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Hess's Law

Hess's Law: Sometimes it is impossible or impractical to measure the ΔH of a reaction by using a calorimeter. In these situations, ΔH can be calculated using Hess's Law!

Hess's Law: Combining two or more reactions to achieve a goal reaction

1. When adding given reactions, they combine to produce the goal reaction.
2. $\Delta H_{\text{new rxn}} = \Delta H_{\text{rxn 1}} + \Delta H_{\text{rxn 2}} + \Delta H_{\text{rxn 3}} + \dots$

Note: Sometimes you have to manipulate your given reactions to produce your goal reaction. If so, you also need to manipulate ΔH_{rxn} using the following rules:

Rule 1: If you reverse the reactions, then change the sign of ΔH . For example,



Rule 2: If you multiply the reaction by a coefficient, then multiply value of ΔH by same coefficient. For example,



Rule 3: Rule 1 and 2 can be combined! For example, if the first reaction is tripled and reversed,



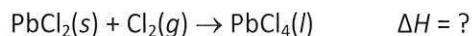
Strategy: Find things in your goal equation that appear in only one of the available reactions and make them match by flipping equations or multiplying/dividing coefficients. Then arrange equations to cancel out things that do not appear in the "goal." **Whatever you do to the equation, you must do to ΔH !**

When combining reactions:

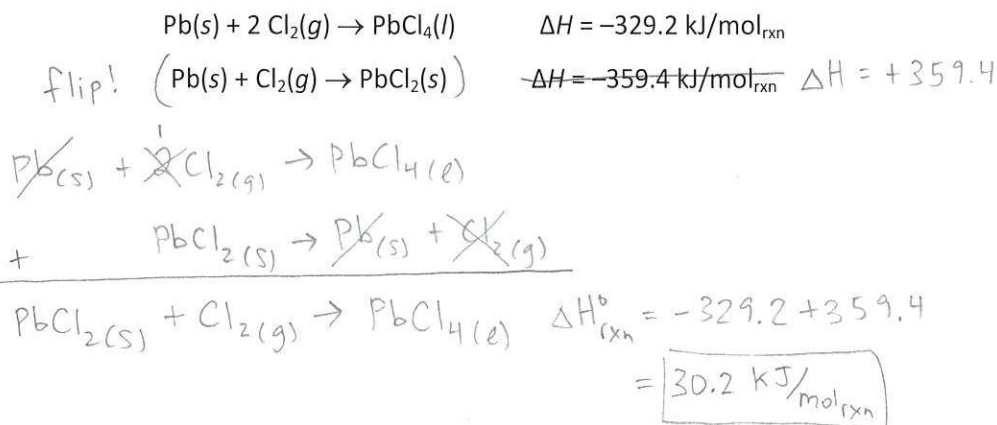
1. Reagents on the same side: add together
2. Reagents on the opposite side: subtract (from the side with the greatest amount)

** note: leave reagents found in multiple rxns til the end!*

Example: Find the enthalpy change for the formation of PbCl_4 by the reaction of lead (II) chloride with chlorine.

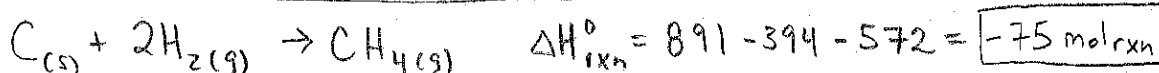
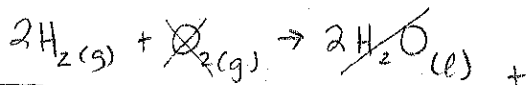
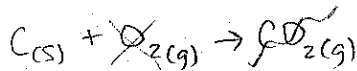
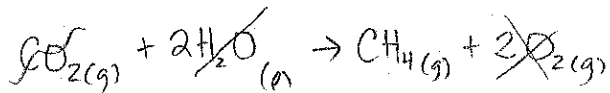
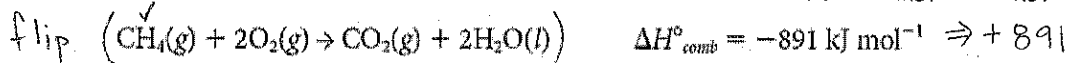


Use the following thermochemical equations:

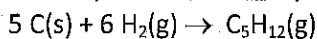


Guided Practice

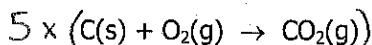
1. Given the following information, find the heat of formation for methane: $C(s) + 2H_2(g) \rightarrow CH_4(g)$



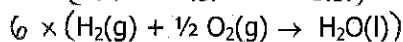
2. Find the enthalpy change for the formation of pentane, C_5H_{12} , by the reaction of carbon with hydrogen.



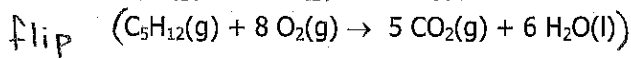
Use the following thermochemical equations:



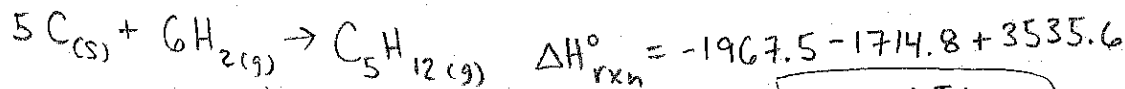
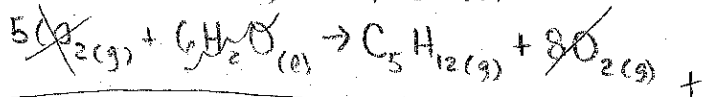
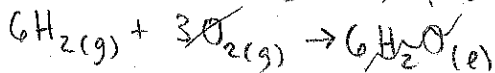
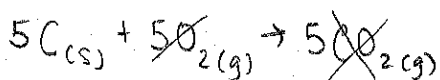
$\Delta H = (-393.5 \text{ kJ/mol}_{rxn}) \times 5 = -1967.5$



$\Delta H = (-285.8 \text{ kJ/mol}_{rxn}) \times 6 = -1714.8$

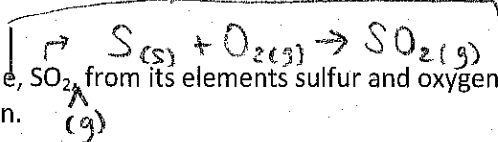


$\Delta H = -3535.6 \text{ kJ/mol}_{rxn} \Rightarrow +3535.6$

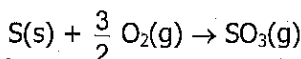


$= -146.7 \text{ kJ/mol}_{rxn}$

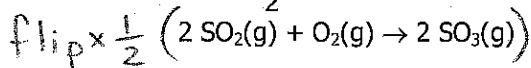
Goal!



3. Calculate the heat of formation for sulfur dioxide, SO_2 , from its elements sulfur and oxygen. Use the balanced chemical equation and the following information.



$\Delta H = -395.2 \text{ kJ/mol}_{rxn}$



$\Delta H = (-198.2 \text{ kJ/mol}_{rxn}) \times -\frac{1}{2} = 99.1 \text{ kJ/mol}_{rxn}$

