**In-class Thermodynamics exam : Chem 6854 Spring 2014 (30 points)**

**Your name: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**Each problem is worth 2 points except where noted**

1. **Which statement is true concerning the sign conventions for heat (Q) and work (W) assumed in your text ?**
2. Q is positive if it flows to the surroundings.
3. W is negative if the surroundings does work on the system.
4. W is positive if the system does work on the surroundings.
5. Q is negative if the system gives up heat to the surroundings.
6. **In an adiabatic process:**
7. A piston will expand by raising system temperature while converting internal heat to work .
8. The surroundings can only do work, on the system while the system can pass only heat to the surroundings.
9. The surroundings and system can only pass work back and forth to each other.
10. A piston will cool when compressed since no heat is passed from surroundings to system.
11. **For an adiabatic expansion or contraction, which equation applies ?**
12. T2/T1= (V2/V1)C/R b) T2/T2 = V1/V2 c)T2/T1 = (V1/V2)C/R d) T2V2 = T1V1

**4) In an isothermal, reversible expansion of an ideal gas from V1🡪V2 , what two things are true below ?**

a) Wsystem = -P(V2-V1) b) ΔSsystem = 0 c) ΔEsystem = 0 d) ΔSsurroundings  = 0

e) ΔSsurroundings - ΔSsystem = 0 f) Qsystem = RT ln V2/V1 g) maximum Q is exchanged between system

 and surroundings

1. **Given the thermodynamic data below, find the heat of reaction for :**

**Ca(s) + O2(g) + H2(g) 🡪 Ca(OH)2(s) \_\_\_\_\_\_\_\_ = ΔrH (kcal)**

Reaction ΔrH (kcal/mol reactant)

CaO(s) 🡪 Ca(s) + ½ O2(g) 151.8

H2O(l) 🡪 H2(g) + ½ O2(g) +68.4

CaO(s) +H2O(l) 🡪 Ca(OH)2(s) -15.3

1. The enthalpy of formation of HF is -273 kJ/mol HF. Given the bond enthalpies below

 Compute the bond energy ε(H-F) in kJ/mol bond

Bond enthalpy (kJ/mol) per product atom

H2🡪 2H 217.9

F2🡪 2F 79.39

ε(H-F)=\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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1. Consider the set of steps carried out on a mole of ideal gas in a piston initially at a temperature = T1

Step 1: reversible expansion at constant P1 from V1🡪V2 P

Step 2: reversible adiabatic compression from V2 to V3 < V1. (P2,V3)

Step 3: reversible isothermal expansion from V3 back to V2 step 3

 Step 4: reversible adiabatic de-pressurization back to (P1,V2) step 2 (P3,V2)

 step 4

1. **In which step(s) does the temperature rise ? (1 pt)**
2. **In which step(s) does no work get done ? (1 pt)**

 step 1

(P1,V1) (P1,V2)

 V

1. In the previous problem, given that n=1, P1=1 atm, V1 = 1 L and T1 = 300 K: (2 pts each)
2. **Compute the temperature T2  reached during step 1 to achieve a new volume V2 = 2 L.**
3. **b) Compute W for step 1 in atm\*L units (include correct sign for W !!!! )**
4. **Compute Q by the system to achieve step 1 given that Cp = 5/2 R**
5. **Compute ΔSsystem for step 1.**
6. **In a reversible, adiabatic expansion the following is not true:**
7. The process takes infinite amounts of time.
8. The temperature of the surroundings and system both remain the same.
9. ΔStotal = ΔSsystem + ΔSsurroundings =0
10. ΔSsystem = ΔSsurroundings  = 0
11. **Given Cv = 3R/2 for an ideal monatomic gas, compute the change in entropy for an isothermal expansion of 1 mole of ideal monatomic gas from 20 to 40 L at T= 300 K. (2 pts)**
12. **The reason enthalpy,** Δ**Hp , is commonly used by chemists is:**
13. At constant pressure, chemical reaction heat Qreaction = ΔHp is a state function.
14. ΔHp = ΔU and we can measure energy changes of systems directly at constant pressure.
15. It allows us to easily compute the entropy change of a gas phase reaction, ΔSgas = ΔHp/T.
16. We can deduce the maximum work from a reaction since Wrev = **ΔHp.**
17. **For any irreversible, spontaneous process, even an adiabatic one, it is inevitable that the process:**
18. Conserves entropy
19. Makes work
20. Causes entropy to increase
21. Causes entropy to decrease
22. Causes energy to increase

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