Form B

Chem 130 **Name**_____
Exam 3, Ch 7, 19, and a little 14 **November 11, 2011**
100 Points

Please follow the instructions for each section of the exam. Show your work on all mathematical problems. Provide answers with the correct units and significant figures. Be concise in your answers to discussion questions.

Part 0: Warmup. 4 points each

1. A spontaneous process:
   a. will happen quickly.
   b. releases large amounts of energy. Answer _____
   c. will continue on its own once begun.
   d. is never endothermic.

2. Reactions with a positive ΔH^o and a negative ΔS^o are:
   a. spontaneous at all temperatures.
   b. non-spontaneous at all temperatures.
   c. spontaneous at low temperatures but non-spontaneous at high temperatures. Answer _____
   d. non-spontaneous at low temperatures but spontaneous at high temperatures.

3. The reaction A + B → C + D is second order in A and zero order in B. The value of k is 0.012 $M^{-1}min^{-1}$. What is the rate of this reaction when [A] = 0.235 M and [B] = 0.125 M?
   a. 6.6×10^{-4} M min^{-1}
   b. 2.8×10^{-3} M min^{-1} Answer _____
   c. 1.9×10^{-4} M min^{-1}
   d. 1.5×10^{-3} M min^{-1}

Part I: Complete all of problems 3-8. 12 points each.

4. For each of the statements below, indicate whether the statement is CORRECT or INCORRECT and justify your choice in no more than two sentences for each item.
   a. As temperature in a gas decreases, ΔS is positive.

   b. As two gases mix, ΔS is positive.

   c. Molecules in a liquid state have higher entropy than molecules in the gaseous state.

5. Determine ΔH^o for the reaction $N_2H_4(l) + 2H_2O_2(l) \rightarrow N_2(g) + 4H_2O(l)$ from these data:

Reaction	ΔH^o
$N_2H_4(l) + O_2(g) \rightarrow N_2(g) + 2H_2O(l)$	-622.2 kJ
$H_2(g) + ½\ O_2(g) \rightarrow H_2O(l)$	-285.8 kJ
$H_2(g) + O_2(g) \rightarrow H_2O_2(l)$	-187.8 kJ

6. A coffee-cup calorimeter contains 100.0 mL of 0.300 M HCl at 20.3°C. When 1.82 g zinc metal also at 20.3°C is added and is allowed to react, the temperature rises to 30.5°C. What is the heat of reaction per mole of Zn? Assume no heat is lost during the course of the reaction and that the heat capacity and the density of the solution is the same as that of pure water.

$$Zn(s) + 2H^+(aq) \rightarrow Zn^{2+}(aq) + H_2(g)$$

7. Determine the standard enthalpy of formation of hexane, $C_6H_{14}(l)$, from the information below. Report your result in units of kJ per mole of hexane.

$$2\ C_6H_{14}(l) + 19\ O_2(g) \rightarrow 12\ CO_2(g) + 14\ H_2O(l) \qquad \Delta H^o = -8326\ kJ$$

Species	ΔH^o_f, kJ mol^{-1}	S^o_f, J mol^{-1} K^{-1}	ΔG^o_f, kJ mol^{-1}
$O_2(g)$	0	205.1	0
$H_2(g)$	0	130.7	0
C(s, graphite)	0	5.74	0
$CO_2(g)$	-393.5	213.7	-394.4
$H_2O(l)$	-285.8	69.91	-237.1
$H_2O(g)$	-241.8	188.8	-228.6

8. For the reaction, $2\ NO(g) + Cl_2(g) \rightarrow 2\ NOCl(g)$, $\Delta H^o = -40.9$ kJ. At what temperatures do you expect the reaction to be spontaneous: high, low, all, or none? Justify your answer.

Part II. Answer <u>two (2)</u> of problems 9-11. Clearly mark the problems you do not want graded. 15 points each.

9. The initial rate of the reaction A + B → C + D is determined for different initial conditions, with the results listed in the table below. Determine the rate law and the rate constant for the reaction.

Experiment	[A], M	[B], M	Initial Rate (Ms^{-1})
1	0.0133	0.0185	3.35×10^{-4}
2	0.0133	0.0370	6.75×10^{-4}
3	0.0266	0.0370	2.70×10^{-3}
4	0.0266	0.0185	1.35×10^{-3}

10. Sketch two reaction coordinate diagrams below. For the first diagram, illustrate a generic reaction that is non-spontaneous and fast in the forward direction. For the second, illustrate a generic reaction that is spontaneous and slow in the forward direction. Clearly label your plots. For each diagram, include a brief description of how it satisfies the spontaneity and speed of the reaction requirements.

11. Consider the reaction $N_2O(g) + 2H_2O(l) \rightarrow NH_4NO_3(s)$ at 298K.

Species	ΔH^o_f, kJ mol^{-1}	S^o_f, J mol^{-1} K^{-1}	ΔG^o_f, kJ mol^{-1}
$O_2(g)$	0	205.1	0
$H_2(g)$	0	130.7	0
$NH_4NO_3(s)$	-365.6	151.1	-183.9
$N_2O(g)$	82.05	219.9	104.2
$H_2O(l)$	-285.8	69.91	-237.1
$H_2O(g)$	-241.8	188.8	-228.6

a. Is the forward reaction exothermic or endothermic?

b. What is the value of ΔG^o at 298 K?

c. Does the reaction occur spontaneously at temperatures above 298 K, below 298 K, both, or neither? Justify your answer.

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Possibly Useful Information

$\Delta G = \Delta H - T\Delta S$	$^{o}C = K - 273.15$
$q_{rxn} = n\Delta H_{rxn}$	$q = mc\Delta T$
Don't eat the yellow snow!	$q_{released} = -q_{absorbed}$

Compound	Molar Mass (g/mol)	Compound	Molar Mass (g/mol)
H_2O	18.0153	C_6H_{14}	86.177
H_2O_2	34.0147	CO_2	44.010
HCl	36.4606	N_2H_4	32.0452
H_2	2.01588	NH_4NO_3	80.0434
N_2	28.0135	N_2O	44.0129
O_2	31.9988	NO	30.0061
Cl_2	70.9054	NOCl	65.4588

Material	Specific Heat Capacity (J/gK)
H_2O (s)	2.050
H_2O (l)	4.184
H_2O (g)	2.080
Zn(s)	0.390