INDIAN SCHOOL AL WADI AL KABIR

Class: XII	**Department: SCIENCE 2020 -21** **SUBJECT : PHYSICS**	**Date of submission:** **29.11.2020**
Worksheet No:09 **WITH ANSWERS**	**Topic: SEMICONDUCTORS**	**Note:** **A4 FILE FORMAT**
NAME OF THE STUDENT-	**CLASS & SECTION**	**ROLL NO.**

Multiple choice questions:

1. The conduction band in a solid is partially filled at 0 K. The solid sample is
   (a) conductor (b) semiconductor (c) insulator (d) none of these
2. In good conductors of electricity the type of bonding that exists is
   (a) ionic (b) Vander Waals (c) covalent (d) metallic
3. In intrinsic semiconductor at room temperature, the number of electrons and holes are
   (a) equal (b) zero (c)unequal (d) infinite
4. The forbidden energy band gap in conductors, semiconductors and insulators are E_{G1}, E_{G2} and E_{G3} respectively. The relation among them is
   (a) $E_{G1} = E_{G2} = E_{G3}$ (b) $E_{G1} > B_{G2} > E_{G3}$
   (c) $E_{G1} < E_{G2} < E_{G3}$ (d) $E_{GI} < E_{G2} > E_{G3}$
5. In an n-type semiconductor, the Fermi level lies 0.3 eV below the conduction band at 300 K. If the temperature is increased to 330 K, where does the new position of the Fermi level lie?
   (a) 0.55 eV below the conduction band
   (b) 0.44 eV below the conduction band
   (c) 0.33 eV below the conduction band
   (d) 0.27 eV below the conduction band
6. n-type semiconductor is obtained when
   (a) germanium is doped with arsenic
   (b) germanium is doped with indium
   (c) germanium is doped with aluminium
   (d) silicon is doped with indium
7. A p-type semiconductor is obtained by doping silicon with
   (a) germanium (b) gallium (c) bismuth (d) phosphorus
8. Which type of semiconductor is obtained by mixing arsenic with silicon?
   (a) n-type (b) p-type (c) Both (d) None.
9. A semiconductor is cooled from T_1 K to T_2 K. Its resistance will
   (a) decrease (b) increase
   (c) first decreases then increases (d) will not change
10. The electrical conductivity of a semiconductor increases when electromagnetic radiation of wavelength shorter than 2480 nm is incident on it. The band gap (in eV) for the semiconductor is
   (a) 0.9 (b) 0.7 (c) 0.5 (d) 1.1

11. The dominant mechanisms for motion of charge carriers in forward and reverse biased silicon p-n junction are

(a) drift in forward biased, diffusion in reverse bias
(b) diffusion in forward biased, drift in reverse bias
(c) diffusion in both forward and reverse bias
(d) drift in both forward and reverse bias

12. The reverse saturation of p-n junction

(a) depends on doping concentration
(b) depends on diffusion lengths of carriers
(c) depends on the doping concentrations and diffusion lengths
(d) depends on the doping concentrations, diffusion length and device temperature

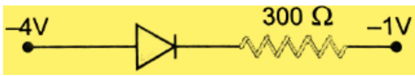
13. In the middle of the depletion layer of a reverse biased p-n junction, the

(a) electric field is zero (b) potential is zero
(c) electric field is maximum (d) potential is maximum

14. The electrical resistance of depletion layer is large because

(a) it has no charge carriers (b) it has few holes as charge carriers
(c) it contains few electrons as charge carriers (d) it contains few ions as charge carriers

15. What is the current in the circuit shown in Fig



(a) 10^{-2} A (b) 10 A (c) 1A (d) zero

16. The built-in potential of p-n junction diode is a function of

(a) temperature (b) biased voltage (c) doping density (d) all of the above

ANSWERS OF MCQs; -1. (a),2. (d), 3. (a), 4. (c), 5. (d), 6. (a), 7. (b), 8. (a), 9. (b), 10. (c), 11. (b), 12. (d), 13. (a), 14. (a), 15. (d),16. (d).

FILL IN THE BLANKS: -

1. The semiconductors available in natural form are called ....
2. The maximum possible energy possessed by free electrons of a material at absolute zero temperature is equal to ....
3. In energy band diagram, the energy gap for carbon (diamond) is ....
4. The fraction (f) of the number of electrons raised from valence band to conduction band at temperature TK in intrinsic semiconductor is given by ....
5. In .... semiconductor, the fermi level lies in the energy gap, very close to conduction band.
6. In .... semiconductor, the fermi level lies in the energy gap, very close to valence band.
7. In n-type semiconductor, the .... are majority carriers and .... are minority carriers.
8. In p-type semiconductors, the .... are majority carriers and .... are minority carriers.
9. Those solids which have high conductivity and low resistivity are called ....
10. Those solids which have very low conductivity and very high resistivity are called ....

ANSWERS OF FILL IN THE BLANKS: -

1. elemental semiconductors **2.** fermi energy **3.** 5·4 eV **4.** $f \propto e^{-Eg/(2kT)}$ **5.** n-type
6. p-type **7.** electrons, holes **8.** holes, electrons **9.** metal conductors **10.** insulators

SHORT ANSWER TYPE QUESTIONS

1. The metallic conductors are opaque. Why?

Ans: - Fee electrons of metallic conductor absorb all the light energy incident on metallic conductor and no amount of light can pass through metallic conductor.

2. Out of the ionic, covalent and metallic and Vander Waal's solids, which will be widely used to produce a conductor, semiconductor and insulator?

Ans; Metallic solids are used to produce good conductors. Covalent solids are generally used to produce semiconductors and the ionic and Vander Waal's solids are used to produce insulators.

3. C, Si and Ge have same lattice structure. Why is C insulator while Si and Ge intrinsic semiconductor?

Ans - Their valence electrons are present in the second, third and fourth orbit of the respective atoms. The energy gap of Ge is 0.72 eV, of Si is 1.1 eV and of C is 5.54 eV. The energy required to take out an electron from these atoms (i.e., ionisation energy E) maximum for C. Due to which the number of free electrons for conduction will be significant in Ge and Si but will be negligibly small for C.

4. What is fermi level and fermi energy?

Ans. In an energy band, the highest energy level occupied by electron at 0 K is called fermi level and its energy is called fermi-energy.

5. Where does the fermi-level of intrinsic semiconductor lie ?

Ans. It lies mid-way.

6. What is doping?

Ans. Doping is a process of deliberate addition of a desirable impurity in a pure semiconductor to modify its properties in a controlled manner.

7. Why doping is done in semiconductor?

Ans. To increase the number of mobile electrons/holes and hence to increase the conductivity.

8. The forbidden energy gap of germanium is 0.72 eV. What do you understand by it?

Ans. It states that if an energy of 0.72 eV is given to an electron in the valence band of germanium it will jump to the conduction band, crossing an energy gap of 0.72 eV.

9. Why diamond behaves like an insulator?

Ans. In the energy band diagram of diamond, there is a large energy gap = 5.54 eV. Due to it, no electron can go from valence band to conduction band.

10. Why do Ge and Si are semiconductors?

Ans. In the energy band diagram of Ge and Si. The energy gap is 0.72 eV and 1.1 eV respectively between conduction band and valence band. As a result of it, they behave as semiconductor.

11. Is Ohm's law obeyed in semiconductors or not?

Ans. In semiconductors, Ohms law is obeyed only for low electric field (less than 10^6 Vm).

12. Out of electron and hole, which one has higher mobility and why?

Ans. Electron has higher mobility than the hole because electron needs less energy to move in a semiconductor.

13. How does the forbidden energy gap of an intrinsic semiconductor vary with the increase in temperature

Ans. The energy gap of an intrinsic semiconductor does not change with the increase in temperature.

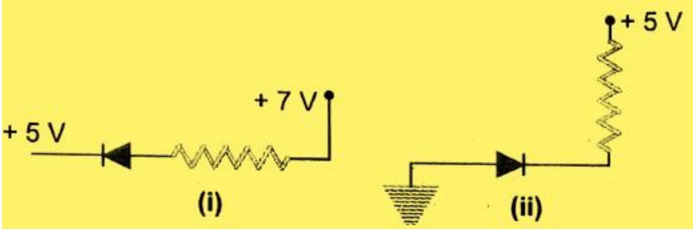
14. What happens when a forward bias is applied to ap-n junction?

Ans. The size of the depletion layer decreases. The resistance becomes low. The movement of the majority carriers takes place across the junction, resulting current, known as forward current which increases rapidly with increase in forward voltage.

15. Can we measure the potential difference of a p-n junction by putting a sensitive voltmeter across its terminals?

Ans. No, because the voltmeter to be used to measure potential difference across the p-n junction must have a very high resistance as compared to junction resistance, which is nearly infinite, if not biased. Apart from it, there are no free charge carriers in the depletion region of p-n junction.

16. In the following circuits, Fig. which one of the two diodes is forward biased and which is reverse biased?



Ans. (i) p-n junction is forward biased
(ii) p-n junction is reverse biased

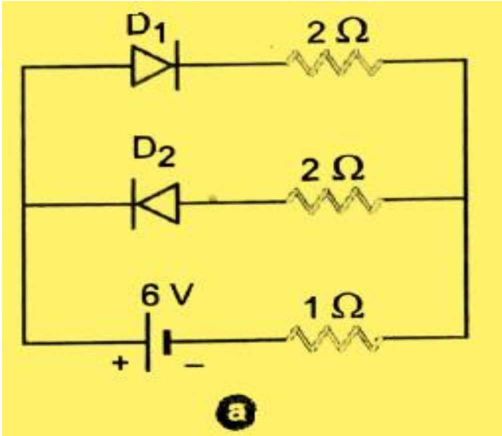
17. What is an ideal junction diode?

Ans. An ideal junction diode is one which acts as a perfect conductor when forward biased and perfect insulator when reverse biased.

18. Can we take one slab of p-type semiconductor and physically join it to another n-type semiconductor to get p-n junction?

Ans- No, any slab of p-type or n-type semiconductor, howsoever flat its surface may be, will have roughness on its surface much larger than the interatomic crystal spacing (~2 to 3 Å). When Such slabs of p-type and n-type semiconductors are brought physically in contact, a continuous contact at the atomic level will not be possible at the junction.

19. For the circuit shown in Fig, find the current flowing through the 1Ω resistor. Assume that the two diode are ideal diodes.



Ans- Here, diode D_2, is reverse biased, it offers infinite resistance.

$I = \frac{6}{(2+1)} = 2$ A.

20. The current in the forward bias is known to be more (~ mA) than the current in the reverse bias (μA). What is the reason then to operate the photodiodes in reverse bias?

Ans-

In case of n-type semiconductor, let n be the majority carrier (*i.e.*, electrons) density and p be the minority carrier (holes) density. Where $n > p$. On illumination of semiconductor, there will be production of equal number of electrons and holes. Let $\Delta n, \Delta p$ be the increase in majority carrier density and minority carrier density due to illumination of semiconductor, where $\Delta n = \Delta p$. Hence, fractional change in majority carrier ($= \Delta n/n$), fractional change in minority carrier ($= \Delta p/p$). Since $n >> p$, so $\frac{\Delta n}{n} < \frac{\Delta p}{p}$

it means, due to photo-effects the fractional change due to minority carriers dominates. As a result of it, the fractional change in the reverse bias current is more easily measurable than the fractional change in the forward bias current. It is due to this reason, photodiodes are preferably used in the reverse bias condition for measuring light intensity.

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