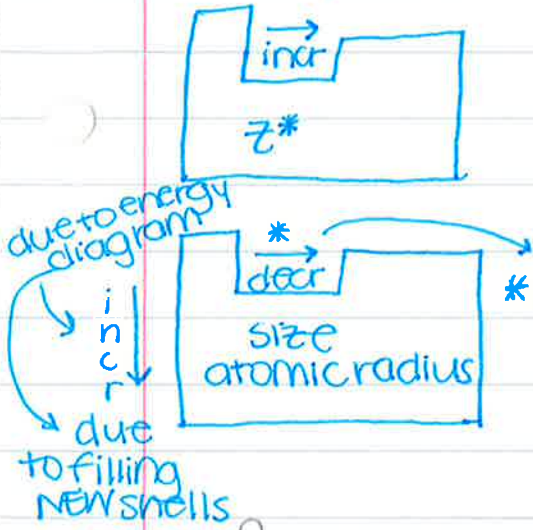
Today: Finish Ch. 6 (except for Born Haber cycle section   October 11th

Over Break: checklist available for CK-3, prelab expr 8 titration

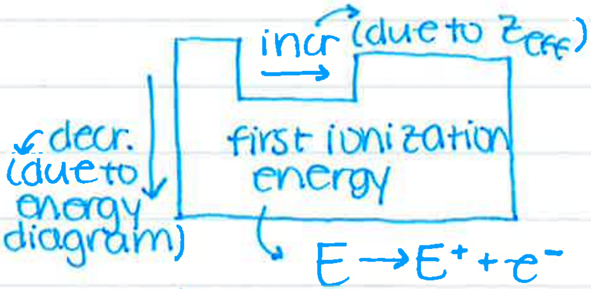
*Problem Club w/ Kendall → Sunday October 20th / Tuesday October 22nd
↳ 7:30 - 9pm, Eppley 211

Periodic Trends

z* or z eff

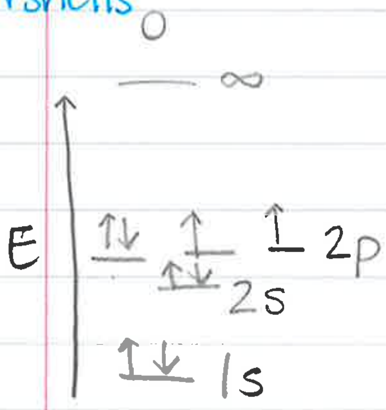


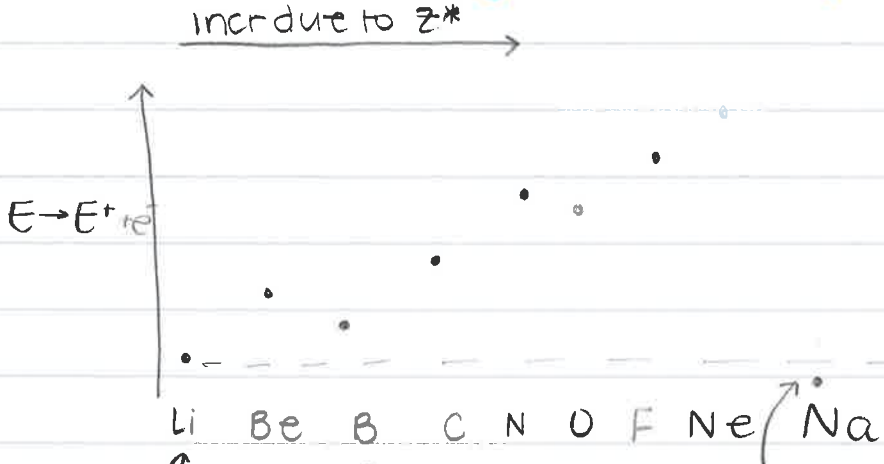
due to z



E → E⁺ + e⁻

↳ taking electron away





↑ $Li \rightarrow Li^+ + e^-$

$2s^1 \rightarrow 2s^0$

$n = 2 \rightarrow n = \infty$

↑ $B \rightarrow B^+ + e^-$

$2s^2 2p^1 \rightarrow 2s^2 2p^0$

lower than Li because of ionization energies decreasing as you go down the periodic table

* All elements want to keep their electrons therefore it takes energy for EVERY ONE! October 11th

takes energy

$Na \longrightarrow Na^+ + e^-$ $\Delta E \overset{+}{=} 496$ KJ/mol

Na

E_{i1} $Na \longrightarrow Na^+ + e^-$ $\Delta E = +496$ KJ/mol

$\underbrace{1s^2 2s^2 2p^6}_{core} \underbrace{3s^1}_{valence} \rightarrow 1s^2 2s^2 2p^6 3s^0$

E_{i2} $Na^+ \longrightarrow Na^{2+} + e^-$ $\Delta E = +4{,}562$ KJ/mol

$\underbrace{1s^2 2s^2 2p^6 3s^0}_{core} \longrightarrow 1s^2 2s^2 2p^5$

* elements can ONLY truly lose their valence electrons, you cannot eat into the core!!!

Mg

[Ne] $3s^2$ [Ne] $3s^1$

↳ $Mg \longrightarrow Mg^+ + e^-$ $\Delta E_{i1} = +738$ KJ/mol

↳ $Mg^+ \longrightarrow Mg^{2+} + e^-$ $\Delta E_{i2} = +1451$ KJ/mol

[Ne] $3s^1$ [Ne] $3s^0$

↳ $Mg^{2+} \longrightarrow Mg^{3+} + e^-$ $\Delta E_{i3} = +7733$ KJ/mol

[Ne] $1s^2 2s^2 2p^5$

Electron Affinity: $E + e^- \longrightarrow E^-$

$Li + e^- \longrightarrow Li^-$ $\Delta E = -60$ KJ/mol

$2s^1$ $2s^2$

↑ energy given off / released

$Be + e^- \longrightarrow Be^-$ $\Delta E \approx 0$ ← doesn't want to do that

$1s^2 2s^2$ $1s^2 2s^2 2p^1$

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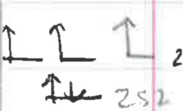
B $\Delta E = -27$ kJ/mol

$\Delta E = -154$ kJ/mol

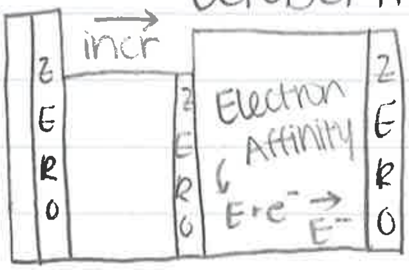
C



$N + e^- \rightarrow N^-$ $\Delta E = -7$ kJ/mol

$[He]2s^2 2p^3$

	ΔE_{EA}
F	-328 kJ/mol
Cl	-349 kJ/mol
Br	-224 kJ/mol
I	-295 kJ/mol



* IF a subshell is filled, they don't want another e^-

$Ca(s) + S(s) \rightarrow CaS(s)$

0 0

Ca^{2+} → oxidized

S^{2-} → reduced

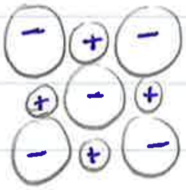
Lattice Energy

$Na^+(g) + F^-(g) \rightarrow NaF(s)$

Na: 11p, 11e

Na^+: 11p, 10e^-

Ionic lattice



*cations = SMALL

*anions = BIG

F: 9p, 9e

F^-: 9p, 10e

Fe^{2+} small → Fe^{3+} smaller → higher charge, smaller it is!

* Forming lattice always releases energy!

charge on cation

Lattice Energy $\propto Z_{cation} Z_{anion}$

charge on anion

LiF $Z_{cat} = +1$

$Z_{anion} = -1$

$E_{lattice} = -1036$ kJ/mol

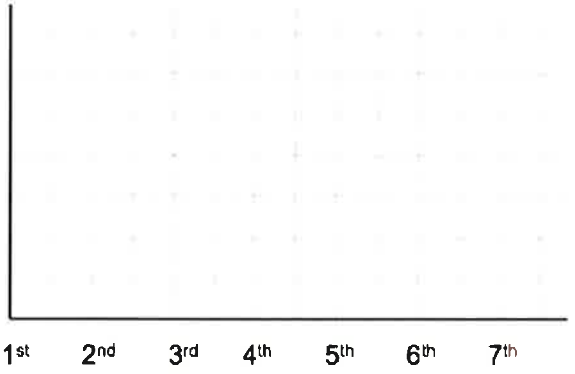
Be^{+2} $Z_{cat} = +2$

O^{-2} $Z_{anion} = -2$

$E_{lattice} = -4443$ kJ/mol

Chapter 6 Day 2 (Sections 6.5 – 6.8) (Unit 3) 11 October 2019

1. 1. The sequential ionization energies for silicon are (all in kJ/mol): E_{i1} = 787; E_{i2} = 1577; E_{i3} = 3231; E_{i4} = 4356; E_{i5} = 16091; E_{i6} = 19784; and E_{i7} = 23783. Plot these data on the graph paper below. (Make each horizontal line an increment of 5000 kJ) Write the electron configuration of the resulting ion near each data point – so for 1st, you would write $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^1$, and so on.



2a. What is the solubility rule involving Group 1 cations?

2b. What is the solubility rule involving halides?

2c. From the table in the book (and on the handout) what is the range of lattice energy values for Group 1 halides? Is this the energy associated with forming the lattice from gas phase ions or breaking the lattice into gas phase ions?

2d. What is energy, E, for this process? (Think carefully about the sign) $Na^+(g) + Cl^-(g) \rightarrow NaCl(s)$ E =

3a. The lattice energies of $CaSO_4$, $SrSO_4$, and $BaSO_4$ are 2653, 2603 and 2423 kJ/mol, respectively. Why do you think these lattice energies are larger than for Group 1 halides?

3b. How does lattice energy seem to relate to solubility?

4a. The charge on the cation is called Z^+ and the charge on the anion is Z^-. Lattice energies are $\propto$ $Z^+ \times Z^-$. Complete this table of $Z^+ \times Z^-$ and give an example of each combination. Circle those that you know or suspect are insoluble from a solubility rule.

$\lvert Z^+ \times Z^- \rvert$	$Z^+ = 1$	$Z^+ = 2$	$Z^+ = 3$
$Z^- = -1$	-1, NaCl		
$Z^- = -2$		-4, $CaCO_3$	
$Z^- = -3$			-9, $AlPO_4$

4b. Can you make a generalization about the product of charges and lattice energies?

Questions in final exam format (multiple choice):

5. Which liberates the most energy?
   A. $Br(g) + e^- \rightarrow Br^-(g)$
   B. $Cl(g) + e^- \rightarrow Cl^-(g)$
   C. $F(g) + e^- \rightarrow F^-(g)$
   D. $I(g) + e^- \rightarrow I^-(g)$

6. What is the ground-state electron configuration of the ion Cu^{2+}?
   A. $[Ar]\ 3d^9$
   B. $[Ar]\ 4s^1\ 3d^8$
   C. $[Ar]\ 4s^2\ 3d^7$
   D. $[Ar]\ 4s^2\ 3d^{10}\ 4p^1$

7. Which ionic compound would be expected to have the highest lattice energy?
   A. Li_2O
   B. Na_2O
   C. K_2O_2
   D. Ca_3PO_4

Now try these problems from the book:

Section 6.5. (Electron affinity) Problems 9, 10, and 66 – 72, even.

Section 6.6. (Octet Rule) Problems 11, 12, 30, and 74 – 78, even.

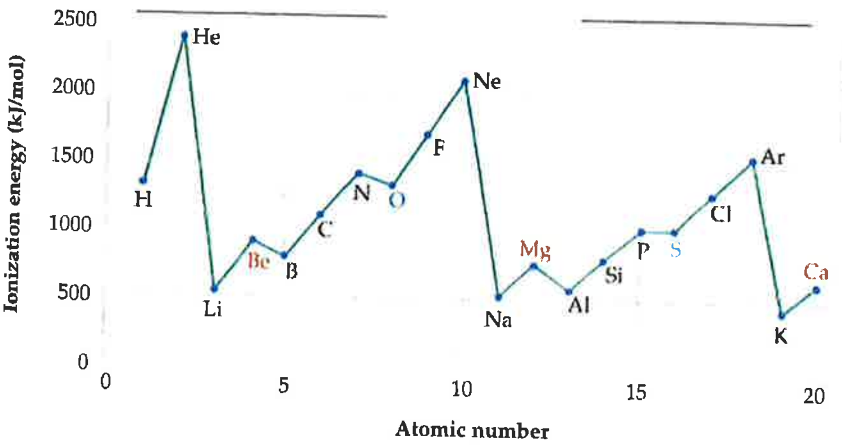
Section 6.7. Skip for now. This section will be discussed after we finish Chapter 9.

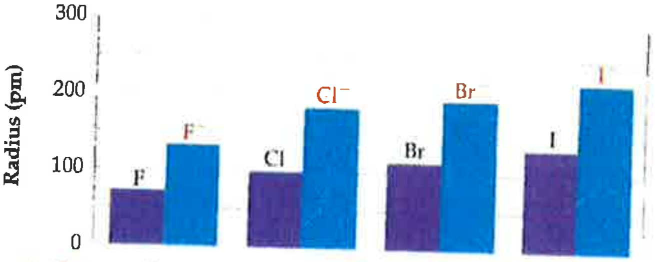
Section 6.8. (Lattice energy) Problems 15, 16, and 98.

Practice Quiz (pg. 231 – 232) Problems 9 – 10, 13.

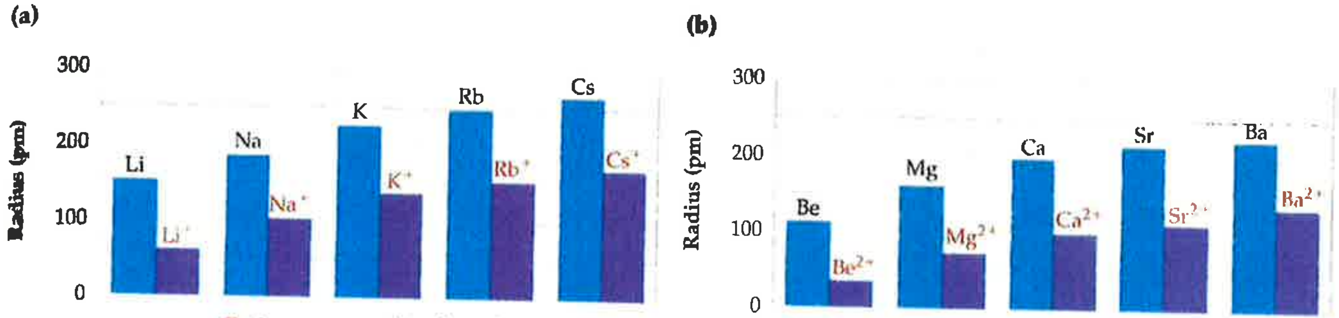
Figure 6.4

Ionization energies of the first 20 elements.

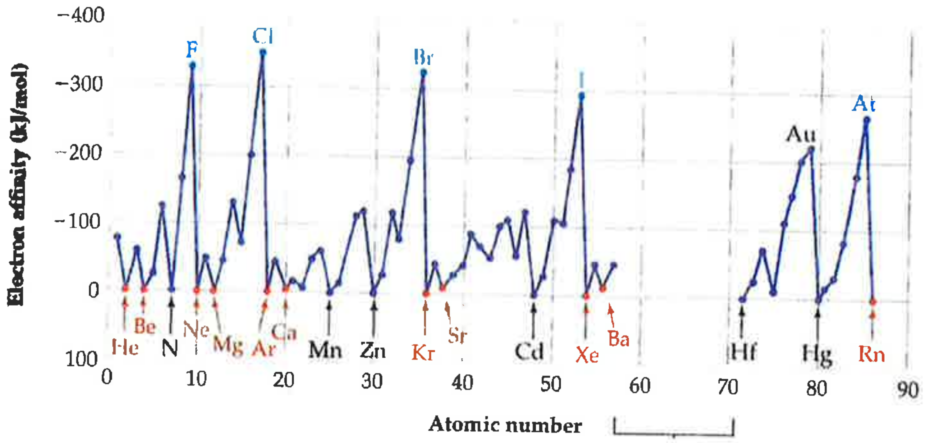




Anions are larger than their neutral atoms because of additional electron–electron repulsions and a decrease in Z_{eff}.



Cations are smaller than the corresponding neutral atoms, both because the principal quantum number of the valence-shell electrons is smaller for the cations than it is for the neutral atoms and because Z_{eff} is larger.



A negative value for E_{ea}, such as those for the **group 7A elements (halogens),** means that energy is released when an electron adds to an atom.

A value of zero, such as those for the **group 2A elements (alkaline earths) and group 8A elements (noble gases),** means that energy is absorbed but the exact amount can't be measured.

TABLE 6.3 Lattice Energies of Some Ionic Solids (kJ/mol)

	Anion				
Cation	F^-	Cl^-	Br^-	I^-	O^{2-}
Li^+	1036	853	807	757	2925
Na^+	923	787	747	704	2695
K^+	821	715	682	649	2360
Be^{2+}	3505	3020	2914	2800	4443
Mg^{2+}	2957	2524	2440	2327	3791
Ca^{2+}	2630	2258	2176	2074	3401
Al^{3+}	5215	5492	5361	5218	15,916