

Adkins 3.6 (0)

We are to find the work required to magnetize a paramagnetic salt, which obeys  $\chi = \frac{a}{T}$  (Curie's law), at  $T = 4.2\text{K}$ . The volume of the sample is  $1e-5\text{m}^3$ . The field is increased from  $H=0$  to  $H=1\text{ Tesla}$ .

Unfortunately, Adkins' expression for work is inconsistent with other sources. I will use the equation from Reif's Statistical and Thermal Physics,

$$dW = MdH$$

Since  $M = \chi H$ , we obtain

$$W = \int_0^{H_0} \chi H dH$$

$$W = \frac{1}{2} \frac{a}{T} H_0^2$$

This is the work per unit volume. Plugging in numbers, we get

$$W = (1e-5\text{m}^3) \frac{1}{2} \left( \frac{0.19}{4.2\text{K}} \right) (1\text{T})^2$$

$$= \boxed{2.3e-7 \text{ Joules}}$$