QP Code: U25C039

Reg. No : ....
Name : ....

ST MARY'S COLLEGE (AUTONOMOUS), THRISSUR-20

III SEMESTER (FYUGP) DEGREE EXAMINATIONS, OCTOBER 2025
PHY3MN 202 : SOLID STATE PHYSICS AND SPECTROSCOPY
2024 Admission Onwards
(Credits: 4)

Time: 2 Hours **Maximum Marks: 70**

Section A

*Answer **all**. Each question carries **3** Marks.* ***(Ceiling: 24 Marks)***

1. State Heisenberg's Uncertainty Principle and how is it applied in real-world scenarios?
2. What are eigen values and eigen functions in quantum mechanics and how do they relate to the Schrodinger time-dependent wave equation?
3. What are the applications of carbon nanotubes?
4. Steel formed by cold rolling is harder than steel formed by hot rolling. Why?
5. Compare different types of bonding.
6. Explain the processes of absorption, spontaneous emission, and stimulated emission.
7. How molecular energies are affected by quantum restrictions?
8. What are Einstein's Coefficients?
9. Explain the concept of electronic spectra of molecules. How do electronic spectra differ from rotational and vibrational spectra?
10. Discuss characteristic vibrational frequencies of different molecular groups and explain the useless of vibrational spectra in molecular structure analysis.

Section B

*Answer **all**. Each question carries **6** Marks.* ***(Ceiling: 36 Marks)***

11. Describe the concept of a particle in a box in quantum mechanics and compare the particle's behaviour to classical systems.
12. How are the fundamental operators in quantum mechanics defined, and how do they contribute to the derivation of the Schrodinger wave equation?
13. Why do diamond and graphite exhibit different physical and electrical properties despite being forms of carbon?

Turn Over

14. The resistivity of copper is $1.72 \times 10^{-8} \Omega m$. Estimate the mean free path between collisions of the free electrons in copper. Given n=8.5 x 10^{28} electrons/m^3, Fermi velocity, $v_F = 7.4 \times 10^{-4} m/s$.

15. Explain the essential components required for laser operation.

16. What is the vibrational frequency corresponding to a thermal energy of kT at 298 K. What is the wavelength of this radiation? $k = 1.38 \times 10^{-23}\ JK^{-1}$, h= 6.6×10^{-34} Js.

17. The carbon monoxide (CO) molecule has a bond length R of 0.113 nm and the masses of the ^{12}C and ^{16}O atoms are 1.99 x 10^{-26} kg and 2.66 X 10^{-26} kg respectively. Find the energy and the angular velocity of the CO molecule when it is in its lowest rotational state. Given $h = 6.6 \times 10^{-34} Js$.

18. Prove that $y = Ae^{-i\omega(t-\frac{x}{v})}$ is a solution of the wave equation $\frac{d^2y}{dx^2} = \frac{1}{v}\frac{d^2y}{dt^2}$

Section C

Answer ***any one****. Each question carries* ***10*** *Marks.* ***(1x10=10marks)***

19. Explain the fundamental principles leading to Schrodinger equation.

20. Analyse the Concept of Raman Scattering and its applications.

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