Keep the Heat
Coolidge invitational
Written test
12/17/11

Useful information:

Although the symbols and abbreviations used on this test are, to my knowledge, fairly standard, it may be helpful to explain what they stand for.

Symbol	Meaning
E	Energy
H	Enthalpy
S	Entropy
G	Gibbs free energy
R	Ideal gas constant
ºF	Degrees Farenheight
ºC	Degrees Celsius
K	Kelvin
mL	Mililiters
L	Liters
J	Joules
kJ	KiloJoules
atm	Atmospheres (pressure)
mol	moles

Constant values:

R= 0.08206 $\frac{L*atm}{mol*K}$ or 8.314 J

Specific heat of water= 4.184 $\frac{J}{g*K}$

Section 1: Multiple choice

1. Which of the following is always true for a spontaneous reaction?
   A. $\Delta E_{universe} > 0$
   B. $\Delta S_{universe} > 0$
   C. $\Delta G_{reaction} > 0$
   D. $\Delta H_{reaction} > 0$

2. Which of the following is a measurement of heat energy?
   A. Mole
   B. Kelvin
   C. Liter
   D. q

Consider the reaction in which water is boiled at 380 Kelvin.

3. Which of the following is true about ΔH for the reaction?
   A. $\Delta H < 0$
   B. $\Delta H = 0$
   C. $\Delta H > 0$
   D. not enough information to tell

4. Which of the following is true about ΔS for the reaction?
   A. $\Delta S < 0$
   B. $\Delta S = 0$
   C. $\Delta S > 0$
   D. not enough information to tell

5. Which of the following is true about ΔG for the reaction?
   A. $\Delta G < 0$
   B. $\Delta G = 0$
   C $\Delta G > 0$
   D. not enough information to tell

Section 2: Problems

1. Suppose that there is a sample of Helium gas occupying 5.00 L at a pressure of 2.00 atm. Assume it to be an ideal gas. The temperature is determined to be 106.79 ºF

   1.1 What is the temperature in Kelvin?

   1.2 How many moles of gas are present?

2. Suppose that the gas in problem 1 is made to contract until the volume is 3.50 L, while keeping a constant pressure of 2.00 atm.

   2.1 Calculate the work involved in this process

   2.2 Calculate ΔE for this process

Please provide both of these answers in Joules.

3. Consider an isolated container containing 193 mL of distilled water at an initial temperature of 19.7 °C. Suppose that 137 mL of distilled water at 83.2 °C is added. What is the final temperature, assuming no heat escapes?

4. In a keep-the-heat-related experiment, a beaker of water is heated up to 80.0 ºC. Over the course of 30 minutes, the temperature drops to 36.2 ºC. It was later determined that the heat transfer was 29,320 Joules. What was the volume of water used? Please provide your answer in Liters.

5. The heat of combustion of compound X is -723.6 kJ/mol. 0.0129 moles of compound X undergoes combustion in a bomb calorimeter. The heat capacity of the calorimeter is 3.18 kJ/K and the initial water temperature is 26.3 º. What is the final temperature of the water and the calorimeter?