

## CHM 152 Group Work 5 Crib

1. Predict whether the entropy change will be positive or negative for the following:

- |  |                                      |
|--|--------------------------------------|
| a. $\text{H}_2\text{O}(\text{g}) \rightarrow \text{H}_2\text{O}(\text{l})$   | $\Delta S$ <u>    -</u> <u>    -</u> |
| b. $\text{C}_6\text{H}_{12}\text{O}_6(\text{s}) \rightarrow 2\text{C}_2\text{H}_5\text{OH}(\text{l}) + 2\text{CO}_2(\text{g})$     | $\Delta S$ <u>  +</u> <u>    </u>    |
| c. $2\text{NH}_3(\text{g}) + \text{CO}_2(\text{g}) \rightarrow \text{H}_2\text{O}(\text{l}) + \text{NH}_2\text{CONH}_2(\text{aq})$ | $\Delta S$ <u>    -</u> <u>    -</u> |
| d. $\text{NaCl}(\text{s}) \rightarrow \text{NaCl}(\text{aq})$  | $\Delta S$ <u>  +</u> <u>    </u>    |
| e. $\text{Cu}(\text{s}) (100^\circ\text{C}) \rightarrow \text{Cu}(\text{s}) (25^\circ\text{C})$                                    | $\Delta S$ <u>    -</u> <u>    -</u> |
| f. $2\text{NH}_3(\text{g}) \rightleftharpoons \text{N}_2(\text{g}) + 3\text{H}_2(\text{g})$  | $\Delta S$ <u>  +</u> <u>    </u>    |

2. Calculate  $\Delta H^\circ_{\text{rxn}}$ ,  $\Delta S^\circ_{\text{rxn}}$  and  $\Delta G^\circ_{\text{rxn}}$  for  $2\text{Mg}(\text{s}) + \text{O}_2(\text{g}) \rightleftharpoons 2\text{MgO}(\text{s})$  (Hint – balance the rxn)

$$\Delta H^\circ_{\text{rxn}} = [ 2(-601.7) ] - [ 0 ] = -1203 \text{ kJ}$$

$$\Delta S^\circ_{\text{rxn}} = [ 2(26.9) ] - [ 1(32.7) + 1(205.0) ] = -216.6 \text{ J/K}$$

$$\Delta G^\circ_{\text{rxn}} = [ 2(-569.4) ] - [ 0 ] = -1139 \text{ kJ}$$

3. From # 2 the results for  $\Delta H^\circ_{\text{rxn}}$  means (**exothermic** or endothermic), the results for  $\Delta S^\circ_{\text{rxn}}$  means (disorder or **order**) increased, and  $\Delta G^\circ_{\text{rxn}}$  means (**products** or reactants) are favored under standard conditions.

4. Calculate K for  $\text{MgCO}_3(\text{s}) \rightleftharpoons \text{MgO}(\text{s}) + \text{CO}_2(\text{g})$

$$\Delta G^\circ_{\text{rxn}} = [ -569.4 + -394.4 ] - [ -1012 ] = 48.2 \text{ kJ}$$

$$\Delta G^\circ_{\text{rxn}} = -RT \ln K$$

$$48.2 \text{ kJ (1000J / kJ)} = (-8.314 \text{ J/molK}) (298 \text{ K}) \ln K$$

$$\ln K = -19.45 \quad \text{so} \quad K = 3.6 \times 10^{-9}$$

5. Calculate the temperature at which this reaction changes from being spontaneous to non spontaneous:  $\text{Mg}(\text{s}) + \text{O}_2(\text{g}) \rightleftharpoons \text{MgO}(\text{s})$ . Is the reaction spontaneous above or **below** this temperature?

**Set  $\Delta G$  to zero to find the temp at which the rxn changes between spont and not spont**

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

$$0 = (-1203 \text{ kJ}) - T (-0.2166 \text{ kJ/K})$$

$$T = -1203 \text{ kJ} / -0.2166 \text{ kJ/K}$$

$$T = 5554 \text{ Kelvin or } 5281^\circ\text{C} \quad \text{rxn is spont BELOW this temp}$$

6. Calculate  $\Delta G$  for  $\text{Mg}(\text{s}) + \text{O}_2(\text{g}) \rightleftharpoons \text{MgO}(\text{s})$  at  $30.5^\circ\text{C}$  if the pressure of oxygen gas is 1.33 atm.

$$\Delta G = \Delta G^\circ_{\text{rxn}} + RT \ln Q$$

$$\Delta G = (-1139 \text{ kJ}) + (8.314 \text{ J/molK}) (\text{kJ} / 1000\text{J}) (303.5 \text{ K}) \ln 1.33^{-1}$$

$$\Delta G = -1140 \text{ kJ} = -1.140 \times 10^3 \text{ kJ}$$