CH301 Fall 2013
XXX (Professor Name)
EXAM 4
25 POINTS

Name:_____KEY_____
UT EID:_____
VERSION #: _____

Questions on front and back. Show work for partial credit. Your work and answers must fit in the boxes provided for each question. ***Responses outside the boxes will not be graded.***

Consider the combustion of **one mole of hydrazine (N_2H_4)** at 1 atm and 298K.

$N_2H_4\,(l) + 3\,O_2\,(g) \rightarrow 2\,NO_2\,(g) + 2\,H_2O\,(l)$

1. (3 points) Calculate the change in the standard reaction entropy for the system.

$\Delta S^\circ_{rxn} = \sum nS^\circ_{products} - \sum nS^\circ_{reactants}$
$\Delta S^\circ_{rxn} = [2(S^\circ_{H20(l)}) + 2(S^\circ_{NO2(g)})] - [1(S^\circ_{N2H4(l)}) + 3(S^\circ_{O2(g)})]$
$\Delta S^\circ_{rxn} = [2(70J/molK) + 2(240J/molK)] - [1(12J/molK) + 3(205J/molK)]$
$\Delta S^\circ_{rxn} = [620J/molK] – [627J/molK]$
$\Delta S^\circ_{rxn} = -7$ J/K (for 1 mol of this reaction, which is what we have when we combust 1 mol hydrazine)
(OR $\Delta S^\circ_{rxn} = -0.007$ kJ/K)

Total of 3 pts:
+1 pts for correct equation/set-up
+2 points for correct answer
(or +3 pts for correct answer with some articulate work shown)

2. (3 points) Calculate the change in the standard reaction enthalpy for the system.

$\Delta H^\circ_{rxn} = \sum n\Delta H_f^\circ{}_{products} - \sum n\Delta H_f^\circ{}_{reactants}$
$\Delta H^\circ_{rxn} = [2(\Delta H_f^\circ{}_{H20(l)}) + 2(\Delta H_f^\circ{}_{NO2(g)})] - [1(\Delta H_f^\circ{}_{N2H4(l)}) + 3(\Delta H_f^\circ{}_{O2(g)})]$
$\Delta H^\circ_{rxn} = [2(-286kJ/mol) + 2(33kJ/mol)] - [1(50kJ/mol) + 3(0kJ/mol)]$
$\Delta H^\circ_{rxn} = [-506kJ/mol] – [50kJ/mol]$
$\Delta H^\circ_{rxn} = -556$ kJ (for 1 mol of this reaction, which is what we have when we combust 1 mol hydrazine)

Total of 3 pts:
+1 pts for correct equation/set-up
+2 points for correct answer
(or +3 pts for correct answer with some articulate work shown)

3. (3 points) Calculate the change in standard Gibbs' Free Energy for the system

$\Delta G^\circ_{rxn} = \Delta H^\circ_{rxn} – T(\Delta S^\circ_{rxn})$
$\Delta G^\circ_{rxn} = -556$ kJ – (298k)(-0.007 kJ/K)
$\Delta G^\circ_{rxn} = -533.914$ kJ

Total of 3 pts:
+1 pts for correct equation/set-up
+2 points for correct answer using the numbers provided from #1 and #2

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(or +3 pts for correct answer with some articulate work shown)

4. (3 points) At what *temperature* will this reaction become spontaneous (or non-spontaneous)? Will the reaction be spontaneous above or below this temperature?

$0 = \Delta G^\circ_{rxn} = \Delta H^\circ_{rxn} - T(\Delta S^\circ_{rxn})$
$0 = \Delta H^\circ_{rxn} - T(\Delta S^\circ_{rxn})$
$0 = -556\ kJ - (T)(-0.007\ kJ/K)$
$T = (-556\ kJ) \div (-0.007\ kJ/K)$
$T = 79{,}428.57\ K$

The reaction will be spontaneous below this temperature.

Total of 3 pts:
+1 pts for correct equation/set-up
+1 points for correct answer using the numbers provided from #1 and #2
+1 point for correct analysis of spontaneity
(or +3 pts for correct answer with some articulate work shown and correct analysis of spontaneity)

5. (3 points) Will the sign on work be positive, negative or zero? Please explain your answer.

It will be positive. There are fewer gas moles in the products than in the reactants. The external pressure will do work ON the system and compress the system.

$Work = -\Delta n_{gas} RT = -(2moles - 3moles)(8.314 J/molK)(298K) = +2{,}477.57\ J$

Total of 3 pts:
+1 pts for correct sign
+2 pts for correct, logical explanation via words or through math

6. (10 points) Match the following terms with the appropriate definition (by placing the corresponding letter in the provided 'blank').

a. Enthalpy b. Entropy c. First Law of Thermodynamics d. Heat e. Work

f. Internal Energy g. Heat Capacity h. Specific Heat Capacity i. Potential Energy

j. Kinetic Energy

Total of 10 pts: +1 pt for each response

_ i.__ energy of a system based on composition and position

_ j.__ energy of motion

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_ b.__ energy dispersed relative to the temperature

_ h.__ intensive measure of heat flow relative to temperature change

_ a.__ heat flow at constant pressure

_ g.__ extensive measure of heat flow relative to temperature change

_ f.__ total energy of a system

_ d.__ transfer of energy from a hot body to a cold body

_ c.__ conservation of energy

_ e.__ organized molecular motion across a distance

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