AP Chemistry

Exercise 8.5
Lattice Energy

Name: _____

Date: _____ Per: _____

DIRECTIONS: Answer the following in the space provided:

1. Give three ions that are isoelectronic with neon. Place these ions in order of increasing size.

   a. _____

   b. _____

   c. _____

Smallest		Largest

2. Which compound in each of the following pairs of ionic substances has the most exothermic lattice energy? Justify your answer.

   a. NaCl, KCl _____ _____

   b. LiF, LiCl _____ _____

   c. $Mg(OH)_2$, MgO _____ _____

   d. $Fe(OH)_2$, $Fe(OH)_3$ _____ _____

   e. NaCl, Na_2O _____ _____

   f. MgO, BaS _____ _____

3. Consider the following energy changes:

	ΔH (kJ/mol)
$Mg(g) \rightarrow Mg^+(g) + e^-$	735
$Mg^+(g) \rightarrow Mg^{2+}(g) + e^-$	1445
$O(g) + e^- \rightarrow O^-(g)$	−141
$O^-(g) + e^- \rightarrow O^{2-}$	878

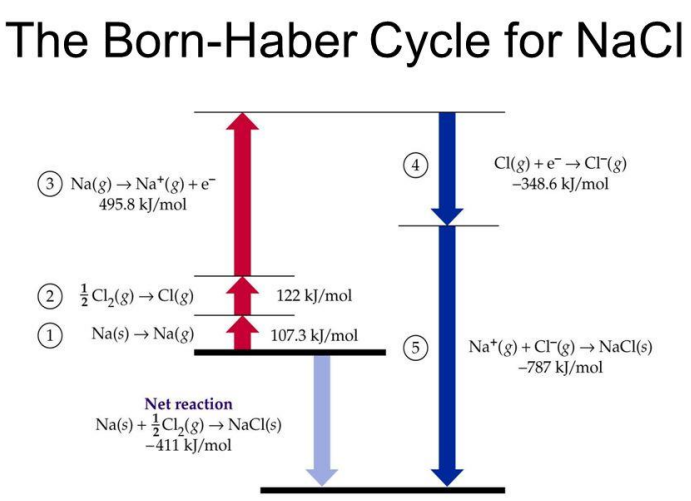
Magnesium oxide exists as $Mg^{2+}O^{2-}$ and not as Mg^+O^{-}. Explain. _____

_____

_____

_____

<u>Born-Haber cycle for lattice energy of NaCl:</u>



Each step adds up in a Hess's Law problem, which relates the enthalpy of formation to the lattice energy of the salt.

Step (1) ΔH of sublimation for Na(g)

Step (2) ΔH of formation for Cl(g)

Step (3) IE for Na(g)

Step (4) EA for Cl(g)

Step (5) ΔH of lattice for the salt

$\Delta H_f = \Delta H_1 + \Delta H_2 + \Delta H_3 + \Delta H_4 + \Delta H_5$

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4. Use the Born-Haber cycle to determine the enthalpy of formation of KCl. Label or write each step in the process and discuss what each step represents. Then, indicate if the process is endothermic or exothermic. (*NOTE: Steps are NOT in order!!)*

Step	Equation	ΔH°(kJ)	Circle One
	$K(s) \rightarrow K(g)$	89	endo / exo
Step 3: Ionization Energy for K(g)		418	endo / exo
Step 2: ΔH_f for Cl(g)		244	endo / exo
	$Cl(g) + e^- \rightarrow Cl^-(g)$	−349	endo / exo
Step 5: $\Delta H_{lattice}$ for KCl(s)		−717	endo / exo

Calculate the ΔH_f for KCl.

5. Use the information below to calculate the lattice energy for lithium bromide. Hint: Consider that only one bromine atom is needed for lithium bromide. Also consider that $Br_2(l)$ must be vaporized to $Br_2(g)$.

Reactions	Energies (kJ/mol)	
$Br(g) + e^- \rightarrow Br^-(g)$	$\Delta H_{EA} = -324$	
$Li(g) \rightarrow Li^+(g) + e^-$	$\Delta H_{IE} = +520.$	
$Br_2(g) \rightarrow 2Br(g)$	$\Delta H_{BE} = +192$	
$Br_2(l) \rightarrow Br_2(g)$	$\Delta H_{vap} = +15$	
$Li(s) \rightarrow Li(g)$	$\Delta H_{sub} = +162$	
	$\Delta H_{EL} = ?$	
$Li(s) + \frac{1}{2}Br_2(l) \rightarrow LiBr(s)$	$\Delta H°_f = -351$	

6. What is the lattice energy of $CaCl_2$?

Reactions	Energies (kJ/mol)	
$Ca(s) \rightarrow Ca(g)$	$\Delta H_{sub} = 178.0$	
$Ca(g) \rightarrow Ca^+(g) + e^-$	$\Delta H_{IE} = 590.0$	
$Ca^+(g) \rightarrow Ca^{2+}(g) + e^-$	$\Delta H_{IE} = 1145$	
$Cl_2(g) \rightarrow 2Cl(g)$	$\Delta H_{BE} = 242.6$	
$Cl(g) + e^- \rightarrow Cl^-(g)$	$\Delta H_{EA} = -348.7$	
$Ca^{2+}(g) + 2Cl^-(g) \rightarrow CaCl_2(s)$	$\Delta H_{EL} = ?$	
$Ca(s) + Cl_2 \rightarrow CaCl_2(s)$	$\Delta H°_f = -795.0$	

7. Calculate the enthalpy of sublimation for lithium using the following information.

Reactions	Energies (kJ/mol)	
$Li(s) \rightarrow Li(g)$	$\Delta H_{sub} = ?$	
$Li(g) \rightarrow Li^+(g) + e^-$	$\Delta H_{IE} = 520.$	
$I_2(g) \rightarrow 2I(g)$	$\Delta H_{BE} = 151$	
$I(g) + e^- \rightarrow I^-(g)$	$\Delta H_{EA} = -295$	
$Li^+(g) + I^-(g) \rightarrow LiI(s)$	$\Delta H_{EL} = -753$	
$Li(s) + \frac{1}{2}I_2(g) \rightarrow LiI(s)$	$\Delta H°_f = -292$	