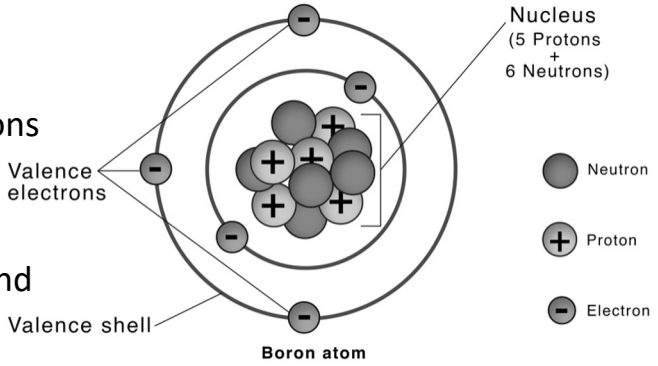
Subatomic Particles

Inner and Valence Electrons (e^-)

Electrons contain different roles within the atom

Inner (*Shell*) Electrons
Provide repulsive force (- to -)
helping protect valence electrons

Valence (*Outer*) Electrons
Electrons that communicate
(*transferred or shared*) and bond
(*connect*) with other atoms



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Subatomic Particles

Counting Valence Electrons (e^-) [*Representative Groups*]

Valence Electrons are based on group on the table

Group	Name	Val e^-	Group		Val e^-
1A (1)	Alkali Metals	1	5A (15)	Pnictogens	5
2A (2)	Alkali Earth Metals	2	6A (16)	Chalcogens	6
3A (13)	Earth Metals	3	7A (17)	Halogens	7
4A (14)	Carbon Group	4	8A (18)	Noble Gases	8

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Subatomic Particles

Octet Rule

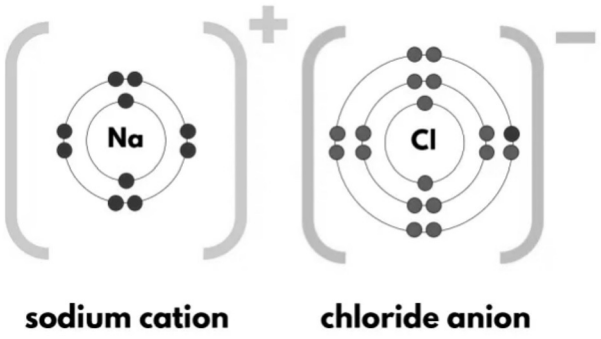
Atoms are the most stable when they have 0 or 8 valence electrons.

Ion – Atom that has lost or gained e^- to fulfil the octet rule

Sodium (Na) loses $1e^-$ to form a **cation**

1 val e^- → 0 val e^-

Cation = + Ion



sodium cation chloride anion

Chlorine (Ca) gains $1e^-$ to form an **anion**

7 val e^- → 8 val e^-

Anion = - Ion

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Valence Electron and Ion Structure

The following chart displays the basic atomic structure including the valence electrons and charges for atoms and ions of representative (1A – 8A) elements

Group Number	1A 1	2A 2	1B – 10B 3 - 12	3A 13	4A 14	5A 15	6A 16	7A 17	8A 18
Valance Electrons (e^-)	1	2	2	3	4	5	6	7	8
Atom Type	Alkali Metals	Alkali Earth Metals	Trans. Metals	Earth Metals	Carbon Group	Picogens	Chalcogen	Halogens	Noble Gases
Ion Charge	+1	+2	Var.	+3	+4	-3	-2	-1	0
Lose e^- Gain e^-	Lose 1	Lose 2	Var.	Lose 3	Lose 4	Gain 3	Gain 2	Gain 1	Gain 0
Ion Valence Electrons (e^-)	0	0	0	0	0	8	8	8	8

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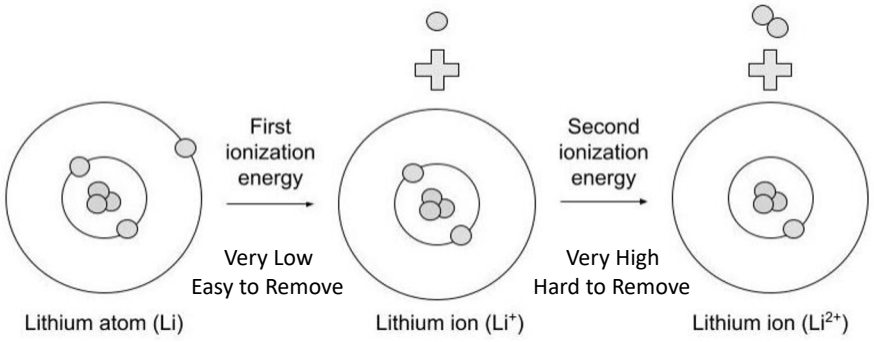
Formation of Ions

Ionization Energy

Energy required to remove an electron from atom to form an ion



Neutral Atom Li^{1+} (0 val e^-) Li^{2+} (-1 val e^-)

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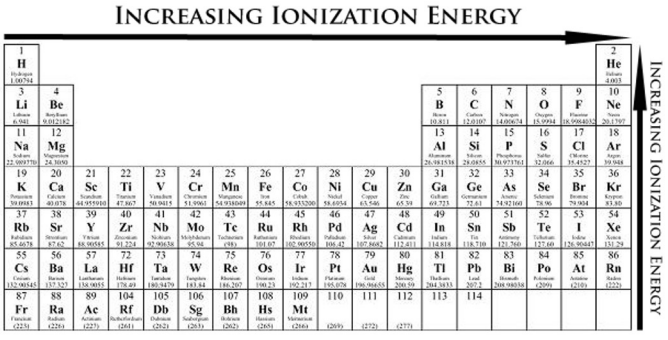
Formation of Ions

Ionization Energy Trends



Not every element always falls the IE trend, for example noble gases (8A/18) don't form ions (*full octet*)

Ionization Energy

Group Trend (*left to right*)
Increases Across Table

More val e^- make it harder to remove val e^- from atom

Period Trend (*up and down*)
Decreases Down Table

Electrons in higher Energy Levels are pushed away from nucleus by inner e^-

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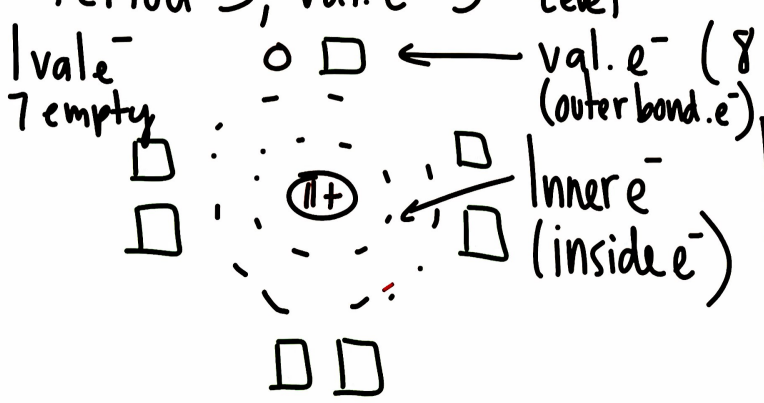
Sodium

○ : val e⁻
□ : empty space

IA (1), 1 val e⁻
Period 3, val. e⁻ 3rd Level



← val. e⁻ (8 spaces for e⁻)
(outer bond. e⁻)

Inner e⁻
(inside e⁻)

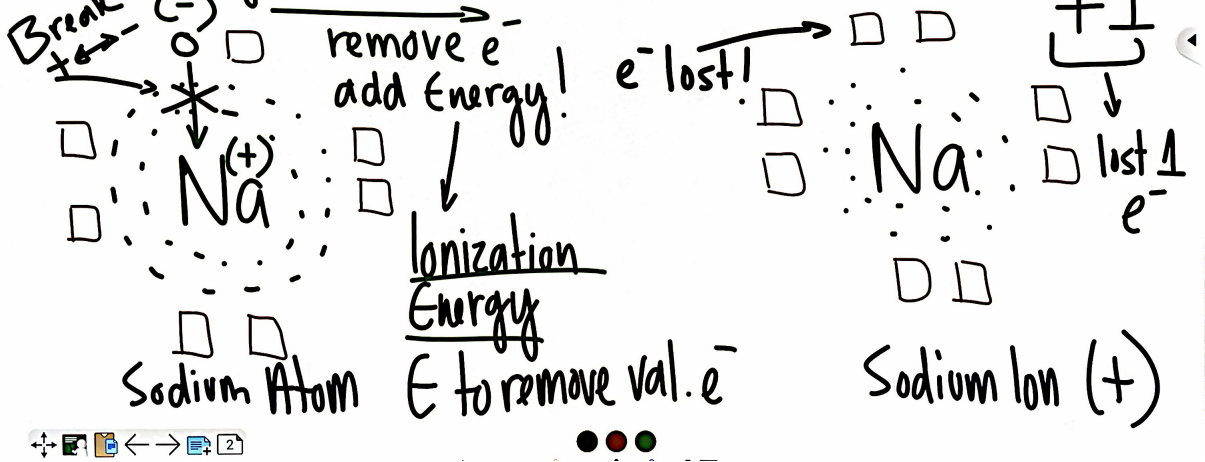
Octet Rule

Atom wants to fill all val. e⁻ spots (all 8 full or empty)

Ionization

"forming ions"

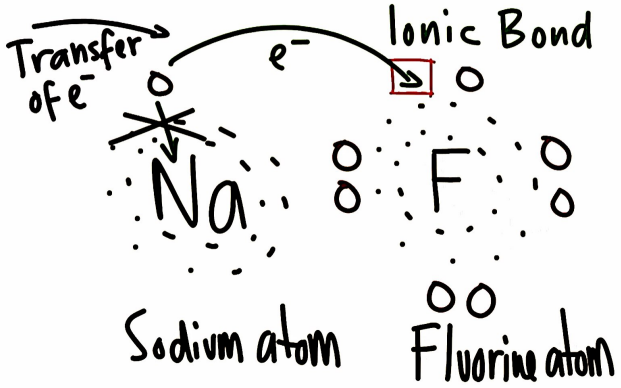
Removing val. e⁻ from outer level of atom

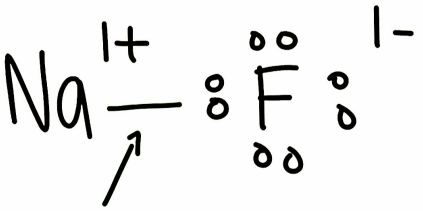


Ionization Energy
E to remove val. e⁻

Ionic Bond (Collision = Transfer of e^- / IE)

Connection between two atoms due to loss / gain e^- (transfer e^-)

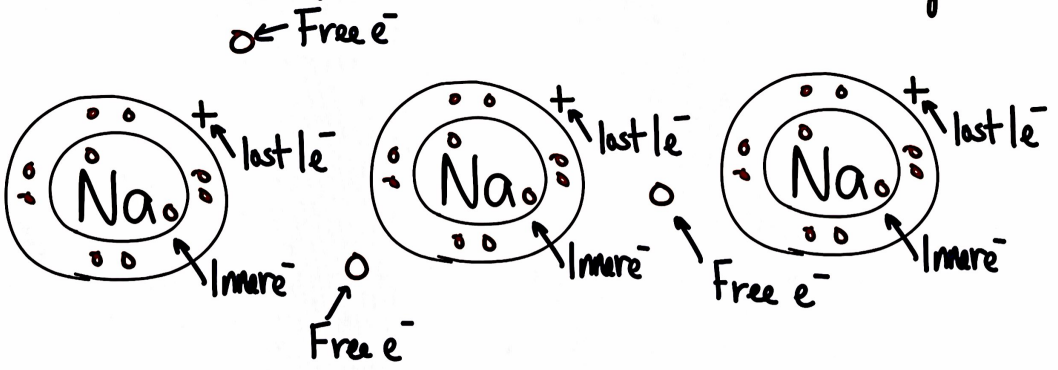




Ionic Bond
Sodium Fluoride

	Neutral Atoms	Ions
Metals	(1 val e^-) Na	+1 charge (0 val. e^-) $[Na]^{1+}$ Cation
Non-Metal	(7 val. e^-) $:\ddot{F}:$	-1 charge (8 val. e^-) $[:\ddot{F}:]^{1-}$ Anion

Metallic Bonding (Metal-Metal) Bonding

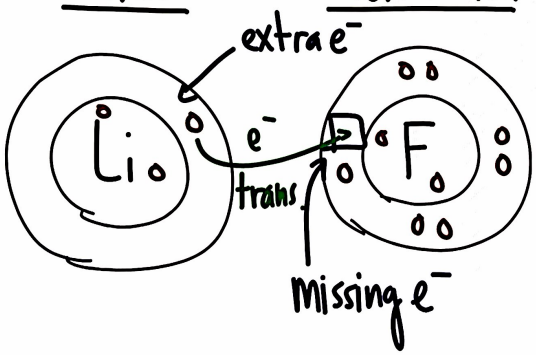


Metal atoms form + ions. Free e⁻ flow around + metal ions

Free e⁻ bond metals together

Ionic Bonding (Transfer of e⁻)

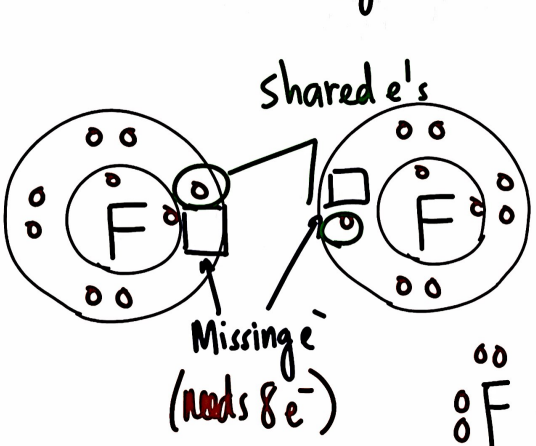
Metal **Non-Metal**

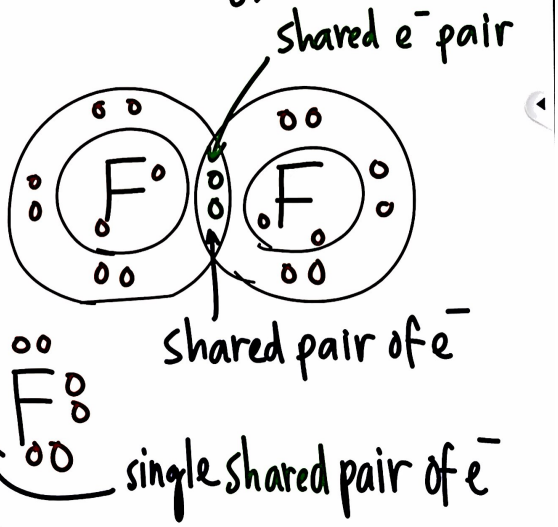


Ionic Compound

+1 cation −1 anion

Non-Metal Bonding (Covalent Bonding)



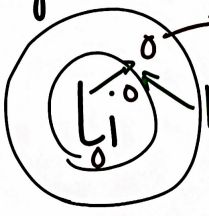


Energy in ion formation (review)

Ionization Energy

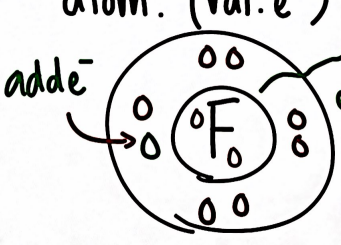
Energy Required to remove an e⁻ from the highest level (Val. e⁻)

Cation (lose 1 e⁻)



Electron Affinity

Energy released when an e⁻ is added to outer level of atom. (Val. e⁻)



Anion (gain 1 e⁻)

Bonding Recap

Metallic Bond

Bond due to e^- cloud (−) forming due to loss of e^- between metals

Ionic Bond

Bond due to transfer of e^- between metal (lose e^-) and non-metal [strongest] (gain e^-)

Covalent Bond

Bond due to sharing e^- between two non-metals to fulfill the octet rule (8 val. e^-) [weakest]