Week 6: Assignment 6

The due date for submitting this assignment has passed.

Due on 2021-10-06, 23:59 IST.

As per our records you have not submitted this assignment.

The tight binding energy dispersion (E-k) relation for electrons in a one-dimensional array of atoms having lattice constant 'a' and total length 'L' is :

$$E = E_0 - \beta - 2\gamma \cos ka$$

Where E_0, β *and* γ are constants and k is the wave vector.

1) The density of states of electrons (including spin degeneracy) in the band is given by — *2 points*

- $\frac{L}{\pi\gamma a \sin(ka)}$
- $\frac{L}{2\pi\gamma a \sin(ka)}$
- $\frac{L}{2\pi\gamma a \cos(ka)}$
- $\frac{L}{\pi\gamma a \cos(ka)}$

No, the answer is incorrect.
Score: 0
Accepted Answers:
$\frac{L}{\pi\gamma a \sin(ka)}$

2) The effective mass of electrons in the band is given by — *2 points*

- $\frac{\hbar^2}{\gamma a^2 \cos(ka)}$
- $\frac{\hbar^2}{2\gamma a^2 \cos(ka)}$
- $\frac{\hbar^2}{\gamma a^2 \sin(ka)}$
- $\frac{\hbar^2}{2\gamma a^2 \sin(ka)}$

No, the answer is incorrect.
Score: 0
Accepted Answers:
$\frac{\hbar^2}{2\gamma a^2 \cos(ka)}$

3) The number of phonon branch in graphite, with four atoms in the primitive cell, is: — *2 points*

- 8, out of which 2 are acoustic and 6 optical
- 9, out of which 3 are acoustic and 6 optical
- 12, out of which 3 are acoustic and 9 optical
- 12, out of which 2 are acoustic and 10 optical

No, the answer is incorrect.
Score: 0
Accepted Answers:
12, out of which 3 are acoustic and 9 optical

Consider point ions of mass 'M' and charge 'e' immersed in a uniform sea of conduction electrons.The ions are imagined to be in stable equilibrium when at regular lattice points. If one ion is displaced a small distance 'r' from its equilibrium position, the restoring force is largely due to the electric charge within the sphere of radius 'r' centered at the equilibrium position. Take the number density of ions (or of conduction electrons) as $\frac{3}{4}\pi R^3$, which defines R.

4) The frequency of a single ion set into oscillation is given as: — *2 points*

- $\omega = \sqrt{\frac{e^2}{MR^3}}$
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- $\omega = \sqrt{\frac{MR^3}{e^2}}$
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No, the answer is incorrect.
Score: 0
Accepted Answers:
$\omega = \sqrt{\frac{e^2}{MR^3}}$

5) The value of this frequency for sodium can be roughly estimated to be: — *2 points*

- $5 \times 10^{12}\ s^{-1}$
- $4 \times 10^{10}\ s^{-1}$
- $2 \times 10^{14}\ s^{-1}$
- $3 \times 10^{13}\ s^{-1}$

No, the answer is incorrect.
Score: 0
Accepted Answers:
$3 \times 10^{13}\ s^{-1}$

6) Estimate the order of magnitude of the velocity of sound in the metal. — *2 points*

- $5 \times 10^{2}\ ms^{-1}$
- $4 \times 10^{1}\ ms^{-1}$
- $2 \times 10^{4}\ ms^{-1}$
- $3 \times 10^{3}\ ms^{-1}$

No, the answer is incorrect.
Score: 0
Accepted Answers:
$3 \times 10^{3}\ ms^{-1}$