NAMIBIA UNIVERSITY
OF SCIENCE AND TECHNOLOGY

FACULTY OF HEALTH AND APPLIED SCIENCES

DEPARTMENT OF NATURAL AND APPLIED SCIENCES

QUALIFICATION : BACHELOR OF SCIENCE	
QUALIFICATION CODE: 07BOSC	**LEVEL:** 7
COURSE CODE: SSP701S	**COURSE NAME**: SOLID STATE PHYSICS
SESSION: JULY 2019	**PAPER:** THEORY
DURATION: 3 HOURS	**MARKS:** 100

SUPPLEMENTARY/SECOND OPPORTUNITY EXAMINATION QUESTION PAPER	
EXAMINER(S)	Prof. Dipti R. Sahu
MODERATOR:	Prof. Benjamin S. Mapani

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 Give a reason why Van der Waals bond is weak? (4)

1.2 Distinguish between ionic and metallic-bonds in solids? (6)

1.3 The total energy per kmol of a crystal is given by the equation (10)

$$U_r = N_A\left[\frac{B}{r^n} - \frac{\alpha e^2}{r}\right]$$

What is the equilibrium nearest-neighbour separation r_0 at which $U(r_0)$ in the above equation is unchanged by replacing $\frac{B}{r^n}$ by $C \exp(-r/\rho)$?

Question 2 **[20]**

2.1 Give the general explanation of closest packing with suitable figures. (4)

2.2 A diffraction pattern of a cubic crystal of lattice parameter a = 0.316 nm is obtained with a monochromatic x-ray beam of wavelength 0.154 nm. The first four lines on this patterns were observed to have the following values: (6)

Line:	1	2	3	4
Angle:	20.3	29.2	36.7	43.6

Determine the interplanar spacings and Miller indices of the reflecting planes.

2.3 What are Miller indices? How are they obtained if a plane cut the axes at 2a, 3b and c on x, y and z axes? (10)

Question 3 **[20]**

3.1 A one dimensional material consists of a monoatomic chain of particles with mass 35g. The force constant between the atoms is 500 N/m. Calculate the highest vibration frequency. (4)

3.2 What is a phonon? Give an evidence for the existence of phonons. (6)

3.3 Describe Einstein model of the lattice heat capacity. Show that it fails to account for the values of specific heat at very low temperature. (10)

Question 4 **[20]**

4.1 Write down the assumption of Drude model which explained Wiedemann-Franz law. (4)

4.2 Find the drift velocity of the free electrons in a copper wire whose cross sectional area (A) is 1×10^6 m^{-2} when the wire carries a current of 1.0 Ampere. Assume that each copper atom contributes one electron to the electron gas (Given: electron density in copper = 8.5×10^{28} electrons m^{-3}) (6)

4.3 Outline salient properties of Fermi probability function. Define Fermi energy. What is its importance? (10)

Question 5 **[20]**

5.1 What is density of energy states? (4)

5.2 What is Hall coefficient? How can we get this experimentally? (6)

5.3 Discuss salient properties of common semiconducting materials. In what important respect does the conductivity of a conductor differ from that of an intrinsic semiconductor. (10)

Given fundamental constants

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

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