Exam V

CH 353 Sumer 2007

Vanden Bout

Name: _____

Carefully read all the problems. The first page has potentially useful information. The last page is for extra writing space.

$R = 8.314\ J\ K^{-1}\ mol^{-1}$ $R = 8.314 \times 10^{-2}\ L\ bar\ K^{-1}\ mol^{-1}$ $R = 8.206 \times 10^{-2}\ L\ atm\ mol^{-1}\ K^{-1}$

1 atm = 1.01325 bar T/K = T/°C + 273.15 1 atm-L = 101.325 J 1 bar-L = 100 J

$g = 9.8\ m\ s^{-2}$ $\Pi = \rho g h$

$$\frac{dP}{dT} = \frac{\Delta S}{\Delta V} = \frac{\Delta H}{T\Delta V} \qquad \ln\left(\frac{K_2}{K_1}\right) = \frac{-\Delta H}{R}\left[\frac{1}{T_2} - \frac{1}{T_1}\right]$$

$$\Delta T = KX_B \quad K \equiv \frac{RT_b^{*2}}{\Delta_{VAP}H} \qquad \Delta T = K'X_B \quad K' \equiv \frac{RT_m^{*2}}{\Delta_{FUS}H}$$

$$\Pi = \frac{n_B}{V}RT = [B]RT$$

$$\left(\frac{\partial \mu}{\partial P}\right)_T = V_M \qquad \left(\frac{\partial \mu}{\partial T}\right)_P = -S_M$$

$\Delta_R G° = -RT\ln K$

Please sign at the bottom to certify that you have worked on your own.
I certify that I have worked the following exam without the help of others, and that the work I am turning in is my own.

Signed: ----------

Signature Date

1. True/False Circle either T or F for each statement (10 points each)

T F The activity of a pure solid is approximately equal to one because solids are incompressible and have a small molar volume.

T F For the following reaction $\Delta_R G°$ greater than zero.

$$2H_2O(l) \longrightarrow 2H_2(g) + O_2(g)$$

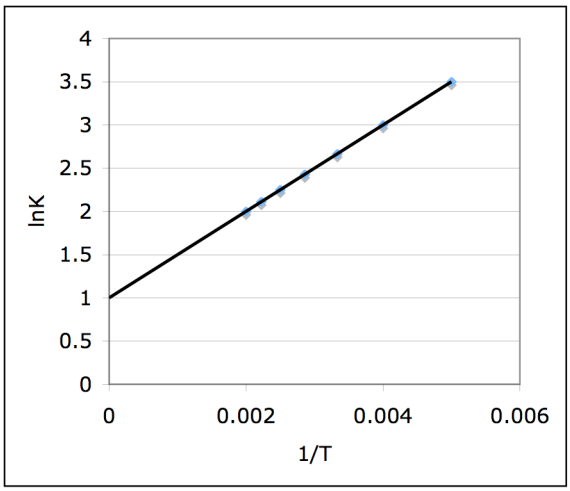
T F For the following reaction increasing the total pressure will increase the equilibrium constant

$$2CO(g) + O_2(g) \longrightarrow 2CO_2(g)$$

T F When a mixture of NO_2 and N_2O_4 is at equilibrium, the chemical potential of NO_2 is higher than that of N_2O_4

T F If $\Delta_R S° > 0$, the equilibrium constant for a reaction will always increase with increasing temperature

2A. (25 points)
Below is plot of the lnK vs 1/T for a reaction. Use this plot to estimate $\Delta_R H°$ and $\Delta_R S°$ for the reaction.



If you can't give a numerical answer, say whether you think each is positive, negative, or zero.

2B. (25 points)

For the reaction

$$N_2(g) + 3H_2(g) \rightarrow 2NH_3(g)$$

$\Delta_R G°$ is 53 kJ mol^{-1} at 500°C. You have a mixture of 0.01 moles N_2, 0.03 moles H_2, and .02 moles NH_3 at a pressure of 2 bar and a temperature of 500°C. Is this mixture at equilibrium? If not, which way will the reaction proceed to reach equilibrium (towards the reactants or towards the products)?

3. (50 Points)

For the following reaction

$$H_2(g) + F_2(g) \rightarrow 2HF(g)$$

Substance	$\Delta_f H°$ (kJ mol^{-1})	S° (J K^{-1} mol^{-1})
$H_2(g)$	-	131
$F_2(g)$	-	203
HF(g)	-271	174

You start with 3 moles of HF(g) at a constant temperature of 298K and a pressure of 1 bar, what is the partial pressure of H_2 at equilibrium?

Would you get more, less, or the same number of moles of H_2 if you increased the pressure to 4 bar,

Would you get more, less, or the same number of moles of if you increased the temperature to 400K?

4. (50 points)

Silver oxide decomposed to silver metal and oxygen gas by the following reaction

$$2Ag_2O(s) \rightarrow 4Ag(s) + O_2(g)$$

39 g of Ag_2O is placed in an evacuated camber with a volume of 10 L. The temperature is raised to 175°C and the system comes to equilibrium. At equilibrium you find there is 5.77 g of silver metal. Given that $\Delta_R H°$ for this reaction is +62.2 kJ mol^{-1} at 450 K, what are $\Delta_R G°$ and $\Delta_R S°$ at 450K?