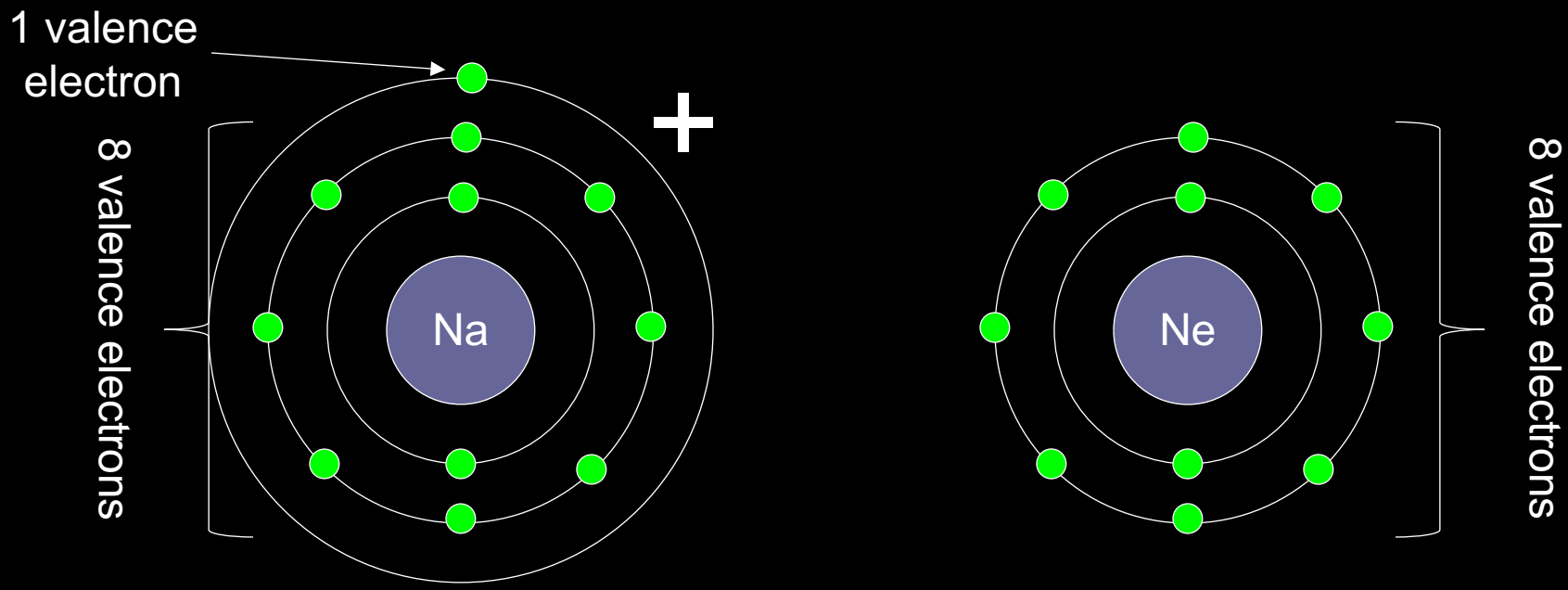
Ions, Ionic Bonds, and Metallic Bonds

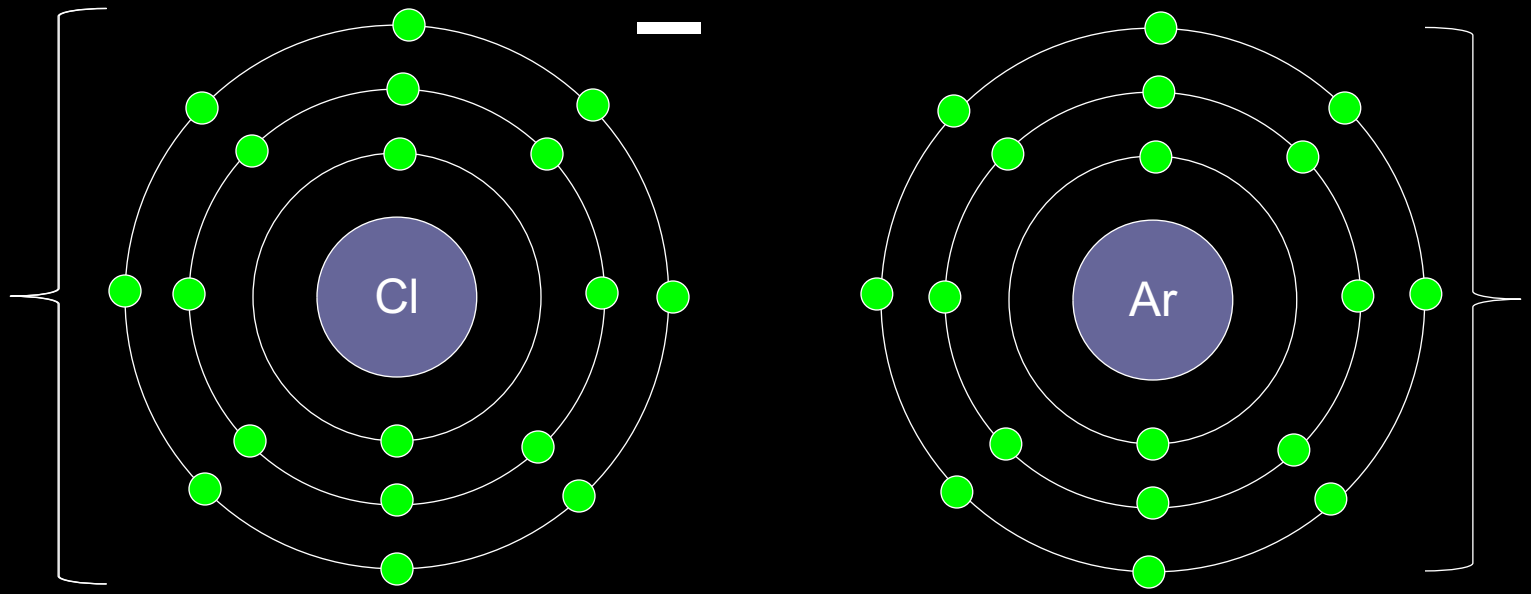
Review

- **Octet Rule**
  - Atoms typically gain or lose valence e^- so they will have the same e^- configuration as a noble gas.
    - Most noble gases have 8 valence electrons.
    - Helium has only 2 valence electrons.

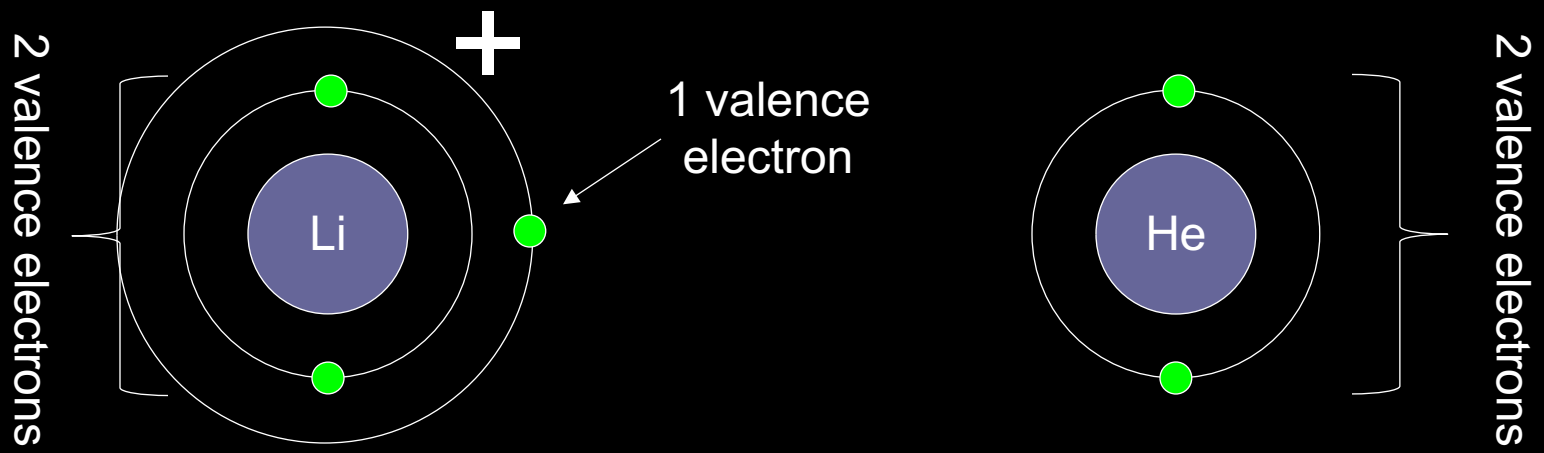
The Octet Rule



The Octet Rule



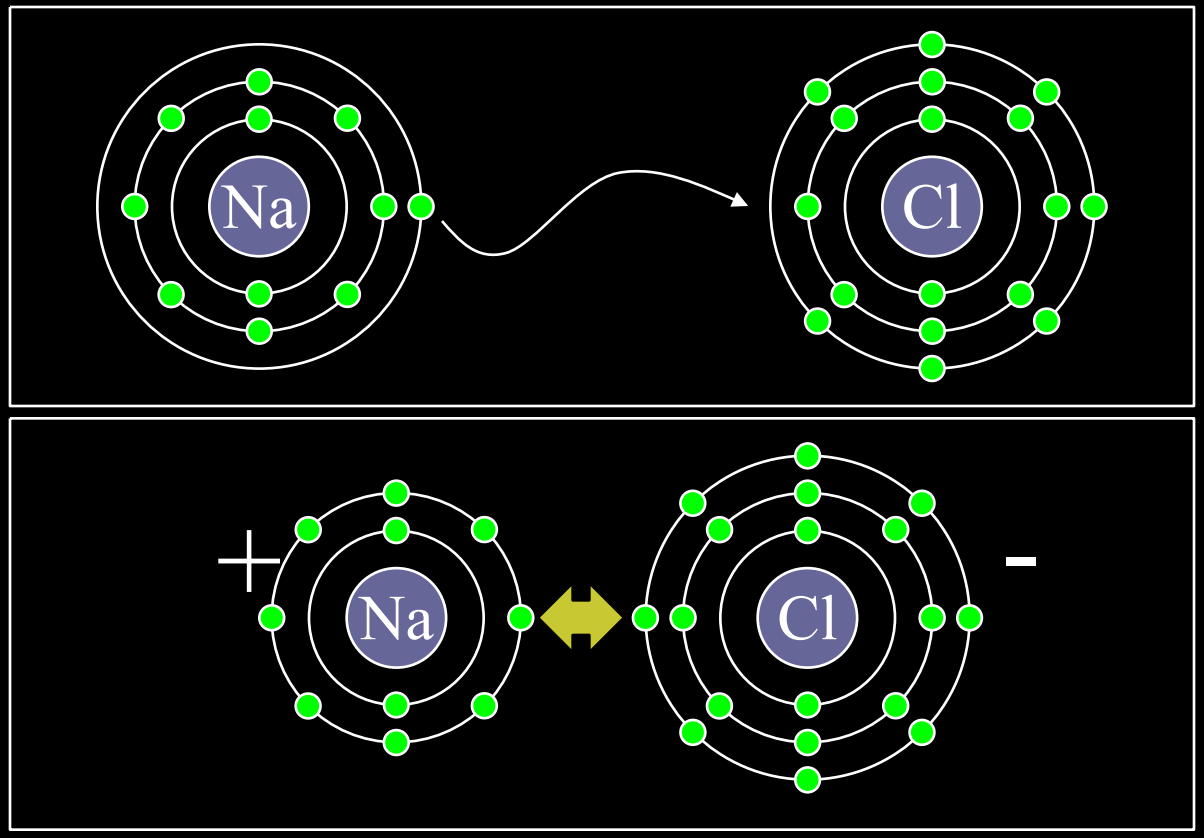
The Octet Rule



Ionic Compounds

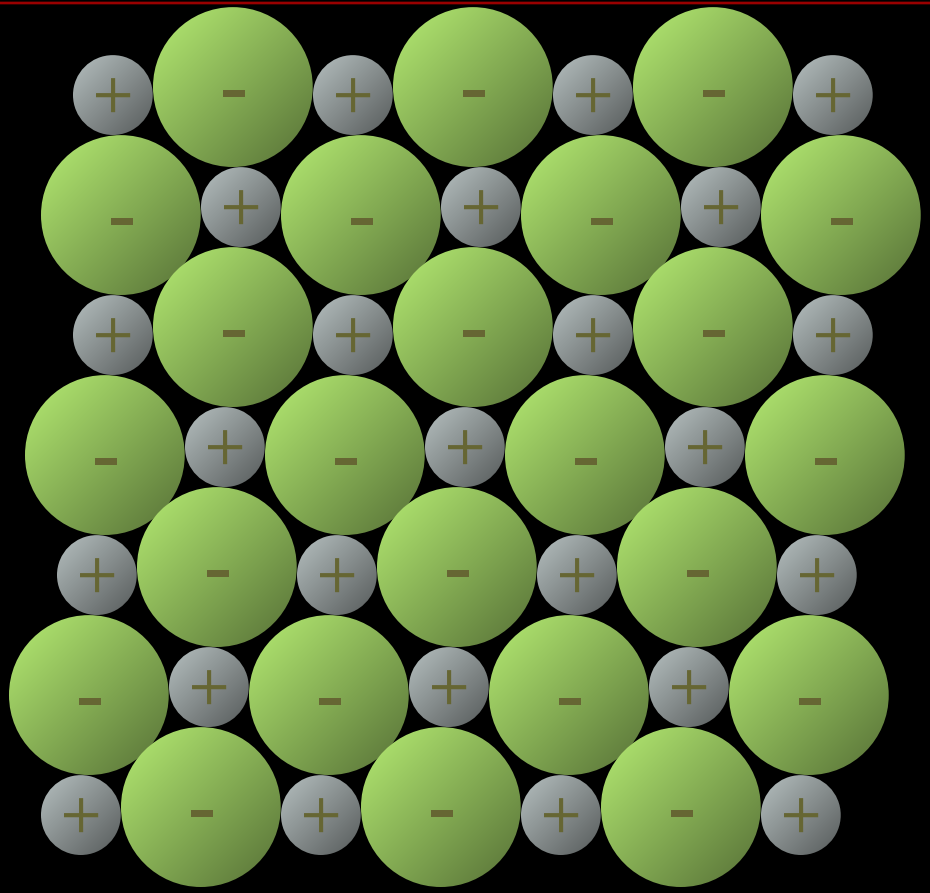
- Ionic compound (salt) – compound made of cations and anions.
  - cations are formed from metals
  - anions are formed from non-metals
- Ionic bond – the force that holds an ionic cmpd together.

Ionic Bonding



Ionic Bonding

IMPORTANT:
Although the ions in a salt are charged, the compound as a whole is not.



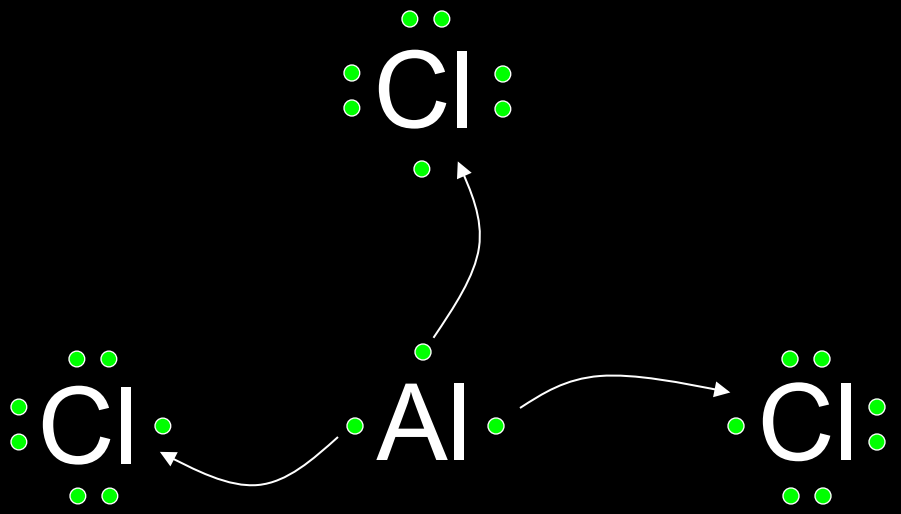
Ionic Formulas

- Chemical formula – indicates the number and type of atoms in a substance.
  - H_2O
    - 2 hydrogen atoms + 1 oxygen atom
  - $NaNO_3$
    - 1 sodium ion + 1 nitrogen atom + 3 oxygen atoms
- Formula unit – lowest whole-number ratio of ions in a compound.
  - The formula unit for table salt is NaCl.
  - 1 unit of Na^+ ions per 1 unit of Cl^- ions.
  - Formula does *not* show the charges of the ions.

Ionic Formulas

- What salt forms when aluminum combines with chlorine?
  - Aluminum has 3 valence electrons.
    - Loses 3 e^- to reach octet.
    - Forms Al^{+3} ion.
  - Chlorine has 7 valence electrions.
    - Gains 1 e^- to reach octet.
    - Forms Cl^{-1} ion.
- If the compound is neutral, it will take 1 Al^{+3} ion for every 3 Cl^{-1} ions.
- The formula is $AlCl_3$.

Aluminum + Chlorine



Writing Ionic Formulas

- Criss-Cross Method of writing ionic formulas:
  - Criss-cross charges to become subscripts
  - Drop the charges when crossing over.
- Example: What salt is formed from sodium and sulfur?
  - Na forms +1 ions.
  - S forms -2 ions.
  - $Na^{+1} + S^{-2} \rightarrow Na_2S$

Writing Ionic Formulas

- sodium + chlorine → $Na^{+1} + Cl^{-1}$ → $NaCl$
- calcium + bromine → $Ca^{+2} + Br^{-1}$ → $CaBr_2$
- lithium + oxygen → $Li^{+1} + O^{-2}$ → Li_2O
- aluminum + oxygen → $Al^{+3} + O^{-2}$ → Al_2O_3
- magnesium + nitrogen → $Mg^{+2} + N^{-3}$ → Mg_3N_2

Writing Ionic Formulas

- If the subscripts can be reduced, do so.
  - Example: calcium + oxygen
    - Ions: Ca^{+2} + O^{-2}
    - Wrong: Ca_2O_2
    - Right: CaO
  - Example: lead + oxygen
    - Ions: Pb^{+4} + O^{-2}
    - Wrong: Pb_2O_4
    - Right: PbO_2

Polyatomic Ions

- Polyatomic Ions – ions made of more than one atom.
  - Examples:
    - NO_3^{-1}
      - 1 nitrogen atom and 3 oxygen atoms that collectively have a -1 charge.
    - SO_4^{-2}
      - 1 sulfur atom and 4 oxygen atoms that collectively have a -2 charge.
    - PO_4^{-3}
      - 1 phosphorus atom and 4 oxygen atoms that collectively have a -3 charge.
    - NH_4^{+1}
      - 1 nitrogen atom and 4 hydrogen atoms that collectively have a +1 charge.

Polyatomic Ions in Salts

- Treat them like single-atom ions.
  - But *do not change their formula!*
- If you need more than one of a particular polyatomic ion, use parentheses.
  - Example:
    - $Na^{+1} + NO_3^{-1} \rightarrow NaNO_3$
    - $Mg^{+2} + NO_3^{-1} \rightarrow Mg(NO_3)_2$
    - $Al^{+3} + NO_3^{-1} \rightarrow Al(NO_3)_3$

Polyatomic Ions in Salts

- $K^{+1} + OH^{-1} \rightarrow KOH$
- $Ca^{+2} + OH^{-1} \rightarrow Ca(OH)_2$
- $Ga^{+3} + OH^{-1} \rightarrow Ga(OH)_3$
- $NH_4^{+1} + Cl^{-1} \rightarrow NH_4Cl$
- $NH_4^{+1} + S^{-2} \rightarrow (NH_4)_2S$
- $NH_4^{+1} + P^{-3} \rightarrow (NH_4)_3P$
- $NH_4^{+1} + SO_4^{-2} \rightarrow (NH_4)_2SO_4$

Metallic Bonding

- Metals have “loose” valence electrons.
  - Can jump freely from atom to atom in a metal.
  - Metals are held together by a mobile “sea of electrons”.
- Explains many properties of metals.
  - Ability to conduct electricity.
  - Ability to bend w/o breaking.