Superconductivity - Numerical Problems

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Example 1

The transition temperature for Pb is 7.2 K. However, at 5 K it loses the superconducting property if subjected to magnetic field of 3.3×10^4 A/m. Find the maximum value of H which will allow the metal to retain its superconductivity at 0 K.

$$H_c = H_0 \left[1 - \frac{T^2}{T_c^2} \right]$$

$$H_0 = 6.37 \times 10^4 \mathrm{A/m}$$

Example 2

The critical field of niobium is $1 \times 10^5 \mathrm{A/m}$ at $8\,\mathrm{K}$ and $2 \times 10^5 \mathrm{A/m}$ at $0\,\mathrm{K}$. Calculate the transition temperature of the element.

$$H_c = H_0 \left[1 - \frac{T^2}{T_c^2} \right]$$

$$T_c = 11.3\text{K}$$

Example 3

The transition temperature for lead is 7.26 K. The maximum critical field for the material is 8×10^5 A/m. Lead has to be used as a superconductor subjected to a magnetic field of 4×10^4 A/m. What is the temperature that is to be maintained?

$$H_c = H_0 \left[1 - \frac{T^2}{T_c^2} \right]$$

$$T = 7.08\text{K}$$

Example 4

The critical magnetic field at 5 K is 2×10^3 A/m in a superconductor ring of radius 0.02 m. Find the value of critical current.

$$i_c = 2\pi R H_c$$

$$I_c = 251.4\text{A}$$

Example 5

Calculate the critical current for a wire of lead having a diameter of 1 mm at 4.2 K. The critical temperature for lead is 7.18 K and $H_c(0) = 6.5 \times 10^4 \text{A/m}$.

$$H_c = H_0 \left[1 - \frac{T^2}{T_c^2}\right]$$

$$H_c(T) = 4.28 \times 10^4 \text{A/m}$$

$$i_c = 2\pi R H_c$$

$$I_c = 134.5\text{A}$$