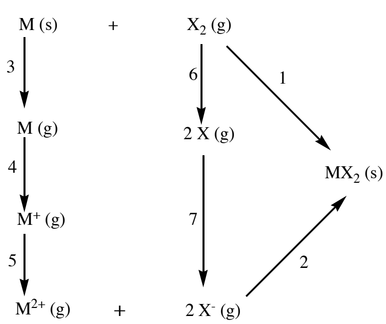
Chem 1711 **Born-Haber Cycle, Practice Problems**

1. Given the following information for magnesium, oxygen, and magnesium oxide calculate the second electron gain enthalpy for oxygen {i.e. for O^- (g) + e^- → O^{2-} (g)}.

for Mg (s), ΔH_{sub} = +148 kJ/mol
1st ionization energy for Mg = +738 kJ/mol
2nd ionization energy for Mg = +1450 kJ/mol
bond dissociation energy for O_2 = +499 kJ/mol
1st electron gain enthalpy for O = –141 kJ/mol
for MgO (s), lattice energy = +3890 kJ/mol
for MgO (s), enthalpy of formation = –602 kJ/mol

2. Consider an ionic compound MX_2 where M is a metal that forms a cation of +2 charge, and X is a nonmetal that forms an anion of –1 charge. A Born-Haber cycle for MX_2 is given below. Each step in this cycle has been assigned a number (1 – 7).



a. Identify one step (1 - 7) that is endothermic as written. ______________

b. Which step (1 - 7) corresponds to ΔH^o_{sub}? ______________

c. Which step (1 - 7) corresponds to ΔH^o_f? ______________

d. Use the following energy values to calculate the lattice energy (in kJ/mol) for MX_2.
ΔH^o_{sub} = 296 kJ/mol; ΔH^o_f = -421 kJ/mol; 1st ionization energy = 378 kJ/mol; 2nd ionization energy = 555 kJ/mol; bond dissociation enthalpy = 310 kJ/mol; electron affinity = -427 kJ/mol.

1. Given the following information for magnesium, oxygen, and magnesium oxide calculate the second electron gain enthalpy for oxygen {i.e. for $O^{-}(g) + e^{-} \rightarrow O^{2-}(g)$}.

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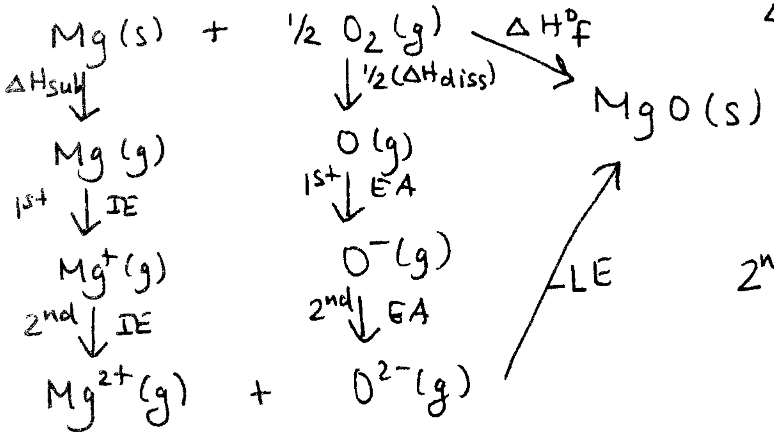


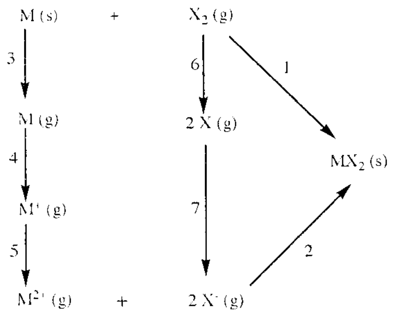
$\Delta H^o_f = \Delta H_{sub} + 1^{st}IE + 2^{nd}IE + \frac{1}{2}(\Delta H_{diss}) + 1^{st}EA + 2^{nd}EA - LE$

so $2^{nd}EA = \Delta H^o_f + LE - \Delta H^o_{sub} - 1^{st}IE - 2^{nd}IE - (\frac{1}{2}\Delta H_{diss}) - 1^{st}EA$

$2^{nd}EA = (-602 + 3890 - 148 - 738 - 1450 - (\frac{1}{2}\cdot 499) + 141)$ kJ/mol

$= +844$ kJ/mol

2. Consider an ionic compound MX_2 where M is a metal that forms a cation of +2 charge, and X is a nonmetal that forms an anion of −1 charge. A Born-Haber cycle for MX_2 is given below. Each step in this cycle has been assigned a number (1 − 7).



a. Identify one step (1 - 7) that is endothermic as written. 3, 4, 5, 6

b. Which step (1 - 7) corresponds to ΔH^o_{sub}? 3

c. Which step (1 - 7) corresponds to ΔH^o_f? 1

d. Use the following energy values to calculate the lattice energy (in kJ/mol) for MX_2. ΔH^o_{sub} = 296 kJ/mol; ΔH^o_f = -421 kJ/mol; 1st ionization energy = 378 kJ/mol; 2nd ionization energy = 555 kJ/mol; bond dissociation enthalpy = 310 kJ/mol; electron affinity = -427 kJ/mol.

$\Delta H^o_f = \Delta H^o_{sub} + 1^{st}IE + 2^{nd}IE + \Delta H_{diss} + 2(EA) - LE$

$\therefore LE = \Delta H^o_{sub} + 1^{st}IE + 2^{nd}IE + \Delta H_{diss} + 2(EA) - \Delta H^o_f$

$= [296 + 378 + 555 + 310 + 2(-427) - (-421)]$ kJ/mol

lattice energy = +1106 kJ/mol