Born-Haber Cycle (See pg. 305 & Fig. 8.6)

- ✓ This will help you solve for problems like #'s 26-28, pg. 334.
- ✓ A thermochemical cycle introduced by Born and Haber to analyze the factors contributing to the stability of ionic compounds.
- ✓ **Direct route:** Calculate the enthalpy change is the heat of formation of a solid ionic compound. See Appendix C.
- ✓ **Indirect route (5 steps):** Use Hess's Law and put these steps together.
    1. Generate gaseous atoms of the metal in the compound. Use Appendix C to calculate the enthalpy of formation of this gas. This is an endothermic process (positive enthalpy change).
    2. Generate gaseous atoms of the nonmetal in the compound. Use Appendix C to calculate the enthalpy of formation of this gas. This is also an endothermic process.
    3. Remove the electron(s) from the gaseous metal. The enthalpy change equals the 1st ionization energy, I_1(metal). If removing more than 1 electron, you'll need the other ionization energies to remove the other electrons (I_2, I_3, etc....). This is also an endothermic process.
    4. Then add electrons to your gaseous nonmetal. The enthalpy change equals the electron affinity of the nonmetal, denoted *E*(nonmetal). This is an exothermic process (negative enthalpy change).
    5. Finally, combine the gaseous metal and nonmetal ions to form the solid ionic compound. This is the reverse of the lattice energy. The enthalpy change is the negative of the lattice energy.
    - Summing these 5 steps gives us the total enthalpy change. From Hess's Law, the sum of the enthalpy changes for these 5 steps equals that for the direct path.

$$\Delta H_f^o[\text{ionic cd(s)}] = \Delta H_f^o[\text{metal(g)}] + \Delta H_f^o[\text{nonmetal(g)}] + I_1(\text{metal}) + I_2,I_3, \text{etc...(metal)} + E(\text{nonmetal}) - \Delta H_{lattice}$$

*rearrange to solve for $\Delta H_{lattice}$.

$$\Delta H_{lattice} = \Delta H_f^o[\text{metal(g)}] + \Delta H_f^o[\text{nonmetal(g)}] + I_1(\text{metal}) + I_2,I_3, \text{etc...(metal)} + E(\text{nonmetal}) - \Delta H_f^o[\text{ionic cd(s)}]$$

***SEE REVERSE SIDE FOR BORN-HABER CYCLE DIAGRAM.**

Born-Haber Cycle