



**Answer all the following questions**

**Question 1                      20 Marks**

- Define dielectric susceptibility and polarizability and give the relation between them.
- Explain the dielectric behavior of dielectrics under static electric fields and derive a relation between polarization P and external electric field E.
- Explain electronic and ionic polarization of a dielectric and give a relation between their polarizability.

**Question 2                      20 Marks**

- Consider a dielectric be placed between the plates of a parallel plate capacitor and let there be an imaginary spherical cavity around the atom A inside the dielectric. From the first principle derive an expression for the internal field of the atom A.
- What are the nano-materials? Describe briefly different types of nano-particles and discuss their structure.
- Reducing the size of bulk materials to nano size changes many of their physical properties, prove this statement with details and explain some examples.

**Question 3                      20 Marks**

- Explain with drawing the differences between the ferromagnetic, ferrimagnetic and anti-ferromagnetic materials
- Explain with details the superparamagnetic phenomenon and the relation between it and the nanomagnetic materials.
- Explain the spinel structure of ferrite materials.

**Question 4                      20 Marks**

- What is the dielectric loss of dielectric material? Show that the dielectric loss is given by  $\tan \delta = \epsilon_r'' / \epsilon_r'$  and find the energy dissipated per unit time per  $m^3$  of the dielectric W.
- Explain the phenomenon of spontaneous polarization in ferromagnetic materials.
- Name the factors that characterize the usefulness of a material to be applied as a dielectric medium. Define and explain them

**Question 5**

**20 marks**

**Choose the correct answer with reason** اختار الاجابه الصحيحه مع ذكر السبب

**Question 1 : Could a single atom have a permanent dipole moment? Yes or No**

**Question 2 : Could a single ion have a permanent dipole moment? Yes or No**

**Question 3 : Could a single molecule have a permanent dipole moment? Yes or No**

**Question 4 : How could one induce a dipole moment in a single atom or ion?**

- Apply a magnetic field.
- Apply an electric field.
- Apply an electromagnetic field (e.g. via an electro-magnetic wave.
- Squeeze it mechanically.

**Question 5 : How could one polarize liquid water?**

- By shifting electron 'clouds' relative to the nuclei in field direction
- By heating it close to the boiling point.
- By cooling it close to the freezing point.
- By rotating its permanent dipole moment somewhat in field direction
- By first inducing a dipole moment and then rotating it somewhat in field direction.
- By making t very pure so it is a good insulator.

**Question 6 : How could one polarize frozen water (= ice)?**

- By shifting electron 'clouds' relative to the nuclei in field direction
- By shifting the somewhat charged atoms relative to their equilibrium lattice positions in field direction
- By heating it close to the freezing point.
- By cooling it down well below the freezing point.
- By orienting dipole layers possibly present on grain boundaries.
- By rotating its permanent dipole moment in field direction
- By first inducing a dipole moment and then rotating it somewhat in field direction.
- By making it very pure so it is a good insulator.

**Question 7 : Which one of the following substances might show orientation polarization?**

\*Water.   \* ice   \* Alcohol   \* Noble Gases.   \* Ionic crystals.   \*none