

## Enthalpy of Atom Combination Worksheet – Answer Key

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

substance	$\Delta H_{ac}^{\circ}$ (kJ/mol <sub>rxn</sub> )
H(g)	0
C(g)	0
N(g)	0
O(g)	0
C(s, graphite)	-716.682
C(s, diamond)	-714.787
H <sub>2</sub> (g)	-435.30
N <sub>2</sub> (g)	-945.408
O <sub>2</sub> (g)	-498.340
CH <sub>4</sub> (g)	-1662.09
H <sub>2</sub> O(g)	-926.29
H <sub>2</sub> O(l)	-970.30
NH <sub>3</sub> (g)	-1171.76
NO <sub>2</sub> (g)	-937.86
N <sub>2</sub> O <sub>4</sub> (g)	-1932.93

Why is  $\Delta H_{ac}^{\circ}$  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  $\Delta H_{ac}^{\circ}$  for the molecules negative? Because the formation of any bond releases energy relative to the separate atoms.

Do the relative  $\Delta H_{ac}^{\circ}$  values for N<sub>2</sub>(g) and O<sub>2</sub>(g) make sense? Of course. Molecules of N<sub>2</sub> have a triple bond and molecules of O<sub>2</sub> have a double bond. The three bonds in N<sub>2</sub> provide for a greater release of energy.

What is  $\Delta H^{\circ}$  if one mole of CH<sub>4</sub>(g) is broken apart into atoms and then reformed? The overall change in enthalpy is 0 because the energy needed to break the bonds is recovered when the bonds reform.

What is  $\Delta H_{ac}^{\circ}$  if 2 moles of NH<sub>3</sub>(g) is made from N(g) and H(g)? Since each mole of NH<sub>3</sub> releases 1171.76 kJ, the enthalpy change for making two moles will be twice this, or an enthalpy change of -2343.52 kJ.

Which has stronger bonds: C<sub>graphite</sub> or C<sub>diamond</sub>? Graphite (!); as shown by its more negative enthalpy of atom combination, the C-C bonds in graphite are stronger than those in diamond.