The Richard Stockton College of New Jersey
Chemistry Program, School of Natural Sciences and Mathematics
PO Box 195, Pomoma, NJ

CHEM 3410: Physical Chemistry I — Fall 2008

Homework 4

Due in Class: September 22, 2008

1. The thermite reaction combines aluminum powder (Al) and iron oxide (Fe_2O_3) and ignites the mixture to make aluminum oxide and iron. As we saw in class, this reaction is quite dramatic and frequently results in a molten iron product.

   (a) From a balanced chemical reaction and standard thermochemical data determine ΔH for the reaction at 25°C .

   (b) According to your calculations, is enough heat released to melt the iron? The melting point of iron is 1513°C . To make things a little simpler, assume that the constant pressure heat capacity of iron is 25.1 J/mole·K and is constant.

2. A sheet of manganese (2 moles) at room temperature (298 K) is placed in thermal contact with a heat supply that slowly transfers 100,698 J of heat into the sample at constant pressure. Use the following thermodynamic data for Mn to answer the questions below:

   Mn has four solid phases, α, β, γ, and δ:

   $$C_p^{\alpha} = 21.6159 \text{ J/mole-K} \quad T_{trans}^{\alpha\rightarrow\beta} = 993 \text{ K} \quad \Delta H_{trans}^{\alpha\rightarrow\beta} = 2010 \text{ J/mole}$$

   $$C_p^{\beta} = 34.9028 \text{ J/mole-K} \quad T_{trans}^{\beta\rightarrow\gamma} = 1373 \text{ K} \quad \Delta H_{trans}^{\beta\rightarrow\gamma} = 2300 \text{ J/mole}$$

   $$C_p^{\gamma} = 44.8 \text{ J/mole-K} \quad T_{trans}^{\gamma\rightarrow\delta} = 1409 \text{ K} \quad \Delta H_{trans}^{\gamma\rightarrow\delta} = 1800 \text{ J/mole}$$

   $$C_p^{\delta} = 47.3 \text{ J/mole-K}$$

   (a) Calculate the final temperature of the sample.

   (b) Calculate the total enthalpy change for this process.

   (c) Calculate the total entropy change for this process.

   (d) What phase (or phases) are present at equilibrium at the end of this process?