The negative sign indicates that the enthalpy at the state of interest is lower than that at the reference state.

Comments   Entropy is calculated in a similar manner. All the required information is given above and the calculation is left as an exercise.

Example 7.3: Condensing a Vapor-Liquid Mixture

Calculate the heat that must be removed from the vapor-liquid mixture of the previous example to produce the saturated liquid at 250 K.

Solution   The required heat is equal to the enthalpy change between the initial state (enthalpy H_A) and the saturated liquid (H^L):

$$Q = \Delta H = H_L - H_A$$

where $H^L = -7304.48$ J/mol and $H_A = -4579.24$ J/mol, both calculated in the previous example. Therefore,

$$Q = (-7304.48) - (-4579.24) = -2725.24 \text{ J/mol}.$$

The heat is negative, that is, it must be removed.

Comments   Once properties have been calculated relative to a reference state, energy calculations become a matter of algebraic differences. This convenience is the reason we have invested so much effort in formulating equations for the absolute enthalpy and entropy.

7.2   Vapor-Liquid Equilibrium

Away from the saturation point a fluid exists as a single phase, either liquid or vapor. The saturation point is a special state where the fluid can form both phases, which coexist in equilibrium with each other, both at the same temperature and pressure. We want to determine the precise conditions that define the saturation point. For this we turn to the Gibbs free energy and in particular to eq. (4.45), which states that the equilibrium state of a system at constant T, P, and n is such that the Gibbs free energy is at a minimum. We imagine the following experiment: a fixed number of moles of a fluid is placed in a closed system at such pressure and temperature as to form two phases. The pressure and temperature are then maintained constant (for example, using a movable piston and a heat bath). Suppose that we take a