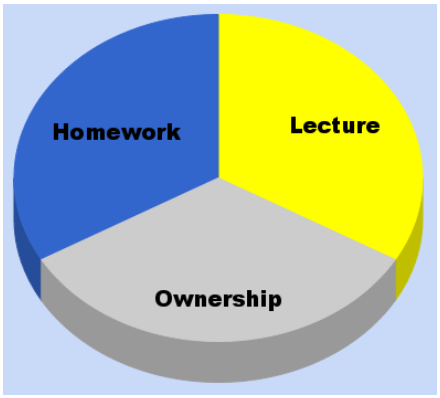
CHEM 121 – Worksheet 14 – Fall 2015

Monday Name: _____

Wednesday Name: _____



Directions: You may not complete this prior to class: by all means use it as a study guide. As usual, the first 50 minutes you'll be working on this without notes, with your partner[s] and with a non-programmable calculator. The next 10 minutes you may use your notes (this might include hard copies of the 5 links Dr. Carman emailed to you). The final 25 minutes is time spent at the board.

You may find this table of help:

Average Bond Energies (kJ/mol)

Single Bonds						Multiple Bonds	
H—H	432	N—H	391	I—I	149	C=C	614
H—F	565	N—N	160	I—Cl	208	C≡C	839
H—Cl	427	N—F	272	I—Br	175	O=O	495
H—Br	363	N—Cl	200			C=O*	745
H—I	295	N—Br	243	S—H	347	C≡O	1072
		N—O	201	S—F	327	N=O	607
C—H	413	O—H	467	S—Cl	253	N=N	418
C—C	347	O—O	146	S—Br	218	N≡N	941
C—N	305	O—F	190	S—S	266	C≡N	891
C—O	358	O—Cl	203			C=N	615
C—F	485	O—I	234	Si—Si	340		
C—Cl	339			Si—H	393		
C—Br	276	F—F	154	Si—C	360		
C—I	240	F—Cl	253	Si—O	452		
C—S	259	F—Br	237				
		Cl—Cl	239				
		Cl—Br	218				
		Br—Br	193				

*C=O(CO_2) = 799

1) Using the above table, determine the ΔE for the following reaction: $H_2 + Cl_2 \rightarrow 2HCl$.

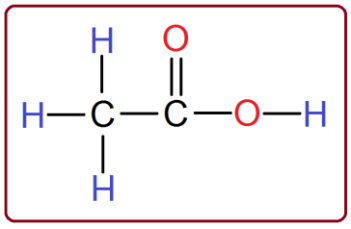
2) Using the above table, determine the ΔE for the following reaction: $H_2 + Br_2 \rightarrow 2HBr$.

3) Using the above table, determine the ΔE for the following reaction: $H_2 + F_2 \rightarrow 2HF$.

4) Using the above table, determine the ΔE for the following reaction: $H_2 + I_2 \rightarrow 2HI$.

5) Using the above table, determine the ΔE for the following reaction: $N \equiv N + 3H_2 \rightarrow 2NH_3$.

6) Using the above table, determine the ΔE for the following reaction: $CH_3OH + C{\equiv}O \rightarrow HC_2H_3O_2$.
$HC_2H_3O_2$ has the following structure:



7) Using the above table, determine the ΔE for the following reaction: $CH4 + H_2O \rightarrow CO + 3H_2$.

8) Using the above table, determine the ΔE for the following reaction: $C_2H_2 + 2.5\ O_2 \rightarrow 2CO_2 + H_2O$.

9) Using the above table, determine the ΔE for the following reaction: $H_2S + 3F_2 \rightarrow SF_4 + 2HF$.

10) Using the above table, determine the ΔE for the following reaction: $CH_3N \equiv C \rightarrow CH_3C \equiv N$.

Here's something that will let you comingle Lewis Structures (lab) with Thermochemistry (reading) in your spare time: http://science.uvu.edu/ochem/index.php/alphabetical/q-r/resonance-theory/

11) Define latent heat in your own words.

12) Define sensible heat in your own words.

13) In the space below, hand-draw a graph that has Temperature (°C) on the vertical and Heat Added on the horizontal that illustrates the phase changes from a solid to a vapor. Make sure to include the following: latent heat, sensible heat, the 3 phases and freezing/thawing and condensing/vaporizing. Use arrows to show either direction the last 4 terms are going.

You may find the following table of assistance in the next problems:

Heat of Formation Values

ΔH_f° (kJ/mol) (concentration of aqueous solutions is 1*M*)

Substance	ΔH_f°	Substance	ΔH_f°	Substance	ΔH_f°	Substance	ΔH_f°
Ag(s)	0	CsCl(s)	−443.04	H_3PO_4(aq)	−1279.0	NaBr(s)	−361.062
AgCl(s)	−127.068	Cs_2SO_4(s)	−1443.02	H_2S(g)	−20.63	NaCl(s)	−411.153
AgCN(s)	146.0	CuI(s)	−67.8	H_2SO_3(aq)	−608.81	$NaHCO_3$(s)	−950.8
Al_2O_3	−1675.7	CuS(s)	−53.1	H_2SO_4(aq)	−814.0	$NaNO_3$(aq)	−447.48
$BaCl_2$(aq)	−871.95	Cu_2S(s)	−79.5	$HgCl_2$(s)	−224. 3	NaOH(s)	−425.609
$BaSO_4$	−1473.2	$CuSO_4$(s)	−771.36	Hg_2Cl_2(s)	−265.22	Na_2CO_3(s)	−1130.7
BeO(s)	−609.6	F_2(g)	0	Hg_2SO_4(s)	−743.12	Na_2S(aq)	−447.3
$BiCl_3$(s)	−379.1	$FeCl_3$(s)	−399.49	I_2(s)	0	Na_2SO_4(s)	−1387.08
Bi_2S_3(s)	−143.1	FeO(s)	−272.0	K(s)	0	NH_4Cl(s)	−314.4
Br_2	0	FeS(s)	−100.0	KBr(s)	−393.798	O_2(g)	0
CCl_4(l)	−128.2	Fe_2O_3(s)	−824.2	$KMnO_4$(s)	−837.2	P_4O_6(s)	−1640.1
CH_4(g)	−74.81	Fe_3O_4(s)	−1118.4	KOH	−424.764	P_4O_{10}(s)	−2984.0
C_2H_2(g)	226.73	H(g)	217.965	LiBr(s)	−351.213	$PbBr_2$(s)	−278.7
C_2H_4(g)	52.26	H_2(g)	0	LiOH(s)	−484.93	$PbCl_2$(s)	−359.41
C_2H_6(g)	−84.68	HBr(g)	−36.40	Mn(s)	0	SF_6(g)	−1220.5
CO(g)	−110.525	HCl(g)	−92.307	$MnCl_2$(aq)	−555.05	SO_2(g)	−296.830
CO_2(g)	−393.509	HCl(aq)	−167.159	$Mn(NO_3)_2$(aq)	−635.5	SO_3(g)	−454.51
CS_2(l)	89.70	HCN(aq)	108.9	MnO_2(s)	−520.03	SrO(s)	−592.0
Ca(s)	0	HCHO	−108.57	MnS(s)	−214.2	TiO_3(s)	−939.7
$CaCO_3$(s)	−1206.9	HCOOH(l)	−424.72	N_2(g)	0	TlI(s)	−123.5
CaO(s)	−635.1	HF(g)	−271.1	NH_3(g)	−46.11	UCl_4(s)	−1019.2
$Ca(OH)_2$(s)	−986.09	HI(g)	26.48	NH_4Br(s)	−270.83	UCl_5(s)	−1059
Cl_2(g)	0	H_2O(l)	−285.830	NO(g)	90.25	Zn(s)	0
Co_3O_4(s)	−891	H_2O(g)	−241.818	NO_2(g)	33.18	$ZnCl_2$(aq)	−488.19
CoO(s)	−237.94	H_2O_2(l)	−187.8	N_2O(g)	82.05	ZnO(s)	−348.28
Cr_2O_3(s)	−1139.7	H_3PO_4(l)	−595.4	Na(s)	0	$ZnSO_4$(aq)	−1063.15

14) Using the above table, determine the $\Delta H_f°$ for the following reaction: $Ca_3(PO_4)_2$ (s) + $3H_2SO_4$ (l) $\rightarrow$ $3CaSO_4$ (s) + $2H_3PO_4$ (l) ($\Delta H_f°$ for $Ca_3(PO_4)_2$ (s) = -4126 kJ/mol; for $CaSO_4$ (s) is -1433 kJ/mol). FYI: (l) = (aq).

15) Using the above table, determine the $\Delta H_f°$ for the following reaction: NH_3 (g) + HBr (g) $\rightarrow$ NH_4Br (s) ($\Delta H_f°$ for NH_3 (g) = -80 kJ/mol; for NH_4Br (s) = -271.54 kJ/mol). FYI: (l) = (aq).

16) Using the above table, determine the $\Delta H_f°$ for the following reaction: NH_3 (g) + HCl (g) $\rightarrow$ NH_4Cl (s) ($\Delta H_f°$ for NH_3 (g) = -80 kJ/mol). FYI: (l) = (aq).

17) If you had 10 grams of calcium phosphate in #14, how much heat was actually generated in the formation of calcium sulfate by the reaction?

18) If you had 34 grams of gaseous ammonia in #15, how much heat was actually generated in the formation of ammonium bromide by the reaction?

19) If you had 18.25 grams of gaseous hydrogen chloride in #16, how much heat was actually generated in the formation of ammonium chloride by the reaction?

20) In advance of your week 10 experiment (Born Haber Cycles and Hess' Law), calculate the ΔH for the reaction CaC_2 (s) + $2H_2O$ (l) $\rightarrow$ $Ca(OH)_2$ (l) + C_2H_2 (g) given the following data:

Reaction	ΔH (kJ)
Ca(s) + ½ O2 $\rightarrow$ CaO (s)	-635.5
Ca(s) + 2C (graphite) $\rightarrow$ CaC_2 (s)	-62.8
CaO(s) + H_2O (l) $\rightarrow$ $Ca(OH)_2$ (l)	-653.1
C_2H_2 (g) + 2.5 O_2 $\rightarrow$ $2CO_2$ (g) + H_2O (l)	-1300
C(graphite) + O_2 (g) $\rightarrow$ CO_2(g)	-393.5

Feel free to use the back of the page to solve this problem if need be.