This week's dry lab ~> MAS439!

11/26/2018

Ionic radii

Cation : lose e^-s $\Rightarrow$ e^- cloud shrinks $\Rightarrow$ radius $\downarrow$
Anion : gain e^-s $\Rightarrow$ e^- cloud expands $\Rightarrow$ radius $\uparrow$

consider $Li \xrightarrow{-1e^-} Li^+$

$r = 152\,pm$ $\qquad$ $r = 60\,pm$

$B \xrightarrow{-3e^-} B^{3+}$

$r = 85\,pm$ $\qquad$ $r = 23\,pm$

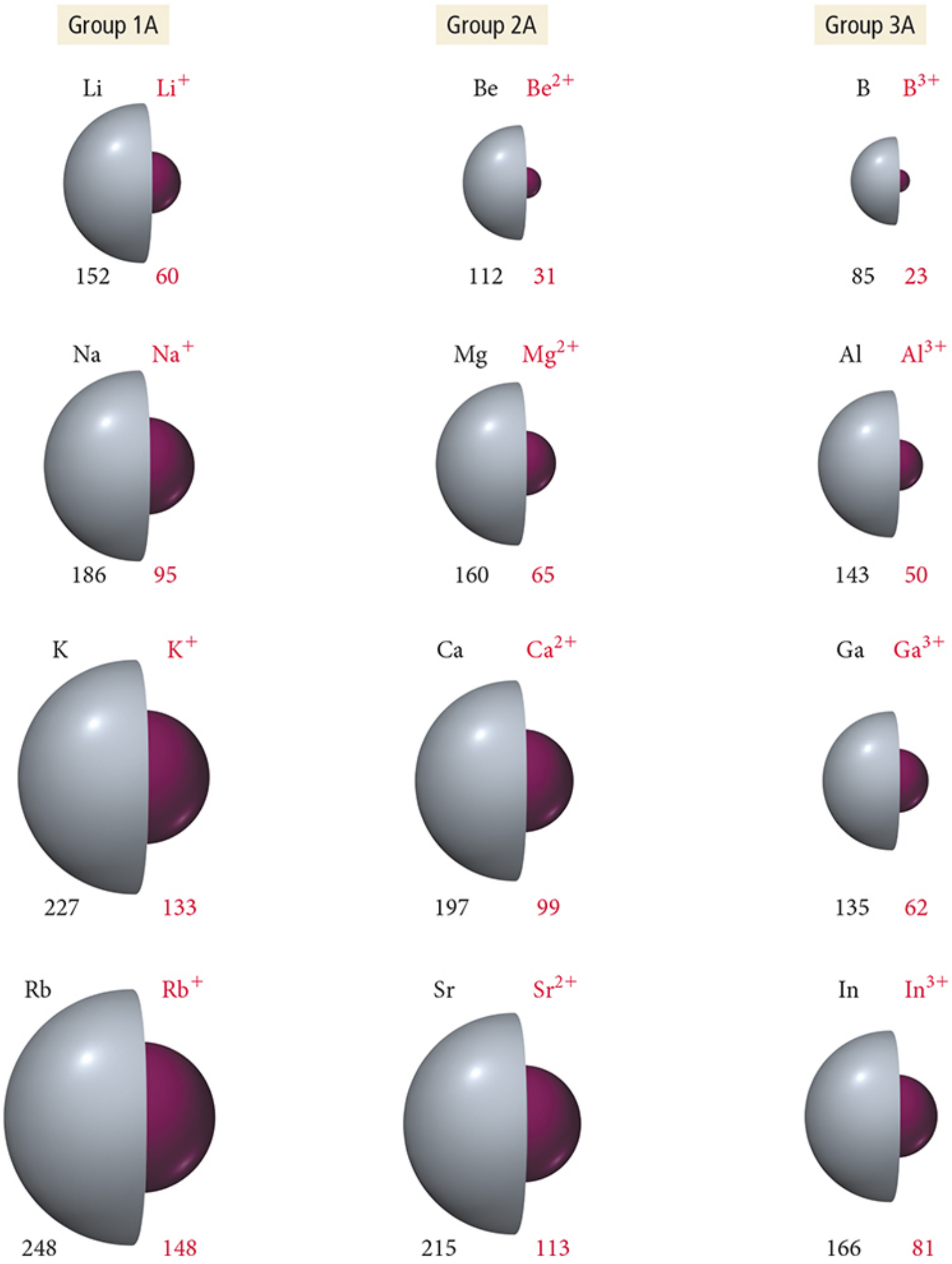
cations.

$O \xrightarrow{+2e^-} O^{2-}$

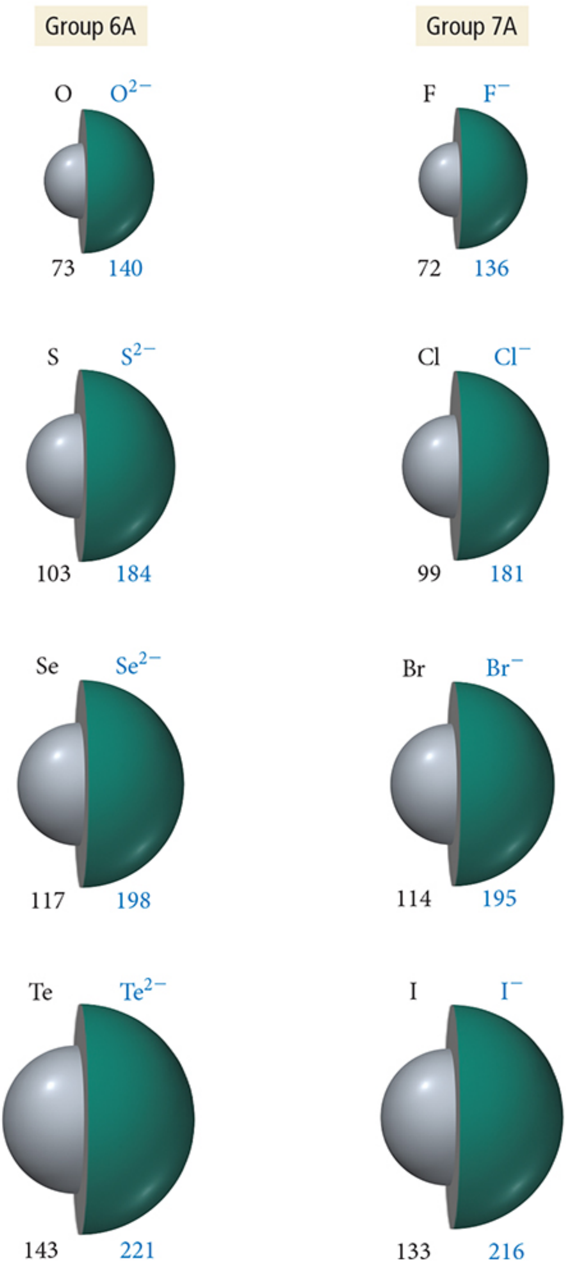
$r = 73\,pm$ $\qquad$ $r = 140\,pm$

Anions

Radii of Atoms and Their Cations (pm)



Radii of Atoms and Their Anions (pm)



consider an $\underbrace{\text{isoelectronic}}_{\text{same \# } e^-}$ series of ions

	Ca^{2+}	K^+	Cl^-	S^{2-}
	$20p^+$	$19p^+$	$17p^+$	$16p^+$
	$18e^-$	$18e^-$	$18e^-$	$18e^-$
ionic radius	99pm	133pm	181pm	184pm

$\xleftarrow{\text{smaller ionic radius}}$

more p^+

same e^-

Ionization Energy, IE

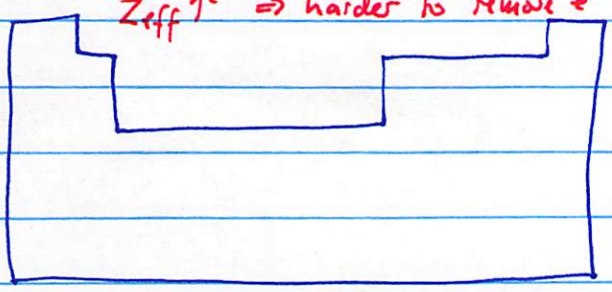
- E to remove $1e^-$ from 1mol of gaseous atoms.

ex: IE for Li: $Li(g) \longrightarrow Li^+(g) + e^-$; $IE_1 = +520 \frac{kJ}{mol}$

can also remove 2^{nd} e^- : $Li^+(g) \longrightarrow Li^{2+}(g) + e^-$; $IE_2 = +7298 \frac{kJ}{mol}$

IE_1 increases $\longrightarrow$

$Z_{eff} \uparrow \Rightarrow$ harder to remove e^-



$\downarrow$ IE_1 decreases.

e^- in larger shell (same Z_{eff})

$\Rightarrow$ easier to remove!

Trends in First Ionization Energy

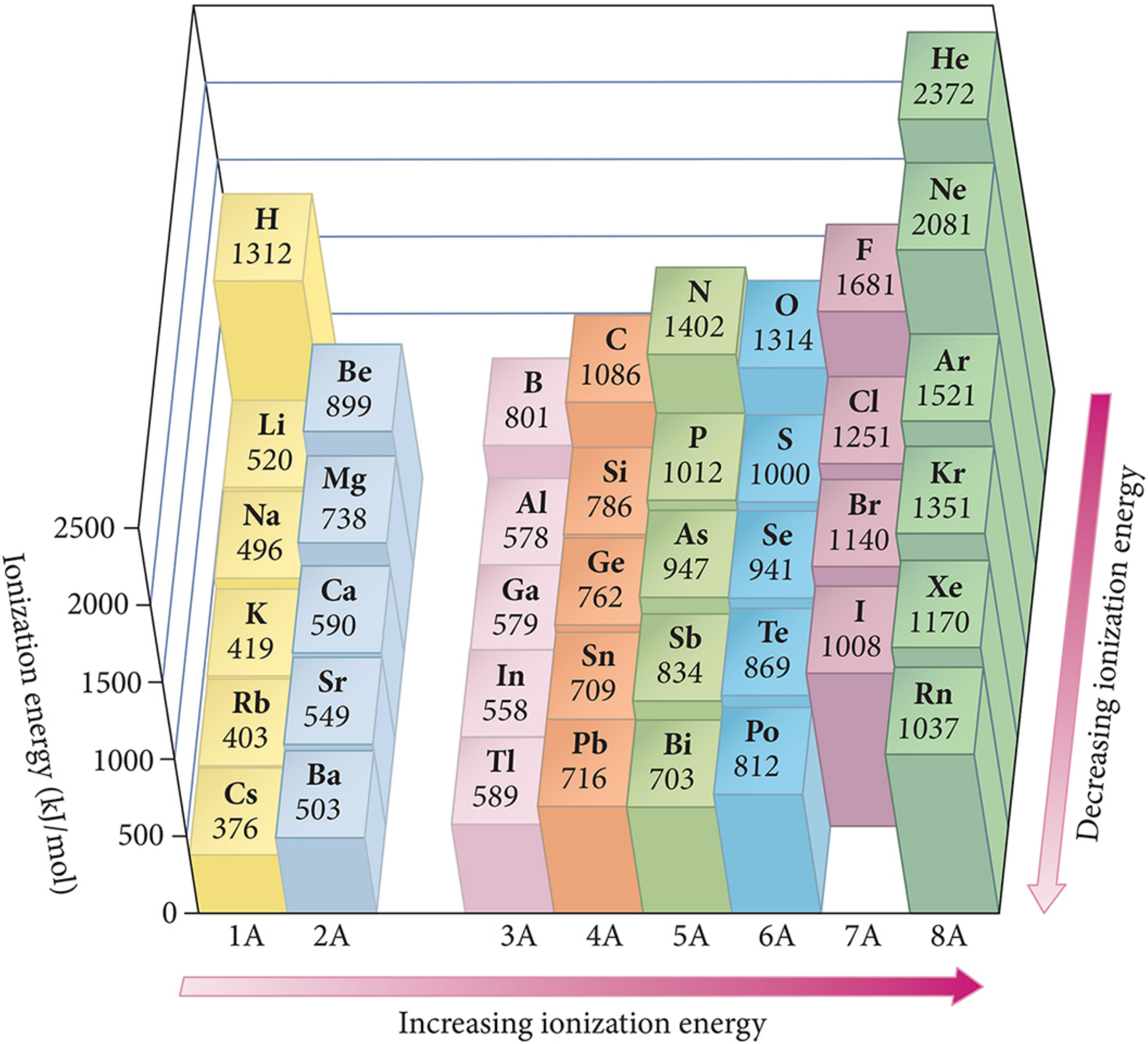


TABLE 8.1 Successive Ionization Energies for the Elements Sodium through Argon (kJ/mol)

Element	IE_1	IE_2	IE_3	IE_4	IE_5	IE_6	IE_7
Na	496	4560					
Mg	738	1450	7730		Core electrons		
Al	578	1820	2750	11,600			
Si	786	1580	3230	4360	16,100		
P	1012	1900	2910	4960	6270	22,200	
S	1000	2250	3360	4560	7010	8500	27,100
Cl	1251	2300	3820	5160	6540	9460	11,000
Ar	1521	2670	3930	5770	7240	8780	12,000

$IE_3 = +11{,}815\ kJ/mol$

$IE_2 = +7298\ kJ/mol$

Why is $IE_2 > IE_1$ for Li?

$IE_1 = +520\ kJ/mol$

ex: $_3Li : 1s^2 2s^1$ $\quad \underbrace{\boxed{\uparrow\downarrow}}_{\text{core}}^{1s} \quad \underbrace{\boxed{\uparrow}}_{\text{valence}}^{2s}$

So for B $\quad \underbrace{IE_1 < IE_2 < IE_3}_{\text{relatively low}} < \underbrace{IE_4 < IE_5}_{\text{much larger!!}}$

$1s^2\underbrace{2s^2 2p^1}_{3 \text{ valence } e^-\text{s}}$

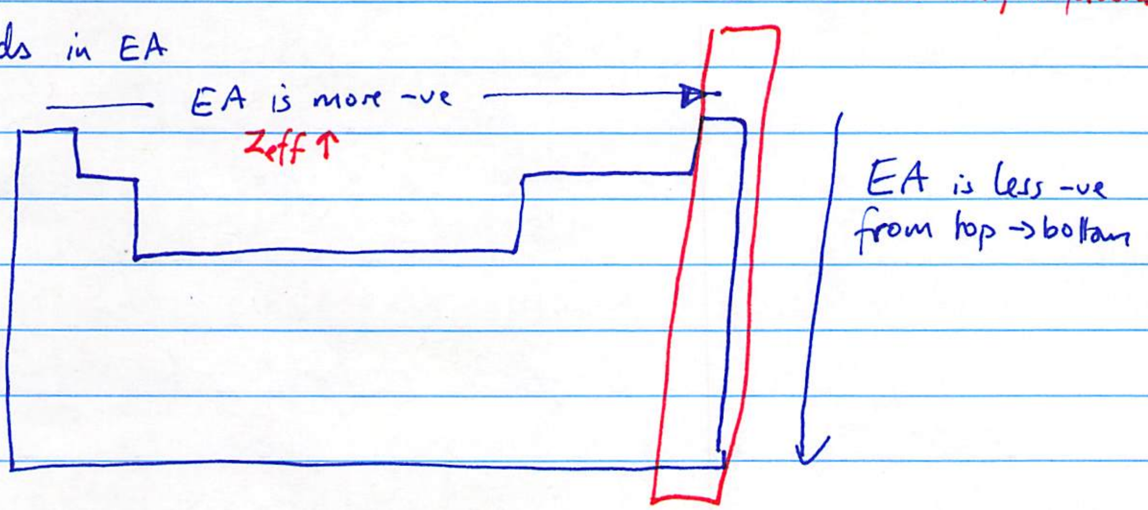
Electron Affinity, EA

E when 1 mol e^- is added to gaseous atoms

ex: EA for chlorine: $e^- + Cl(g) \longrightarrow Cl^-(g)$; $EA = -349\ \frac{kJ}{mol}$

EA>0 (all +ve, unfavorable)

trends in EA



trends are "iffy"
XPTs ~ hard!

Noble gases.
e^- is added to new shell
$Z_{eff} \approx 0$

Electron Affinities (kJ/mol)

1A	2A	3A	4A	5A	6A	7A	8A
H −73							**He** >0
Li −60	**Be** >0	**B** −27	**C** −122	**N** >0	**O** −141	**F** −328	**Ne** >0
Na −53	**Mg** >0	**Al** −43	**Si** −134	**P** −72	**S** −200	**Cl** −349	**Ar** >0
K −48	**Ca** −2	**Ga** −30	**Ge** −119	**As** −78	**Se** −195	**Br** −325	**Kr** >0
Rb −47	**Sr** −5	**In** −30	**Sn** −107	**Sb** −103	**Te** −190	**I** −295	**Xe** >0

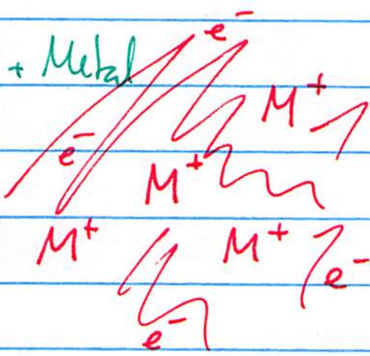
Ch 9 ~ Chemical Bonding 1: The Lewis Model

3 types of bonds:

(1) Ionic bonds: Metal + Non-metal: $M^+ X^-$ e^- transfer Redox

(2) Covalent bonds: Non-metals + Non-metal: $X-Y$ e^-'s shared between 2 atoms

(3) Metallic bonds: Metal + Metal e^- sea between metal ions!



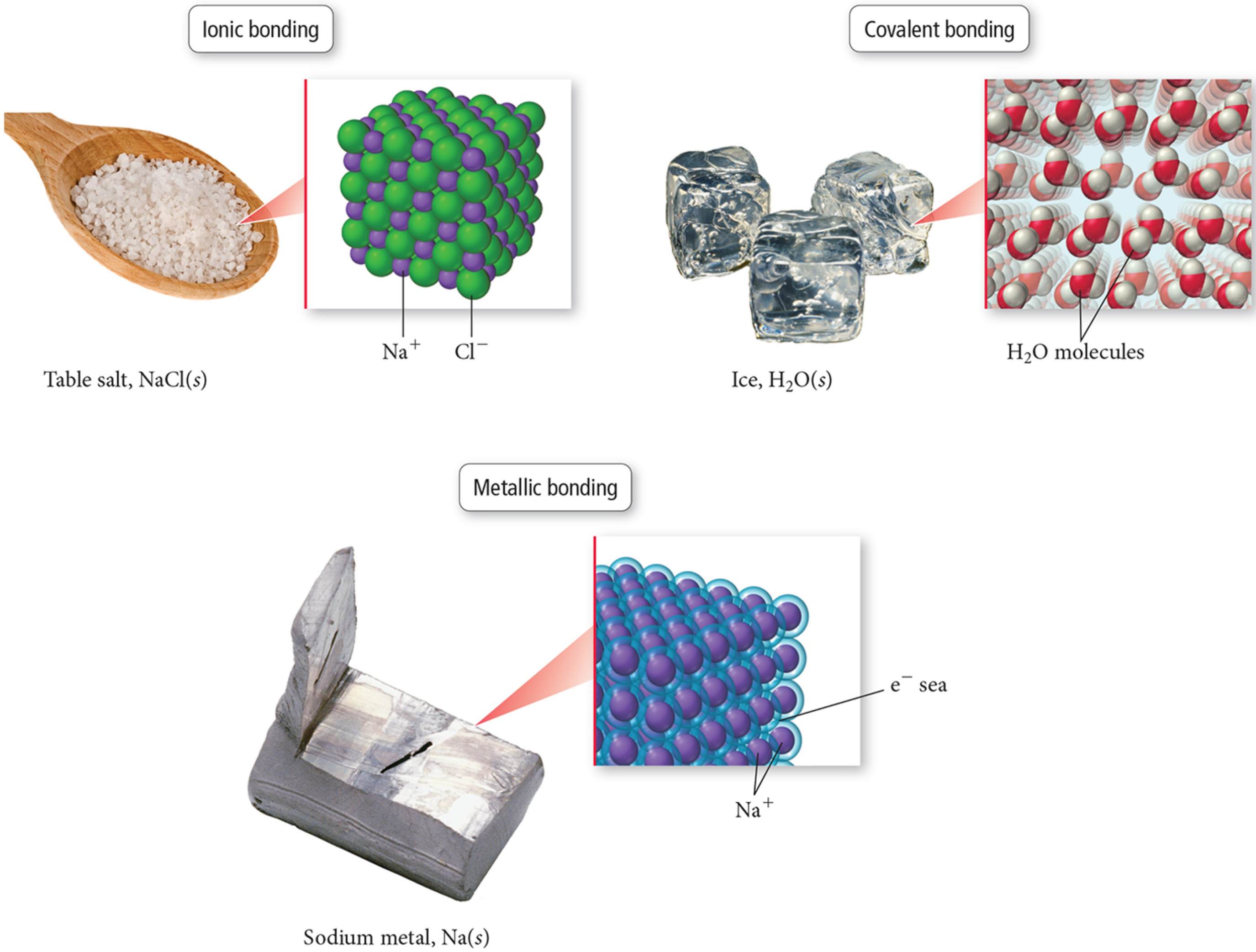
Lewis's dot symbols

use a "dot" for each valence e^- (~ gp # 1A–8A ~ for main gp.
He ⤳ 2

Li· ·Be· ·Ḃ· ·Ċ· ·N̈· ·Ö· :F: :Ne:

For ionic cpds: ◻ Metal loses all of its valence e^-'s to expose a full inner core (8 e^-'s)
◻ Non-metals: gain valence e^-'s to fill outer shell to 8 e^-'s OCTET rule.

except H, He ⤳ only need $2e^-$ to fill outer shell ($1s^2$) DUET rule


Ionic bonding
Na^+
Cl^-
Table salt, NaCl(*s*)
Covalent bonding
H_2O molecules
Ice, H_2O(*s*)
Metallic bonding
e^- sea
Na^+
Sodium metal, Na(*s*)