CHEM 3423 001 Spring 2024 **Name:** Key
ID:

Worksheet #9 (Total number of points you can get is **3 pts**)

1. For a certain chemical reaction one finds a enthalpy difference ΔH = -150 kJ/mol and an entropy difference ΔS = -300 J/(K mol). Assume that these two values do not depend on temperature. At what temperature will be the Gibb's energy difference $\Delta G = 0$?

$$\Delta G = \Delta H - T\Delta S = 0$$

$$\Rightarrow T\Delta S = \Delta H$$

$$\Rightarrow T = \frac{\Delta H}{\Delta S} = \frac{-150 \cdot 10^3 \, J/mol}{-300 \, J/(K \cdot mol)} = 500 \, K$$

2. The equilibrium constant for the reaction

$$(C_6H_5COOH)_2 \rightleftharpoons 2\, C_6H_5COOH$$

in benzene solution at 280 K is K_c= 0.0022 mol/dm^{-3}. Calculate ΔG^0.

$$\Delta G^0 = -RT \ln K_c^0$$

$$= -8.3145 \cdot 280 \cdot \ln(2.2 \cdot 10^{-3}) \, J/mol$$

$$= -8.3145 \cdot 280 \cdot (-6.1193) \, J/mol$$

$$= 14.25 \, kJ/mol$$

The Gibbs energies of formation of A(g) and B(g) are 50 kJ/mol and 25.5 kJ/mol, respectively. The standard state is 1 bar and 300 K. Assume ideal behavior and a reaction A $\rightleftharpoons$ 2B. Calculate the pressure where 50% of A is dissociated.

$$\Delta G^0 = 51\,kJ - 50\,kJ = 1\,kJ$$

$$= -RT \ln K_p^0 \Rightarrow \ln K_p^0 = \frac{-\Delta G^0}{RT} = \frac{-1000 \, J/m}{8.3145 \frac{J}{K \cdot mol} \cdot 300\,K} = 0.4009$$

$$\Rightarrow K_p^0 = 0.67$$

$$A \leftrightarrow 2B$$

$1-\alpha$ $\quad 2\alpha \quad$ total $1+\alpha$

$$P_A = \frac{1-\alpha}{1+\alpha} P, \quad P_B = \frac{2\alpha}{1+\alpha} P$$

$$K_p^0 = \frac{[2\alpha/(1+\alpha)]^2}{[1-\alpha/(1+\alpha)]} = \frac{4\alpha^2}{1-\alpha^2} \frac{P}{1\,bar}$$

$$\Rightarrow P = \frac{1-\alpha^2}{4\alpha^2} K_p^0 \, bar$$

$$\alpha = 0.5$$

$$\Rightarrow P = \frac{0.75}{1} \cdot 0.67 \, bar$$

$$= 0.5025 \, bar$$