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NPTEL

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Courses » Semiconductor Devices and Circuits

Announcements

Course

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Unit 3 - Week 2 : Excursion in Solid State Physics

Course outline

How to access the portal

Week 1 : Excursion in Quantum Mechanics

Week 2 : Excursion in Solid State Physics

- Solids :
Formation of
Bands, Kronig-
Penney Model
- Solids : Kronig-
Penney Model -
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- Solids :
Electrons and
Holes
- Solids :
Electrons and
Holes -
Continued
- Solids :
Crystals
- Quiz :
Assignment 2
- Assignment 2
solution

Week 3 : Density

Assignment 2

The due date for submitting this assignment has passed.

As per our records you have not submitted this assignment.

Due on 2018-08-15, 23:59 IST.

1) Number of lattice points per unit cell in a body-centered cubic lattice is

1 point

- ☐ 1
- ☐ 2
- ☐ 3
- ☐ 4

No, the answer is incorrect.

Score: 0

Accepted Answers:

2

2) Gallium Arsenide (GaAs) has a zinc-blend crystal structure (which is equivalent to face-centered cubic lattice with two atoms per lattice point). Assume a lattice spacing of $a = 5.65$ angstrom. How many numbers of atoms per cc are there in GaAs?

1 point

- ☐ 4.44×10^{22}
- ☐ 2.22×10^{22}
- ☐ 1.42×10^8
- ☐ 2.51×10^{15}

No, the answer is incorrect.

Score: 0

Accepted Answers:

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- ☐ 164.1
- ☐ 2.88

No, the answer is incorrect.

Score: 0

Accepted Answers:

2.88

Week 5 : Metal-
Semiconductor
Junctions

Week 6 : PN
Junction

Week 7 : Bipolar
Junction
Transistors

Week 8 : Metal
Oxide
Semiconductor
Capacitor
(MOSCAP) and
CV
Characteristics

Week 9:
MOSFET: I

Week 10:
MOSFET: II

Week 11:
Circuits

Week 12: Thin
Film Transistors
(TFTs), Tutorial
Sessions

4) Consider a semiconductor whose energy dispersion relation for the conduction band is defined by **1 point**

$$E = A + B(k - C)^2$$

where, A, B and C are constants. Assume the mobility of the electron is μ_0 . Find the mean free time of electrons in the conduction band.

☐ $\frac{\mu_0}{2Bq\hbar^2}$

☐ $\frac{Bq\hbar^2}{\mu_0}$

☐ $\frac{\mu_0\hbar^2}{2Bq}$

☐ None of the above

No, the answer is incorrect.

Score: 0

Accepted Answers:

$\frac{\mu_0\hbar^2}{2Bq}$

5) Assume that the electrons in an n-doped crystalline silicon suffer scattering only due to i) the lattice vibration and ii) the interaction with impurity ions. At an extremely low temperature region, mobility _____ with increase in temperature. (Fill in the gap) **1 point**

- ☐ increases
- ☐ decreases
- ☐ remains constant
- ☐ becomes zero

No, the answer is incorrect.

Score: 0

Accepted Answers:

increases

6) Consider a 1D crystal with lattice constant 'a' and crystal length 'L'. Where do you observe the energy band gaps on the energy dispersion graph (E-k diagram)? **1 point**



At $k = n \frac{\pi}{a}$, where n is an integer



At $k = n \frac{\pi}{L}$, where n is an integer



At $k = n \frac{\pi}{a}$, where n is any real number



At $k = n \frac{\pi}{L}$, where n is any real number

No, the answer is incorrect.

Score: 0

Accepted Answers:

At $k = n \frac{\pi}{a}$, where n is an integer

7) What is a Brillouin zone?

1 point

- ☐ A region of position-space where the electrons can reside within.
- ☐ A region of energy-space that contains all the allowed energy levels.
- ☐ Another name for the unit cell of the crystal.
- ☐ A region of k-space that contains all the unique solutions of the wave-equation.

No, the answer is incorrect.

Score: 0

Accepted Answers:

A region of k-space that contains all the unique solutions of the wave-equation.

8) Consider the following 1D band structure:

1 point

$$E(k_x) = \hbar v_F |k_x|$$

where, v_F is a velocity. What is the effective mass?

- ☐ $m^* = \hbar v_F$
- ☐ $m^* = \infty$
- ☐ $m^* = 0$
- ☐ Not defined

No, the answer is incorrect.

Score: 0

Accepted Answers:

Not defined

9) Bloch's theorem for a periodic potential is given by, $\psi(x + a) = \psi(x)e^{ika}$, where 'a' is the lattice constant. Assume that $u(x)$ is the periodic lattice potential given by $u(x + a) = u(x)$. Which of the following represents an equivalent mathematical form of Bloch's theorem? **1 point**

- ☐ $\psi(x + a) = u(x)e^{ikx}$
- ☐ $\psi(x + a) = u(x + a)e^{ika}$
- ☐ $\psi(x) = u(x)e^{ikx}$
- ☐ $\psi(x) = u(x)e^{ik(x+a)}$

No, the answer is incorrect.

Score: 0

Accepted Answers:

$\psi(x) = u(x)e^{ikx}$

10) Molybdenum (Mo) crystallizes in a body-centered cubic structure with a lattice constant of $a = 3.147$ angstrom. If the radius of a Mo atom is one-half of the center-to-center spacing of the nearest neighbours, compute the percent of the cubic volume, a^3 , that is occupied by Mo atoms. **1 point**

☐ 50 %☐ 68 %☐ 32 %☐ 78 %

No, the answer is incorrect.

Score: 0

Accepted Answers:

68 %

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