**Gibbs Free Energy Practice Problems**

**1.** Using the following values for ΔH, ΔS, and T, determine the change in free energy and if the reaction is spontaneous or nonspontaneous.

a) ΔH = 40,000 J, ΔS = 300 J/K, T = 130 K
b) ΔH = 40,000 J, ΔS = 300 J/K, T = 150 K
c) ΔH = 40,000 J, ΔS = -300 J/K, T = 150 K

**2.** Given the following information, calculate ∆G° for the reaction below at 25.0°C:

SnCl4(l) + 2 H2O(l) → SnO2(s) + 4 HCl(g)

∆H° = 133,000 J and ∆S° = 401.5 J/K

**3.** Calculate ΔG° for the reaction below. The standard molar entropy change for the reaction at 298 K is -287.5 J/K.

3NO2(g) + H2O(l) 🡪 2HNO3(aq) + NO(g) + 136,800 J

**4.** What is the standard free energy change, ∆G, for the following reaction at 25°C? The ∆H = -91,800 J and ΔS =

-197 J/K.

N2 (g ) + 3H2 (g ) → 2NH3 (g )

**5.** Answer the questions below for each of the following reaction coordinate diagrams:



**a)** Is the reaction exothermic or endothermic? **a)** Is the reaction exothermic or endothermic?

**b)** What is the sign of ΔH? **b)** What is the sign of ΔH?

**c)** Is heat absorbed or released? **c)** Is heat absorbed or released?

**d)** What happens to the temperature of the **d)** What happens to the temperature of the

surroundings? surroundings?

**6.** Find the ∆G for the following reaction at 25.0°C and 1000.°C. The ∆H = -178,300 J and ΔS = -159 J/K. Relate this to reaction spontaneity.

CaCO3 (s) → CaO (s) + CO2 (g)

**7.** The combustion of acetylene is as follows:

C2H2(g) + 5/2 O2(g) --> 2 CO2(g) + H2O(g)

Calculate the ∆G given that the ∆H = -1238 kJ and ∆S = -97.4 J/K or -0.0974 kJ/K at a temperature of 298K.

**8.** Calculating ∆G of a reaction where ∆H = +25.7 kJ and ∆S = +108.7 J/K or +0.1087 kJ/K at a temperature of 25°C.

**9.** For the reaction below:

2 Fe2O3(s) + 3 C(s) ---> 4 Fe(s) + 3 CO2(g)

The ∆H = +467.9 kJ and ∆S = +560.3 J/K or +0.5603 kJ/K. Is this reaction spontaneous at 298k?

**10.** Based on the following equation:

**2 C3H7OH (l) + 9 O2 (g)** 🡪 **6 CO2 (g) + 8 H2O (g) + heat**

 a) Is this reaction **exothermic** or **endothermic**? (circle one)

b) Is the entropy (randomness) of the system **increasing** or **decreasing**? (circle one)

c) Label the sign (+ or –) of each variable in the equation below. If ΔG depends on the temperature, enter a question mark (?).

**ΔG = ΔH – T ΔS**

**( ) = ( ) – ( )( )**

d) At what temperatures is the reaction above spontaneous? (circle one below)

**at all temperatures only spontaneous at only spontaneous at at no temperatures**

**(always spontaneous) low temperatures high temperatures (never spontaneous)**

**11.** Based on the following equation:

**NH4Cl (s) + heat** 🡪 **NH4** **+ (aq) + Cl– (aq)**

a) Is this reaction **exothermic** or **endothermic**? (circle one)

b) Is the entropy (randomness) of the system **increasing** or **decreasing**? (circle one)

c) Label the sign (+ or –) of each variable in the equation below. If ΔG depends on the temperature, enter a question mark (?).

**ΔG = ΔH – T ΔS**

**( ) = ( ) – ( )( )**

d) At what temperatures is the reaction above spontaneous? (circle one below)

**at all temperatures only spontaneous at only spontaneous at at no temperatures**

**(always spontaneous) low temperatures high temperatures (never spontaneous)**

**Partial Answers (in random order):**

-131000 -51100 -33000 -5000 -1210 -6.7 301 1000 13400 24100 85000

J J J J J J J J kJ kJ kJ