

A Method of Determining the Relative Contributions of Individual Equations in Hess' Law Problems

Idea initiated by Haig Mastikian and extended by Prof. John Milligan

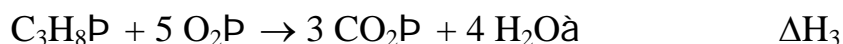
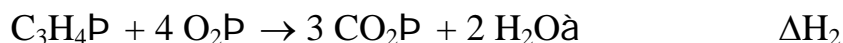
This method is similar to the mathematical method of balancing chemical equations. However, here we have a system of equations that is over specified so we can calculate the exact numbers.

Example:

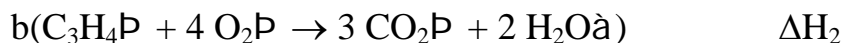
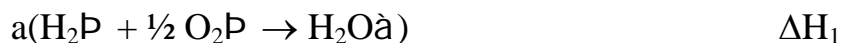
Use Hess' Law to determine the enthalpy of the reaction



given



First we will multiply each equation by a generic constant (i.e. a, b, c, etc.)



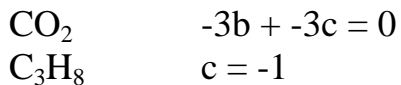
We then set up an equation for each **compound** in the given reactions. The coefficients of reactants are positive numbers; those of products are negative numbers. The equations are equal to the coefficient in the overall equation. If the substance is not present in the overall equation, the equation equals zero.

$$\text{H}_2 \quad a = 2$$

$$\text{O}_2 \quad \frac{1}{2} a + 4 b + 5 c = 0$$

$$\text{H}_2\text{O} \quad -a + (-2b) + (-4c) = 0$$

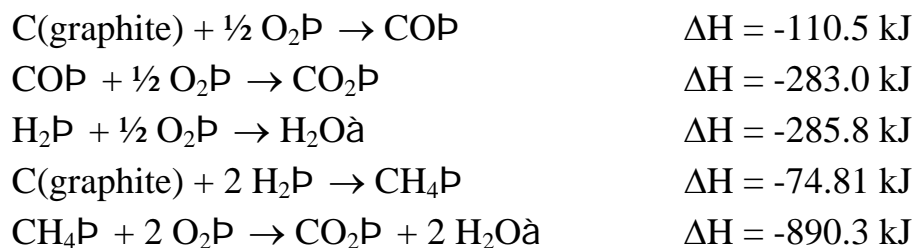
$$\text{C}_3\text{H}_4 \quad b = 1$$



In this example the solution is given explicitly $a = 2$, $b = 1$ and $c = -1$.

Let's look at a more complicated example:

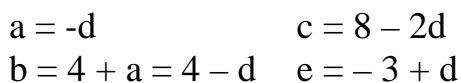
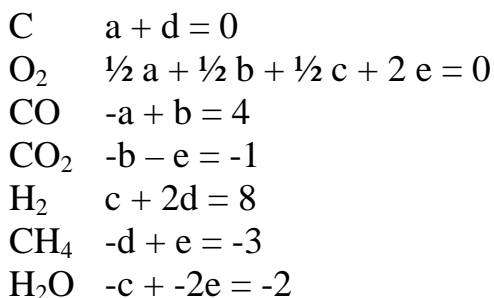
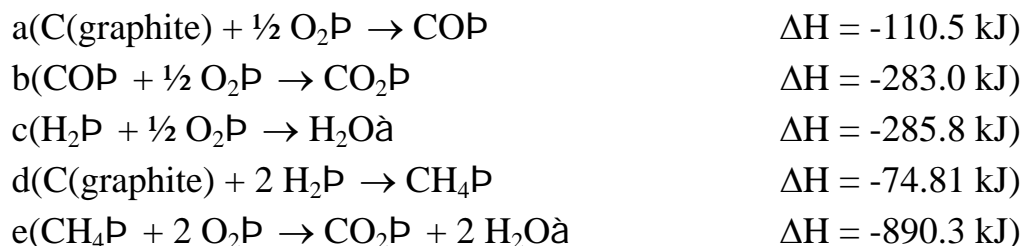
Given



Find ΔH for



Set up equations



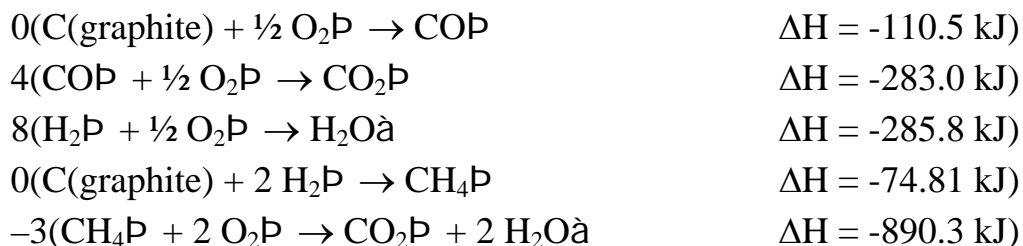
$$\frac{1}{2}(-d) + \frac{1}{2}(4 - d) + \frac{1}{2}(8 - 2d) + 2(-3 + d) = 0$$

$$-\frac{1}{2}d + 2 - \frac{1}{2}d + 4 - d - 6 + 2d = 0$$

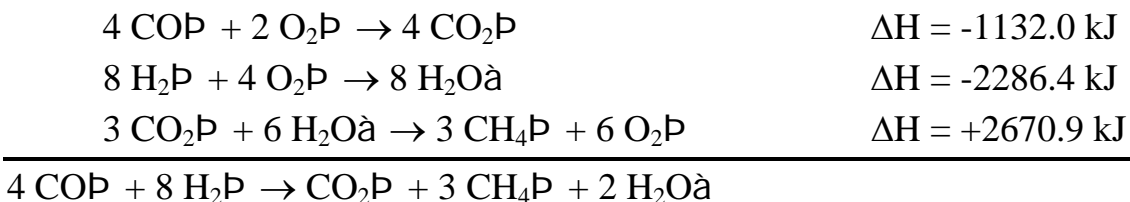
All the d's and the numbers cancel to zero so d can be anything.

$$0d + 0 = 0$$

Here, however, it must be zero because just any number will not make sense. Because $d = 0$ then $c = 8$ and $e = -3$ and $a = 0$ and $b = 4$. Let's check:



Rewriting this gives



This is what we are trying to find so the enthalpy of this reaction is:

$$\Delta H = -1132.0 \text{ kJ} + -2286.4 \text{ kJ} + 2670.9 \text{ kJ} = -747.5 \text{ kJ}$$