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**NATIONAL OPEN UNIVERSITY OF NIGERIA**

**14-16 AHMADU BELLO WAY, VICTORIA ISLAND LAGOS**

**SEPTEMBER/OCTOBER 2015 EXAMINATION**

**SCHOOL OF SCIENCE AND TECHNOLOGY**

**COURSE CODE: PHY407**

**COURSE TITLE: Solid State Physics II**

**TIME: 3 Hours**

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

**PHYSICAL CONSTANTS**:

Speed of light ; mass of electron; Electronic charge ; Avogadro’s number Boltzmann constant ; Plank’s constant

1.(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 *ω*o, 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**

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

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

3.(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, and 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 **3 marks**

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

**4 marks**

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

(i) 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 Calculate the saturation magnetization and the Curie constant. **6 marks**

5. (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 associated with an orbiting electron of a hydrogen atom is given as

where is the current produced and the area enclosed by the electron. Starting with this definition, show that

**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 . Calculate the smallest allowed magnitude of the atomic dipole moment in.

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

6. (a) (i) Using relevant examples, distinguish between *point defects* and

*dislocations.***4 marks**

(ii) Explain the possible effects of planar defects. **3 marks**

(b) (i) Define the term grain boundary **4 marks**

(ii) What s an intersticialcy?**3 marks**

7.(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**