

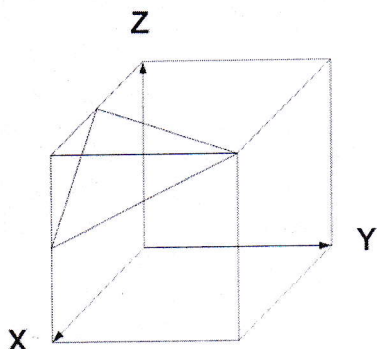

**NAVRACHANA
UNIVERSITY**
a UGC recognized University

School: School of Science
Program/s: B.Sc. (Chemistry)
Year: 2nd **Semester:** 3rd
Examination: End Semester Examination
Examination year: December - 2021

Course Code: PH204 **Course Name:** Quantum Mechanics and Solid State Physics
Date: 06/12/2021 **Total Marks:** 40
Time: 08:30 am to 10:30 am **Total Pages:** 02

Instructions:

- Write each answer on a new page.
- Use of a calculator is permitted.
- * COs=Course Outcome mapping. # BTL=Bloom's Taxonomy Level mapping

Q. No.	Details	Marks	COs*	BTL#
Q.1	Fill in the following gaps with necessary explanation/solution/drawing. Without details, no marks will be awarded for the answers.	15		
a.	The probability of finding a quantum particle described by a wavefunction $\Psi(x,t) = 3i \cos(kx + \omega t)$ is proportional to -----.		CO1 CO2 CO3	BT2 BT3 BT4
b.	Hexagonal Close Packed lattice has -----type of atomic packing.		CO4	BT2 BT3 BT4
c.	$[\hat{x}, \hat{p}_x] =$ -----		CO1 CO3	BT2 BT3 BT4
d.	For a wave function given by $\Psi(x,t) = -4x^3 e^{-3i\omega t}$, $\hat{p}_x \Psi(x,t) =$ -----.		CO1 CO2 CO3	BT2 BT3 BT4
e.	For a 3 dimensional cubic potential well, the degeneracy for an energy level $E = \frac{17\pi^2 \hbar^2}{2ma^2}$ is equal to -----.		CO2 CO3	BT2 BT3 BT4
f.	The Miller indices for the following plane are ----- 		CO4	BT2 BT3 BT4
g.	Packing factor for a body centered cubic lattice is -----		CO4	BT2 BT3 BT4
h.	Face centered tetragonal lattice is not considered as a Bravais lattice. True or False-----?		CO4	BT2 BT3 BT4

i.	Draw $[10\bar{1}0]$ inside a hexagonal crystal lattice.		CO4	BT2 BT3 BT4
j.	GaAs is ----- type bandgap semiconductor.		CO6	BT2 BT3 BT4
Q.2 Answer the following questions in details.		13		
a.	For the wavefunction, $\Psi(x,0) = Ax(a-x)$; $0 \leq x \leq a$, where A is a constant, corresponding to a free particle in 1D box, find the expectation value of Hamiltonian, H, at time $t = 0$. (Hint: V inside the 1D box = 0 and $\hat{H} = -\frac{\hbar^2}{2m} \frac{\partial^2}{\partial x^2} + \hat{V}(x)$)	2	CO1 CO2 CO3	BT2 BT3 BT4
b.	In Compton scattering experiment, derive a formula for difference in wavelength of scattered photon and incident photon.	3	CO1	BT2 BT3 BT4
c.	What are Bloch functions? Explain origin of energy bands with the help of following graph as depicted in Kronig Penny model. What is the significance of P in this figure? 	3	CO5	BT2 BT3 BT4
d.	With the help of a neat diagram and derivation, explain Hall Effect in details.	3	CO6	BT2 BT3 BT4
e.	What is the workfunction of a metal if the threshold wavelength for it is 590 nm? If light of 480 nm wavelength falls on the metal, what is its stopping potential?	2	CO1	BT2 BT3 BT4
Q.3 Write short notes on Any Three of the following topics in details.		12		
a.	Phonons in one dimensional monoatomic lattice of infinite length		CO5	BT2 BT3 BT4
b.	Frank-Hertz Experiment		CO1	BT2 BT3 BT4
c.	Particle in one dimensional infinite potential well		CO1 CO2 CO3	BT2 BT3 BT4
d.	Intrinsic and Extrinsic Semiconductors		CO6	BT2 BT3 BT4

*****End of Question Paper*****