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Courses » Introduction to Solid State Physics

Announcements **Course** Ask a Question Progress FAQ

Unit 6 - Direct Imaging of Atomic Structure, Diffraction of Waves by Crystals, Reciprocal lattice, Brillouin Zones

Register for Certification exam

Course outline

Assignment 5

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

Due on 2019-03-06, 23:59 IST.

1) The intensity of X-rays scattered to a point on the screen depends *1 point*

- only on the electronic density of the scattering crystal
- only on the intensity of the X-ray source
- on the Fourier transform of the density of the scattering material
- only on the wavelength of incoming X-ray

No, the answer is incorrect.
Score: 0

Accepted Answers:
on the Fourier transform of the density of the scattering material

2) The X-rays emitted by a source in the Roentgen tube are produced by hitting a target by an accelerating electron beam. The characteristics X-rays are then emitted *1 point*

- due to de-excitation of inner shell electrons in the atoms excited by the collision of electrons with the target atoms in the X-ray tube
- due to electrons de-accelerating in the target
- due to a sudden stopping of the accelerating electrons on striking the target
- due to a special property possessed by only a few specific type of metals that they can spontaneously emit X-rays when bombarded by electrons

No, the answer is incorrect.
Score: 0

Accepted Answers:
due to de-excitation of inner shell electrons in the atoms excited by the collision of electrons with the target atoms in the X-ray tube

3) The reciprocal lattice vectors of a simple cube with lattice constant a is *1 point*

- $a\hat{x},\ a\hat{y},\ a\hat{z}$
- $\frac{2\pi}{a}\hat{x},\ \frac{2\pi}{a}\hat{y},\ \frac{2\pi}{a}\hat{z}$
- $\frac{\pi}{a}\hat{x},\ \frac{\pi}{a}\hat{y},\ \frac{\pi}{a}\hat{z}$
- $\frac{a}{2\pi}\hat{x},\ \frac{a}{2\pi}\hat{y},\ \frac{a}{2\pi}\hat{z}$

No, the answer is incorrect.
Score: 0

Accepted Answers:
$\frac{2\pi}{a}\hat{x},\ \frac{2\pi}{a}\hat{y},\ \frac{2\pi}{a}\hat{z}$

4) For the FCC lattice with lattice constant a, the appropriate primitive lattice vectors are *1 point*

- $\frac{a}{2}(\hat{x}+\hat{y}),\ \frac{a}{2}(\hat{y}+\hat{z}),\ \frac{a}{2}(\hat{x}+\hat{z})$
- $\frac{a}{2}\hat{x},\ \frac{a}{2}\hat{y},\ \frac{a}{2}\hat{z}$
- $\frac{a}{2}(-\hat{x}+\hat{y}+\hat{z}),\ \frac{a}{2}(\hat{x}+\hat{y}-\hat{z}),\ \frac{a}{2}(\hat{x}-\hat{y}+\hat{z})$
- $\frac{a}{2}(\hat{x}+\hat{y}),\ \frac{a}{2}(\hat{y}+\hat{z})$

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

Magnetism in materials

Superconductivity

Solutions of Assignments

5) For the primitive lattice vectors of FCC in the previous problem, the reciprocal lattice vectors are *1 point*

- $\frac{2\pi}{a}(\hat{x}+\hat{y}+\hat{z}),\ \frac{2\pi}{a}(\hat{x}+\hat{y}-\hat{z}),\ \frac{2\pi}{a}(\hat{x}-\hat{y}+\hat{z})$
- $\frac{2\pi}{a}(\hat{x}+\hat{y}-\hat{z}),\ \frac{2\pi}{a}(\hat{x}-\hat{y}+\hat{z}),\ \frac{2\pi}{a}(-\hat{x}+\hat{y}+\hat{z})$
- $\frac{2\pi}{a}(\hat{x}+\hat{y}+\hat{z}),\ \frac{2\pi}{a}(-\hat{x}+\hat{y}+\hat{z}),\ \frac{2\pi}{a}(\hat{x}-\hat{y}+\hat{z})$
- $\frac{2\pi}{a}(\hat{x}+\hat{y}+\hat{z}),\ \frac{2\pi}{a}(\hat{x}-\hat{y}+\hat{z}),\ \frac{2\pi}{a}(\hat{x}+\hat{y}-\hat{z})$

No, the answer is incorrect.
Score: 0

Accepted Answers:
$\frac{2\pi}{a}(\hat{x}+\hat{y}-\hat{z}),\ \frac{2\pi}{a}(\hat{x}-\hat{y}+\hat{z}),\ \frac{2\pi}{a}(-\hat{x}+\hat{y}+\hat{z})$

6) The volume of the primitive unit cell of the FCC lattice with lattice constant a is *1 point*

- a^3
- $\frac{a^3}{2}$
- $\frac{a^3}{4}$
- $\frac{a^3}{8}$

No, the answer is incorrect.
Score: 0

Accepted Answers:
$\frac{a^3}{4}$

7) The volume of the reciprocal lattice of FCC of question (6) is *1 point*

- $\frac{4(2\pi)^3}{a^3}$
- $\frac{(2\pi)^3}{2a^3}$
- $\frac{(2\pi)^3}{4a^3}$
- $\frac{(2\pi)^3}{8a^3}$

No, the answer is incorrect.
Score: 0

Accepted Answers:
$\frac{4(2\pi)^3}{a^3}$

8) In a cubic lattice, the lattice planes (111) (Miller indices, h = 1, k = 1, and l = 1) are perpendicular to the reciprocal lattice vector *1 point*

- $\frac{2\pi}{a}(\hat{x}+\hat{y}+\hat{z})$
- $\frac{2\pi}{a}(\hat{x}+\hat{y})$
- $\frac{2\pi}{a}(\hat{y}+\hat{z})$
- $\frac{2\pi}{a}(\hat{x}+\hat{z})$

No, the answer is incorrect.
Score: 0

Accepted Answers:
$\frac{2\pi}{a}(\hat{x}+\hat{y}+\hat{z})$

9) The spacing between (hkl) lattice planes in a cubic lattice d_{hkl} is *1 point*

- $\frac{a}{\sqrt{h^2+k^2+l^2}}$
- $\frac{\sqrt{h^2+k^2+l^2}}{a}$
- $\frac{2\pi}{a\sqrt{h^2+k^2+l^2}}$
- $\frac{2\pi}{a}\sqrt{h^2+k^2+l^2}$

No, the answer is incorrect.
Score: 0

Accepted Answers:
$\frac{a}{\sqrt{h^2+k^2+l^2}}$

10) An x-ray of wavelength 1.5 Å is incident on the (001) plane of a cubic lattice. The first maximum is observed at an angle of $\theta = 42.2°$ then the lattice spacing is *1 point*

- 0.55 Å
- 0.33 Å
- 1.11 Å
- 2.11 Å

No, the answer is incorrect.
Score: 0

Accepted Answers:
1.11 Å

11) *1 point*
The BCC lattice structure can be considered as a cubic unit cell with basis atoms at (0,0,0) and $(\frac{a}{2}, \frac{a}{2}, \frac{a}{2})$ the value of a quantity $S = \sum_i e^{i.\vec{K}.\vec{r}_i}$ when $\vec{r}_i$ is the location of the basis atoms (where $\vec{K} = \vec{k}' - \vec{k}$ is the sca wave vector) is

- $1 + e^{i\vec{K}\frac{a}{2}(\hat{x}+\hat{y}+\hat{z})}$
- $1 + e^{-i\vec{K}\frac{a}{2}(\hat{x}+\hat{y}+\hat{z})}$
- $1 - e^{i\vec{K}\frac{a}{2}(\hat{x}+\hat{y}+\hat{z})}$
- $1 + e^{i2\vec{K}\frac{a}{2}(\hat{x}+\hat{y}+\hat{z})}$

No, the answer is incorrect.
Score: 0

Accepted Answers:
$1 + e^{i\vec{K}\frac{a}{2}(\hat{x}+\hat{y}+\hat{z})}$

12) The quantity S defined in question (11) is called the structure factor. Along with the Laue's condition, the quantity S determines the final intensity of the diffracted x-rays. (If S = 0, even if the Laue's condition is satisfied the diffracted intensity will be minimum. And S ≠ 0 with Laue's condition for maxima will give maximum intensity.) *1 point*
For the question (11) what is the condition on the Miller indices (*hkl*) for observing a maximum

- $h + k + l$ is odd
- $h + k + l$ is even
- $h = 0$ and $k + l$ is any value
- *h*, *k* and *l* has to be only zero

No, the answer is incorrect.
Score: 0

Accepted Answers:
h + k + l is even

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