

Lesson 3.11 Key



-394 kJ

(3)

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If the above equations (2 & 3) are manipulated, meaning multiplied by a coefficient or reversed, the overall reaction (1) can be obtained.

Follow the steps below to solve any Hess's Law problem.

1. Balance the individual equations
2. If necessary look up standard enthalpies
3. Put a square around the substances that should be reactants. Circle everything that should be products.
4. Flip equations around if necessary to cancel out terms on opposite sides and ensure reactants are reactants and products are products.
5. Changing the equation around requires a sign change of the H of that individual step
6. Sum up the individual steps

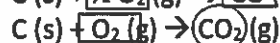


(1)



-111 kJ

(2)



-394 kJ

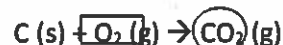
(3)

Checking to ensure all substances that need to be reactants are on the left hand side of the arrow and everything that needs to be products are on the right hand side of the arrow, it is observed that carbon monoxide (CO) needs to be a reactant, therefore reaction number 2 needs to be reversed. Once it is reversed the sign on the heat also needs to be reversed. Also oxygen is on both sides of the equation, but that is okay because only half of a mole is required.



111 kJ

(2)



-394 kJ

(3)

Knowing the reactions are balanced the next step would be to cancel like terms on opposite sides of the arrow. Solid carbon is found on opposite sides of the equation and therefore can be cancelled as well as $\frac{1}{2}$ oxygen. Once all like terms have been cancelled the next step is to sum up the reactants and products and the heats of reactions to give the overall reactions.



111 kJ

(2)



-394 kJ

(3)



-283 kJ

(1)

One the reactions have been summed, as well as the heats, the overall heat required to convert carbon monoxide to carbon dioxide is -283 kJ.

To sum it up, Hess's law says that if two or more equations for which the enthalpy is given or otherwise known can be added together to create a target equation, the enthalpy changes can also be summed to find the enthalpy change of the target equation.

Lesson 3.11 Key

HESS'S LAW PRACTICE PROBLEMS

- 1) Calculate ΔH° for the formation of 1 mol of strontium carbonate (the material that gives the red color in fireworks) from its elements.



The information available is



- 2) The combination of coal and steam produces a mixture called coal gas, which can be used as a fuel or as a starting material for other reactions. If we assume coal can be represented by graphite, the equation for the production of coal gas is:

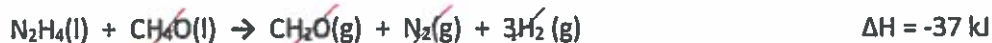


Determine the standard enthalpy change for this reaction from the following standard enthalpies of reaction:



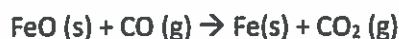
$$\Delta H^\circ = 15.3 \text{ kJ}$$

- 3) Find the ΔH for the reaction below, given the following steps and subsequent ΔH values:



$$\Delta H = -18 \text{ kJ}$$

- 4) One reaction involved in the conversion of iron ore to the metal is:



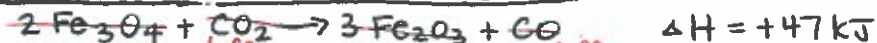
Calculate the standard enthalpy change for this reaction from the following reactions of iron oxides with carbon monoxide.



$$\text{so for eqn above, } \Delta H = -66/6 = -11 \text{ kJ}$$



$$\Delta H = 19 \text{ kJ flip, } \times 2$$



$$\Delta H = -66 \text{ kJ}$$



$$\Delta H = 19 \text{ kJ}$$

5) Find the ΔH for the reaction below, given the following steps and subsequent ΔH values:



$$\Delta H = 73 \text{ kJ}$$

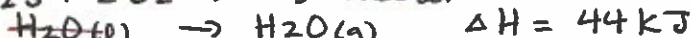
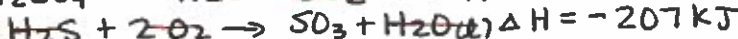
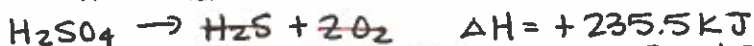
$$\Delta H = -235.5 \text{ kJ flip}$$



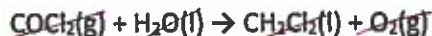
$$\Delta H = -207 \text{ kJ}$$



$$+ \Delta H = 44 \text{ kJ}$$



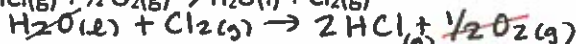
6) Find the ΔH for the reaction below, given the following steps and subsequent ΔH values:



$$\Delta H = 47.5 \text{ kJ}$$



$$\Delta H = 185 \text{ kJ flip}$$



$$-105 \text{ kJ}$$



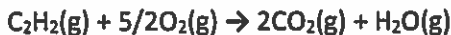
$$+ \Delta H = -402.5 \text{ kJ}$$



$$\Delta H = -460 \text{ kJ}$$

$$\text{so for } \frac{1}{2} \text{H}_2 + \frac{1}{2} \text{Cl}_2 \rightarrow \text{HCl} \quad \Delta H = -460/2 = -230 \text{ kJ}$$

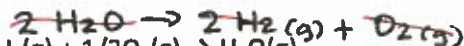
7) Find the ΔH for the reaction below, given the following steps and subsequent ΔH values:



$$-283.5 \text{ kJ}$$



$$\Delta H = 283.5 \text{ kJ flip}$$



$$\Delta H = -283.5 \text{ kJ flip, } \times 2$$



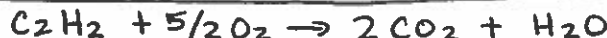
$$+ 427.2 \text{ kJ}$$



$$+ \Delta H = 849 \text{ kJ flip}$$



$$-849 \text{ kJ}$$



$$\Delta H = -705 \text{ kJ}$$

8) Find the ΔH for the reaction below, given the following steps and subsequent ΔH values:



$$\Delta H = -79 \text{ kJ}$$

$$\Delta H = 507 \text{ kJ flip}$$



$$\Delta H = -427 \text{ kJ flip}$$



$$\Delta H = -43 \text{ kJ}$$



$$\Delta H = 34 \text{ kJ flip}$$



$$\Delta H = -507 \text{ kJ}$$



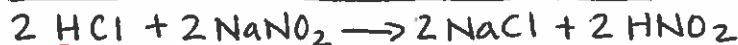
$$\Delta H = +427 \text{ kJ}$$



$$\Delta H = -43 \text{ kJ}$$



$$+ \Delta H = -34 \text{ kJ}$$

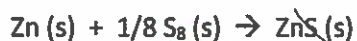
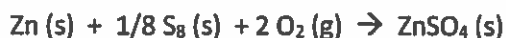


$$\Delta H = -157 \text{ kJ}$$

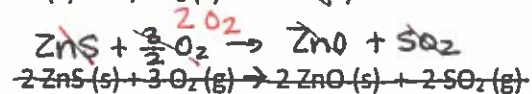


$$\Delta H = -157/2 = -79 \text{ kJ}$$

9) Calculate the standard enthalpy change for this reaction from the combustion of Zn (g) with oxygen:

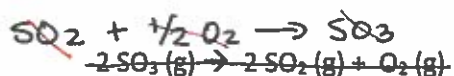


$$\Delta H = -183.92 \text{ kJ}$$



$$\Delta H = -463.77 \text{ kJ}$$

$$\Delta H = -927.54 \text{ kJ} \div 2$$

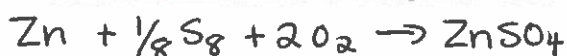


$$-\Delta H = -196.04 \text{ kJ flip, } \div 2$$

$$\Delta H = -98.02 \text{ kJ}$$

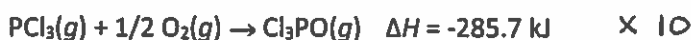


$$\Delta H = -230.32 \text{ kJ}$$

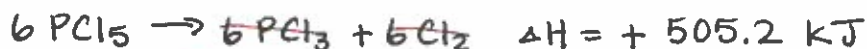
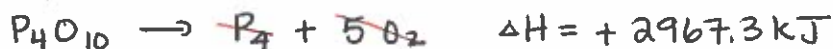


$$\Delta H = -976.03 \text{ kJ}$$

10) You are given the following data:



Calculate ΔH for the following reaction.



Works Cited

Anderson, J. (2016, May 1). *Honors Chemistry*. Retrieved from Mr. A's Chemistry:

<http://www.pkwy.k12.mo.us/west/teachers/anderson/honors/honors.html>

LibreTexts Libraries. (2016, July 13). *Standard Enthalpy of Formation*. Retrieved from Chemistry

LibreTexts: Given a simple chemical equation with the variables A, B and C representing different compounds: