

1. The reaction $\frac{1}{2} N_2(g) + \frac{3}{2} H_2(g) = NH_3(g)$ has a Gibbs free energy of formation of $\Delta G_f^\circ = -16.5 \text{ KJ/mole}$ at 298K. Find the equilibrium constant at 298K for (a) the reaction as written, (b) the reaction $N_2(g) + 3 H_2(g) = 2 NH_3(g)$.
2. Please describe the Carnot Cycle and discuss how would one enhance the efficiency of a heat engine.
3. Small amount of gold have been observed to supercool by a maximum amount of 230°C . What is the entropy change associated with the isothermal solidification of 1 mole of such supercooled gold?

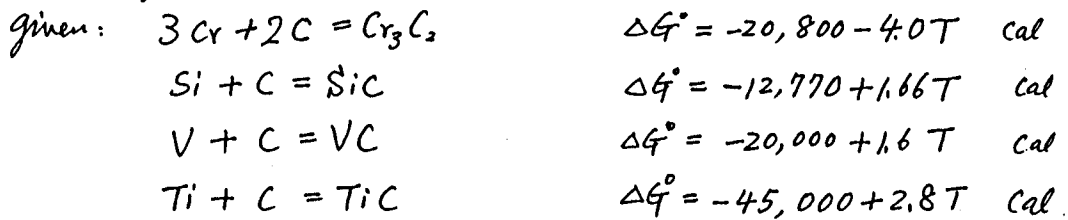
$$C_{p, Au(s)} = 5.0 \text{ cal/deg. mole}$$

$$C_{p, Au(l)} = 7.0 \text{ cal/deg. mole}$$

$$m.p. Au(s) = 1063^\circ\text{C}$$

$$\text{heat of fusion of gold} = 3050 \text{ cal/mole}$$

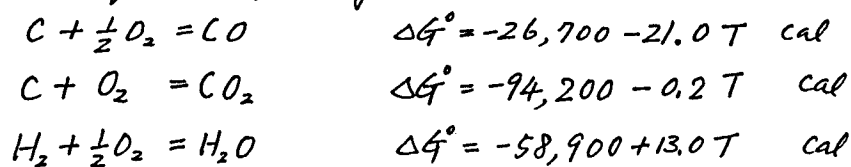
4. Chromium and carbon present in stainless steel form chromium carbide at 600°C . Show by thermodynamic calculation which of the metals among Si, Ti, and V should be alloyed to stainless steel, so as to prevent the formation of Chromium carbide.



5. A gas mixture of the following composition by volume

$\text{CO}: 30\%$, $\text{CO}_2: 10\%$, $\text{H}_2: 10\%$, and $\text{N}_2: 50\%$

is fed into a heating furnace at 927°C . Calculate the equilibrium composition of the gas mixture, assuming the total pressure in the furnace to be 1 atm, from the following data:



Assume that all the gases behave ideally.

6. If 2m^3 of air at a temperature of 25°C and pressure of 100 kPa, were adiabatically compressed to a pressure of 400 kPa, what would be the volume of the compressed air? What would be its temperature?

