

In-class problem linked to lecture pages 138-151

A ferromagnet at 300K has a magnetic moment of $m_z = 10^{-3} J / \text{tesla}$. It is sitting in an external field oriented along the z-axis, of strength $B_z = 0.1 \text{ tesla}$. The external field suddenly changes so that the number of accessible states doubles.

- (a) Did the field strength increase or decrease?
- (b) By how much?

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$$\Delta S = k_B \ln \frac{\Omega_2}{\Omega_1}$$

$$\Delta U = m \Delta B$$

$$T = 300 \text{ K}$$

$$m = 10^{-3} \text{ J}$$

total

$$B = 0.1 \text{ Tesla}$$

$$\frac{\Omega_2}{\Omega_1} = 2$$

Find ΔS

$$T \Delta S = m \Delta B$$

$$\Delta S = \frac{m \Delta B}{T}$$

$$k_B \ln 2 = \frac{m \Delta B}{T}$$

$$\Delta B = \frac{k_B T \ln 2}{m} = \frac{1.381 \times 10^{-23} \text{ J} \cdot 300 \text{ K} \cdot \ln 2}{10^{-3} \text{ J/Tesla}}$$

$$10^{-3} \text{ J/Tesla}$$

$$= 2.87 \times 10^{-18} \text{ Tesla increase}$$