5.5

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| How is $\Delta H$ different from $\Delta H°$? | $\Delta H$ is the enthalpy change for a reaction. $\Delta H°$ is the enthalpy change for a reaction occurring at 25°C and 1 atm. |
| What is another name for $\Delta H°$? | Standard heat of reaction (25°C and 1 atm are standard conditions). |
| Why is it useful to express $\Delta H°$ values instead of $\Delta H$ values? | The $\Delta H$ for a reaction changes for different conditions of temperature and pressure. $\Delta H°$ allows for the comparison of different chemical reactions (and are used later in Hess's law calculations). |
| What is a thermochemical equation? | A chemical equation written with its value of $\Delta H°$. For example:<br>$N_2(g) + 3H_2(g) \rightarrow 2NH_3(g)$ $\Delta H°= -92.38$ kJ |
| How many moles of product are formed in a thermochemical equation? | Any number of moles can be formed, though the value of $\Delta H°$ will vary depending on this number. |
| In what three ways can a thermochemical equation be manipulated? | They can be reversed, multiplied by some factor, or added together. |
| What happens to $\Delta H°$ when an equation is reversed? | The sign on the $\Delta H°$ value is also reversed:<br>$N_2(g) + 3H_2(g) \rightarrow 2NH_3(g)$ $\Delta H°= -92.38$ kJ<br>$2NH_3(g) \rightarrow N_2(g) + 3H_2(g)$ $\Delta H°= +92.38$ kJ |
| What happens to $\Delta H°$ when an equation is multiplied by some factor? | The $\Delta H°$ value is multiplied by the same factor:<br>$N_2(g) + 3H_2(g) \rightarrow 2NH_3(g)$ $\Delta H°= -92.38$ kJ<br>$1/2\ N_2(g) + 3/2\ H_2(g) \rightarrow NH_3(g)$ $\Delta H°= -46.19$ kJ<br>$10\ N_2(g) + 30\ H_2(g) \rightarrow 20\ NH_3(g)$ $\Delta H°= -923.8$ kJ |

5.6

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| What happens to $\Delta H°$ when thermochemical equations are added? | The $\Delta H°$ values are also added:<br>$C(s) + ½\ O_2(g) \rightarrow CO(g)$ $\Delta H°= -110.5$ kJ<br>$\underline{CO(g) + ½\ O_2(g) \rightarrow CO_2(g) \quad \Delta H°= -283.0 \text{ kJ}}$<br>$C(s) + ½\ O_2(g) + CO(g) + ½\ O_2(g) \rightarrow CO(g) + CO_2(g)$ $\Delta H°= -393.5$ kJ<br>Crossing out terms that appear on both sides of the equation, we get:<br>$C(s) + O_2(g) \rightarrow CO_2(g)$ $\Delta H°= -393.5$ kJ |
| Under what circumstances would you add thermochemical equations? | If you wanted to know what the $\Delta H°$ when a reaction occurs as a series of steps (or when two or more reactions occur simultaneously). |
| What law is associated with adding thermochemical equations? | Hess's Law (of Heat Summation). |
| State Hess's law. | For any reaction that can be written in steps, the $\Delta H°$ for the whole reaction is the same as the sum of the $\Delta H°$s for the individual steps. |
| What illustrates why Hess's law of heat summation works? Explain? | Enthalpy diagrams show that for any reaction that can be written in steps the $\Delta H°$ for whole reaction is equal to the sum of the $\Delta H°$s of the steps. |
| Draw the enthalpy diagram for the two step reaction of $C(s) + O_2(g) \rightarrow CO_2(g)$ (see above for the steps). | Refer to fig 5.6 (pg. 165) |

5.7

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| What is $\Delta H°_f$ known as? | Standard heat of formation. |
| What is the difference between $\Delta H°$ and $\Delta H°_f$? | $\Delta H°_f$ is the $\Delta H°$ for a reaction when one mole of product is made from its elements. For example:<br>$C(s) + O_2(g) \rightarrow CO_2(g)$ will have a $\Delta H°_f$<br>$CO(g) + ½\ O_2(g) \rightarrow CO_2(g)$ will not because CO is not an element.<br>$2C(s) + 2O_2(g) \rightarrow 2CO_2(g)$ will not because 2 mol of $CO_2(g)$ is formed<br>$C(s) + O_2(l) \rightarrow CO_2(s)$ will not have a $\Delta H°_f$ because $O_2$ and $CO_2$ are not in their standard states (i.e. their natural physical states at 25°C and 1 atm). |
| What equation allows us to use individual values of $\Delta H°_f$ to calculate $\Delta H°$ of a reaction? Give the equation. | Hess's law equation:<br>$\Delta H° = [\text{sum of } \Delta H°_{products}] – [\text{sum of } \Delta H°_{reactants}]$ |
| Give the Hess's law equation for the reaction $aA + bB \rightarrow cC$ | $\Delta H° = [c \text{ x } \Delta H°_f \text{ (C)}] - [a \text{ x } \Delta H°_f \text{ (A)} + b \text{ x } \Delta H°_f \text{ (B)}]$,<br>where $a$, $b$, $c$ are in mol and A, B, C are in kJ/mol (thus $\Delta H°$ will be in kJ) |