Unit 7 - Vibrations of Crystals with Monatomic Basis, Acoustic modes

Assignment 6

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

Due on 2019-03-13, 23:59 IST

1) *1 point*

Of the following functions, which ones describe a traveling wave? All the letters used have their usual m

i: $e^{-(x+10t)^2/4}$

ii: $e^{-x^2}e^{-10t^2}$

iii: $\sin(x/4)\cos(t/2)$

iv: $\frac{1}{(\frac{x}{2}-\frac{t}{3})^2+4}$

- (i) and (ii)
- (ii) and (iv)
- (ii) and (iii)
- (i) and (iv)

No, the answer is incorrect.
Score: 0

Accepted Answers:
(i) and (iv)

2) *1 point*

If $\omega^2 = \omega_p^2 + c^2k^2$ for light wave in a plasma, where ω_p and c are constants, the group velocity of lig plasma is ,

- $\omega(k)/k$
- $kc/\omega(k)$
- $\omega(k)/kc^2$
- $kc^2/\omega(k)$

No, the answer is incorrect.
Score: 0

Accepted Answers:
$kc^2/\omega(k)$

3) *1 point*

Consider point on of mass m and charge e immersed in a uniform sea of conduction electrons. These are equilibrium at lattice points. If one ion is displaced from its equilibrium position by a distance r, the force on it is mainly due to electronic charge within the sphere of radius r. In that case, frequency of os of an ion will be (Take the number density of ions to be $\frac{3}{4\pi R^3}$) ,

- $\sqrt{\frac{e^2}{4\pi\epsilon_0 mR^3}}$
- $\sqrt{\frac{e^2}{\epsilon_0 mR^3}}$
- $\sqrt{\frac{3e^2}{4\pi\epsilon_0 mR^3}}$
- $\sqrt{\frac{3e^2}{\epsilon_0 mR^3}}$

4) *1 point*

For sodium $R = 4a_0$, where a_0 is the Bohr radius. Using result of question 3, the speed of sound in s ms^{-1} will be in the range ,

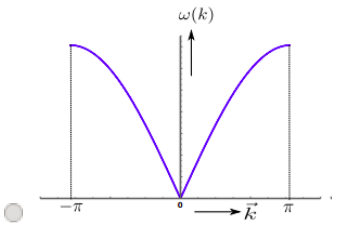
- 0 - 500
- 500 - 1000
- 1000 - 2000
- Greater than 2000

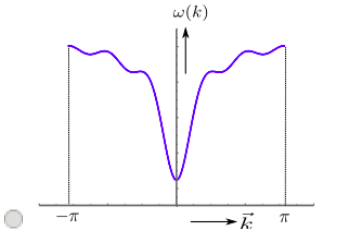
No, the answer is incorrect.
Score: 0

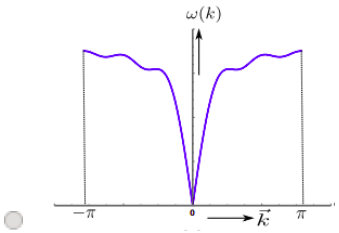
Accepted Answers:
Greater than 2000

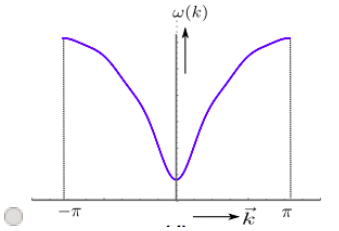
5) *1 point*

Suppose that the interaction coefficient in a one-dimensional crystal is non zero for atoms beyond neare and is of the form $c_s \propto 1/|s|$ for $s = 1, 2, \ldots, 5$. In that case the dispersion curve will appear as (use a c to generate the points),



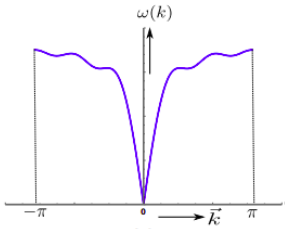






No, the answer is incorrect.
Score: 0

Accepted Answers:



6) *1 point*

Consider a long chain of atoms of mass m in a one-dimensional crystal performing vibrations in lon direction. The displacement of atoms is given as $Ae^{i(ksa-wt)}$ with all symbols having their standard r Then the momentum carried by N atoms will be proportional to,

- N
- $\sin(Nka)/\sin(ka)$
- $\sin(Nka/2)/\sin(ka/2)$
- Nka

No, the answer is incorrect.
Score: 0

Accepted Answers:
$\sin(Nka/2)/\sin(ka/2)$

7) De Broglie Wavelength of a thermal neutron carrying energy corresponding to 300K is, *1 point*

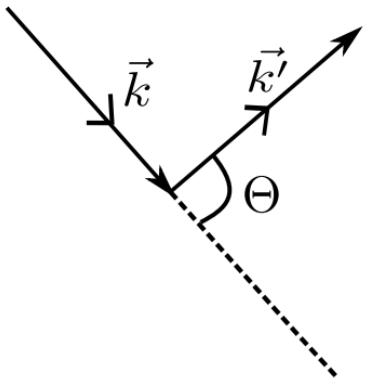
- 0.5 Å
- 1.0 Å
- 1.5 Å
- 2.0 Å

No, the answer is incorrect.
Score: 0

Accepted Answers:
1.5 Å

8) *1 point*

Consider a light wave of frequency ω travelling in a crystal of refractive index n (since wavelength of ligh larger than the spacing between atoms, one can talk about refractive index). Its wavevector in the mediun after exciting a phonon of frequency ω_q and wavevector $\vec{q}$, it changes to $\vec{k'}$ with the scattering angle b figure),



Considering energy conservation and the conservation rule $\vec{k} = \vec{q} + \vec{k'}$, which of the following describe relationship describing the scattering event,

- $q^2c^2 = 4\omega(\omega - \omega_q)\sin^2(\frac{\Theta}{2}) + \omega_q^2$
- $n^2q^2c^2 = 4\omega(\omega - \omega_q)\sin^2(\frac{\Theta}{2}) + \omega_q^2$
- $\frac{q^2c^2}{n^2} = 4\omega(\omega - \omega_q)\sin^2(\frac{\Theta}{2}) - \omega_q^2$
- $\frac{q^2c^2}{n^2} = 4\omega(\omega - \omega_q)\sin^2(\frac{\Theta}{2}) + \omega_q^2$

No, the answer is incorrect.
Score: 0

Accepted Answers:
$\frac{q^2c^2}{n^2} = 4\omega(\omega - \omega_q)\sin^2(\frac{\Theta}{2}) + \omega_q^2$

9) *1 point*

If a 532 nm laser light is incident in a solid of refractive index of 2.1 and a small fraction of photons scattering after exciting an acoustic phonon. What is the magnitude of the wavevector of the phonon and the change in the wavelength of light if the scattering angle is 90° and the speed of sound in the is 5000 ms^{-1} (to calculate the wavevector of phonon, you may neglect the energy of phonon in the a question 8),

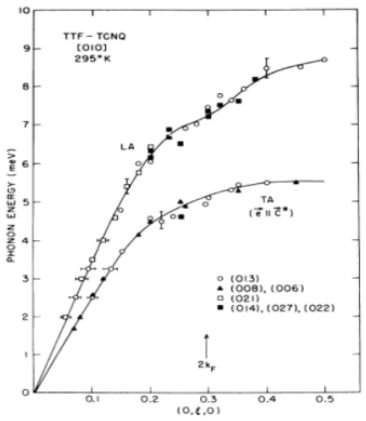
- $q = 0.5\ Å^{-1} and \quad \delta\lambda = 5nm$
- $q = 0.05\ Å^{-1} and \quad \delta\lambda = 0.10nm$
- $q = 0.0017 Å^{-1} and \quad \delta\lambda = 0.026nm$
- $q = 5\ Å^{-1} and \quad \delta\lambda = 0.0nm$

No, the answer is incorrect.
Score: 0

Accepted Answers:
$q = 0.0017 Å^{-1} and \quad \delta\lambda = 0.026nm$

10) *1 point*

Given below is the experimentally determined curve for phonon energy $\omega(k)$ versus the wavevector $\vec{k}$ TCNQ at 295K along the (010) direction which is the direction of the one-dimensional conductor chain et al., Phys. Rev. B 14, 2325 (1976)]. If the reciprocal lattice constant is 1.646 /Å along the chain directi of sound along this direction will be close to,



- 1200
- 2500
- 3200
- 4400

No, the answer is incorrect.
Score: 0

Accepted Answers:
3200

Previous Page End