



KIBABII UNIVERSITY

UNIVERSITY EXAMINATIONS

2020/2021 ACADEMIC YEAR

FOURTH YEAR FIRST SEMESTER

SPECIAL/SUPPLEMENTARY EXAMINATIONS

FOR THE DEGREE OF BACHELOR OF EDUCATION SCIENCE AND BSc (Physics)

COURSE CODE: SPH 423

COURSE TITLE: SOLID STATE PHYSICS II

DURATION: 2 HOURS

DATE: 12/1/2022

TIME: 2-4PM

INSTRUCTIONS TO CANDIDATES

- Answer **QUESTION ONE** (Compulsory) and any other two (2) Questions.
 - Indicate **answered questions** on the front cover.
- Start every question on a new page and make sure question's number is written on each page

This paper consists of **3** printed pages. Please Turn Over

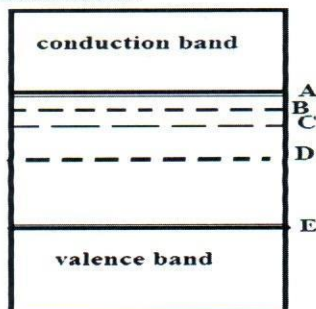
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QUESTION ONE (28 MARKS)

- a) Define the following terms (7 marks)
- i) Superconductor
 - ii) Semiconductor
 - iii) Doping
 - iv) Dopant
 - v) Conductivity
 - vi) Drift Mobility
 - vii) Charge density
- b) Semiconductor depends on the ratio $\frac{E_g}{k_B T}$, what happens to concentration of intrinsic carriers and the conductivity when this ratio is
- i) small (2 marks)
 - ii) large (2 marks)
- c) Why is doping introduced in semiconductors? (1 mark)
- d) Write an equation relating mobility of charge carriers to the drift velocity of the same charges (1 mark)
- e) Define the following terms as used in superconductivity
- i) Zero resistivity (1 mark)
 - ii) Transition temperature (1 mark)
 - iii) Critical magnetic field (1 mark)
- f) Diagrammatically differentiate between ferromagnetism, ferrimagnetism and antiferromagnetism (6 marks)
- g) What are dislocations? (1 mark)
- h) What are the edge and screw dislocations? (1 mark)
- i) What are the characteristics of dielectric materials? (2 marks)
- j) What are the possible polarization types in a dielectric? (2 marks)

QUESTION TWO (14 MARKS)

- a) The figure below shows the schematic energy bands for an n-type extrinsic semiconductor



- Name A, B, C, D and E (5 marks)
- b) Explain the conductivity of this extrinsic semiconductor at
- i) The ionization regime (3 marks)
 - ii) Medium temperature regime (3 marks)
 - iii) High temperature regime (3 marks)

QUESTION THREE (14 MARKS)

- a) Explain what you understand by Meissner effect (3 marks)
b) Differentiate between Type I and II superconductors giving examples in each case (7 marks)
c) By using a sketch explain how heat capacity depends on the energy gap in a superconductor (4 marks)

QUESTION FOUR (14 MARKS)

- a) Given the Clausius-Mosotti relation (the symbols used have their usual meaning)

$$\frac{\epsilon - 1}{\epsilon + 2} = \frac{1}{3\epsilon_0} N_i \alpha_i$$

Rearrange the equation giving the condition under which polarization catastrophe will be experienced (4 marks)

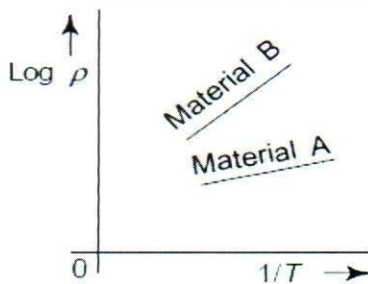
- b) Briefly discuss the following types of magnetism giving clear differences between them
i) Diamagnetism (5 marks)
ii) Paramagnetism (5 marks)

QUESTION FIVE (14 MARKS)

- a) Define the term Neel temperature (2 marks)
b) Discuss the difference between Schottky and Frenkel defects (6 marks)
c) Find the conductivity and resistivity of a pure silicon crystal at temperature 300°K. The density of electron hole pair per cc at 300°K for a pure silicon crystal is 1.072×10^{10} and the mobility of electron $\mu_n = 1350 \text{ cm}^2/\text{volt-sec}$ and hole mobility $\mu_h = 480 \text{ cm}^2/\text{volt-sec}$. (6 marks)

QUESTION SIX (14 MARKS)

- a) How can a solid solution be formed? (2 marks)
b) Figure below shows the plot of log of resistivity versus reciprocal of temperature for two different semiconductors A and B. Assume that mobility is proportional to $T^{-3/2}$,



Find

- i) Which material has wider band gap? (9 marks)
ii) Which material will require light of shorter wavelength for generation of electron-hole pair? (3 marks)