Department of Chemistry
University of Texas at Austin

Name:_____

Thermodynamics Unit - RAQ

Part I
Consider the following CHEMICAL CHANGE:

Acetylene (C_2H_2) combusts in oxygen to form carbon dioxide and water.

1. Estimate the enthalpy of combustion of acetylene using bond energies data.

Single Bond Energies (kJ/mol of bonds)

	H	C	N	O	S	F	Cl
H	436						
C	413	346					
N	391	305	163				
O	463	358	201	146			
S	347	272	—	—	226		
F	565	485	283	190	284	155	
Cl	432	339	192	218	255	253	242

Multiple Bond Energies (kJ/mol of bonds)

C=C 602	C=N 615	C=O 799
C≡C 835	C≡N 887	C≡O 1072
N=N 418	O=O 498	N≡N 945

Name:_____

2. Calculate the enthalpy of combustion of one mole of C_2H_2 using heats of formation data found on the course website using your personal wireless device.

3. Calculate the change in entropy for this reaction using standard molar entropy data found on the course website.

Name:_____

4. Calculate the change in Gibbs free energy for this reaction. Is there ever a temperature where this reaction would be non-spontaneous? If so, what is that temperature? If not, why?

5. Imagine this reaction was run at constant pressure and temperature, what is the work for this process (combustion of 4 g C_2H_2)?

Name:_____

6. At constant pressure, use the change in enthalpy and the work to find the change

7. 4 g of acetylene was combusted in a bomb calorimeter that had a heat capacity of 3.51 kJ/C for the device and contained 2000 g of water (C = 4.184 J/g C) to absorb the heat as well. What is the expected temperature change in such a calorimeter given the complete combustion of the 4 g of the fuel.

Name:_____

Thermodynamics Unit - RAQ

Part II
PHYSICAL CHANGE:

$$N_2(liq, 77K) \longrightarrow N_2(gas, 298K)$$

$\Delta H^0_{vaporization} = 5.56$ kJ mol^{-1}

$C(N_{2gas}) = 29.1$ J K^{-1}mol^{-1}

$T_b = 77$ K

$T_{surr} = 298$ K

1. How much heat is absorbed during this change given 4 moles of N_2?

2. What is the work for this process (assuming the initial volume of the liquid is zero?)

3. What is the change in internal energy for this process?

4. What is the change in enthalpy for this process?

5. What is the change in entropy of the system for this process?

Name:_____

6. What is the change in entropy of the surrounding for this process?

7. What is the total change in entropy (change in entropy of universe) for this process?

8. Does the thermodynamic calculation predict the observation that this process is spontaneous?