Fall 09 CH301 Worksheet 10 Thermodynamic Calculations for Chemical Reactions and Phase Changes

Assume T = 298K. First describe the reaction below where it is written, then predict the sign for each answer and only then, do the calculation. The BE values are at the bottom of the worksheet. The formation constants are found in the textbook appendix and also as Worksheet 10a at http://courses.cm.utexas.edu/dlaude/ch301/worksheetsf09.html

This worksheet is painful at first, but once you get it you are a profoundly better chemist (and exam 3 test taker.)

Chemical Reaction	**ΔH (kJ)**	**BE (kJ)**	**Δn_{gas}**	**w (kJ)= -ΔnRT**	**Δn_{system}**	**TΔS (kJ)**	**ΔG (kJ)**
$CH_{4g} + 2O_{2g} \rightarrow CO_{2g} + 2H_2O_g$							
$2H_{2g} + O_{2g} \rightarrow 2H_2O_g$							
$2H_2O_g \rightarrow 2H_{2g} + O_{2g}$							
$C_2H_5OH_l + 3O_{2g} \rightarrow 2CO_{2g} + 3H_2O_g$							
$C_2H_5OH_l + 3O_{2g} \rightarrow 2CO_{2g} + 3H_2O_l$							
$C_3H_{8g} + 5O_{2g} \rightarrow 3CO_{2g} + 4H_2O_g$							
$4H_2O_g + 3\ CO_2g \rightarrow C_3H_{8g} + 5O_{2g}$							
$CCl_{4l} \rightarrow C_s + 2Cl_{2g}$							

$Ba(OH)_2(H2O)_{8s} + 2NH_4NO_3 \rightarrow Ba(NO_3)_2s + 2NH_{3g} + 10H_2O_l$							
$2O_{3g} \rightarrow 3O_{2g}$							
$H_2O_s \rightarrow H_2O_l$							
$CO_{2g} \rightarrow CO_{2s}$							
$NH_{3g} + HCl_g \rightarrow NH_4Cl_s$							
$2H_2O_{2l} \rightarrow 2H_2O_l + O_{2\ g}$							

Bond Energy Table (in addition, assume C=O is 799 kJ/mol for carbon dioxide)

TABLE 6.8 Mean Bond Enthalpies ($kJ \cdot mol^{-1}$)

Bond	Mean bond enthalpy	Bond	Mean bond enthalpy
C—H	412	C—I	238
C—C	348	N—H	388
C=C	612	N—N	163
C⌣C*	518	N=N	409
C≡C	837	N—O	210.
C—O	360	N=O	630.
C=O	743	N—F	195
C—N	305	N—Cl	381
C—F	484	O—H	463
C—Cl	338	O—O	157
C—Br	276		

*In benzene.

Thermodynamic Data for Chemical Compounds Including Formation Data is found at
http://courses.cm.utexas.edu/dlaude/ch301/worksheetsf09.html