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Courses » **Solid State Chemistry** Announcements **Course** Ask a Question Progress FAQ

Unit 14 - Week 11 : Theory of Electronic Structure of Solids

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Course outline

Assignment 11

The due date for submitting this assignment has passed.
As per our records you have not submitted this assignment.

Due on 2019-04-17, 23:59 IST.

1) For a free electron in 3 dimensions travelling along the negative z direction, the waefunction in the usual notation is given by (here k is a componenet of the wavevector) ***1 point***

- e^{ikz}
- e^{-ikz}
- $e^{-ik(x+y+z)}$
- $e^{ik(x+y+z)}$

No, the answer is incorrect.
Score: 0

Accepted Answers:
e^{-ikz}

2) For an electron in 3 dimensions confined to a cubic box of length L located between $x = 0$ and $x = L, y = 0$ and $y = L$ and $z = 0$ and $z = L$, the wavefunction is proportional to (here n_x, n_y and n_z are positive integers) ***1 point***

- $\sin\left(\frac{(n_x+n_y+n_z)\pi x}{L}\right)$
- $\sin\left(\frac{n_x\pi x}{L}\right)\sin\left(\frac{n_y\pi y}{L}\right)\sin\left(\frac{n_z\pi z}{L}\right)$
- $\sin\left(\frac{(n_x+n_y+n_z)\pi(x+y+z)}{L}\right)$

3) For a system of 20 electrons in 2 dimensions confined to cubic box of length L located between $x = 0$ and $x = L, y = 0$ and $y = L$, the Fermi energy is equal to *1 point*

- $\frac{5h^2}{m_e L^2}$
- $\frac{17h^2}{m_e L^2}$
- $\frac{32h^2}{m_e L^2}$
- None of the other choices

No, the answer is incorrect.
Score: 0

Accepted Answers:
None of the other choices

4) The effect of lattice periodicity on the wavefunction of a Bloch electron is given by the condition (here $\vec{R}$ is the Bravais lattice translation vector and $\vec{K}$ is the reciprocal lattice translation vector) *1 point*

- $\psi_{\vec{k}}(\vec{r}) = \psi_{\vec{k}}(\vec{r} + \vec{R})$
- $\psi_{\vec{k}}(\vec{r}) = \psi_{\vec{k}+\vec{K}}(\vec{r})$
- $\psi_{\vec{k}}(\vec{r}) = \psi_{\vec{k}+\vec{K}}(\vec{r} + \vec{R})$
- None of the other choices

No, the answer is incorrect.
Score: 0

Accepted Answers:
$\psi_{\vec{k}}(\vec{r}) = \psi_{\vec{k}+\vec{K}}(\vec{r})$

5) Bloch's theorem assumes that the valence electrons of the metal *1 point*

- do not interact with each other
- are confined within the crystal
- experience a periodic potential due to the atoms
- satisfy all the other three choices

No, the answer is incorrect.
Score: 0

Accepted Answers:
satisfy all the other three choices

6) The Born- von Karman boundary conditions imply that the wave vector $\vec{k}$ of the electron in a crystal satisfies (Here $\vec{R}$ and $\vec{K}$ are translation vectors of the Bravais lattice and the reciprocal lattice respectively) *1 point*

- $e^{i\vec{k}\vec{R}} = 1$
- $e^{i\vec{k}\vec{R}} = e^{i(\vec{k}+\vec{K})\vec{R}}$

$\vec{k} = \frac{n_x\pi}{L_x}\hat{i} + \frac{n_y\pi}{L_y}\hat{j} + \frac{n_z\pi}{L_z}\hat{k}$ where L_x, L_y, L_z are the lengths of the cell in the three directions and n_x, n_y, n_z are integers

None of the other choices

No, the answer is incorrect.
Score: 0

Accepted Answers:
$\vec{k} = \frac{n_x\pi}{L_x}\hat{i} + \frac{n_y\pi}{L_y}\hat{j} + \frac{n_z\pi}{L_z}\hat{k}$ where L_x, L_y, L_z are the lengths of the cell in the three directions and n_x, n_y, n_z are integers

7) For a 1D lattice of size a in a crystal of size L, the separation between allowed values of the wave vector k is equal to **1 point**

$2\pi/a$

$2\pi/L$

π/L

None of the other choices

No, the answer is incorrect.
Score: 0

Accepted Answers:
π/L

8) The concept of band gap is illustrated by **1 point**

the free electron model

the free electron model with the constraint of lattice periodicity

the nearly free electron model where the electron interacts weakly with the periodic lattice

None of the other choices

No, the answer is incorrect.
Score: 0

Accepted Answers:
the nearly free electron model where the electron interacts weakly with the periodic lattice

9) The effect of lattice periodicity on the energy of a Bloch electron is given by the relation **1 point**

$E(\vec{r}) = E(\vec{r} + \vec{R})$ only if $\vec{R}$ is a Bravais lattice vector

$E_{\vec{k}} = E_{\vec{k}+\vec{K}}$ only if $\vec{K}$ is a reciprocal lattice vector

$E_{\vec{K}} = 0$ only if $\vec{K}$ is a reciprocal lattice vector

None of the other choices

No, the answer is incorrect.
Score: 0

Accepted Answers:
$E_{\vec{k}} = E_{\vec{k}+\vec{K}}$ only if $\vec{K}$ is a reciprocal lattice vector

10) The first Brillouin zone of a monoatomic BCC crystal has the shape of a **1 point**

- cube
- truncated octahedron
- rhombic dodecahedron
- None of the other choices

No, the answer is incorrect.
Score: 0

Accepted Answers:
rhombic dodecahedron

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