Enthalpy of Atom Combination Worksheet – Answer Key

Here is a small table giving the enthalpy of atom combination for several elements and molecules. Use these values to answer the questions shown below.

substance	$\Delta H°_{ac}$ (kJ/mol$_{rxn}$)	substance	$\Delta H°_{ac}$ (kJ/mol$_{rxn}$)
$H(g)$	0	$N_2(g)$	–945.408
$C(g)$	0	$O_2(g)$	–498.340
$N(g)$	0	$CH_4(g)$	–1662.09
$O(g)$	0	$CO_2(g)$	–1608.531
$C(s, graphite)$	–716.682	$H_2O(g)$	–926.29
$C(s, diamond)$	–714.787	$H_2O(l)$	–970.30
$H^+(aq)$	–217.65	$NH_3(g)$	–1171.76
$OH^-(aq)$	–696.81	$NO_2(g)$	–937.86
$H_2(g)$	–435.30	$N_2O_4(g)$	–1932.93

Why is $\Delta H°_{ac}$ for $C(g)$ equal to 0 kJ/mol? *There are no bonds to form and, therefore, there is no enthalpy for atom combination.*

Why are values of $\Delta H°_{ac}$ for the molecules negative? *Because the formation of any bond releases energy relative to the separate atoms.*

Do the relative $\Delta H°_{ac}$ values for $N_2(g)$ and $O_2(g)$ make sense? *Of course. Molecules of N_2 have a triple bond and molecules of O_2 have a double bond. The triple bond in N_2 provides a greater release of energy than the double bond in O_2.*

What is $\Delta H°$ if one mole of $CH_4(g)$ is broken apart into atoms and then reformed? *The overall change in enthalpy is zero because the energy needed to break the bonds is recovered when the bonds reform.*

What is $\Delta H°_{ac}$ if we make two moles of $NH_3(g)$ from $N(g)$ and $H(g)$? *Since each mole of NH_3 releases 1171.76 kJ, the enthalpy change for making two moles is twice this, or a $\Delta H°_{ac}$ of –2343.52 kJ.*

Which has stronger bonds: $C_{graphite}$ or $C_{diamond}$? *Graphite (!); as shown by its more negative enthalpy of atom combination, the C-C bonds in graphite are stronger than those in diamond.*