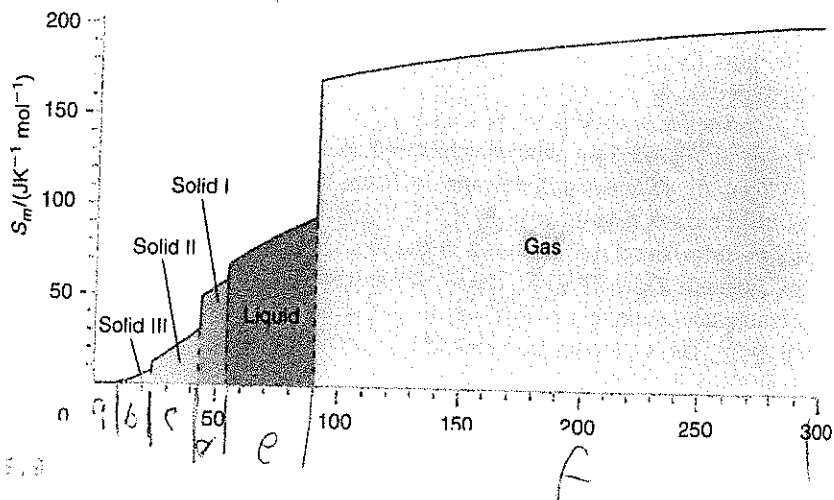


The molar entropy for O₂ is shown as a function of temperature. The vertical dashed lines indicate constant temperature-phase transitions, and the most stable phase at a given temperature is indicated in the figure.



EXAMPLE PROBLEM 5.9

The heat capacity of O₂ has been measured at 1 atm pressure over the interval 12.97 K < T < 298.15 K. The data have been fit to the following polynomial series in T/K, in order to have a unitless variable:

a → 0 K < T < 12.97 K:

$$\frac{C_{P,m}(T)}{\text{J mol}^{-1} \text{K}^{-1}} = 2.11 \times 10^{-3} \frac{T^3}{\text{K}^3}$$

b → 12.97 K < T < 23.66 K:

$$\frac{C_{P,m}(T)}{\text{J mol}^{-1} \text{K}^{-1}} = -5.666 + 0.6927 \frac{T}{\text{K}} - 5.191 \times 10^{-3} \frac{T^2}{\text{K}^2} + 9.943 \times 10^{-4} \frac{T^3}{\text{K}^3}$$

c → 23.66 K < T < 43.76 K:

$$\frac{C_{P,m}(T)}{\text{J mol}^{-1} \text{K}^{-1}} = 31.70 - 2.038 \frac{T}{\text{K}} + 0.08384 \frac{T^2}{\text{K}^2} - 6.685 \times 10^{-4} \frac{T^3}{\text{K}^3}$$

d → 43.76 K < T < 54.39 K:

$$\frac{C_{P,m}(T)}{\text{J mol}^{-1} \text{K}^{-1}} = 46.094$$

e → 54.39 K < T < 90.20 K:

$$\frac{C_{P,m}(T)}{\text{J mol}^{-1} \text{K}^{-1}} = 81.268 - 1.1467 \frac{T}{\text{K}} + 0.01516 \frac{T^2}{\text{K}^2} - 6.407 \times 10^{-5} \frac{T^3}{\text{K}^3}$$

f → 90.20 K < T < 298.15 K:

$$\frac{C_{P,m}(T)}{\text{J mol}^{-1} \text{K}^{-1}} = 32.71 - 0.04093 \frac{T}{\text{K}} + 1.545 \times 10^{-4} \frac{T^2}{\text{K}^2} - 1.819 \times 10^{-7} \frac{T^3}{\text{K}^3}$$

The transition temperatures and the enthalpies for the transitions indicated in Figure 5.8 are as follows:

Solid III → solid II	23.66 K	93.80 J mol ⁻¹
Solid II → solid I	43.76 K	743 J mol ⁻¹
Solid I → liquid	54.39 K	445 J mol ⁻¹
Liquid → gas	90.20 K	6815 J mol ⁻¹

4 phase transitions

10 terms/events total

a. Using these data, calculate S_m^o for O₂ at 298.15 K.

b. What are the three largest contributions to S_m^o?

* See solution on page 122