Thermodynamics of Materials
3.00 Fall 2002

Problem Set 6

Exercise 6.1

Methane CH_4 and carbon dioxide CO_2 are mixed in equal molar proportions in a reservoir fixed at $T = 1750K$ and 1 atmosphere pressure. Find the equilibrium concentrations of the gaseous components.

Assume that the only gaseous components are CH_4, CO_2, H_2, CO, O_2, and H_2O.

Free energies as a function of temperature for several reactions are tabulated below:

Reaction	Change in Molar Gibbs Free Energy (joules)
$CH_4(gas) \rightleftharpoons C(graphite) + 2H_2(gas)$	$69120 - 22.25T \log T + 65.35T$
$2CO(gas) \rightleftharpoons 2C(graphite) + O_2(gas)$	$223400 + 175.3T$
$CO_2(gas) \rightleftharpoons C(graphite) + O_2(gas)$	$394100 + 0.8T$
$H_2(gas) + \frac{1}{2}O_2(gas) \rightleftharpoons H_2O(gas)$	$-246400 + 54.8T$

Exercise 6.2

Find an expression that relates the change in Gibbs free energy with temperature at constant volume, $\left(\frac{\partial G}{\partial T}\right)_V$, in terms of the, entropy, volume, thermal expansivity $\alpha \equiv \frac{1}{V}\left(\frac{\partial V}{\partial T}\right)_P$, and the isothermal compressibility $\kappa_T \equiv \frac{-1}{V}\left(\frac{\partial V}{\partial P}\right)_T$.

Describe how you would measure κ_T and α in an experiment.