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**NATIONAL OPEN UNIVERSITY OF NIGERIA**

**PLOT 91, CADASTRAL ZONE, NNAMDI AZIKIWE EXPRESSWAY, JABI - ABUJA**

**FACULTY OF SCIENCE**

 **JULY 2017\_1 EXAMINATION**

Course Code: Phy407 Course Title: Solid State Physics II

Credit Unit 3

 Time: 3 Hours

Instruction: Answer Question One and any other Four Questions.

Question 1

 *(a) (i) Explain the term linear defect* ***3 marks***

*(ii) List four categories of point defect.* ***3marks***

*(b) (i) Distinguish between Schottky and Frenkel defects* ***4 marks***

*(ii) Write short notes on twin boundaries, stacking faults, phase boundaries and ferromagnetic domain wall.* ***4 marks***

Question 2

 *(a) (i)What are dielectrics? Give two examples.* ***3 ½ marks***

*(ii) List five (5) properties of a dielectric.* ***2 ½ marks***

*(b) (i) What is an electric dipole?* ***2 marks***

*(ii) Show that the field of an electric dipole may be expressed as*

$$\vec{E}=\frac{1}{4πϵ\_{0}}\left[\frac{3\left(\vec{p}.\vec{r}-r^{2}\vec{p}\right)}{r^{5}}\right]$$

*The symbols have their usual meaning.* **6 *marks***

 Question 3

 (a) (i) What are *ferromagnetic materials?* Give two examples. **4 marks**

(ii) Briefly explain the *domain theory* of ferromagnetism. **4 marks**

(*b) The Curie temperature of iron is 1043 K. Assume that iron atoms, when in the metallic form, have moments of two Bohr magneton per atom. Iron is body-centred with lattice parameter* $a=0.285 nm.$ *Calculate the saturation magnetization and the Curie constant.* ***6 marks***

Question 4

 *(a) (i) List the main classification of materials based on their magnetic properties.* ***3 marks***

*(ii) Explain the term magnetization. Mention three origins of the magnetic moment of a material from the atomic point of view.* ***3 marks***

*(b) (i) The magnetic dipole moment* $μ$ *associated with an orbiting electron of a hydrogen atom is given as*

$$\left|μ\right|=IA$$

*where* $I$ *is the current produced and* $A$ *the area enclosed by the electron orbit. Starting with this definition, show that*

$\left|μ\right|=\frac{e}{2m}\left|\vec{L}\right|$***4 marks***

*where L is the angular momentum, e and m are the electronic charge and mass of the electron respectively.*

*(ii) In the Bohr hydrogen atom, the orbital angular momentum of the electron is quantized in units of* $ℏ$*. Calculate the smallest allowed magnitude of the atomic dipole moment in*$ JT^{-1}$*.*

*(This quantity is known as Bohr magneton).* ***4******marks***

 Question 5

*(a) (i) Write down the classical Langevin expression for the diamagnetic susceptibility and explain all the symbols giving their SI units.* ***3 marks.***

*(ii) Assuming one electron,* $\left〈r\_{0}\right〉=0.1 nm$ *and* $N=5×10^{28}/m^{3}$ *in your relation in 2(a)(i), obtain a value for the classical susceptibility.* ***4 marks.***

*(b) (i) Calculate the magnitude of the Lamor frequency of an electron of the hydrogen atom placed in a magnetic field* $\rightharpoonaccent{B}=0.1 T$***3 marks***

*(ii) Calculate the current due to the precession of the electron of the hydrogen atom in 2(b)(i)*

***4 marks***

Question 6

*.(a) (i) Define electric susceptibility and polarizability.* ***4 marks***

*(ii) Obtain the frequency dependence of the electronic polarizability of an electron having the resonance frequency ωo, treating the system as a simple harmonic oscillator.* ***4 marks***

 *(b) Obtain the Clausius–Mossotti equation relating the macroscopic dielectric constant with the atomic polarizabilities.* ***6 marks***