



NATIONAL OPEN UNIVERSITY OF NIGERIA
PLOT 91, CADASTRAL ZONE, NNAMDI AZIKIWE EXPRESSWAY, JABI - ABUJA
FACULTY OF SCIENCES

DEPARTMENT OF PHYSICS

2024 I EXAMINATION.

COURSE CODE: PHY 307
COURSE TITLE: SOLID STATE PHYSICS I
CREDIT UNIT: 2
TIME ALLOWED: (2 HRS)

INSTRUCTION: *Answer question 1 and any other three questions*

QUESTION 1

- (a). Define the following terms: (i) Barvais Lattice (ii) basis (4 marks)
- (b). Write Short note on the first Brillouin zone of a crystal plane? (4 marks)
- (c). Let the interaction energy between two atoms be given by: $E(r) = -\frac{A}{r^2} + \frac{B}{r^9}$ If the atoms form a stable molecule with an inter-nuclear distance of 0.4 nm and a dissociation energy of 3 eV, calculate A and B. (7 marks)
- (d). Consider two-dimensional electrons subjected to a weak periodic potential coming from a square lattice of spacing $a = 5\text{\AA}$. For a k vectors far away from the Brillouin zone boundary, the wavefunction can be well described by planes waves. Assume we want to write the wavefunction in the Bloch form, $\psi(k) = e^{-ikr}u(r)$. and considering a state of energy E and wavevector $k = \begin{pmatrix} 0.05\text{\AA}^{-1} \\ 0 \end{pmatrix}$, show that the three lowest energies will be 0.95 eV, 2.17 and 6.96 eV, respectively at this wavenumber? (Note that $\frac{\hbar^2}{m} = 3.806 \text{ eV\AA}^2$). (10 marks)

QUESTION 2

- (a). Write short note on the following terms: (i) Simple cubic lattice (ii) Body-Centered cubic Lattice (iii) Face- Centered Cubic Lattice (5 marks)
- (b). The Bragg angle corresponding to the first order reflection from plane (111) in a crystal is 30° when X-rays of wavelength 1.75\AA are used. Calculate the interatomic spacing. (5 marks)
- (c). Show that the atomic radius r of a body centered cubic (BCC) can be determined as $a^2 = \frac{16r^2}{3}$, where a is the cubic edge element. (5 marks)