

**GOVERNMENT ZIRTIRI RESIDENTIAL SCIENCE COLLEGE**

**Subject:PHYSICS**

**Paper name:Solid State Physics-II**

**Paper No:PHY/VI/CC/21(a)**

**Semester:6<sup>th</sup> Semester**

**A. Multiple choice questions [25 (5 from each unit)]**

1. The lattice wave behaves like a standing wave without any transfer of energy at frequency
  - a)  $\omega > \sqrt{2\beta / m}$
  - b)  $\omega = \sqrt{2\beta / m}$
  - c)  $\omega < \sqrt{2\beta / m}$
  - d)  $\omega = 0$
  
2. The forbidden frequency band of solids disappears at  $k = \pm\pi / 2a$ , if
  - a)  $m > M$
  - b)  $m < M$
  - c)  $m = M$
  - d)  $mM = 1$where m and M are the masses of the light and heavy atoms respectively.
  
3. For optical branch, the light and heavy atoms move in opposite directions if their respective amplitudes A and B are related as
  - a)  $A / B = 1$
  - b)  $A / B = -1$
  - c)  $AB = 1$
  - d)  $AB = 0$
  
4. Phonons are quantized energy unit and obey
  - a) MB statistics
  - b) FD statistics
  - c) BE statistics
  - d) Planks Law
  
5. If  $v_p$  and  $v_g$  be the phase velocity and group velocity of the lattice wave, then in the long wavelength side
  - a)  $v_p > v_g$
  - b)  $v_p = v_g$
  - c)  $v_p < v_g$

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- d)  $v_p = v_g = \infty$
6. All materials exhibit
- Diamagnetism
  - Paramagnetism
  - Ferromagnetism
  - Ferrimagnetism
7. The spontaneous magnetization of ferromagnetic at Curie temperature is
- 1
  - 0
  - $\infty$
  - $>0$
8. If the susceptibility of a material is independent of temperature, then it is
- Ferrimagnetic
  - Ferromagnetic
  - Paramagnetic
  - Diamagnetic
9. The ferromagnetic susceptibility is given by
- $\chi = \frac{C}{T + T_C}$
  - $\chi = C(T + T_C)$
  - $\chi = \frac{C}{T - T_C}$
  - $\chi = \frac{CT}{T + T_C}$
10. The dimension of ferromagnetic domain is of the order of
- $10^6 m$
  - $10^{-9} m$
  - $10^{-6} m$
  - $10^{-3} m$
11. In the absence of an electric field the non-polar molecules have a
- Dipole moment
  - Zero dipole moment
  - Transient dipole moment

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- d) Exponentially increasing dipole moment
12. In a polar dielectric, in absence of electric field, the dipoles are
- Parallel
  - Anti-parallel
  - Randomly oriented
  - Incline at  $45^\circ$  to horizontal direction
13. At moderate temperature  $T$ , the electronic polarisability ( $\alpha_e$ ) is
- Linearly depends on  $T$
  - Independent of  $T$
  - Inversely dependent of  $T$
  - Exponentially dependent of  $T$
14. Select the correct relation
- $D = \epsilon_0 (\epsilon_r - 1)$
  - $E = \epsilon_0 (\epsilon_r - 1) P$
  - $P = \epsilon_0 (\epsilon_r - 1) E$
  - $\epsilon_r = (\chi - 1)$
15. At optical frequencies ( $\approx 10^{15} \text{ Hz}$ ) the dielectric constant ( $\epsilon_r$ ) depends on the refractive index ( $\eta$ ) as
- $\epsilon_r \propto \eta$
  - $\epsilon_r \propto \eta^2$
  - $\epsilon_r \propto 1/\eta$
  - $\epsilon_r \propto 1/\eta^2$
16. The solution of Schrodinger equation for an electron moving in a periodic potential is of the form
- $\psi_k(\vec{r}) = e^{i\vec{k}\cdot\vec{r}}$
  - $\psi_k(\vec{r}) = u_k(\vec{r})$
  - $\psi_k(\vec{r}) = u_k(\vec{r})e^{i\vec{k}\cdot\vec{r}}$
  - $\psi_k(\vec{r}) = u_k(\vec{r}) + Ae^{i\vec{k}\cdot\vec{r}}$
17. The K-electron of copper atom is so slightly bound to the nucleus that its effective mass is
- $m_e^* = 0$
  - $m_e^* = \infty$

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- c)  $m_e^* = m_e$
- d)  $0 < m_e^* < \infty$

18. The velocity of an electron from ( $E$ -  $k$ ) curve is

- a)  $v = \frac{1}{\hbar} \frac{dE}{dk}$
- b)  $v = \hbar \frac{dE}{dk}$
- c)  $v = \frac{1}{\hbar} \frac{d^2E}{dk^2}$
- d)  $v = \frac{1}{\hbar} \left/ \frac{dE}{dk} \right.$

19. In an ( $E$ -  $k$ ) curve, the condition for energy discontinuity is

- a)  $k = \pm \frac{n\pi}{a}$
- b)  $k = \pm \frac{a}{n\pi}$
- c)  $k = \pm \frac{2a}{n\pi}$
- d)  $k = \pm \frac{n\pi}{2a}$

20. In a crystal having  $N$  primitive cells, the maximum number of electrons per band is

- a) 0
- b)  $N$
- c)  $2N$
- d)  $\infty$

21. According to BCS theory, the exchange of virtual phonons between the two electrons forming Cooper pair takes place through

- a) Magnetic field
- b) Spin-orbit inter action
- c) Lattice deformation
- d) Electric field

22. The temperature at which the conductivity of a material becomes infinite is called

- a) Critical temperature

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- b) Absolute temperature
- c) Mean temperature
- d) Crystallization temperature

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23. In a superconductor Fermi level lies
- a) Midway between the ground state and first excited state
  - b) Below the ground state
  - c) At the first excited state
  - d) Above the first excited state
24. There three important lengths which enter the theory of superconductivity except
- a) London penetration length/depth
  - b) Intrinsic coherence length
  - c) Normal electron mean free length
  - d) Mean path length
25. Which of the following is/are the properties of superconductors?
- a) They are diamagnetic in nature
  - b) They have zero resistivity
  - c) They have infinite conductivity
  - d) All of the above.

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### B. Fill up the blanks [15 (3 from each unit)]

1. At the Brillouin zone edge  $\left(k = \frac{\pi}{2a}\right)$  the lighter atom of diatomic lattice vibrates in the \_\_\_\_\_ branch.
2. Just as photon is the quantum of electromagnetic energy, phonon is the quantum energy of \_\_\_\_\_.
3. In inelastic scattering of photon by \_\_\_\_\_, a phonon is created/absorbed.
4. If  $T > T_c$ ,  $\chi$  is positive and the material behave as \_\_\_\_\_.
5. The lag of magnetisation behind the magnetising field in ferromagnetic materials is called \_\_\_\_\_.
6. The diamagnetic susceptibility \_\_\_\_\_ with increase in number of atom/volume.
7. The macroscopic field caused by a uniform polarisation is equal to the electric field in vacuum of a fictitious surface charge density given by \_\_\_\_\_ on the surface of the body.
8. Lorentz cavity field given by \_\_\_\_\_ is field from polarisation charges on inside of a spherical cavity cut out of the specimen with the reference atom as centre.
9. Claussius-Mossotti relation relates \_\_\_\_\_ with the atomic polarisability.
10. If the barrier potential strength P is large, we get \_\_\_\_\_ spectrum.
11. The value of energy of electrons in conduction band range from zero to a maximum value called \_\_\_\_\_.
12. Around  $k = 0$ , effective mass of electron  $m^*$  increases till the point of inflection of the (E-k) curve, above which  $m^*$  is \_\_\_\_\_.
13. The depth from the surface of a superconductor where the magnetic field reduces to 1/e of its value at the surface is called \_\_\_\_\_.
14. The minimum amount of current passed through the body of a superconductor in order to destroy the superconductivity is called \_\_\_\_\_.
15. The magnetic lines of force cannot penetrate the body of a superconductor, this phenomenon is known as \_\_\_\_\_.

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## Key Answers

### A. Multiple choice questions

- |        |        |        |        |        |        |        |
|--------|--------|--------|--------|--------|--------|--------|
| 1. b)  | 2. c)  | 3. b)  | 4.c)   | 5. b)  | 6.a)   | 7. b)  |
| 8. d)  | 9. c)  | 10. c) | 11. b) | 12. c) | 13. b) | 14. c) |
| 15. b) | 16. c) | 17. b) | 18. a) | 19. a) | 20. c) | 21. c) |
| 22. a) | 23. a) | 24. d) | 25. d) |        |        |        |

### B. Fill up the blanks [replace x]

1. optical
2. lattice vibration
3. lattice
4. paramagnetic
5. Hysteresis
6. increases
7.  $\frac{\mathbf{r}}{\sigma} = \hat{n} \cdot \hat{P}$
8.  $E = \frac{P}{3\epsilon_0}$
9. dielectric constant
10. line
11. Fermi energy
12. Negative
13. Penetration depth
14. Critical current
15. Meissner effect



