Valence Electrons and Ionic Compounds

Essential Question

Why do elements form the ions they do?

Valence Electrons

- Electrons in the outermost shell
- They take part in bonding
- Main groups: use the group number

Group 1	Group 2	Group 13	Group 14	Group 15	Group 16	Group 17	Group 18
1	2	3	4	5	6	7	8

Valence electrons (He is the exception, with 2)

Gaining and Losing Electrons

- Metals lose electrons → cations (+)
- Nonmetals gain electrons → anions (−)
- Both end with a noble gas configuration

Na
[Ne] $3s^1$

lose 1 e^- →

Na^+
[Ne]

Cl
[Ne] $3s^2\ 3p^5$

gain 1 e^- →

Cl^-
[Ne] $3s^2\ 3p^6$ = [Ar]

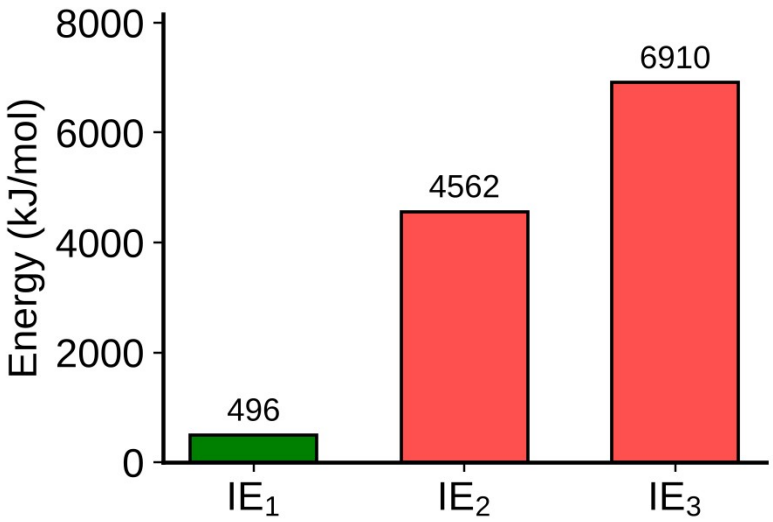
Predicting Ion Charges

- Charge comes from position on the periodic table
- Lose or gain the fewest electrons to look like a noble gas

Group 1	Group 2	Group 13	Group 15	Group 16	Group 17
+1	+2	+3	−3	−2	−1
Li^{+}	Mg^{2+}	Al^{3+}	N^{3-}	O^{2-}	F^{-}

Why Sodium Stays +1

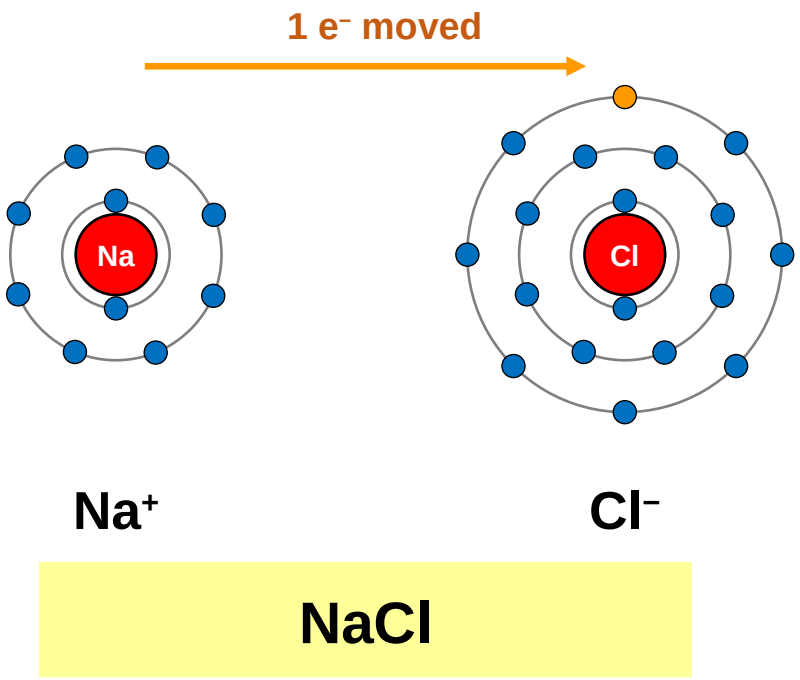
- Removing the one 3s electron is easy
- The next electron is a core electron
- Removing it takes far too much energy



Ionization energies of sodium

Forming an Ionic Compound

- Metal + nonmetal: electrons transfer
- Opposite charges attract (Coulomb's law)
- The result is an ionic compound



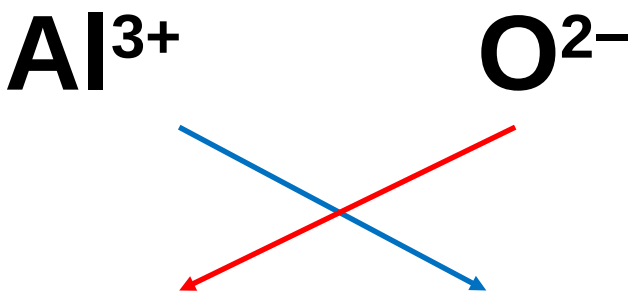
Same Group, Same Pattern

- Elements in the same group form similar compounds

Group 1 + Cl	Group 2 + O	Group 1 + O
LiCl	MgO	Li_2O
NaCl	CaO	Na_2O
KCl	SrO	K_2O

Writing Ionic Formulas

- Total charge must equal zero
- Use the lowest whole-number ratio

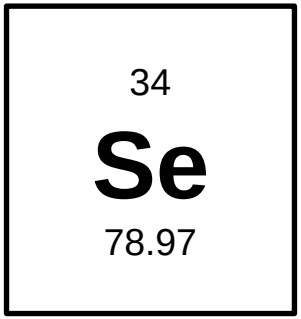


Al_2O_3

Check: 2(+3) + 3(−2) = 0

Example: Predicting an Ion

Predict the charge on the most common ion of selenium, Se. Write the ion's electron configuration.



Example: Writing a Formula

Write the formula of the ionic compound formed from calcium and nitrogen.

20	7
Ca	**N**
40.08	14.01

Example: Analogous Compounds

Magnesium and chlorine form $MgCl_2$.

Predict the formula of the compound formed from barium and bromine. Justify your answer.

$MgCl_2$

Ba + Br → ?

Example: Using Ionization Energy Data

Element X forms an ionic compound with oxygen. Use the ionization energies of X to predict the formula of the compound, using X as the symbol.

Element X (kJ/mol)	
IE_1	590
IE_2	1,145
IE_3	4,912

Valence Electrons and Ionic Compounds

Big Ideas

- Valence electrons decide how atoms bond
- Metals lose e^-, nonmetals gain e^-
- Ion charge comes from group position
- Ionic formulas have zero total charge

Al_2O_3

$2(+3) + 3(-2) = 0$