

QP Code: D133942		Total Pages: 2	Name:
		Register No.	
<b>THIRD SEMESTER UG DEGREE EXAMINATION, NOVEMBER 2025</b>			
(CUFYUGP)			
<b>PHY3MN202-SOLID STATE PHYSICS AND SPECTROSCOPY</b>			
2024 Admission onwards			
Maximum Time :2 Hours			Maximum Marks :70
<b>Section A</b>			
<b>All Questions can be answered. Each Question carries 3 marks (Ceiling : 24 Marks)</b>			
1	What are the conditions for a wavefunction to be physically acceptable?		
2	What is meant by an operator in quantum mechanics? Write down the expressions for the momentum operator and the total energy (Hamiltonian) operator.		
3	Explain the need of an optical cavity in a laser?		
4	What is meant by Doppler broadening of spectral lines?		
5	Briefly explain the formation of metallic bond with reference to the free electron model.		
6	Explain the significance of Van der Waals forces.		
7	Explain how energy bands are formed in solids.		
8	What is Born Oppenheimer approximation?		
9	Explain the difference between fluorescence and phosphorescence.		
10	Explain the origin of rotational spectra in molecules. State the selection rule for rotational transitions.		
<b>Section B</b>			
<b>All Questions can be answered. Each Question carries 6 marks (Ceiling : 36 Marks)</b>			
11	The moment of inertia of the CO molecule is $1.46 \times 10^{-46} \text{ kg m}^2$ . Calculate the energy in eV, and the angular velocity in the lowest rotational energy level of the CO molecule.		

12	Calculate the ratio between Einstein coefficients for spontaneous emission $A_{21}$ and stimulated emission $B_{21}$ in free space when the energy difference between the states is 2.2 eV.
13	The fundamental vibration frequency of HCl is $2989 \text{ cm}^{-1}$ . Find the force constant of the HCl bond.
14	<p>A particle confined to the x-axis has the wavefunction</p> $\psi(x) = C(1-x) \text{ for } 0 \leq x \leq 1,$ $\psi(x) = 0, \text{ elsewhere.}$ <p>(a) Normalize the wavefunction and determine the constant C.</p> <p>(b) Find the probability of locating the particle between <math>x=0.25</math> and <math>x=0.5</math></p> <p>(c) Calculate the expectation value <math>\langle x \rangle</math>.</p>
15	An eigen function of the operator $\frac{d^2}{dx^2}$ is $\sin(3x)$ . Find the corresponding eigen value. Test whether $\psi(x) = e^{2x}$ is an eigenfunction of the same operator, and if so, find its eigenvalue.
16	In an NaCl crystal, the equilibrium distance $r_0$ between ions is 0.281 nm. Find the potential energy per ion pair in NaCl. Madelung constant for NaCl is 1.748.
17	The resistivity of copper at $20^\circ\text{C}$ is $1.72 \times 10^{-8} \Omega m$ . Estimate the mean free path of the collisions of the free electrons at $20^\circ\text{C}$ . Given the free electron density in copper is $8.48 \times 10^{28} m^{-3}$ and the value of fermi velocity is $1.57 \times 10^6 m/s$ .
18	What is the vibrational frequency corresponding to a thermal energy of $kT$ at 298 K. What is the wavelength of this radiation?
<b>Section C</b>	
<b>Answer any ONE .Each Question carries 10 marks (1x10=10 Marks)</b>	
19	Write an essay on the broadening of spectral lines, explaining the various factors that contribute to it.
20	Derive the energy eigenvalues and normalized eigenfunctions for a particle confined in a one-dimensional box of width L.