**Chemistry 6854: first law exercises part 2**

**First Law Problems-Using ΔHo and Cp**

**Spring 2012 Alfred State**

2.1. What part of the average, required caloric intake of 2000 large calories (kcal) are provided by eating

454 g (1 dry weight lb ~ ½ box ~ two plates full ) of spaghetti, assumed to be essentially the simple carbohydrate, C6H12O6 (MW = 180 g/mol) given :

ΔHf(C6H12O6(s)) =-1275 kJ/mol

 ΔHf(CO2(g)) = -393 kJ/mol)

 ΔHf(H2O(l) ) = -286 kJ/mol

Note 1: 1 cal = 4.184 J. (see also: problem 19.38 pg 805)

Note 2: no sauce, Parmesan or other toppings are assumed, and, we actually eat a more

 energetically dense polysaccharide version of C6H12O6 .

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

 ΔrHo

1. OH(g) 🡪H(g) + O(g)
2. H2O(g) 🡪 2H(g) + O(g)
3. H2O(g)🡪 H(g) + OH(g)

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)

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2.3. 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 HF HCl

ΔHfo (kJ/mol) -45.94 -241.8 -273 -92.3

 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 |  | 459.8 |
| H-Cl |  | 430.9 |
| H-F |  | 564.8 |
| N-H |  | 390.8 |

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

F2🡪 2F 79.39

Cl2🡪2Cl 121.302

N2🡪 2N 472.68

2.4. The reaction: CaC2(s) + 2O2(g) 🡪 CaCO3(s) + CO(g) has a ΔrHo = -1257.4 kJ/mol .

Assuming ideal gas behavior, calculate ΔrEo for the reaction assuming it occurs at a constant

pressure of 1 atm (1.013 bar) and 300 K (see also: problem 19.23 page 803 of text)

2.5 Write the integral that computes ΔH at 1 bar for raising 2 moles of O2(g) from 298🡪 1273 K given:

 Cp(O2 (g))/R = 3.094 +(1.561\*10-3)T –(4.65\*10-7)T2

Assume: T(K) and R= 8.314 J/K mol

2.5b. While it isn’t in fact true, suppose a transition for O2 occurs at 1273 K, after which the new `mystery’ phase of O2 forms after an input of ΔHt = +340 kJ/mol. After 1273, the new phase has a simpler Cp(O2(mystery phase)) of the form: Cp(O2(mystery phase) )/R= 4.00 + 0.05 T

Write the expression for ΔH at 1 bar for raising 2 moles of O2(g) from 298🡪 1500 K