

ENTROPY OF ALUMINUM AT LOW TEMPERATURES

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Reference: Daniel V. Schroeder, *An Introduction to Thermal Physics*, (Addison-Wesley, 2000) - Problem 3.14.

A curve fit to experimental measurements of the heat capacity of one mole of aluminum at low temperatures is

$$(1) \quad C_V = aT + bT^3$$

where $a = 0.00135 \text{ J K}^{-2}$ and $b = 2.48 \times 10^{-5} \text{ J K}^{-3}$.

We can use this to work out the entropy from the formula

$$(2) \quad S_f - S(0) = \int_0^{T_f} \frac{C_V(T)}{T} dT$$

$$(3) \quad = aT_f + \frac{b}{3}T_f^3$$

If we take $S(0) = 0$, we can evaluate the formula at a few temperatures.

At $T = 1 \text{ K}$, we have

$$(4) \quad S(1) = 1.358 \times 10^{-3} \text{ J K}^{-1}$$

In dimensionless form, we have

$$(5) \quad \frac{S(1)}{k} = 9.84 \times 10^{19}$$

At $T = 10 \text{ K}$

$$(6) \quad S(10) = 0.0218 \text{ J K}^{-1}$$

$$(7) \quad \frac{S(10)}{k} = 1.58 \times 10^{21}$$