NAMIBIA UNIVERSITY
OF SCIENCE AND TECHNOLOGY

FACULTY OF HEALTH, APPLIED SCIENCES AND NATURAL RESOURCES

DEPARTMENT OF NATURAL AND APPLIED SCIENCES

QUALIFICATION : BACHELOR OF SCIENCE	
QUALIFICATION CODE: 07BOSC	**LEVEL:** 7
COURSE CODE: SSP701S	**COURSE NAME:** SOLID STATE PHYSICS
SESSION: JUNE 2022	**PAPER:** THEORY
DURATION: 3 HOURS	**MARKS:** 100

FIRST OPPORTUNITY EXAMINATION QUESTION PAPER	
EXAMINER(S)	Prof Dipti R. Sahu
MODERATOR:	Dr Zivayi Chiguvare

INSTRUCTIONS
1. Answer all five questions. 2. Write clearly and neatly. 3. Number the answers clearly.

PERMISSIBLE MATERIALS

Non-programmable Calculators

THIS QUESTION PAPER CONSISTS OF 3 PAGES (Including this front page)

Question 1 **[20]**

1.1 Calculate the lattice constant of Iron. Given density of iron 7.86 kg/cm^3, atomic weight of iron 55.85 and Avogadro's number 6.023 x 10^{26}/kmol. (4)

1.2 Sketch the unit cell and show the following planes (112), (101), (123) (6)

2.3 Show that the atomic packing factor for FCC and HCP metals are the same. (10)

Question 2 ***[20]***

2.1 What is Madelung constant? What is its significance? (4)

2.2 How are secondary bonds formed? Give names of secondary bonds. (6)

2.3 Compute the net potential energy of a simple Na^+Cl^- pair. The equilibrium distance between the ions is 0.28nm. The potential energy due to repulsion between electron sis given by $U_r = \beta/r^8$ (10)

Question 3 **[20]**

3.1 What is meant by phonons? Do phonons have mass? (4)

3.2 What is lattice wave? Calculate the value of cutoff frequency in a solid assuming a linear lattice. If velocity of sound in a solid is 3 x 10^3 m/s and Interatomic distance is 5 x 10^{-10} m. (6)

3.3 What is Einstein theory of specific heat? Derive an expression for heat capacity of a solid based on Einstein theory. (10)

Question 4 **[20]**

4.1 Give the assumptions of the classical free electron theory. (4)

4.2 State and explain Wiedemann-Franz law? Calculate Lorentz number, given the thermal and electrical conductivities of Cu at 20^{0}C are 390 $Wm^{-1}K^{-1}$ and 5.87 x$10^7\Omega^{-1}m^{-1}$ respectively (6)

4.3 Using the free electron mode, derive an expression for electrical conductivity in metals. (10)

Question 5 **[20]**

5.1 Show that the probability of occupancy of energy level E by an electron is 50% for $E = E_F$ at temperature ($T \neq 0K$). (4)

5.2 Indicate on an energy level diagram the conduction and valence bands, donor and acceptor states and the position of Fermi level for

(i) an intrinsic semiconductor.
(ii) a n-type semiconductor.
(iii) a p-type semiconductor. (6)

5.3 Define mobility of a carrier of current. How is it related to the Hall coefficient? Is the mobility of an electron in the conduction band of a semiconductor the same as the mobility of an electron (or hole) in the valence band? Give reason for your answer. (10)

Given fundamental constants

Speed of light = $3x10^8$m/s
Planck constant = $6.626 x10^{-34}$ Js
Mass of electron= 9.1×10^{-31} kg
Charge of electron = 1.6×10^{-19} C
Avogadro number= 6.022×10^{23} /mole
Boltzmann Constant =1.38×10^{-23} JK^{-1}

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