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: JUNE 2019	**PAPER:** THEORY
DURATION: 3 HOURS	**MARKS:** 100

FIRST 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 magnesium oxide is bonded ionically? (4)

1.2 Discuss the characteristics of hydrogen bonded crystals. (6)

1.3 Show that the Madelung constant for a linear ionic solid having 2N ions of alternate charge ± e is 2 ln 2. (10)

Question 2 [20]

2.1 Distinguish space lattice and crystal structure. (4)

2.2 Show that for a cubic lattice, the lattice constant a is given by (6)

$$a = \left[\frac{nM_A}{N_A\rho}\right]^{1/3}$$

where n is the number of atoms in a unit cell, M_A is the atomic weight, N_A is Avogador's number and ρ is the density of the material

2.3 State and derive Bragg Law. What assumptions were made while deriving Bragg equation? (10)

Question 3 [20]

3.1 A solid with a basis consisting of four atoms. How many branches of acoustic and optical vibration modes are there? (4)

3.2 What is phonon density and why is it proportional to temperature? (6)

3.3 Explain the Dulong-Petit law. Why does one obtain a constant heat capacity per mol? (10)

Question 4 [20]

4.1 Provide a simple description of the electrical conductivity in the free electron model (4)

4.2 What is Lorentz number ? The thermal and electrical conductivities of Cu at 20^0C are 390 $Wm^{-1}K^{-1}$ and 5.87 x$10^7\Omega^{-1}m^{-1}$ respectively. Calculate Lorentz number. (6)

4.3 Drive Ohm's law based on the concept of Free Electron Theory? (10)

Question 5 [20]

5.1 A crystal has N primitive cell. Then what is the maximum number of energy states per band and the maximum number of electrons per band. (4)

5.2 Briefly discuss the physical origin of Hall effect? (6)

5.3 The electron and hole mobilities in a Si sample are 0.135 and 0.48m^2/V-s respectively. Determine the conductivities of intrinsic Si at 300 K if the intrinsic carrier concentration is 1.5 x 10^6 atom/m^3. The sample is then doped with 10^{23} phosphorus atom/m^3. Determine the equilibrium hole concentration, conductivity and position of the Fermi level relative to the intrinsic level. (10)

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Given fundamental constants

Speed of light = 3x10^{8}m/s
Planck constant = 6.626 x10^{-34} Js
Mass of electron= 9.1 x 10^{-31} kg

Charge of electron = 1. 6 x 10^{-19} C
Avogadro number= 6.022 x 10^{23} /mole
Boltzmann Constant =1.38 x 10^{-23} JK^{-1}

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