MAJOR

EPL 206 - SOLID STATE PHYSICS

me: 90 Minutes | 3 May 2014 | Max. Marks:30

OTE: **Limit your answers within 5-6 lines for Q1-4.**

List out three essential criteria which are crucial for the occurrence of ferromagnetism in a solid. 3

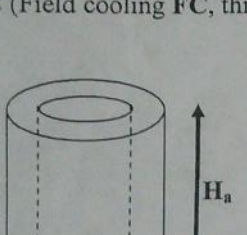
Explain the physics behind the occurrence of multi-domain structure in a bulk ferromagnetic (FM) solid. 2

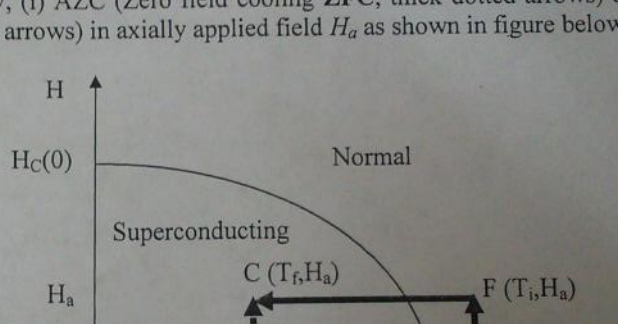
Why do the elongated single domain ferromagnetic particles exhibit high coercivity in their ***M-H*** loop recorded for field applied along their long-axis? 2

What happens to the magnetization of a **particular domain** inside a FM solid as the field strength H is changed from **zero** to H_{sat} (i.e., H required for magnetic saturation)? Justify your reasoning. 2

Sketch neatly the typical shapes of **full** (a) M-H and (b) B-H loops of **same** ferromagnetic solid. Highlight the main difference by marking on each of the sketches **(no text required)**. 2

Consider cooling a **hollow Type-I superconducting cylinder** from a initial temperature T_i above its transition temperature T_C to a final low temperature T_f ($T_f << T_c$) by following two different field-temperature cooling routes, namely, (i) AZC (Zero field cooling **ZFC**, thick dotted arrows) and (ii) AFC (Field cooling **FC**, thick solid arrows) in axially applied field H_a as shown in figure below:





(a) Sketch the profiles of **magnetic flux lines** covering all space **within and outside** this hollow superconductor and clearly indicate the direction of **shielding currents** corresponding to the **final state C** reached through (i) **ZFC** and (ii) **FC**. 4

(b) How the above sketches of flux profile and induced currents are modified after the magnetic field is SWITCHED off in each of the **two** cases **(draw the sketch, no description)**. 2

Indium metal ^{115}In ($5s^2 4d^{10} 5p^1$) has a density of 7.31 g/cm^3, and T_C=3.4K. Calculate (a) the density of Cooper pairs at T= 0 K and (b) the T_C of ^{100}In. 4

On the same **-M** vs. **H** plot, draw the **M** vs. **H** variation (at $T<T_C$) for (a) **bulk** piece of lead and (b) **thin film** of lead having thickness ~ penetration depth (no description required). 2

In a diffraction pattern of an *fcc* material using x-ray of wavelength 1.54Å, only one peak is observed at 2θ=121°. Find the indices of the diffracting plane. Show that next index peak cannot occur.

The polarizability of NH_3 molecule in the gaseous state, from the measurement of dielectric constant is found to be 2.42×10^{-39} Fm^2 at 309K and 1.74×10^{-39} Fm^2 at 448K, respectively. Calculate (a) polarizability due to permanent dipole moment at 448K, (b) due to the deformation of the molecule. Neglect electronic polarizability contributions)