MULTIPLE CHOICE (3pts each): Write the ONE letter corresponding to the correct answer on the line next to each question. The LETTER ASSOCIATED WITH THE CORRECT ANSWER MUST BE WRITTEN ON THE LINE NEXT TO THE QUESTION in order to receive full credit.

1.) Which response best describes equilibrium? 1.) D

a.) The concentrations of reactants and products are equal
b.) The reaction has reached the point where no more reactants or products are being formed
c.) The reaction has begun to form reactants and not products
d.) The rate of the forward and reverse reactions are equal.

2.) For the reaction A(g) + 2B(g) <--> C(g), the value of $K_p = 2.68 \times 10^3$. What is the value of K_p for the reaction 2C(g) <-->2A(g) + 4B(g) ? 2.) B

a.) 3.73×10^{-4} b.) 1.39×10^{-7} c.) 7.18×10^{6} d.) 7.46×10^{-4}

$(1/2.68 \times 10^3)^2$

3.) A reaction A + B --> C is nonspontaneous at 25°C. If $\Delta H_{rxn} = 28.7 kJ/mol$ and $\Delta S_{rxn} = 39.7 J/molK$, at what temperature will this reaction become spontaneous? 3.) A

a.) 449.8°C b.) 722.9°C c.) -272.4°C d.) 11.8°C

$0 = 28.7\ kJ/mol - (T)(0.0397\ kJ/mol\,K)$ Answer = T - 273.15

4.) Which of the following can be described as a measurement of the disorder of a system? 4.) C

a.) free energy b.) enthalpy c.) entropy d.) spontenaeity

5.) Which of the following processesis most likely to result in an increase in entropy? 5.) C

a.) $C_7H_6O_3$ (aq) + $C_2H_4O_2$ (aq) --> $C_9H_{10}O_5$ (aq)
b.) H_2O (l) --> H_2O (s)
c.) $C_4H_8O_4$ (s) --> 2 CO_2 (g) + 2 N_2 (g) + 2 CH_4 (g)
d.) All of the above responses would lead to an increase in entropy

6.) At 298K, the K_c for the reaction A(g) <--> B (g) + 2C(g) is 56.3. What is the value of Kp at 298K? 6.) A

a.) 3.37×10^4 b.) 3.46×10^8 c.) 56.3 d.) 1.38×10^3

$K_p = (56.3)(0.08206 \cdot 298)^{3-1}$

7.) Which of the following options would allow you to produce more of the product of the following reaction? $N_2(g) + 3H_2(g) <--> 2NH_3(g)$ $\Delta H° = -91.88 kJ$ 7.) B

a.) Increase the volume of the reaction flask b.) remove NH_3 from the reaction flask
c.) add a catalyst d.) increase the temperature

too high compared to K

8.) For the sublimation process A (s) <--> A (g), the value of K_p is 12.58. If the pressure of the gas is 20.52atm, which of the following responses is correct? 8.) C

a.) The reaction is at equilibrium b.) The rate is higher in the forward direction
c.) The rate is higher in the reverse direction d.) The reaction requires a catalyst

9.) Which of the following processes is **LEAST** likely to be spontaneous? 9.) D

a.) iron rusting near the ocean b.) sugar dissolving in a cup of hot coffee
c.) water freezing at -20°C d.) A college student's dorm room cleaning itself

10.) Which of the following molecules is most likely to have the highest entropy? 10.) D

a.) C_2H_6 b.) C_4H_{10} c.) C_6H_{14} d.) C_8H_{18}

SHORT ANSWER (10 pts each): Completely answer all of the following questions. Read all questions carefully!!! ALL WORK MUST BE SHOWN TO RECEIVE FULL CREDIT. If your work is in a different location, you must make a note of this in the given work area for the problem in order for the work to be considered for partial credit. Make sure to include units and report all mathematical answers to the correct number of significant figures. Write final answers in designated locations when indicated.

1.) A compound with a molar mass of 145.894g/mol has a molar enthalpy of vaporization of 37.2kJ/mol and a boiling point of 97.6°C at 1.00atm. What is the change in entropy in J/K when 122.9g of this compound boils at 1.00atm? Include the correct sign with your answer.

Answer: _____

2.) Use the information provided to answer the following questions about the following reaction. Make sure to include the correct sign with all numerical answers.

$C_2H_4(g) + 3\ O_2(g) \rightarrow 2\ CO_2(g) + 2\ H_2O(l)$

	$\Delta H°$ (kJ/mol)	S° (J/molK)		$\Delta H°$ (kJ/mol)	S° (J/molK)
C_2H_2 (g)	226.6	200.8	CO_2 (g)	-393.5	213.6
C_2H_4 (g)	52.3	219.5	H_2O (l)	-285.8	69.9
C_2H_6 (g)	-84.7	229.5	O_2 (g)	0	205.0
C_3H_8 (g)	-103.9	269.9			

a.) What is the value of $\Delta H°$ for this reaction? Answer: _____

b.) What is the value of $\Delta S°$ for this reaction? Answer: _____

c.) What is the value of $\Delta G°$ for this reaction at 25°C? Answer: _____

d.) Is this reaction spontaneous at 25°C? Answer: _____

e.) Briefly explain your answer to part d.

3.) A given equation 2A (aq) + B (l) ←→ 3C (aq) + D(aq) has the following equilibrium amounts: A = 0.956M, B = 0.887mL, C = 0.724M, D = 0.246M

a.) Write the equilibrium expression for this reaction.

b.) Calculate the value of K_c for this reaction. Answer: _____

4.) The reaction 3A(g) ←→ 2B(g) + C(g) has a K_c value of 47.8. If you start with just 1.65M of compound A, what are the equilibrium concentrations of each compound? Do not use the approximation method.

[A]: _____

[B]: _____

[C]: _____

5.) A reaction has $\Delta H°_{rxn}$ = +26.9kJ/mol and $\Delta S°_{rxn}$ = +125.6 J/molK.

a.) What is the value of K_{eq} at 455K? Answer: _____

b.) If the value of K_{eq} is 0.1 at 298K, would you expect to have more products at 298k or at 455K?

Answer: _____

c.) Briefly explain your answer to part b.

6.) The reaction 2A(aq) ←→ 3B(aq) has a $\Delta G°$ of +77.6kJ/mol at 298K. What is the value of ΔG at 298K when [A]=0.765M and [B]=0.228M? Include the sign with your answer.

Answer:_____

7.) Given the reaction $2NOCl(g) \leftrightarrow 2NO(g) + Cl_2(g)$ $\Delta H_{rxn} = +77.16kJ/mol$, state whether each of the following stresses will shift the equilibrium toward the reactants, toward the products, or have no impact on the equilibrium.

a.) Increase the pressure _____

b.) Increase the volume _____

c.) Add NO _____

d.) Add argon gas _____

e.) Increase the temperature _____