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Courses » Introduction to Solid State Physics

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# Unit 11 - Introductory Semiconductor Physics

Register for  
Certification exam

## Course outline

How to access  
the portal

Introduction to  
Drude's free  
electron theory  
of metals,  
electrical  
conductivity  
Ohm's law and  
Hall effect

Introduction to  
Sommerfeld's  
model

Specific heat of  
an electron gas  
and the  
behaviour of  
thermal  
conductivity of a  
solid and  
relationship with  
electrical  
conductivity

Introduction to  
crystal structure  
and their  
classifications

Direct Imaging  
of Atomic  
Structure.

## Assignment 10

The due date for submitting this assignment has passed.

As per our records you have not submitted this **Due on 2019-04-10, 23:59 IST.**  
assignment.

1) The band gap of a semiconducting material is 1.18 eV and it has no impurities . If and **1 point**  
the  
effective masses of hole and electrons are taken to be the same as the free electron mass, the  
number density of electrons in the conduction band (or the number density of holes in the  
valence band) of this material at 300K will be of the order of

- $10^{15} m^{-3}$
- $10^{19} m^{-3}$
- $10^{23} m^{-3}$
- $10^{29} m^{-3}$

**No, the answer is incorrect.**

**Score: 0**

**Accepted Answers:**

$10^{15} m^{-3}$

2) A highly pure germanium sample is at room temperature (300K). If the band gap of **1 point**  
germanium is 0.7eV, the temperature at which the conductivity of a sample of germanium is 25%  
higher than that at the room temperature is close to

- 405K
- 305K
- 325K
- 375K

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### Crystals with Monatomic Basis, Acoustic modes

### Two Atoms per Primitive Basis, Quantization of Elastic Waves, Phonon Momentum

### Bloch's theorem for wavefunction of a particle in a periodic potential, nearly free electron model, origin of energy band gaps, discussion of Bloch wavefunction

### Band theory of metals, insulators and semiconductors, Kronig-Penney model, tight binding method of calculating bands, and semi-classical dynamics of a particle in a band

### Introductory Semiconductor Physics

- Concept of hole as a current carrier in semiconductors-I
- Concept of hole as a current carrier in semiconductors-II
- Calculating carrier density in semiconductors - I
- Calculating carrier density in semiconductors - II
- Donor and acceptor energy levels in a

ce De about this material will be at

- 11.3 meV
- 5.6 meV
- 1.3 meV
- 0.7 meV

No, the answer is incorrect.

Score: 0

Accepted Answers:

-0.7 meV

4) In a particular semiconductor, there are  $10^{19}$  donors/ $m^3$  and conduction level is 1 meV below the bottom of the conduction band. If the effective mass of electrons in conduction band is  $m_e^* = 0.01m_e$ , the number density of conduction electrons at 2K will be of close to

1 point

- $7.8 \times 10^{15} m^{-3}$
- $2.8 \times 10^{16} m^{-3}$
- $5.0 \times 10^{17} m^{-3}$
- $1.2 \times 10^{18} m^{-3}$

No, the answer is incorrect.

Score: 0

Accepted Answers:

$1.2 \times 10^{18} m^{-3}$

5) In the problem above, the Fermi level is about

1 point

- 0.88 meV above the donor level
- 0.54 meV above the donor level
- 0.35 meV above the donor level
- 0.18 meV above the doneor level

No, the answer is incorrect.

Score: 0

Accepted Answers:

0.35 meV above the donor level

6) A sample of silicon contains  $10^{-4}$  atomic percent of phosphorus donors which are all singly ionized at room temperature. If the mobility of electrons in silicon is  $0.15m^2V^{-1}s^{-1}$ , the extrinsic resistivity of this material is (silicon atomic weight is 28 and its density is  $2300kgm^{-3}$ )

1 point

- $1.3 \times 10^{-3} \Omega m$
- $8.4 \times 10^{-4} \Omega m$
- $5.5 \times 10^{-4} \Omega m$
- $9.7 \times 10^{-5} \Omega m$

semiconductor

Charge carrier density in n-type and p-type semiconductors

Electrical conductivity and hall coefficient in semiconductors

Quiz : Assignment 10

Introduction to Solid State Physics : Feedback For Week 10

**Magnetism in materials**

**Superconductivity**

**Solutions of Assignments**

**No, the answer is incorrect.**

**Score: 0**

**Accepted Answers:**

$$8.4 \times 10^{-4} \Omega m$$

7) It may be generally expected that an intrinsic semiconductor will Hall coefficient  $R_H = 0$  because of equal number of electrons and holes. However, difference in the mobility of the carriers gives a non-zero Hall coefficient. If the number of electrons and holes is  $n$  and their mobility  $\mu_e$  and  $\mu_h$ , respectively then (keep in mind that the transverse field is such that the current in that direction vanishes) **1 point**

$$R_H = \frac{1}{ne} \left( \frac{\mu_h - \mu_e}{\mu_h + \mu_e} \right)^3$$

$$R_H = \frac{1}{ne} \left( \frac{\mu_h - \mu_e}{\mu_h + \mu_e} \right)^2$$

$$R_H = \frac{1}{ne} \frac{\mu_h^2 - \mu_e^2}{(\mu_h + \mu_e)^2}$$

$$R_H = \frac{1}{ne} \left( \frac{\mu_h^2 - \mu_e^2}{\mu_h^2 + \mu_e^2} \right)$$

**No, the answer is incorrect.**

**Score: 0**

**Accepted Answers:**

$$R_H = \frac{1}{ne} \frac{\mu_h^2 - \mu_e^2}{(\mu_h + \mu_e)^2}$$

8) For silicon semiconductor with band gap 1.12eV, position of the Fermi level at 300K,  $m_e^* = 0.12m_0$  and  $m_h^* = 0.28m_0$  is **1 point**

0.57eV

1.14eV

2.5eV

0.27eV

**No, the answer is incorrect.**

**Score: 0**

**Accepted Answers:**

0.57eV

9) The electrical conductivity of intrinsic Silicon at 300K, having electron mobility  $\mu_e = 0.15m^2V^{-1}s^{-1}$  and hole mobility  $\mu_h = 0.05m^2V^{-1}s^{-1}$  is close to **1 point**

$$3.84\Omega - m^{-1}$$

$$38.4\Omega - m^{-1}$$

$$1.42\Omega - m^{-1}$$

$$14.2\Omega - m^{-1}$$

**No, the answer is incorrect.**

**Score: 0**

**Accepted Answers:**

$$3.84\Omega - m^{-1}$$

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