Groups + Electron Configurations

ex			
H	$1s^1$		$= 1s^1$
Li	$1s^2 2s^1$		$= [He]2s^1$
Na	$1s^2 2s^2 2p^6 3s^1$		$= [Ne]3s^1$
K	$1s^2 2s^2 2p^6 3s^2 3p^6 4s^1$		$= [Ar]4s^1$

all have $1e^-$ in outer shell!

Core e⁻'s ↑ — Valence e⁻'s ↑

Outer e⁻'s : reactivity + bonding.

Ions + e⁻ config

Cations : lose e^-
Anions : gain e^-
} valence e⁻'s! from shell w/ largest n.

Table 8.1

Electron Configurations of Group 1A and Group 2A Elements

Group 1A		Group 2A	
Li	$[He]2s^1$	Be	$[He]2s^2$
Na	$[Ne]3s^1$	Mg	$[Ne]3s^2$
K	$[Ar]4s^1$	Ca	$[Ar]4s^2$
Rb	$[Kr]5s^1$	Sr	$[Kr]5s^2$
Cs	$[Xe]6s^1$	Ba	$[Xe]6s^2$
Fr	$[Rn]7s^1$	Ra	$[Rn]7s^2$

ex: Na: $[Ne]3s^1$

Na^+: $[Ne]$

Ca: $[Ar]4s^2$

Ca^{2+}: $[Ar]$

Al: $[Ne]3s^2 3p^1$

Al^{3+}: $[Ne]$

stable noble gas core!

ex: F: $1s^2 2s^2 2p^5$

F^-: $1s^2 2s^2 2p^6 = [Ne]$

O: $1s^2 2s^2 2p^4$

O^{2-}: $1s^2 2s^2 2p^6 = [Ne]$

N: $1s^2 2s^2 2p^3$

N^{3-}: $1s^2 2s^2 2p^6 = [Ne]$

O: $1s^2 2s^2 2p^4$

O^{6+}: $1s^2 = [He]$

Atoms/Ions w/ same e^- configuration

ISOELECTRONIC

ex: Al^{3+}, Na^+, F^-, O^{2-}, N^{3-}, Ne

all isoelectronic w/ Ne

Transition Metals

careful...

ex: $_{22}Ti^{2+}$

remove these 1st ($n=4$)

Ti: $[Ar]4s^2 3d^2$ ($n=3$)

Ti^{2+}: $[Ar]3d^2$

Fe: [Ar] $4s^2$ $3d^6$
(n=4) (n=3)

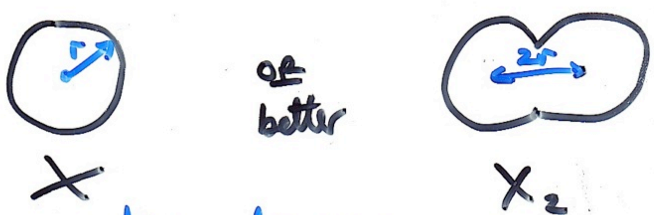
Fe^{2+} [Ar] $3d^6$

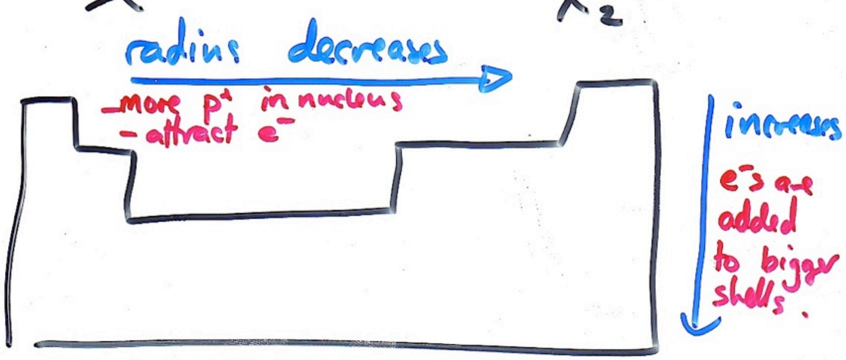
Fe^{3+} [Ar] $3d^5$

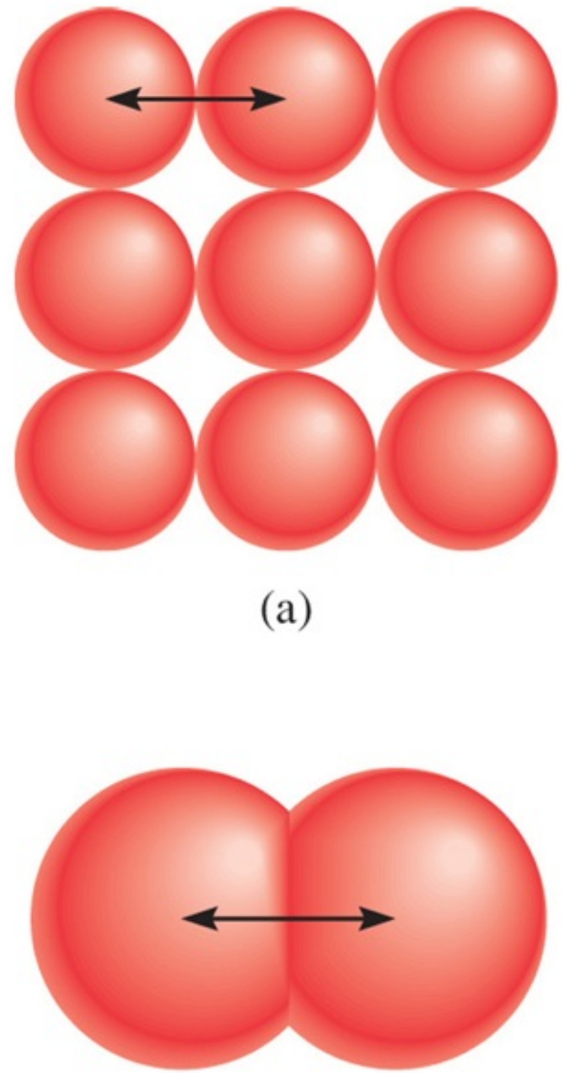
often not isoelectronic w/ noble gases!

Periodic Properties

Atomic radius







(a)

(b)

Ionic radius

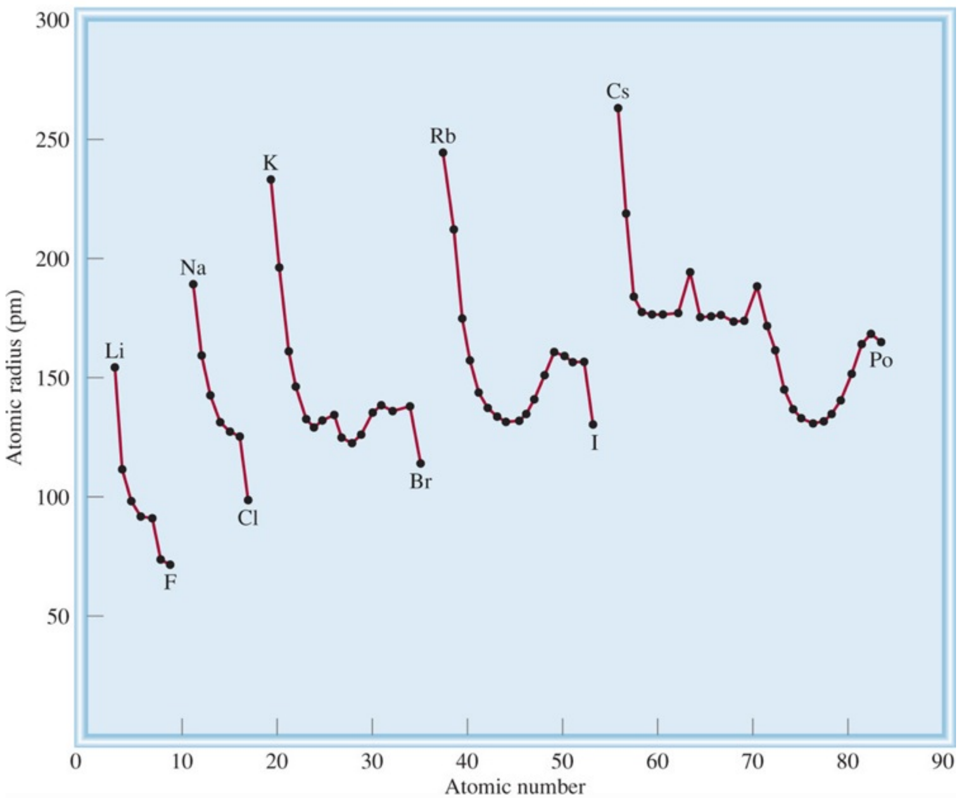
cations are smaller than the atoms they came from.

anions are larger...

ex:

	Al^{3+}	Mg^{2+}	Na^{+}	F^{-}	O^{2-}	N^{3-}
# p^+	13	12	11	9	8	7
# e^-	10	10	10	10	10	10

isoelectronic w/ Ne



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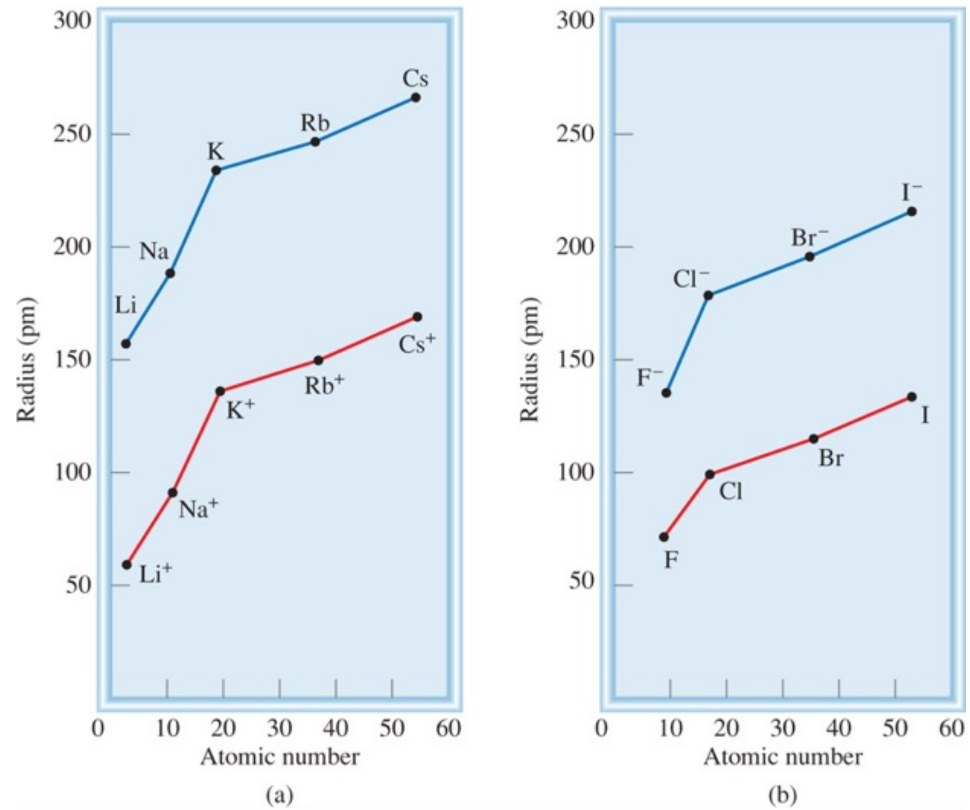

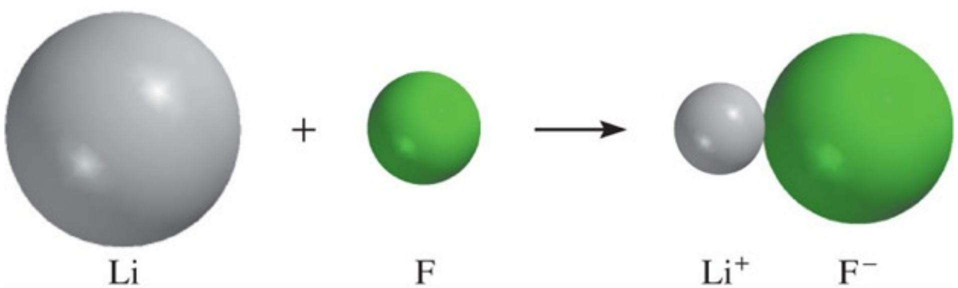

Ionization Energy -

$$\text{energy} + X_{(g)} \longrightarrow X^{+}_{(g)} + e^{-}$$

↑ 1st ionization energy

I_1

$$\text{energy} + X^{+}_{(g)} \longrightarrow X^{2+}_{(g)} + e^{-}$$

↑ 2nd ionization energy, I_2

$$\text{energy} + X^{2+}_{(g)} \longrightarrow X^{3+}_{(g)} + e^{-}$$

↑ 3rd ionization energy, I_3

. . .

In general, it becomes harder + harder to remove each successive e^-.

$$I_1 < I_2 < I_3 < \ldots$$

as we remove e⁻'s, we get a larger + larger ⊕ charge!

Table 8.2 The Ionization Energies (kJ/mol) of the First 20 Elements

Z	Element	First	Second	Third	Fourth	Fifth	Sixth
1	H	1,312					
2	He	2,373	5,251				
3	Li	520	7,300	11,815			
4	Be	899	1,757	14,850	21,005		
5	B	801	2,430	3,660	25,000	32,820	
6	C	1,086	2,350	4,620	6,220	38,000	47,261
7	N	1,400	2,860	4,580	7,500	9,400	53,000
8	O	1,314	3,390	5,300	7,470	11,000	13,000
9	F	1,680	3,370	6,050	8,400	11,000	15,200
10	Ne	2,080	3,950	6,120	9,370	12,200	15,000
11	Na	495.9	4,560	6,900	9,540	13,400	16,600
12	Mg	738.1	1,450	7,730	10,500	13,600	18,000
13	Al	577.9	1,820	2,750	11,600	14,800	18,400
14	Si	786.3	1,580	3,230	4,360	16,000	20,000
15	P	1,012	1,904	2,910	4,960	6,240	21,000
16	S	999.5	2,250	3,360	4,660	6,990	8,500
17	Cl	1,251	2,297	3,820	5,160	6,540	9,300
18	Ar	1,521	2,666	3,900	5,770	7,240	8,800
19	K	418.7	3,052	4,410	5,900	8,000	9,600
20	Ca	589.5	1,145	4,900	6,500	8,100	11,000

$e^- \leftrightarrow (+)$

$e^- \leftrightarrows (2+)$

$e^- \leftrightarrows (3+)$

Look @ Be: $1s^2 2s^2$

	kJ/mol	
I_1	899	remove $2s^2$
I_2	1757	
		enormous increase in E!
I_3	14,850	removing $1s^2$ core e⁻s
I_4	21,005	