Enthalpy of Atom Combination

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

substance	ΔH^o_{ac} (kJ/mol$_{\text{rxn}}$)	substance	ΔH^o_{ac} (kJ/mol$_{\text{rxn}}$)
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 ΔH^o_{ac} for C*(g)* equal to 0 mol$_{\text{rxn}}$?

> There are no bonds to form and, therefore, there is no enthalpy for atom combination.

Why are values of ΔH^o_{ac} for the molecules negative? Is a positive value possible?

> Because the formation of a bond always releases energy relative to the free atoms, the enthalpy of atom combination for a molecule always is negative.

Do the relative ΔH^o_{ac} values for N_2*(g)* and O_2*(g)* make sense?

> Of course. A molecule of N_2 has a triple bond and a molecule of O_2 has a double bond. We can reasonably expect that it takes more energy to break a triple bond than it does a double bond; thus, the amount of energy released on forming N_2 is greater than that when forming O_2.

What is ΔH^o 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 ΔH^o_{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 of energy, the enthalpy change for making two moles of NH_3 is –2353.52 kJ.

Which has stronger bonds: C_{graphite} or C_{diamond}?

> Graphite(!). As shown be its more negative enthalpy of atom combination, the C–C bonds in graphite are stronger than those in diamond.