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 = $1.602*10^{-19}C$

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

Permitivity of free space = $8.85*10^{-12}Fm^{-1}$

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

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 $-90.5*10^{-12}m^3mol^{-1}$, 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 $1000Vm^{-1}$, if the susceptibility of the medium is 20. Take permittivity of free space as $8.85*10^{-12}Fm^{-1}$ 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 $\frac{\varepsilon - 1}{\varepsilon + 2} = \sum_i \left(\frac{N\alpha_i}{3\varepsilon_0} \right)$ **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 $0.5 * 10^{-10} m$, $1.602 * 10^{-19} C$ and $9.11 * 10^{-31} Kg$ **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 $5.0 * 10^{-11} Fm^{-1}$ **3 marks**

b. If the permittivity of the material reduce to $1.0 * 10^{-11} Fm^{-1}$ 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

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**