



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

DEPARTMENT OF PURE AND APPLIED SCIENCE

2021_2 EXAMINATIONS

COURSE CODE: PHY407
COURSE TITLE: SOLID STATE PHYSICS II
CREDIT UNIT: 3
TIME ALLOWED: (2½ HRS)

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

Charge on an electron = $1.602 \times 10^{-19} C$

Mass of an electron = $9.118 \times 10^{-31} Kg$

Permittivity of free space = $8.85 \times 10^{-12} Fm^{-1}$

Boltzmann constant = $8.617 \times 10^{-5} eVK^{-1}$

QUESTION 1

a. Discuss the following briefly

- i Magnetic Dipole Moment (μ_m) **4 marks**
- ii Intensity of magnetization (I) **4 marks**
- iii Magnetic permeability **4 marks**

b i Explain why the magnetic susceptibility of a diamagnetic material is less than zero **4 marks**

ii Calculate the change in susceptibility of a material caused by a 10 % temperature increase, if the original temperature is 1500 K, the material has a curie constant of 0.04 and a Curie temperature of 1250 K **4 marks**

iii Define Paramagnetism **2 marks**

QUESTION 2

a. The diamagnetic susceptibility of Ne atom is given as $-90.5 \times 10^{-12} m^3 mol^{-1}$, using Langevin theory, calculate the mean electron radius **4 marks**

b. Calculate the polarization produced in a dielectric medium subjected to an electric field of $1000 Vm^{-1}$, if the susceptibility of the medium is 20. Take permittivity of free space as $8.85 \times 10^{-12} Fm^{-1}$ **4 marks**

- c. Differentiate between susceptibility and polarizability **4 marks**

QUESTION 3

- a. Show that the Clausius-Mossotti equation which relate the dielectric constant ϵ and the polarizability α_i for multiple dielectric medium is given by $\frac{\epsilon - 1}{\epsilon + 2} = \sum_i \left(\frac{N\alpha_i}{3\epsilon_0} \right)$ **5 marks**
- b. State three examples of elements that are ferromagnetic in nature **3 marks**
- c. Differentiate between diamagnetism and Ferromagnetism **4 marks**

QUESTION 4

- a. State the symbols in the Langevin expression and their S.I unit **4 marks**
- b. Using Langevin equation in (CGS), calculate the molar susceptibility of Li atom.
Take average electron radius r , charge and mass of an electron, as $0.5 \times 10^{-10} m$, $1.602 \times 10^{-19} C$ and $9.11 \times 10^{-31} Kg$ **6 marks**
- c. Define Magnetization **2 marks**

QUESTION 5

- a. A parallel plate capacitor with polystyrene as dielectric has an electric field of 200V. Calculate the energy density of the capacitor, if the permittivity of the material is $5.0 \times 10^{-11} Fm^{-1}$ **3 marks**
- b. If the permittivity of the material reduce to $1.0 \times 10^{-11} Fm^{-1}$ and its dimension is $10^{-1} * 10^{-2} * 10^{-2}$. Calculate the dielectric constant of the material **3 marks**
- (ii) Calculate the capacitance of the capacitor **2 marks**
- (iii) Calculate the induce electric field **2 marks**
- c. Define Dielectric material **2 marks**

QUESTION 6

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| a. | Explain the Domain theory of Ferromagnetism | 4 marks |
| b. | Calculate the magnetic susceptibility of a material with a Curie constant of 0.85, if the difference between the critical temperature and the paramagnetic Curie temperature is 0.5 K | 4 marks |
| c.i | Differentiate between Ferromagnetism and Antiferromagnetism | 2 marks |
| ii | State two examples of Ferromagnetic and Diamagnetic materials | 2 marks |