Notes

October 1st Electron Configuration & Bonding

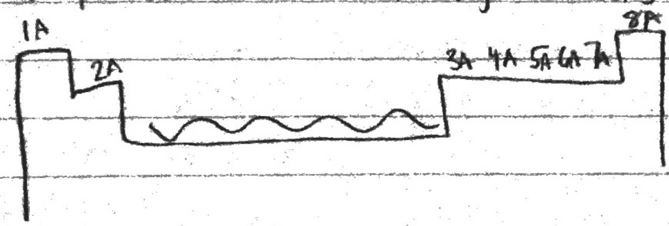
L to R Z_{eff} increasing
T to B Z_{eff} is similar
T to B Electron in higher energy. Farther from nucleus

less protons means less interaction

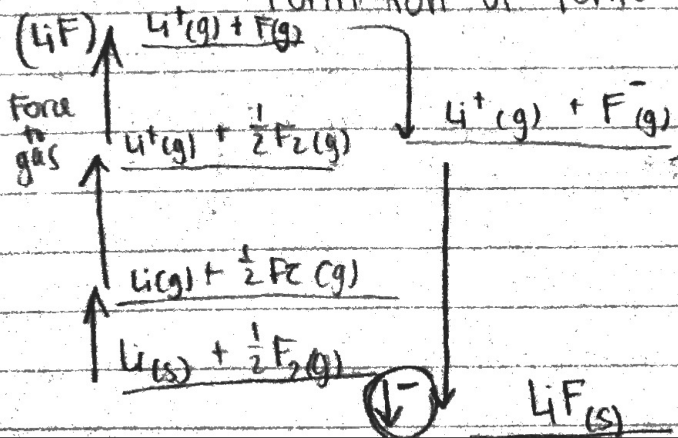
Ionization Energy - how much energy required to take an electron
ex. Cl > Br
Na < Cl
Na > Cs

Some Electron Configurations of Ions
Na: $1s^2 2s^2 2p^6 3s^1$ = [Ne]$3s^1$ ←
Na^+: remove electron from right = [Ne]
Br: [Ar]$4s^2 3d^{10} 4p^8$
Br^{2+}: [Ar] $4s^2 3d^{10} 4p^3$
↑ : [Ar] $4s^2 3d^{10} 4p^6$ ⟹ [Kr] = Br^-
$+3e^-$

Any column with "A" by it states valence electron



To get to most stable form, either add or remove electrons
Formation of Ionic Compound - Downhill Energy



Lattice energy = amount of E required to remove one formula unit out of whole lattice

Lattice energy depends on & crystal structure

↓

Coulomb's Law ← charge

$$E = \frac{q^+ q^-}{4\pi\varepsilon_0 r}$$

→ radius

($4\pi\varepsilon_0$) constant

which would have larger lattice energy?

(a) NaF (smaller radius means greater lattic energy required to remove the one lattice)

ALSO the high charge they dont want to separate.

Polyatomic Ions

ex: CO_3^{2-} (carbonate)

ex: Sodium oxide → Na_2O (Na^{+1} O^{2-})

WEBSITE FUNDAMENTALS

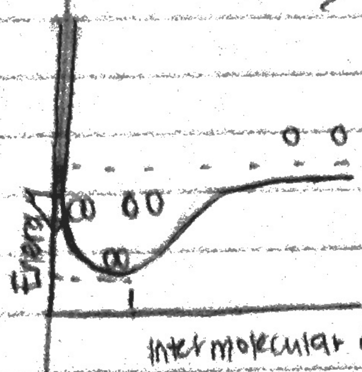
Covalent

two non-metals. shared electrons

CO_2 : Carbon dioxide

CO : carbon monoxide

characterize bond...

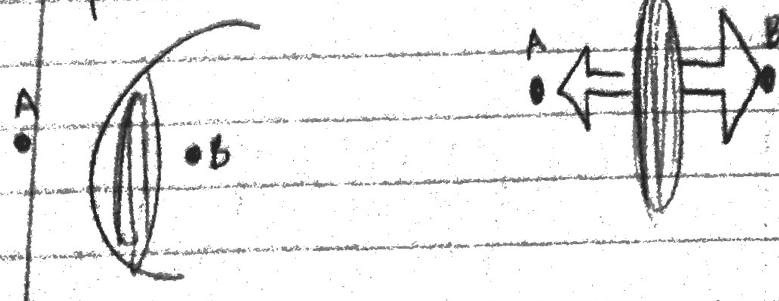


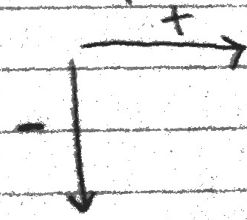
- Bond Length single > double > triple
- Bond Strength single < double < triple
- Electron pair shared Equally?

YES - pure covalent

NO - polar covalent

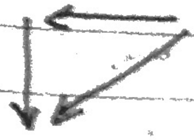
Electronegativity - electron pulling power of an atom when it is part of a molecule.



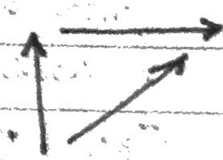


Electron configuration & Bonding.

Atomic Radii



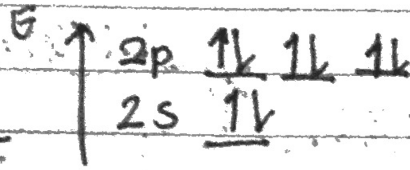
Ionization E : E required to move e^-

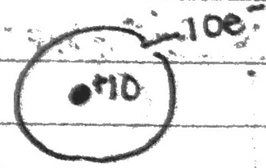


Ne :

extremely stable

core : 10 e^-



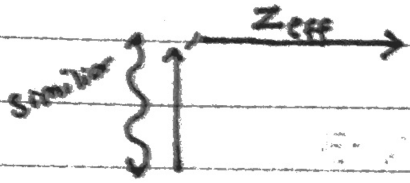


Na 11 - 10 = 1

Z_{eff} = protons - core e^- = 1

K

Z_{eff} = 19 - 18 = 1 . . . (:)



across periodic table L → R Z_{eff} ↑

adding more protons

pull electrons in closer

radius decreases

ion comparison

$Na^+ < Na < Na^-$

↑ one less e^- so closer pulling

↑ more e^- can't pull as close

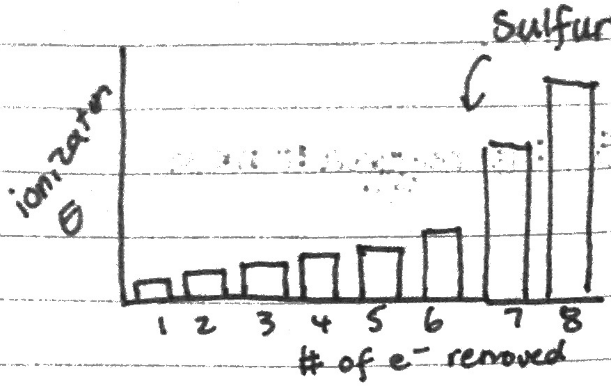
I.E. complete octets have highest ionization energies

F > O

Cl > Br

Na < Cl

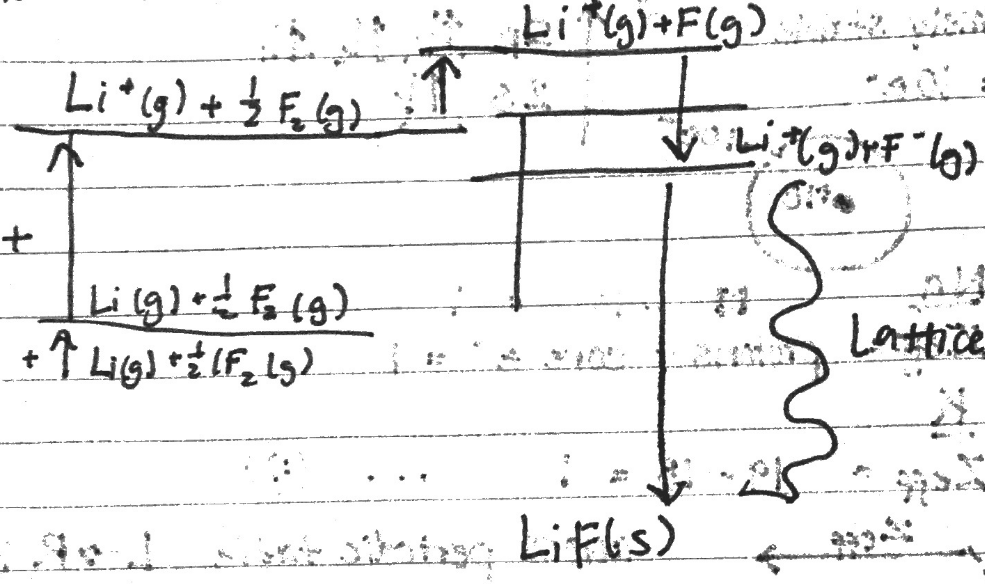
Na <



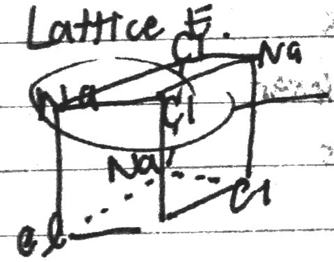
because sharp inc. from 6 → 7
6 valence e^- on sulfur

[Ne] $3s^2$ $3p^4$ = 6
[Ne] ← hard to remove.

Carbon: ±4 e^-



Lattice E.



lattice E remove | A-B
only ionic lattice

Coulomb's Law

$$E = \frac{q^+ q^-}{4\pi\varepsilon_0 r}$$

- $q^+ q^-$ ← charge
- r ← radius
- $4\pi\varepsilon_0$ ← constant

$H^{\delta+} - F^{\delta-}$

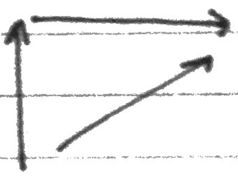
Covalent compounds

single > double > triple	length
single < double < triple	strength

Electron pair shared equally?
YES - PURE COVALENT
NO - POLAR COVALENT

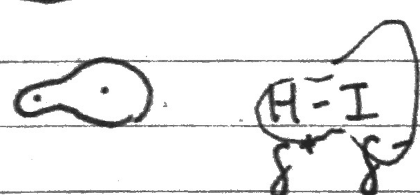
become near ea. other => more stable
so perfectly attracted => repulsed

Electronegativity trend

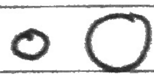


Ionic vs Covalent

covalent nonpolar (noside unequal)
H - H



covalent polar



Polar ionic (no share)
electroneg values so diff
transferring e-

Electron Configuration & Bonding
Where did all that salt come from?
LM 18
★ Study ionic & covalent bonding & Nomenclature
Quiz thurs.

Electron config. & bonding
- Valence shell config. to bonding
- ionic vs. covalent bonding
- Recognize & name compounds

Clicker — The trend on the periodic table is that atomic radii increase from T to B & decrease from L to R. L to R, Z_{eff} increases

"stable" gas - low energy. ex. noble gas
- unreactive
Na - not so stable. [Ne]$3s^1$ ← extra e^-, must go in new shell
K - " " [Ar]$4s^1$ ← extra e^- 4s Z=19 (all)
(really reactive) Z_{eff}=1 (last shell)

Left to Right, Z_{eff} is increasing
Top to bottom Z_{eff} is similar - shielding
T to B - e^- higher in energy - farther from nucleus
- n is increasing
L to R e^- lower in E. Z_{eff} increasing
The farther away from the nucleus the e^- is, the higher the energy

Filled "subshell" - extra stable
½ filled "subshell" - extra stable

Ca: [Ar] $4s^2$ Ca^{2+}: [Ar] ← "iso-electronic" w/ Ar
(↑ lose e^-)

Cl: [Ne] $3s^2 3p^5$ Cl^-: [Ar] ← "iso-electronic" (gains e^-)

Where do the e^- go?
- Metals tend to give up e^- to nonmetals, in each case the valence is "satisfied"

$2Na(s) + Cl_2(g) \rightarrow 2NaCl(s)$ Na^+Cl^- (e^-) very strong.

ionic bond

$Li^+(g) + F(g) + e^-$

Formation of Ionic Compound - Downhill in Energy

$Li^+(g) + \frac{1}{2}F_2(g) + e^-$

ε ↑ $Li(g) + \frac{1}{2}F_2(g)$ ↑ add ε to get to gas state

$Li(s) + \frac{1}{2}F_2(g)$

$Li^+(g) + F^-(g)$ (2 ions in gas phase) ↓ lattice energy

so $Li^+(g) + F^-(g) \rightarrow LiF(s)$ (lower ε)

lattice ε OR crystal lattice ε.

From start to finish, energy is released (exothermic)

Ionic compounds - whole collection (Lattice energy), not discrete pairs of ions

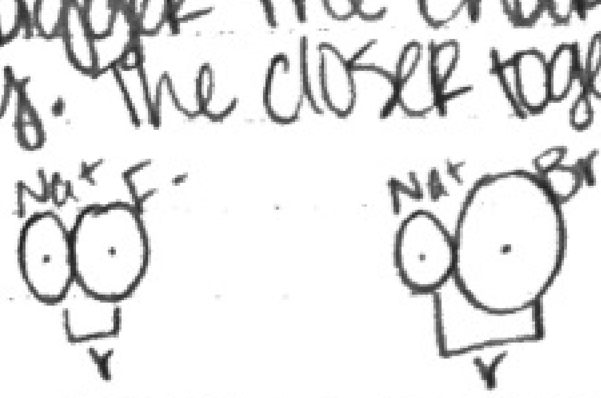
Coulomb's Law

$$\varepsilon = \frac{q_+ q_-}{4\pi\varepsilon_0 r}$$

(charges; $4\pi\varepsilon_0$ constants; r ← separation)

clicker Assuming the same crystal structure, NaF has a larger lattice energy than NaBr

The bigger the charge, the bigger the lattice energy. The closer together they can get, larger lattice



they can't get as close together

Polyatomic ions
Calcium carbonate
Ca^{2+}
CO_3^{2-} $E \propto \frac{q^+ q^-}{r}$

not ionic-covalent
electronegativity (sp.)

look at data & tables under more on the eBook

Be able to name polyatomic ions Thursday

Unit 2 Day 4 – Electron configuration +

Wed, Oct. 2 at 7pm – Energy: the Next 50 years SAC 7.412

· Nomenclature "Quiz Thurs!"

Polyatomic Ions
Covalent Nomenclature

– Electron Configuration & Bonding

· relate the valence shell e^- configuration to bonding
· understand sim + diff. b/w ionic + covalent bonding (bringing atoms together)
· recognize + name compounds based on elemental composition

Quiz? – · The trend on the periodic table is that atomic radii:

✓ C) Increase as you move from T to B down
& Increase right to left

↓ ~~Increase b/c adding extra e^- shell (go to higher n #s)~~
& ones inside shielding other ones

→ decrease — adding protons so ↑ing nuclear ~~charge~~ so pulling e^-'s closer + no increase in shells

→ Z_{eff} increases
↑ ~~the feel of nucleus of sense (e^- get closer)~~

Quiz? – Which of the following symbols does not match the elemental name?

✓ C. Co – Copper
↑ it is cobalt Copper = Cu

Quiz – demo: The 2 metals were tossed in water + metals spun around surface of water + then burst into flames
✓

b/c alkali metals react w/ H_2O violently as seen thru class demo

– think of what is "stable" or "low energy"

– What are the e^-'s in Ne?

$1s^2 2s^2 2p^6$ very stable gas
Z=10 ↑ unreactive

- What are the electrons in Na?

[Ne] $3s^1$ not so stable metal

Z = 11 ↑ extra "e^-" - not really extra, but it is what makes it diff. from Neon

Must go in a new shell

11 protons surrounded w/ core of 10 e^-'s leaves,

$Z_{eff} \sim 1$ ←

- e^-'s in K?

[Ar] $4s^1$ more, not so stable metal

Z = 19 ← core Ar "extra e^-'s" 4s farther out (it's at higher & higher energy)

$Z_{eff} \sim 1$

- Shielding & Effective Nuclear Charge

(the pull on e-s is stronger) · Left to Right Z_{eff} is increasing ← Add protons, Add e^- (but same shell)

(unchanged to noble gas (most unreactive & stable)) · Top to Bottom Z_{eff} is similar b/c shielding

· Top to Bottom. Electron in higher in Energy. farther from nucleus.

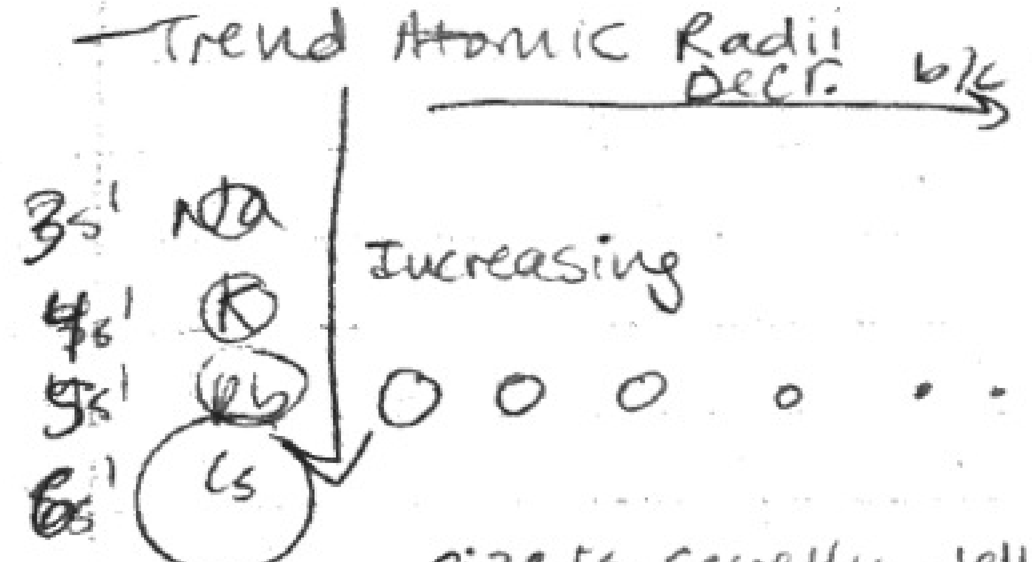
This can explain a lot about the periodic table.

T→B: n is increasing

L to R: e^- lower in E, Z_{eff} big

- Trend Atomic Radii

Decr. b/c Z_{eff} is increasing →



size is secretly telling us energy

higher energy e^- is then the further away from nucleus

- Ionization Energy

↓

take atom $X_{(g)}$ how much E takes to go from $X_{(g)} \to X^+_{(g)} + e^-$

because I'm removing an e^-

distance e^- to nucleus = ∞

how much energy to pull away e^- = ionization energy

1st [illegible]

He [illegible] [illegible] [illegible]

Na [illegible] off an e^-

a [illegible] stability [illegible] "[illegible]" [illegible]
"[illegible]" extra stable

— [illegible] $[Ne]3s^2 3p^4$
[illegible] take off, [illegible]

$Mg \rightarrow Mg^{+} + e^-$ 1st I.E.

$Mg^{+} \rightarrow Mg^{2+} + e^-$ 2nd
↑ stable noble gas configuration [illegible] Neon

$Mg^{2+} \rightarrow Mg^{3+} + e^-$
↖ Jump in energy [illegible]

so needed to take ~~off~~ 6 e^-'s for Sulfur to be [illegible]
huge increase in I.E. b/c achieved stable state

— Ca $[Ar]4s^2$ Ca^{2+} ← lose e^-'s $[Ar]$
"iso-electronic" ← many elements want to achieve
↑ same e^- configuration | this configuration b/c noble gas are most stable

Cl $[Ne]3s^2 3p^5$ Cl^- ← gain $[Ar]$

— Halogen group on periodic table – gain $1e^-$ (F, Cl, Br, I)

lose $1e^-$	← lose $2e^-$		← gain $2e^-$	gain $1e^-$
H	Be	complicated	O	F
Li	Mg	middle	S	Cl
Na	Ca		Se	Br
K	Sr		Te	I
Rb	Ba		Po	At
Cs	Ra			
Fr				

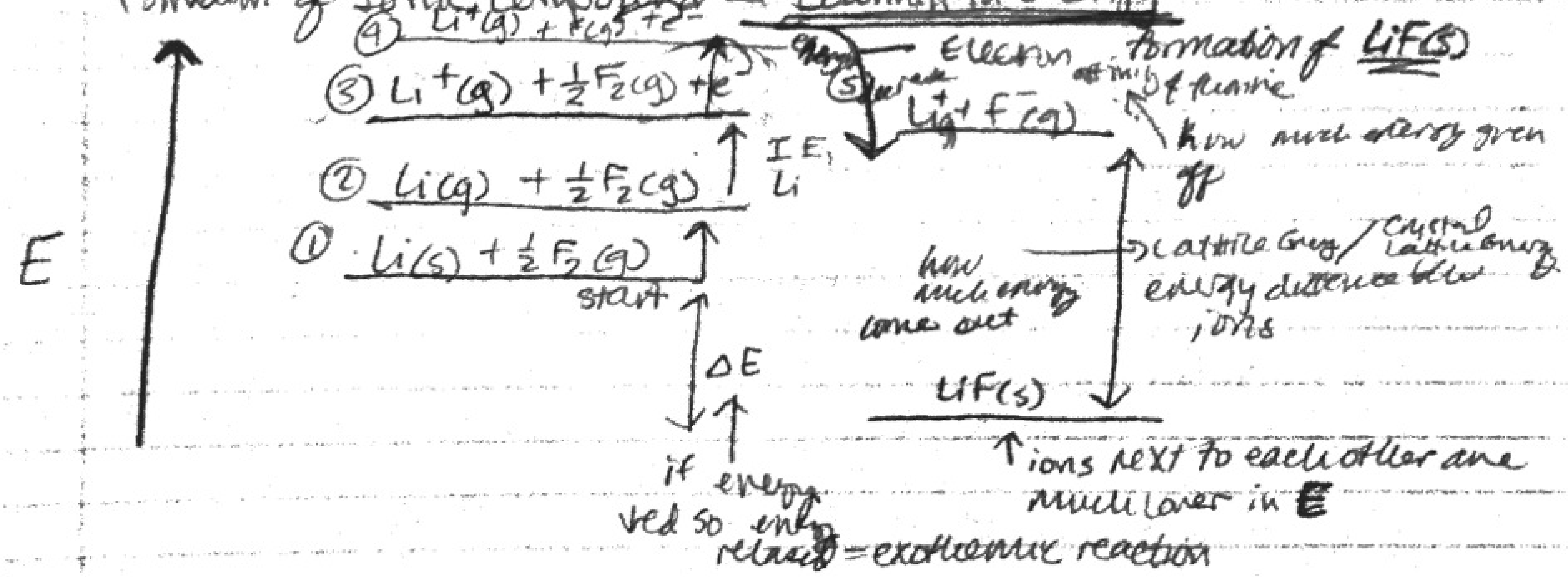
All — where did guy get all of that salt (NaCl)?
class Q4
A) It formed from (Na^+) & (Cl^-) ions in the water
these stable configurations have satisfied "valence"
↑ Noble gas configuration ↑ e⁻ outside core

- Electron leaves... Where did it go?
  - Metals tend to give up e⁻'s to nonmetals, in each case the valence is "satisfied"
  - sometimes is complicated... eg in sodium in water demo $Na \rightarrow Na^+$
  - Sometimes is more obvious... $2H^+ \longrightarrow H_2$

$2Na(s) + Cl_2(g) \rightarrow 2NaCl(s)$ Na^+Cl^- very strong bond

✱ context + env't it is in = very important in understanding bonding ✱

- Formation of Ionic Compounds — Downhill in Energy



Lattice = compare ions far apart + come together

- Ionic Compounds... Lattice Energy
  Not a discrete pair of ions... it is a (whole collection)