Homework #7: CHEM 2141

Due Monday April 17th, 5:00 P.M.

For full credit, please show your work including all units utilized in dimensional analysis!

1. For the chemical reaction: $2\ O_2 + 2\ O \rightarrow 2O_3$ + heat heat = 192.4 KJ (mol rxn)$^{-1}$
Compute the heat liberated when 1.85×10^{-3} moles of O atom reacts with excess O_2?

2. An athlete bench presses a 300.0 pound barbell 0.650 meters. Using the conversion 1.00 Kg = 2.2 pounds, and g = 9.8 m s^{-2}, determine the amount of work done in KJ.

3. If 30.0 kJ of work is done on a system and the system releases 450.0 J of heat, what is the change in internal energy of the system?

4. The **First Law of Thermodynamics** was stated in this course as $\Delta E = q + w$. q (q>0)is defined as heat supplied to (absorbed by) the system and w (w>0) as work supplied to (done on) the system. What if we adopt a different convention such as $\Delta E = q - w$. Define q and w in this new convention.

5. The equilibrium population of various levels of a system is:

Level	Population (# molecules)	Energy (J)
0	6	0.0 E-19
1	2	1.5 E-19
2	1	3.0 E-19

For the above distribution what is the value of E, the internal energy in units of kcal?

6. $C_6H_6(g) + 15/2\ O_2(g) \rightarrow 6CO_2(g) + 3H_2O(g)$ $\Delta E_1 = -3.171\text{x}10^3$ KJ mol^{-1}
$C_6H_6(g) \rightarrow 3\ C_2H_2\ (g)$ $\Delta E_2 = 591$ KJ mol^{-1}

Using the information above determine the change in internal energy for the below reaction:

$C_2H_2(g) + 5/2\ O_2(g) \rightarrow 2CO_2(g) + H_2O(g)$ $\Delta E_3 =$?

7. If 5.00 moles of an organic substance is burned in a calorimeter with heat capacity C_{cal} = 7.794 kJ K^{-1} the temperature increases from 25.5 ^{0}C to 75.8 ^{0}C, what is the heat of rxn for the substance in units of kJ per mole of substance?

8. Express the ΔH of the following reaction: $CH_3OH(l) + 3/2\ O_2(g) \rightarrow CO_2(g) + 2H_2O(l)$
in terms of ΔH_1 , ΔH_2, and ΔH_3.

$CH_3OH(l) \rightarrow CH_3OH(g)$ ΔH_1
$H_2O(l) \rightarrow H_2O(g)$ ΔH_2
$CH_3OH(g) + 3/2\ O_2(g) \rightarrow CO_2(g) + 2H_2O(g)$ ΔH_3

9. Determine the heat released when 4.50 grams of $H_2O(g)$ is condensed to $H_2O(l)$ given the following information: $H_2O(l) \rightarrow H_2O(g)$ $\Delta H = 44.01$ KJ

10. Using Table AI.2 determine the amount of heat needed to dissociate 8.013 grams of $N_2H_4(l)$:

$$N_2H_4(l) \rightarrow NH_3(g) + HN_3(l) + H_2(g)$$

11. Using the bond enthalpies of Tables 3.5 and where appropriate the mean bond enthalpies of 2.6 compute ΔH of the following reaction of benzene and chlorine gas to produce ethyne, chloroethyne and hydrogen gas:

$$C_6H_6(g) + Cl_2(g) \rightarrow C_2Cl_2(g) + 2C_2H_2(g) + H_2(g)$$

12. Calculate $D_{N=O}$, the bond dissociation energy of the N= O bond in O-N=O, given the reaction: **CO + O-N=O ® CO$_2$ + N-O**
(assume only 1 of the 2 resonance Lewis dot structures for NO_2: O-N=O)
and the following information:

Bond Dissociation Energy	
Bond	**Bond Energy (kJ mol^{-1})**
C-O	**343.1**
C=O	**803.3**
C≡O (triple Bond)	**1071**

Internal Energy	
molecule	**Internal Energies (kJ mol^{-1}) of formation**
NO	**90.4**
NO_2	**34.3**
CO	**-110.5**
CO_2	**-393.7**

13. If the first electronic excited state of NO_2, the $[A^2B_2]$ state lies 9721 cm^{-1} above the ground state $[x^2A_1]$ use this information coupled with the info below to find ΔE of the following reaction

$$N_2O_4(g) \rightarrow NO_2(g)(x^2A_1) + NO_2(A^2B_2) \qquad \Delta E = ?$$

Internal Energy	
Molecule	**Internal Energies (kJ mol^{-1})) of formation**
N_2O_4	**14.1**
NO_2	**34.3**