GOVERNMENT ZIRTIRI RESIDENTIAL SCIENCE COLLEGE

Subject: PHYSICS
Paper name: Solid State Physics
Paper No: PHY/VI/CC/21a
Semester: 6 (Sixth)

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

1. The vibration of a crystal lattice is
    a) Simple harmonic
    b) Coupled vibration
    c) Mixture of (a) and (b)
    d) None of these

2. If v_p and v_g be the phase velocity and group velocity of the lattice wave, then in the long wavelength side
    a) $v_g > v_p$
    b) $v_g = v_p$
    c) $v_g < v_p$
    d) $v_g = v_p = \infty$

3. If the heavier mass $M \to \infty$, then
    a) the acoustical branch disappears
    b) the optical branch disappears
    c) both the above branches disappear
    d) none of these

4. If the light mass $m \to 0$, then
    a) acoustical branch disappears
    b) optical branch disappears
    c) both acoustical branch and optical branch disappear
    d) none of these

5. In inelastic scattering of a photon with lattice a phonon is
    a) created
    b) absorbed
    c) created or absorbed
    d) none of these

6. The origin of magnetism in material is the presence of
    a) electric dipole
    b) magnetic dipole
    c) magnetic monopole
    d) electric monopole

7. Diamagnetic susceptibility is
    a) small and positive
    b) small and negative
    c) large and positive
    d) large and negative

8. The paramagnetic susceptibility varies as
    a) T
    b) T^2
    c) $\frac{1}{T}$
    d) $\frac{1}{T^2}$

9. The relative permeability is related to magnetic susceptibility by
    a) $\mu_r = 1 - \chi$
    b) $\mu_r = \frac{1}{\chi}$
    c) $\mu_r = \chi - 1$
    d) $\mu_r = \chi + 1$

10. The permanent magnetic moment in ferromagnetic arises due to
    a) partially filled electronic shells
    b) completely filled electronic shells
    c) innermost electronic shells
    d) none of these

11. If ε and ε_0 be the permittivity of material and of free space respectively, then the relative permittivity (or dielectric constant) of the material is
    a) $\varepsilon_r = \varepsilon_0/\varepsilon$
    b) $\varepsilon_r = \varepsilon_0\varepsilon$
    c) $\varepsilon_r = \varepsilon/\varepsilon_0$
    d) $\varepsilon_r = 1/\varepsilon\varepsilon_0$

12. In polar molecules in absence of an electric field the centre of gravity of the positive and negative charges
    a) coincides
    b) does not coincide
    c) almost coincides
    d) none of these

13. In absence of an electric field the non-polar molecules have a
    a) dipole moment
    b) zero dipole moment
    c) transient dipole moment
    d) none of these

14. Select the correct relation
    a) $D = \varepsilon_0(\varepsilon_r - 1)E$
    b) $E = \varepsilon_0(\varepsilon_r - 1)P$
    c) $P = \varepsilon_0(\varepsilon_r - 1)E$
    d) $\varepsilon_r = (\chi - 1)$

15. Lorentz field is expressed as
    a) $E_L = E + \dfrac{P}{3\varepsilon_0}$
    b) $E_L = E + \dfrac{3P}{\varepsilon_0}$
    c) $E_L = E - \dfrac{P}{3\varepsilon_0}$
    d) $E_L = \dfrac{3P}{\varepsilon_0 E}$

16. In an $(E - k)$ curve, the condition for energy discontinuity is
    a) $k = \pm\dfrac{n\pi}{a}$
    b) $k = \pm\dfrac{a}{n\pi}$
    c) $k = \dfrac{2a}{n\pi}$
    d) $k = \dfrac{n\pi}{a}$

17. The extent to which an electron is free is given by f_k, where f_k is equal to
    a) $\dfrac{m}{\hbar^2}\left(\dfrac{d^2E}{dk^2}\right)$
    b) $m\hbar^2\left(\dfrac{d^2E}{dk^2}\right)$
    c) $\dfrac{\hbar^2}{m}\left(\dfrac{d^2E}{dk^2}\right)$
    d) $\dfrac{m}{\hbar^2}\left(\dfrac{d^2k}{dE^2}\right)$

18. The solution of Schroedinger equation for an electron moving in a periodic potential is of the form
    a) $\Psi_k(\vec{r}) = e^{i\vec{k}.\vec{r}}$
    b) $\Psi_k(\vec{r}) = u_k(\vec{r})$
    c) $\Psi_k(\vec{r}) = u_k(\vec{r})e^{i\vec{k}.\vec{r}}$
    d) $\Psi_k(\vec{r}) = u_k(\vec{r}) + Ae^{i\vec{k}.\vec{r}}$

19. The effective mass of an electron moving in a periodic lattice is
    a) $m_e^* = \hbar^2 / \dfrac{d^2E}{dk^2}$
    b) $m_e^* = \hbar^2 \dfrac{d^2E}{dk^2}$
    c) $m_e^* = \dfrac{\hbar^2 d^2k}{dE^2}$
    d) $m_e^* = m_e$
    where E and k are the field and wave vectors relating to the motion of the electron.

20. 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) $v = \hbar / \left(\frac{dE}{dk}\right)$

21. The resistivity of a superconductor as $T \to 0$ becomes
    a) ∞
    b) 0
    c) any value between 0 and ∞
    d) none of these

22. Below transition temperature (T_c) a superconductor exhibits
    a) only zero resistance
    b) only diamagnetic property
    c) zero resistance and diamagnetic property
    d) zero resistance and paramagnetic property

23. The magnetic susceptibility χ of a superconductor has
    a) a positive value
    b) $\chi \to 0$ as $T \to T_c$
    c) $\chi \to \infty$ as $T \to T_c$
    d) a negative value

24. When a material becomes superconductor
    a) it becomes ferromagnetic
    b) the property of lattice structure does not change
    c) magnetic property does not change
    d) lattice property does change

25. London penetration depth is given by
    a) $\lambda = \frac{m}{\mu_0 n_s e^2}$
    b) $\lambda = \left(\frac{m}{\mu_0 n_s e^2}\right)^2$
    c) $\lambda = \left(\frac{m}{\mu_0 n_s e^2}\right)^{1/2}$
    d) $\lambda = \left(\frac{m\mu_0}{n_s e^2}\right)^{1/2}$

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

1. Group velocity of a wave is the velocity with which _____ energy is transmitted along the direction of propagation of wave
2. If the light mass m and heavy mass M be equal, then the frequency range in both the monatomic and diatomic lattices is the same and the forbidden band_____
3. Phonons are quantized energy units and obey _____
4. All materials exhibit _____
5. If the susceptibility of a material is independent of temperature, then it is _____
6. The materials in which the permanent dipoles are aligned due to bonding forces are called _____
7. The unit of dipole moment per unit volume is _____
8. The relation $\frac{N\alpha}{3\varepsilon_0} = \frac{\varepsilon_r-1}{\varepsilon_r+2}$ is called _____
9. Dielectrics are basically _____
10. The energy spectrum of an electron moving in a periodic potential consists of _____
11. According to band theory of solids an electron can have _____
12. Bloch theorem is applicable to _____
13. The width of the energy gap of a superconductor is zero at _____
14. In Cooper pair the electrons have _____
15. According to BCS theory the zero resistance of a superconductors arises due to _____

Key Answers

A. Multiple choice questions [replace x]

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

B. Fill up the blanks

1. energy
2. does not exist
3. BE-statistics
4. diamagnetism
5. diamagnetic
6. ferromagnetic
7. coulomb/metre^2
8. Clausius-Mosotti relation
9. insulators
10. allowed and forbidden energy regions
11. only the energy corresponding to energy bands
12. periodic potential
13. transition temperature
14. anti-parallel spin
15. absence of phonon scattering