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| University of Salahaddin-Erbil |  | Academic Year (2021-2022) |
| College of Science |  | Examination in: |
| Department of Physics |  | **“Semiconductor Physics”** |
| 4th Year / General |  | Time: 1.5 hours |

***Q.1)*** Choose the correct answer : ***[ 10 Marks]***

1. What type of material is obtained when intrinsic semiconductor is doped with pentavalent impurity?

 **Extrinsic semiconductor, Insulator, P-type semiconductor, N-type semiconductor**

1. At room temperature a semiconductor material is

**Perfect insulator, Conductor, Slightly conducting, none of them**

1. A semiconductor has …………….. temperature coefficient of resistance.

**( negative, positive, zero, none of them )**

1. At any temperature, the total number of electrons in extrinsic semiconductor is

 **the thermally generated electrons**

 **the electrons donated by the donor atoms**

 **the sum of thermally generated electrons and the electrons donated by the donor atoms**

 **the sum of electrons and holes.**

1. Effectively, how many valence electrons are there in each atom within a silicon crystal?

**2, 4, 8, 16**

1. In the process of formation of energy bands in the Si crystal, the antibonding orbital $ψ\_{A}$ overlap to give the ………………… .

 **valence band , conduction band , energy gap**

1. The ratio of impurity atoms to intrinsic semiconductor atoms in an extrinsic semiconductor is about ………… .

**1:10 , 1:102 , 1:106 , 1:108**

1. When doping increases, ……………………… of a semiconductor decreases.

**conductivity , bulk resistance, minority carrier , majority carrier**

1. The electric current through a semiconductor is due to the drifting of

 **Holes, Electrons, Both electron and holes, Neither electrons nor holes**

1. Fermi energy level for p-type extrinsic semiconductors lies

 **At middle of the band gap, Close to conduction band, Close to valence band, Anywhere**

***Q.2)*** Calculate the intrinsic carrier concentration in Gallium Arsenide at *T = 300 K*. The values of the density of allowed states near the edges of the conduction band and valence band at $300 K$ for gallium arsenide are $4.7×10^{17} cm^{-3}$ and $7.0×10^{18} cm^{-3}$ , respectively. Assume the band gap energy of gallium arsenide is $1.42 eV$ and does not vary with temperature over this range.  ***[10 Marks]***

**Answer:**

$$kT=\left(8.6174×10^{-5}\frac{eV}{k}\right)\left(300k\right)=0.0259eV$$

$$n\_{i}^{2}=N\_{c}N\_{v}exp\left(\frac{-E\_{g}}{kT}\right)$$

$$n\_{i}^{2}=\left(4.7×10^{17}\right)\left(7.0×10^{18}\right)exp\left(\frac{-1.42}{0.0259}\right)=5.09×10^{12}$$

*So that*

$$n\_{i}=2.26×10^{6}cm^{-3}$$

***Q.3)***

 ***A/*** Give two differences between intrinsic and extrinsic semiconductors.  ***[4 Marks]***

**Answer:**

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Note: There are more than these two differences may be written.

***B/*** State three main properties of semiconductors. **[6 Marks]**

**Answer:**

Some main properties of semiconductors are,

1. The resistivity is less than an [insulator](https://www.electrical4u.com/electrical-insulator-insulating-material-porcelain-glass-polymer-insulator/) and more than a conductor.
2. The temperature coefficient of resistance is negative.
3. When impurities are added to a [semiconductor](https://www.electrical4u.com/theory-of-semiconductor/), the resistivity of the semiconductor changes abruptly.

***Q.4)***

***A/***  State the expression for the temperature dependence of intrinsic carrier concentration in an intrinsic semiconductor and show how this quantity depends on the temperature.

**[5 Marks]**

**Answer:** The relation between temperature and concentration of charge carrier in a pure or intrinsic semiconductor is given as $n\_{i}=A\_{o}T^{3/2} e^{-\frac{E\_{g}}{2kT}}$

where, ***T*** is the temperature in Kelvin scale. From the above equation, it is found that the concentration of charge carriers in a semiconductor exponentially increases very rapidly with the increase of temperature.

***B/*** Define only two of the following : **[5 Marks]**

Semiconductor, Doping in semiconductor, Binary semiconductor, Energy band diagram.

**Answer:**

Semiconductor: The materials that are neither conductor nor insulator with energy gap of about 1 eV are called semiconductors.

 Doping in semiconductor: The process of changing the conductivity property of semiconductor by adding impurities is known as doping.

Binary semiconductor: Combination of group (III) and group (V) or group (II) and group (VI) elements produce binary semiconductor compounds such as (AlP, AlAs, GaAs, InP,…),

 ( ZnO, ZnS, ZnSe, ZnTe, CdS, CdSe, CdTe)…….

 Energy band diagram: is the diagram shows the levels of energies of electron in the material.

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Constants:

Electronic charge: $e=1.6×10^{-19} c$

Planck constant: $h=6.626×10^{-34} J.s$

 Boltzmann’s constant: $k=8.617×10^{-5} eV/K$

Good luck  ***Lecturer: Jala Muhamed***