Multiple Choice (circle the best answer)

1. The heat for this reaction at constant temperature and pressure

$CO_2(g) \rightarrow C(s, \text{graphite}) + O_2(g)$

A. is equal to half the bond energy of a C-O bond.
B. is equal to but opposite in sign to the bond energy of a C=O bond.
C. is equal to twice the bond energy of a C=O bond.
D. is equal to the enthalpy of formation of CO_2.
E. is equal to but opposite in sign to the enthalpy of formation of CO_2.

2. Which of the following values of K_p most strongly favors the reactants?

A. 6.9×10^{2}
B. 9.3×10^{-2}
C. 1.0×10^{0}
D. 1.8×10^{-1}

3. When Q > K a reaction will do the following:

A. go forward
B. go backwards
C. no change
D. go back and forth

4. What is the role of time on a chemical reaction that is already at equilibrium?

A. Time is not a factor in systems at equilibrium.
B. As time increases a chemical reaction will favor the direction that is exothermic.
C. As time increases a chemical reaction will favor the direction that is endothermic.
D. Longer times will yield more products as the reactants are consumed.

5. Equilibrium in a chemical reaction can be attained by

A. starting with products only
B. Starting with a combination of reactants and products
C. starting with reactants only
D. all the choices are correct

2. True/False. For each of the following statements circle the best response.

It is impossible for a real process to result in an increase in the entropy of the system. True False

All endothermic reactions are spontaneous at extremely high temperatures. True False

Heat transfer to a substance always causes the temperature to increase. True False

At constant pressure, exothermic reactions increase the entropy of the surroundings. True False

The enthalpy for this reaction is the enthalpy of formation of CO (*g*) True False

$$C(g) + O(g) \rightarrow CO(g)$$

If $\Delta G°$ for a given reaction is large and positive, the equilibrium constant (K) will be very small and favor the reactants. True False

$\Delta S°$ is greater than zero for the following reaction True False

$$2H_2O(l) \rightarrow 2H_2(g) + O_2(g)$$

If ΔH and ΔS are independent of temperature then ΔG is independent of temperature. True False

The equilibrium constant for any reaction is independent of temperature. True False

1 mole of an ideal gas at constant temperature is compressed from 1 atm to 10 atm. True False
For this process $w > 0$, $q <$, and $\Delta U = 0$.

3. For each pair choose the system with higher entropy (or note if they are the same).

1 g Hg (*s*, -30°C, 1 atm)	1 g Hg (*l*, 30°C, 1 atm)	Same	(T_m of Hg is -30°C
1 mol Ar (*g*, 300 K, 1 L)	1 mol Ar (*g*, 500 K, 1 L)	Same	
1 L pure H_2O (300 K, 1 atm)	1 L 1M NaCl solution (300 K, 1 atm)	Same	
1 mol H_2 (*g*, 300 K, 1 L)	1 mol H_2 (*g*, 300 K, 10 L)	Same	

4. 1 g of methane (CH_4) is burned in a constant pressure calorimeter with an excess of oxygen gas. The reaction is carried out in a calorimeter with a heat capacity of 10^5 J K^{-1} and an initial temperature of 25 °C. After the reaction the temperature of the calorimeter is 25.506°C.

(a) How much heat was evolved during the reaction?

(b) What is $\Delta H_{rxn}°$ for this reaction?

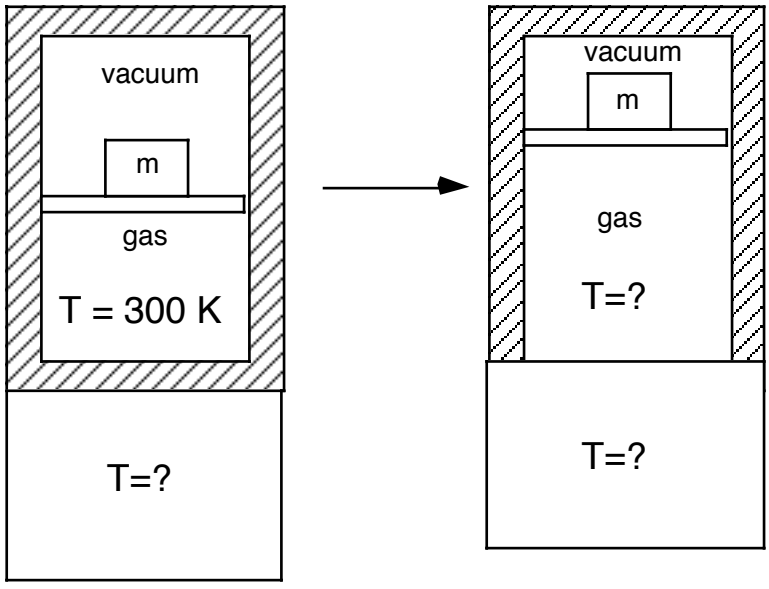
(c) Assuming the temperature of the experiment to be essentially constant what is total work for this reaction (the burning of 1 g of methane)?

(d) What is ΔU for the reaction of 1 g of methane with oxygen?

(e) Given the data below what is the heat of formation of methane?

$\Delta H°_f\ H_2O(g) = -241.8$ kJ mol^{-1}
$\Delta H°_f\ CO_2(g) = -393.5$ kJ mol^{-1}

5. 2 moles of an ideal gas are in an insulated piston at an initial temperature of 300K. The piston has a mass on top of it that supplies a constant pressure. The insulation in the bottom of the piston is removed and it is brought into contact with a constant temperature bath of an unknown temperature. Heat flows into the system causing the gas to both expand and change temperature. After the temperature has equilibrated, the work for this process is found to be, w= -3.325 kJ. What is the temperature of the bath?



6. For the following reaction:

$CH_4(g) + H_2O(g) \rightarrow CO(g) + 3H_2(g)$

an equilibrium mixture at 600 K is found to have the following partial pressure

$P_{CH4} = 1$ atm
$P_{H2O} = 1$ atm
$P_{H2} = 0.01$ atm
$P_{CO} = 0.18$ atm

(a) What is the equilibrium constant for this reaction at 600 K?

(b) What is $\Delta G°$ for this reaction at 600 K?

(c) What is K for this reaction?

(c) Is the reaction endothermic or exothermic? Explain.