Thermodynamics tutorhour 3

Question 1

Given the following reaction: $PbO(s) + CO(g) \rightleftarrows Pb(s) + CO_2(g)$.
The standard Gibbs energy for this reaction ($\Delta_r G^{\ominus}_{298K}$) is: –68.3 kJ mol^{-1}, the standard enthalpy of reaction $\Delta_r H^{\ominus}_{298K}$ is –63.99 kJ mol^{-1} and the standard entropy of reaction $\Delta_r S^{\ominus}_{298K}$ is 14.4 J mol^{-1} K^{-1}.
Calculate the equilibrium constant at the temperatures:
a) 298 K
b) 400 K
Use the data given above. Assume $\Delta_r H$ and $\Delta_r S$ are temperature-independent.

Question 2

HI decomposes to I_2 and H_2 in a reactor at 1000 K and 1.00 bar overall pressure:

$2\ HI(g) \rightleftarrows H_2(g) + I_2(g)$

22.8% of the initial HI has decomposed after equilibrium has been established.
You may assume that the gases behave as perfect gases.

In equilibrium, what is the value of:
a) $\Delta_r G$
b) K
c) $\Delta_r G^{\ominus}$

Question 3

The standard Gibbs energy of the reaction below is –4.73 kJ mol^{-1} at 298 K.

$2\ NO_2(g) \rightleftarrows N_2O_4(g)$

a) The partial pressure of NO_2 is equal to 6.0 bar and that of N_2O_4 is 2.0 bar. Calculate the Gibbs energy of the reaction at 298 K. You may assume that the gases behave as perfect gases.
b) In what direction does the reaction proceed spontaneously at 298 K?

Additional material:

Question 4

For the dehydration of $CuSO_4.5H_2O$ the $\Delta_r H^{\ominus}_{298K}$ = 299 kJ mol^{-1} and the $\Delta_r S^{\ominus}_{298K}$ = 753 J mol^{-1} K^{-1}.
Estimate the temperature at which $CuSO_4.5H_2O$ undergoes dehydration.
To answer this question some sensible assumptions have to be made. Give these assumptions and the calculation.