1. (17) Consider the ideal-gas reaction, \(A + 2B \leftrightarrow C + 3D\), carried out at constant \(T\) and \(V\).

(a) Suppose that 1.00 mol of \(A\) is converted to products via this reaction, and that you can measure \(\Delta H\), \(\Delta S\), and \(\Delta G\) for this conversion. Are any of these equal to the corresponding standard-state changes — \(\Delta H^\circ\), \(\Delta S^\circ\), and \(\Delta G^\circ\)? Explain briefly.

(b) Now suppose that a reaction mixture is prepared, containing the four components at the following partial pressures (in \(P^\circ\)): \(P_A = 2.0\), \(P_B = 0.8\), \(P_C = 1.0\), and \(P_D = 1.5\). Further, suppose that \(K^\circ = 1.00\). Calculate the reaction quotient \(Q\), and predict whether the reaction will proceed to the right or left.

(c) When \(T\) is raised by 10 K, \(K^\circ\) is found to be 1.50. Is the reaction exothermic or endothermic?

(d) Under the conditions stated in (b), the reaction vessel contains \(n_0\) mol of \(A\). How much (in terms of \(n_0\)) of each of the other components is present?

(e) Again starting as in (b), let the equilibrium \(P_A\) be \((2.0 - x)\). Set up (but do not solve) an equation you could solve for \(x\), and hence for all \(P_i\).

2. (9) At 100.0˚C the vapor pressure of \(\text{Hg}(\ell)\) is 0.2729 torr, and we found from Problem 7.25 that \(\Delta H_{\text{vap}} = 61.34\) kJ/mol, independent of \(T\) over the range 80–140˚C.

(a) What are \(\Delta G\) and \(\Delta S\) for the equilibrium vaporization process at 100.0˚C?

(b) At 120.0˚C the vapor pressure is 0.7457 torr. What are \(\Delta G\) and \(\Delta S\) at this \(T\)?

(c) Suppose you are able to look up from thermo data tables the information to compute \(\Delta H^\circ\), \(\Delta G^\circ\), and \(\Delta S^\circ\) for \(\text{Hg}(\ell) \leftrightarrow \text{Hg}(g)\) at 100.0˚C. Would any of these values agree with the given \(\Delta H_{\text{vap}}\) or the values of \(\Delta G\) and \(\Delta S\) calculated in (a)? Explain briefly.