram, the use of a Zener diode as a voltage regulator.
    iii. 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.

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Answers

1. b. majority carriers while diffusing to the other side leave behind immobile ionized atoms

   Explanation: The depletion region, also called depletion layer, depletion zone, junction region, space charge region or space charge layer, is an insulating region within a conductive, doped semiconductor material where the mobile charge carriers have been diffused away, or have been forced away by an electric field. The only elements left in the depletion region are ionized donor or acceptor impurities.

   The depletion region is so named because it is formed from a conducting region by removal of all free charge carriers, leaving none to carry a current.

2. c. increase its electrical conductivity

   Explanation: Conductivity of intrinsic semiconductors is increased by adding an appropriate amount of suitable impurity. This process is called doping. Doping is nothing but adding N or P type impurities to a pure semiconductor. So these impurities will contain electrons or holes based on their impurity. When these kind of doping takes place in semiconductors and voltage is applied, these electrons will conduct electricity. In case of holes, electrons due to potential excitation jump from their original positions to these holes and form immobile ions at that point, whereas equal amount of holes are created from where these electrons jumped. Thus conductivity increases due to doping.

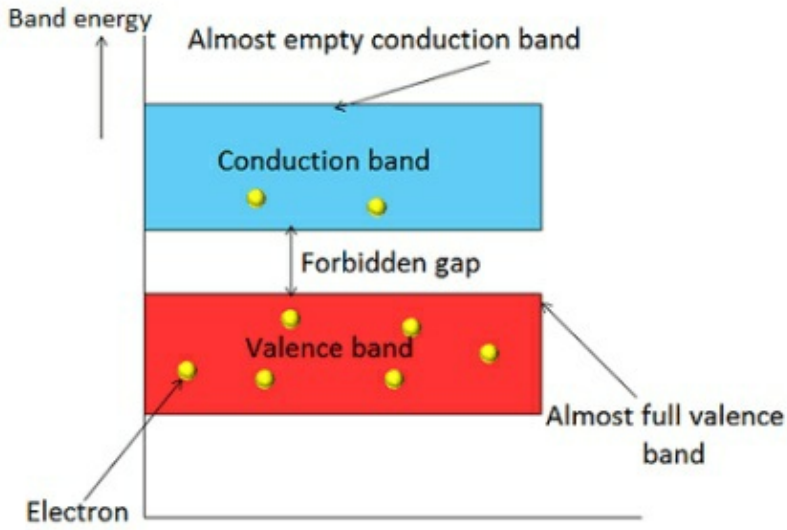
3. a. a rectifier

   Explanation: The resistance of p-n junction diode becomes low when forward biased and becomes high when reverse biased. Therefore it allows the current to pass through it when it is forward biased and does not allow when reverse biased. Hence it can rectify AC into DC.

4. b. 1 ev

   Explanation: The material which has electrical conductivity between that of a conductor and an insulator is called as semiconductor. Silicon, germanium and

graphite are some examples of semiconductors.



In semiconductors, the forbidden gap between valence band and conduction band is very small. It has a forbidden gap of about 1 electron volt (eV).

5. d. overlap, energy gap =0

Explanation: The materials can be classified by the energy gap between their valence band and the conduction band. The valence band is the band consisting of the valence electron, and the conduction band remains empty. Conduction takes place when an electron jumps from valence band to conduction band and the gap between these two bands is forbidden energy gap. Wider the gap between the valence and conduction bands, higher the energy it requires for shifting an electron from valence band to the conduction band.

- In the case of conductors, this energy gap is absent or in other words conduction band, and valence band overlaps each other. Thus, electron requires minimum energy to jump from valence band. The typical examples of conductors are Silver, Copper, and Aluminium.
- In insulators, this gap is vast. Therefore, it requires a significant amount of energy to shift an electron from valence to conduction band. Thus, insulators are poor conductors of electricity. Mica and Ceramic are the well-known examples of insulation material.
- Semiconductors, on the other hand, have an energy gap which is in between that of conductors and insulators. This gap is typically more or less 1 eV, and thus, one electron requires energy more than conductors but less than insulators for shifting valence band to conduction band.

6. The graph represents a Zener diode .It is used as a DC voltage regulator.

7. Reverse Biasing

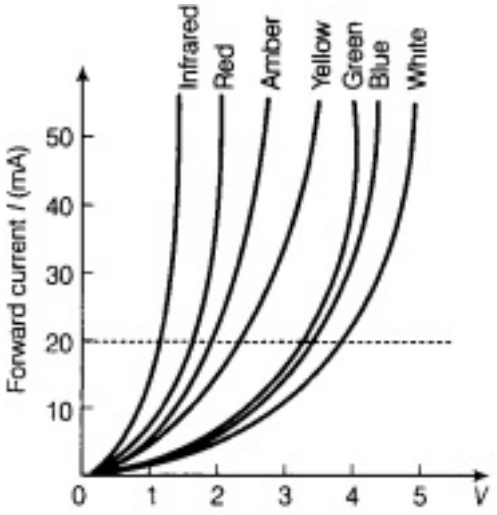
8. i. The given figure shows common-emitter (CE) configuration of an n-p-n transistor. The input circuit emitter is forward biased and collector circuit is reverse biased. As, the base resistance R decreases, the base current (I_B) and emitter current (I_E) in the circuit increases. This will also increase the collector current (l_C) as $I_E = I_B + l_C$. As l_C increases,the flow of current in the lamp increases so brightness of bulb increases.

   ii. As the current across the bulb increases so the voltage across the bulb increases. So the voltmeter connected in parallel with the lamp reads more voltage.

9. i. It is a heavily doped p-n junction.

   ii. The reverse breakdown voltages of LED are very low.

   iii. The semiconductor used for fabrication of visible LED must at least have a band gap of 1.8 eV.
   The order of band gap is about 3 eV to 1.8 eV.



The semiconductor used for fabrication of visible LEDs must at least have a band gap of l.8eV (spectral range of visible light is from about O4 μm to 0.7 μm i.e. from about 3 eV to 1.8 eV

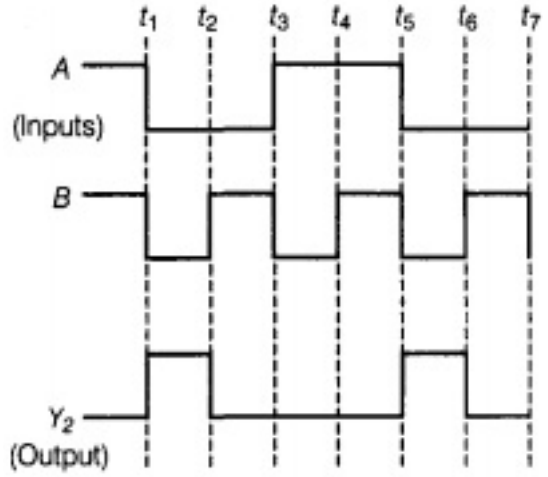
10. i. **GATE:- OR**Y_1 = A + B,

GATE:- NOR $Y_2 = \overline{A + B}$

A	**B**	**Y_1**	**Y_2**

1	1	1	0
1	0	1	0
0	1	1	0
0	0	0	1

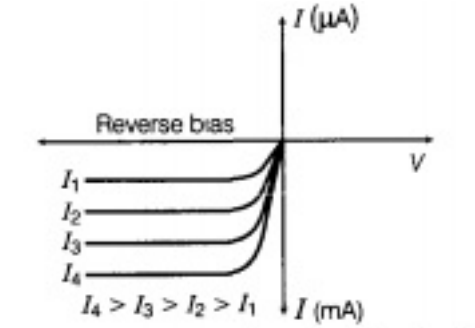
ii.



11. Total voltage gain $A_V = \frac{\Delta V_0}{\Delta V_i} = A_{V_1} \times A_{V_2}$
or $\Delta V_0 = \Delta V_i \times A_{V_1} \times A_{V_2} = 0.01 \times 10 \times 20$ = 2V

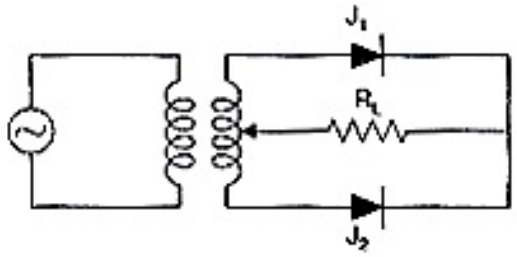
12. i. **Working of LED**: LED is a forward biased p-n junction diode which converts electrical energy into optical energy of infrared and visible light region. When high energy electron of conduction band combines with the low energy holes in valence band, then energy is released in the form of photon.
    ii. Semiconductors with appropriate band gap (E_s) close to 1.5 eV are preferred to make LED size, e.g. GaAs. The other reasons to select these materials are high optical absorption, availability of raw material and low cost.
    iii. **Uses of LEDs**
        a. LED consumes less power
        b. Unlike the lamps, they take very less operational time and have long life.
13. i. Photodiode is connected in reverse bias and feeble reverse current flows due to thermally generated electron-hole pair, known as **dark current**. When light of suitable frequency (v) such that hv > E_s, where E_s is the band gap incident on diode, additional electron-hole pair generated and current grows in the circuit.
    ii. Photodiode is used as an optical detector.

iii. Circuit diagram of illuminated photodiode in reverse bias is shown below.

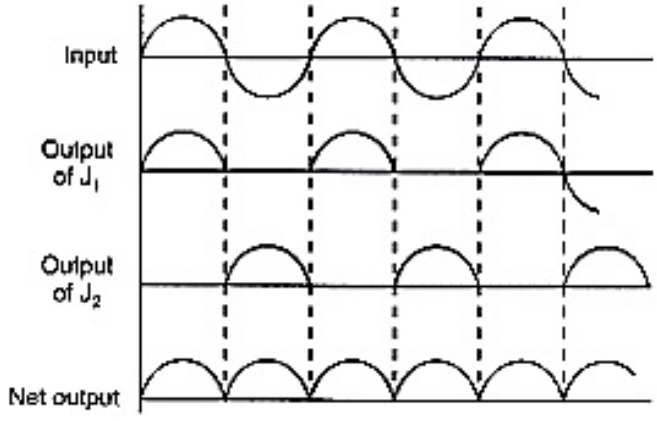


Reverse bias currents through a photodiode

14. Circuit diagram present in black box is drawn in figure.



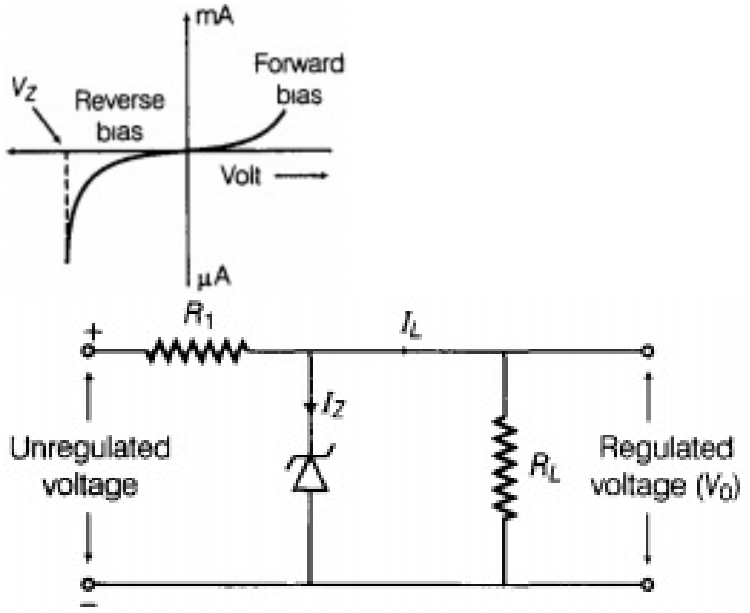
It is full wave rectifier. For half cycle of the applied input a.c. one junction diode conducts and other does not conduct to work as half wave rectifier. Similarly for another half cycle the other junction diode conducts and the first one does not conduct to work is another half wave rectifier, hence the complete applied a.c. input is rectified which is drawn across the load resistance R_L. The input and output waveform diagram is shown in the given figure.



15. i. Zener diode is used as voltage regulator.

Principle: Zener diode is a specially designed diode and it is heavily doped and operates in the reverse breakdown region. The voltage across it remains constant, equal to the breakdown voltage for large charge in reverse current. As it is connected in parallel to load so voltage across the load remains the same. I-V

characteristics of diode are as shown in the figure.



ii. Zener diode is connected with unregulated DC voltage in reverse bias in parallel across the load. When the input voltage increases, then current through R_1 increase and hence, voltage drop across R_1, increases while voltage across the Zener diode remains constant. The voltage across Zener diode remains constant beyond Zener voltage and hence, same/constant regulated voltage is obtained across R_L.

iii. In n-type semiconductor, the number density of electrons is high than the number density of holes.

$n_e > n_h$ ... (i)

As light of high energy is incident on the junction, some bonds in the crystal break and there is equal rise in number of electrons and holes [i.e. Δn (say)]

$\Rightarrow \quad \frac{1}{n_e} < \frac{1}{n_h}$

or $\quad \frac{\Delta n}{n_e} < \frac{\Delta n}{n_h}$ ...(ii)

where, Δn = change in electron or hole charge carrier. From equation (ii) , fractional change in minority charge carrier (hole) is much higher than fraction change in majority charge carriers (electron). Also, minority charge carrier contribute in drift current in reverse bias. Thus, with incidence of light, fractional change in minority charge carrier is significant as compared to the minority carriers. Therefore, photo diode should be connected in reverse bias for measuring light intensity.