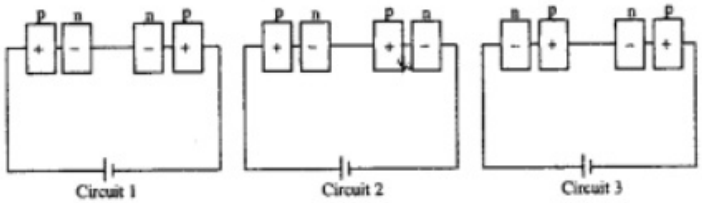
CBSE Test Paper-03

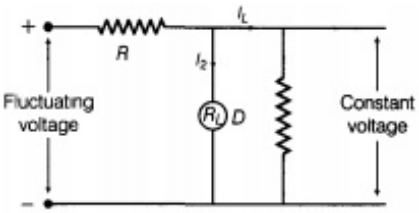
Class - 12 Physics (Electronic Devices)

1. Two identical P-N junctions may be connected in series with a battery in three ways as shown. The potential drops across the two P –N junctions are equal in

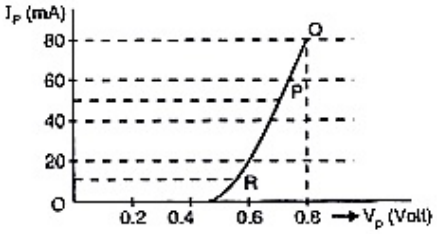


   a. circuit 1 and 2
   b. circuit 2 and 3
   c. circuit 3 and 1
   d. circuit 1 only
2. In an n-type silicon, which of the following statement is true:
   a. Holes are minority carriers and pentavalent atoms are the dopants.
   b. Electrons are majority carriers and trivalent atoms are the dopants.
   c. Holes are minority carriers and trivalent atoms are the dopants.
   d. Holes are majority carriers and trivalent atoms are the dopants.
3. Diffusion in a p-n junction is due to
   a. None of these
   b. concentration gradient
   c. carrier injection
   d. minority carriers
4. When we apply reverse bias to a junction diode it
   a. lowers the potential barrier
   b. raises the potential barrier
   c. increases the minority carrier current
   d. increases the majority carrier current
5. The depletion layer in the p-n junction region is caused by
   a. Drift of holes
   b. Drift of electrons
   c. Diffusion of carriers
   d. Migration of impurity ions

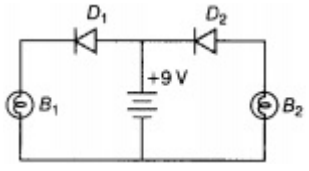
6. Name the type of biasing of a p-n junction diode so that the junction offers very high resistance.
7. What is the main cause of electron's diffusion from ntype region to ptype region, even when there is no external supply used?
8. Name the device, D which is used as a voltage regulator in the given circuit and give its symbol.



9. Name two factors on which electrical conductivity of a pure semiconductor at a given temperature depends.
10. At what temperature would an intrinsic semiconductor behave like a perfect insulator?
11. Distinguish between a metal and an insulator on the basis of energy band diagram.
12. i. How is a photodiode fabricated?
    ii. Briefly explain its working. Draw its V-I characteristics for two different intensities of illumination.
13. The characteristics curve of a diode is shown in the above figure. Determine the d.c. and a.c. resistance around point.



14. i. In the following diagram, which bulb out of B_1 and B_2 will glow and why?



    ii. Draw a diagram of an illuminated p-n junction solar cell.
    iii. Explain briefly the three processes due to which generation of emf takes place in a solar cell.
15. Mention two advantages and disadvantages of semiconductor devices.

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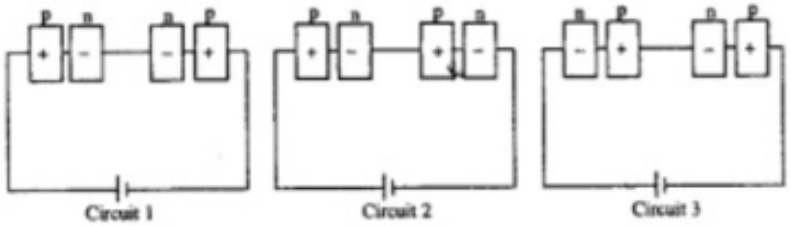
Answers

1. b. circuit 2 and 3

   Explanation: The potential drops across the two p - n junctions, connected in series, are equal in circuit 2 and circuit 3. These two circuits are either forward biased or reverse biased in terms of the p - n junctions.

   In circuit 1, the two p - n junctions are such that one is forward biased and the other is reverse biased.

2. a. Holes are minority carriers and pentavalent atoms are the dopants.

   Explanation: n-type obtained by doping the Ge or Si with pentavalent atoms. In n-type semiconductor, electrons are majority carriers and holes are minority carriers.

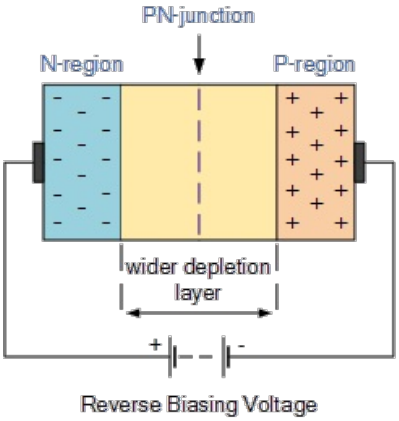
3. b. concentration gradient

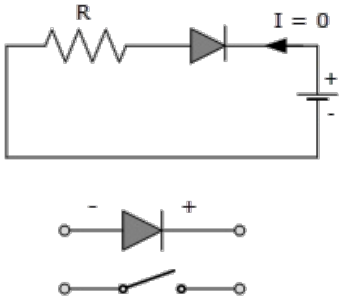
   Explanation:

   - In n-type semiconductor, the concentration of electrons is more compared to the concentration of holes. Similarly, in p-type semiconductor, the concentration of holes is more compared to the concentration of electrons
   - The first process that occurs in the p-n semiconductor is diffusion
   - In the formation of the p-n junction, due to the concentration gradient across the p and the 'n' sides, the electrons diffuse from 'n' region to 'p' region and the holes diffuse from p region to n region.

4. b. raises the potential barrier

   Explanation: When a diode is connected in a Reverse Bias condition, a positive voltage is applied to the N-type material and a negative voltage is applied to the P-type material.





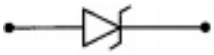
The positive voltage applied to the N-type material attracts electrons towards the positive electrode and away from the junction, while the holes in the P-type end are also attracted away from the junction towards the negative electrode. The net result is that the depletion layer grows wider due to a lack of electrons and holes and presents a high impedance path, almost an insulator. The result is that a high potential barrier is created thus preventing current from flowing through the semiconductor material.

5. c. Diffusion of carriers

   Explanation: In semiconductor physics, 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 the ionized donor or acceptor impurities.

6. Reverse biasing.
7. Because of difference in free electron density and mobility between n-type and p-type region.
8. Device - Zener diode.

   Symbol is

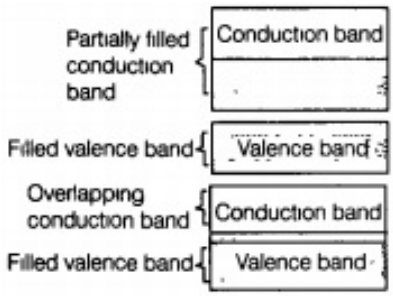
   P(anode)  N(cathode)
9. Electrical conductivity of a pure semiconductor depends upon:

   (i) The width of the forbidden band

   (ii) Intrinsic charge carrier concentration.
10. At Absolute zero temperature (0 Kelvin) the electrons in the valence band of semiconductors do not possess enough thermal energy to overcome forbidden energy

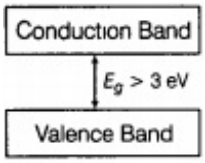
gap. So semiconductors stop conducting and behave as insulators.

11. **Metal:** For metals, the valence band is completely filled and the conduction band overlaps with balance band so it is always partially filled as shown in figure.



Metals can conduct electricity even at low electric field.

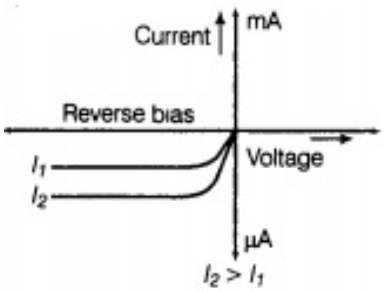
Insulators: For insulator, the forbidden energy gap between the conduction and valence bands is very large, and conduction band is practically empty, as shown below:



Large amount of energy is required by electrons to jump to the conduction band. Thus, the conduction band remains empty. So no current flows through insulators.

12. i. A photodiode is fabricated by allowing light to fall on a diode through a transparent window. It is fabricated such that the generation of e-h pairs take place near the depletion region.

    ii. **Working of photodiode:-** When a reverse biased photodiode is illuminated with the light of energy greater than the forbidden energy gap (E.,), the electron- hole pairs are generated in, or near, the depletion region. Due to junction field, electrons are collected on the n-side and holes on p-side, giving rise to a potential difference.



13. d.c. resistance

$r_{dc} = \frac{0.5}{5\times10^{-3}} = 100\Omega$

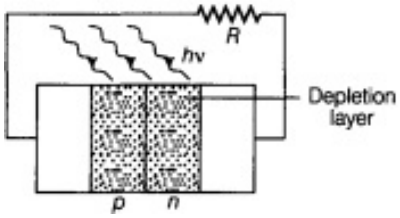
a.c. resistance

$r_{ac} = \frac{0.8-0.5}{(80-20)\times10^{-3}}$

$= \frac{0.3}{60\times10^{-3}} = 5\mu$

14. i. The bulb B_1 will glow because the diode D_1 is forward biased.

    ii. The diagram of illuminated p-n junction solar cell is given below



    iii. Processes involved due to generation of emf in a solar cell are given below

    a. Generation of electron hole pairs in the depletion region
    b. Separation of electron hole pairs leading to the generation of potential difference.
    c. When load is connected in the external circuit, current starts flowing through it due to photo-voltage.

15. **Advantages:**

- As semiconductor devices have no filaments, hence no power is needed to heat them to cause the emission of electrons.
- Since no heating is required, semiconductor devices are set into operation as soon as the circuit is switched on.
- During operation, semiconductor devices do not produce any humming noise.
- Semiconductor devices require low voltages for their operation as compared to vacuum tubes.
- Owing to their small sizes, the circuits involving semiconductor devices are very compact.
- Semiconductor devices are shock proof.

Disadvantages:

- Noise level is higher in semiconductor devices as compared to that in the vacuum tubes.
- Ordinary semiconductor devices cannot handle as much power as ordinary vacuum tubes can do. In high frequency range, they have poor response.
- The semiconductor devices are temperature-sensitive. The maximum temperature, the semiconductor devices can withstand, is very low.