**Chemistry 6854: First Law In-Class exercises: part 1**

**Spring 2016 Alfred State**

1. 1 mole of ideal gas is compressed isothermally from 2 to 0.5 dm3 at 300 K.
2. Using the sign conventions for work in McQuarrie what is the work done (in J) ?

dW= PdV = RT/V dV => = -8.314 \*300 ln (0.5/2)=3,457.6 J

(work done on system by surroundings is positive)

1. How much heat was absorbed to do the work ?

Since this is an isothermal process: ΔE=0=Q +W so –W=Q=-3,457.6 J

1. A 1 mole sample of monatomic ideal gas is compressed adiabatically from 2 to 0.5 dm3 starting at 300 K.
2. Without doing any calculations, what do you think the temperature will become inside the system as the adiabatic compression occurs ? Explain your answer. …increases since external work adds momentum to gas as it hits walls
3. Compute the actual temperature the gas attains at 0.5 dm3.

**T2/T1 = (V1/V2)R/Cv for adiabatic system of ideal gas Cv=3/2 R=> T2/T1 = (V1/V2)2/3**

**T2 =300(2/0.5)2/3 =755.9 K**

1. Compute the work (with correct sign) carried out during this compression

dW=dE = CvdT => W = = 3/2 \*R(755.9-300) =3/2\*8.314\*(755.9-300)=5,685.5 J

1. Since the compression is done adiabatically, where does the energy come from to change the temperature ? Does it make sense that the compression stroke here is used as a model for a refrigerator run in reverse, e.g. a heat pump ?

From the work put into the system to compress gas…opposite motion would cool gas adiabatically

**Chemistry 6854: First Law In-Class exercises: part 2**

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2.1 Given the data in the table provided, use Hess’ Law to ΔrHo for:

ΔrHo

1. OH(g) 🡪H(g) + O(g) **428.2 kJ**
2. H2O(g) 🡪 2H(g) + O(g) **926.98**
3. H2O(g)🡪 H(g) + OH(g) **498.76**

reaction known ΔrHo

½ H2(g) + ½ O2(g) 🡪 OH(g) 38.95 kJ/mol  
 H2(g) + ½ O2(g) 🡪 H2O(g) -241.814 kJ/mol

H2(g) 🡪2 H(g) +435.994 kJ/mol

O2(g) 🡪 2O(g) +498.34 kJ/mol

(see also problems 19.35-19.36 pp 804-5)

b) H2O(g)🡪H2(g) + ½ O2(g) +241.814

H2(g) 🡪2 H(g) 435.994

½ O2(g) 🡪 O(g) ½ (498.34)

**H2O(g) 🡪 2H(g) + O(g) 926.98**

1. OH(g) 🡪½ H2(g) + ½ O2(g) -38.95

½ H2(g) 🡪 H(g) ½ (435.994)

½ O2(g) 🡪 O(g) ½( 498.34)

½ H2(g) + ½ O2(g) 🡪 OH(g) **+428.2 kJ**

c)H2O(g)🡪H2(g) + ½ O2(g) +241.814

½ H2(g) + ½ O2(g) 🡪 OH(g) 38.95

½ H2 (g)🡪 H(g) ½ (435.994)

1. **H2O(g)🡪 H(g) + OH(g) 498.76**

2.2. Given the heats of formation for the gas compounds listed, and the bond enthalpies listed below, find the single bond enthalpies for H-O, H-Cl, H-F, N-H,

NH3 H2O

ΔHfo (kJ/mol) -45.94 -241.8

Bond enthalpy (kJ/mol) per product atom\*

H2🡪 2H 217.9 Calculated vs Actual Bond Enthalpies

O2🡪 2O 249.17

|  |  |  |
| --- | --- | --- |
| Bond | Calculated | Actual1 |
| H-O | 463.3 | 459.8 |
| N-H | 390.8 | 390.8 |

1 in kJ/mol Klotz, p 69 table 5.3 (1964)

N2🡪 2N 472.68

\*thus, the reaction H2🡪 2H requires 2 x 217.9 kJ=435.8 kJ

½O2 + H2 🡪 2H + O 2\*217.9 +249.17=684.97

2H + O 🡪H2O -2\*εOH

½ O2 + H2 🡪 H2O -241.8

684.97-2εOH = -241.8

-2εOH =-241.8-684.97=> εOH =463.3

½ N2 3/2 H2 🡪 N + 3H 472.68 + 3\*217.9=1126.38

N + 3H🡪 NH3 -3εN-H

½ N2 + 3/2 H2 🡪NH3 -45.94

1126.38 -3εN-H = -45.94

εN-H =390.8