Dougherty Valley HS Chemistry - AP
Thermodynamics – Practice ΔH°, ΔS°, ΔG°

Worksheet #5

Name: **Period:** **Seat#:**

Directions: Show all work in a way that would earn you credit on the AP Test! This is always the rule! Some answers are provided at the end in italics and underlined. If you need more space, use binder paper and staple to your worksheet.

1) Consider the decomposition of H_2O_2 (hydrogen peroxide) at 298 K and 1 atm pressure according to:

$$2\ H_2O_2(liq) \rightarrow 2\ H_2O(liq) + O_2(gas)$$

Please find the

a) standard enthalpy of reaction

b) standard entropy of reaction.

2) For the reaction in the previous question, please find the

a) standard (Gibbs) free energy of reaction

b) the value of the (thermodynamic) equilibrium constant at 298 K, 1 atm

3) Using standard enthalpies of formation given in kJ/mol, please calculate the standard enthalpy of reaction for:

$$NH_4Cl(s) \rightarrow NH_3\ (g) + HCl(g)$$

4) Carbon monoxide in the atmosphere slowly converts to carbon dioxide at normal atmospheric temperatures

$$CO(g) + ½\ O_2\ (g) \Leftrightarrow CO_2\ (g)$$

The standard enthalpy of reaction is -284 kJ and the standard entropy of reaction is -87 J/K. Estimate the temperature at which the equilibrium begins to favor the decomposition of CO_2. Assume that the enthalpy and the entropy of reaction are not affected by temperature

5) Using standard entropies given in J/K, please calculate the standard entropy of reaction for:

$$2\ NH_3\ (g) \rightarrow N_2H_4\ (liq) + H_2\ (g)$$

6) Please calculate the standard (Gibbs) free energy of reaction for:

$$2\ NO(g) + O_2(g) \Leftrightarrow 2\ NO_2(g)$$

7) Calculate the entropy of vaporization of propane given that its enthalpy of vaporization is 16.9 kJ/mol at its normal boiling point of -42.1°C.

8) Obtain the numerical value of the equilibrium constant (at 298K) for the following reaction:

$$CO_2(g) + H_2O(liq) \Leftrightarrow H_2CO_3(aq)$$

9) Please indicate if TRUE or FALSE (Explain why as well):

	The entropy of a gas increases with increasing temperature
	The energy of a perfect crystal is zero at 0 K.
	Spontaneous processes always increase the entropy of the reacting system
	All spontaneous processes release heat to the surroundings
	An endothermic reaction is more likely to be spontaneous at high temperatures than at low temperatures
	The entropy of sugar decreases as it precipitates from an aqueous solution

10) Ammonia gas a standard (Gibbs) free energy of formation equal to -16.367 kJ/mol

a) Find $\Delta G°$ for the reaction: $N_2\ (g) + 3\ H_2\ (g) \Leftrightarrow 2\ NH_3\ (g)$

b) In which direction will this reaction proceed if a mixture of gases is made with:
P_{NH_3}= 1.00 atm P_{H_2}= 0.50 atm P_{N_2}= 0.50 atm

c) What pressure of hydrogen gas should be added to a mixture already containing 0.20 atm NH_3 and 0.50 atm N_2 if one does not want the amounts of NH_3 and N_2 to change?

ANSWERS:

1. -196.4 kJ; 125 J/K
2. -233.6 kJ; 9.18 x 10^{40}
3. 175.9 kJ
4. T > 3264 K
5. -133.2 J/K
6. -69.7 kJ
7. 73.1 J/K
8. 4.0 x 10^{-2} (using $\Delta G_f°$ data); 3.1 x 10^{-2} (using $\Delta H_f°$ and $S°$ data)
9. T F F F T T
10. -32.734 kJ; proceed to the right; 5.3x10^{-3} atm