Chemical Bonding

IONIC, METALLIC AND COVALENT BONDS

Learning Target #1

CBLT1: Explain the formation, structure and properties of ionic and metallic compounds.

Be able to define, explain, identify or provide examples of each of the following:

- Valence Electrons
- Core Electrons
- Octet Rule
- Cation
- Anion
- Electron Dot Diagram
- Salts
- Noble Gas Configuration
- Formula Unit
- Crystalline Structure
- Metallic Structure
- Coordination Number
- Electron Sea
- Malleable
- Ductile

Textbook Practice

- Page 193 #s 3 – 11
- Page 199 #s 14 – 17, 20 – 22
- Page 203 #s 23, 25 – 28
- Page 207 #s 30 – 40, 43, 44, 46 – 49
- Page 208 – 209 #s 53, 55, 56, 58, 59, 60, 67, 70, 73, 76, 78, 79, 81

Core and Valence Electrons

- The electrons are responsible for chemical properties of atoms are those in the **outer/highest** energy level (principle quantum number ***n***).
- **Valence e^-**: The ***s*** and ***p*** orbital electrons in the highest energy level.
- **Core e^-**: All the electrons in the energy levels below the highest.

Modeling Valence Electrons: Electron Dot Structures

- Electron dot structures are used to represent the valence electrons in a atom.
  - They are represented as dots on the top, bottom an sides of an element symbol.
- When creating an electron dot structure, place a dot at one of the sides of the element and continue placing dots around the symbol but not pairing them up until you have to (Hund's rule)
  - This is very important because the bonds that form incorporate paired and unpaired electrons in different ways.

Electron Dot Structure/Diagram

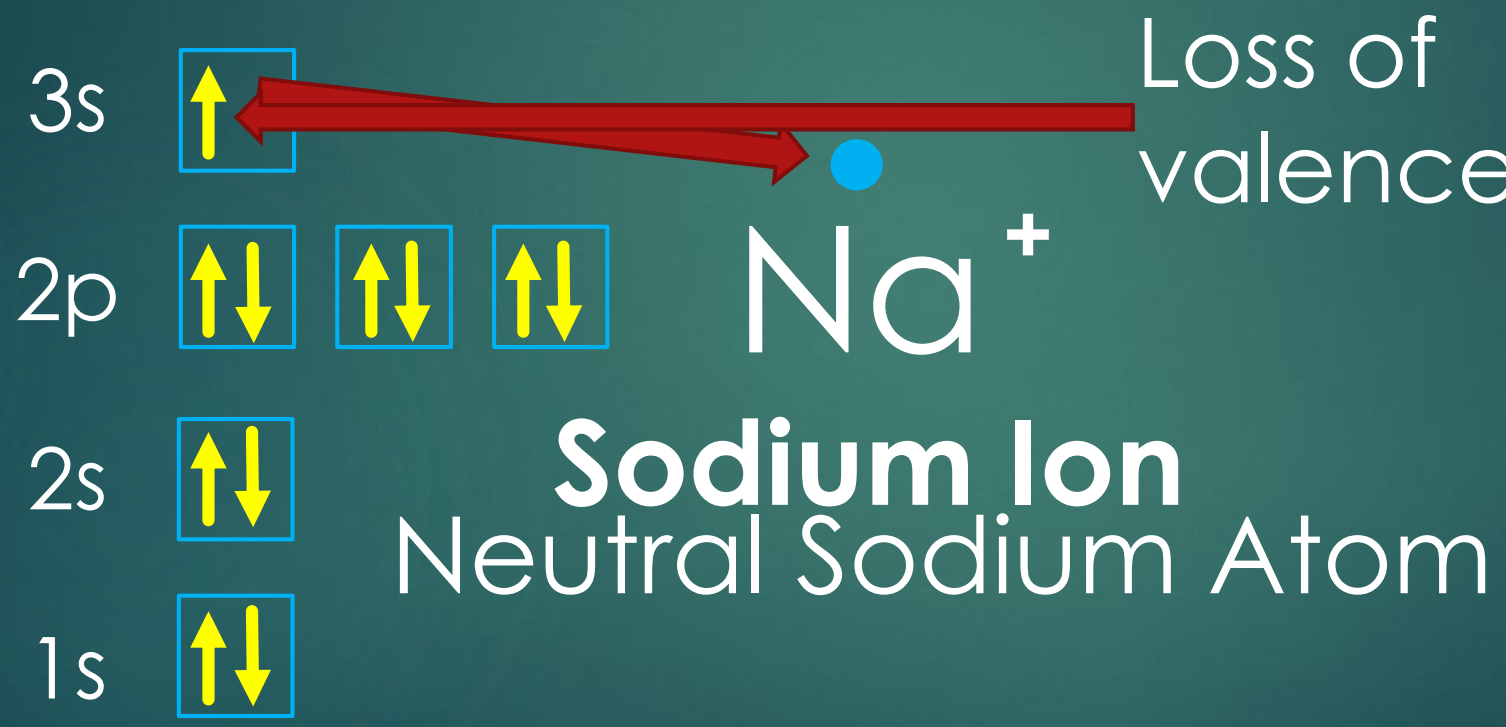
- Place first dot.
- Next dot is placed at an adjacent side.
- Continue the pattern.
- Never more than 8 dots.
- Use Periodic Table for the number of valence e^-.

Octet Rule

- When forming compounds, atoms tend to achieve a noble gas configuration; 8 e- in the outer level is the most stable.
  - There are exceptions, but we will only work with compounds that obey this rule.
- Metals lose valence electrons.
- Nonmetals gain (or share) one or more electrons to fill their highest energy level.

Cations

- The name for atoms (or compounds) that have a positive charge due to the loss of one or more electrons.



Anions

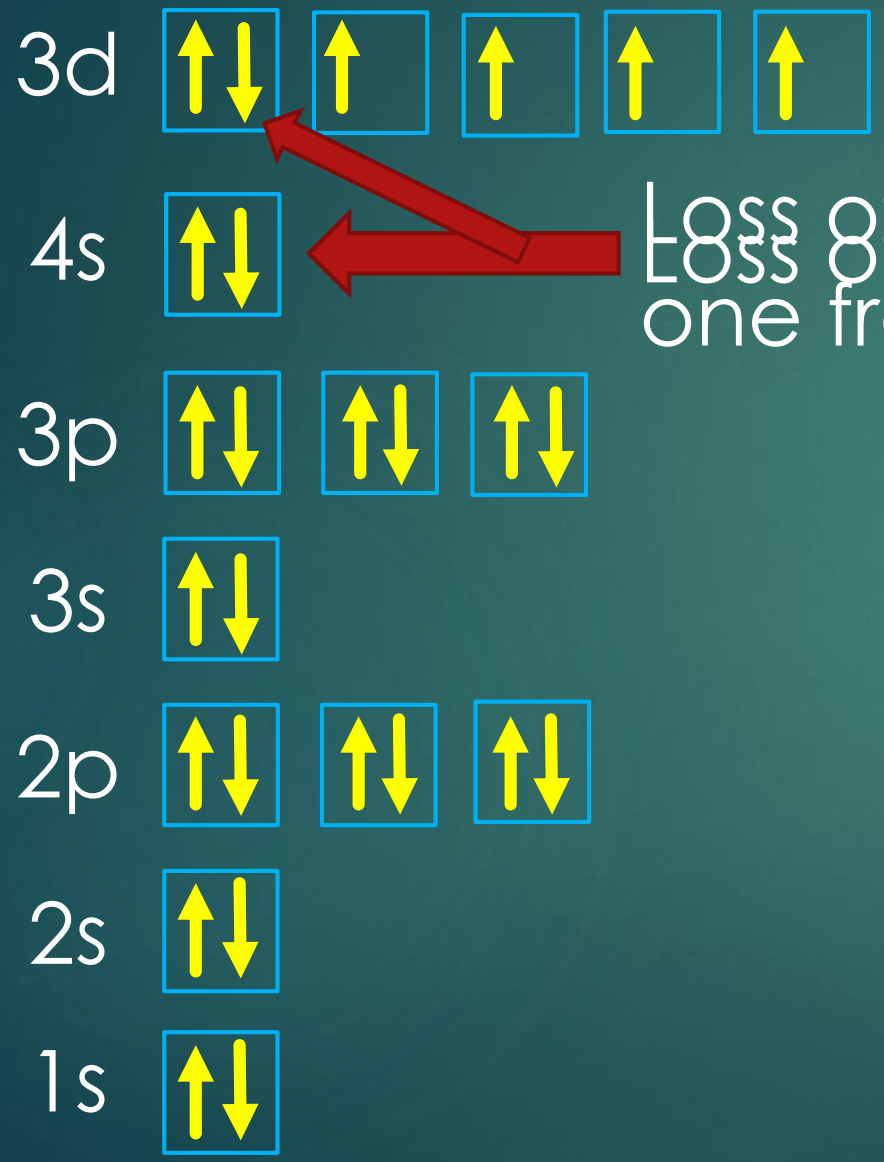
- The name for atoms (or compounds) that have a negative charge due to the gain of one or more electrons.

Gain 2 valence e^-

Sulfide

Neutral Sulfur Atom

Cations With More Than One Ion



Half-filled orbital is a lower energy/more stable configuration

Loss of Valence e⁻ and one from the ***3d*** orbital

Fe^{3+}

Predict Tin's Possible Ionic Charges

Sn^{2+}

Filled orbital is a lower energy/more stable configuration

Ionic Compounds

- Are compounds composed of cations and anions.
  - Also called ***salts***.
- Electrically neutral (charges are present, but they balance out.
- Cations transfer electrons to the anions, the electrostatic force between the ions creates the ***ionic bond***.
- Simplest ratio of ions is called the ***formula unit***.

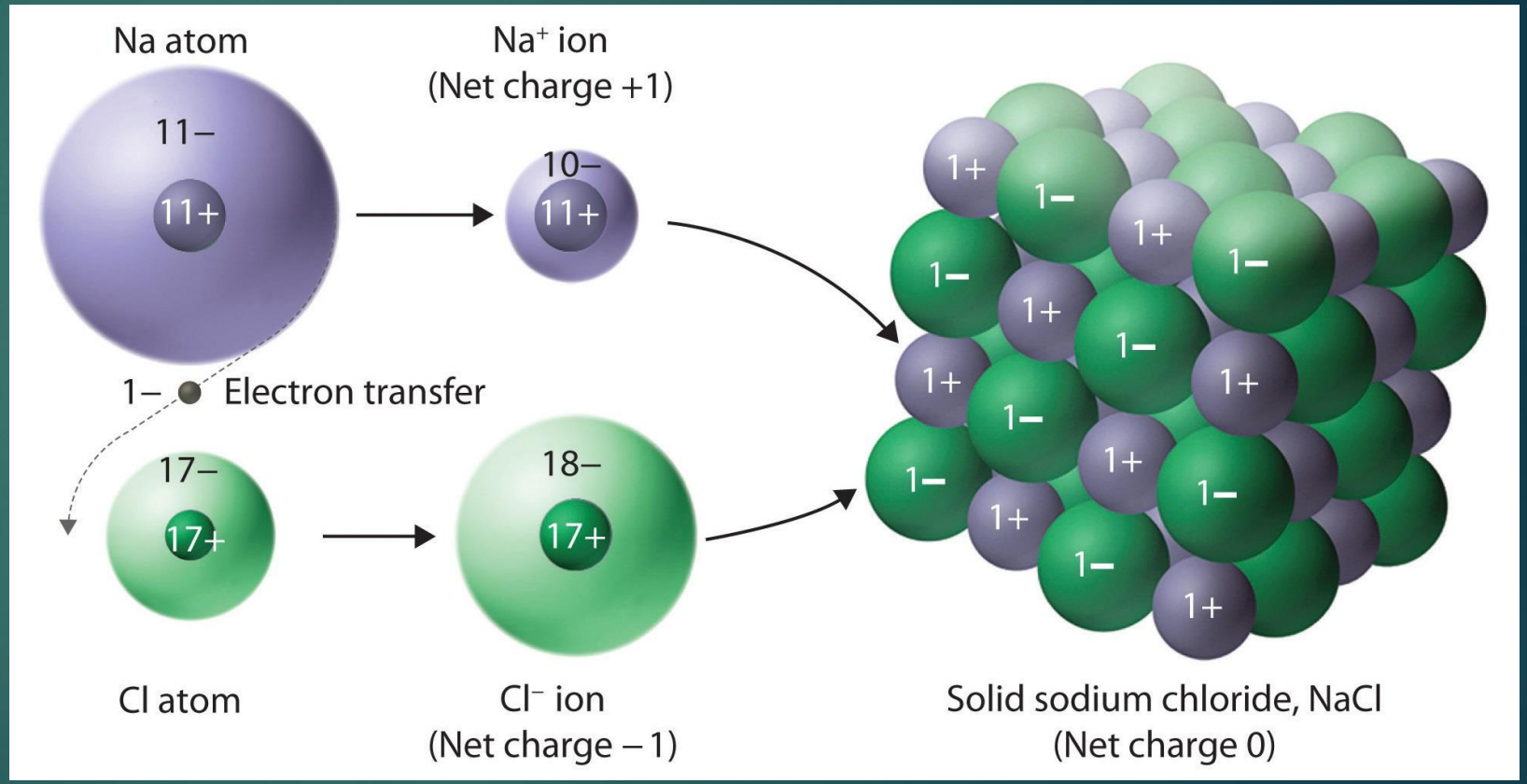
Ionic Compound

- Electrons are transferred to achieve a noble gas configuration ($8e^-$ in the highest energy level).

Noble Gas Configuration

Structure of Ionic Compounds

- Exist as a crystalline solid – a regular repeating arrangement of ions.



Formula Unit vs Chemical Formula

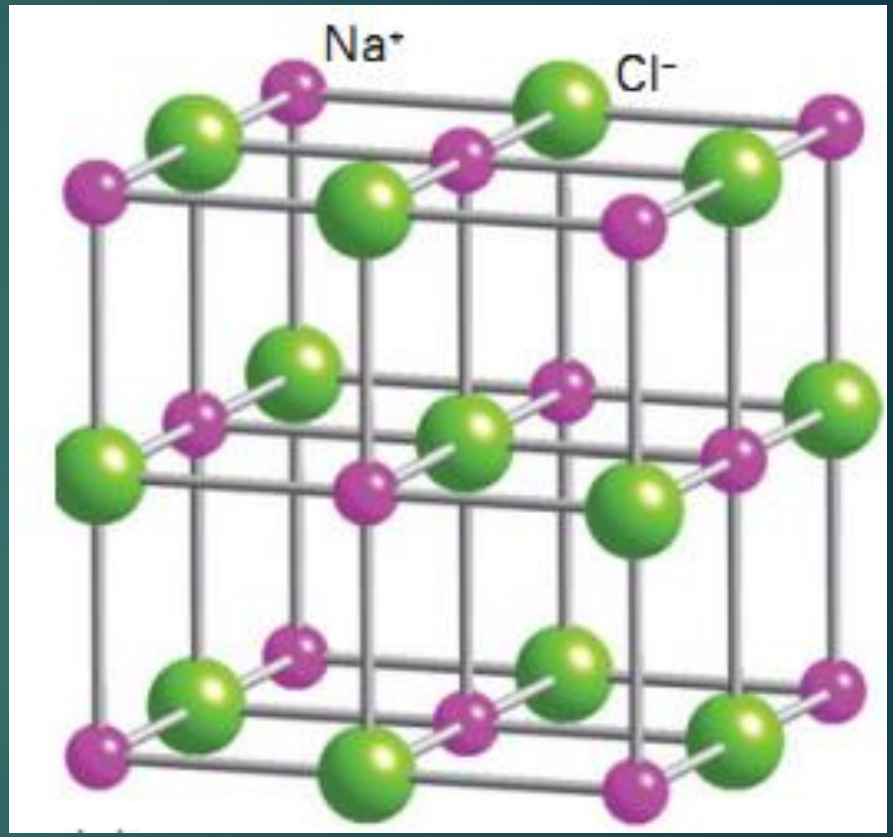
- A ***chemical formula*** communicates the kinds and number of atoms in the smallest part of a substance.
  - Ionic compounds don't have a "smallest part"
- Ionic compounds have a ***formula unit***, the lowest whole-number ratio of ions to have a neutral charge.
- NaCl is a 1:1 ratio
- Fe_2O_3 is a 2:3 iron-to-oxygen ratio

Properties of Ionic Compounds

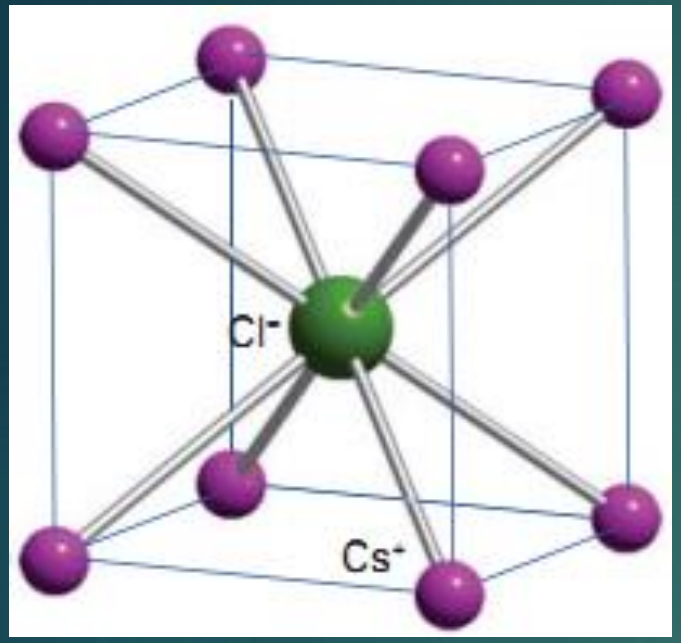
- Crystalline solids at room temperature.
  - The alternating of + and – ions results in a very stable structure.
  - The electrostatic force between the ions is very strong.
  - Very high melting points.
  - Conduct electric current when melted or dissolve.

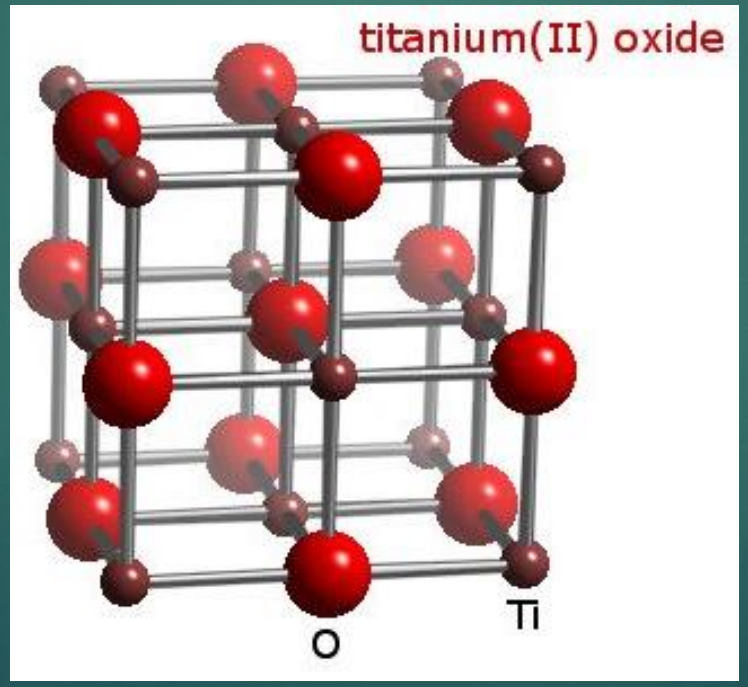
Crystalline Structure

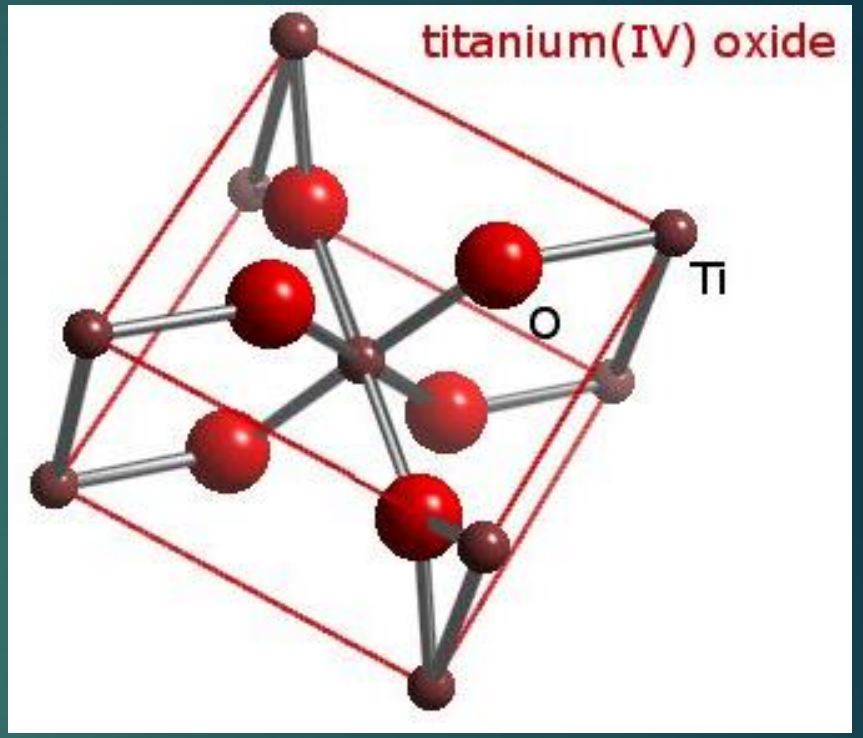
- The arrangement of ions in ionic compounds is an alternating of + and – ions, but the varying sizes of the atoms the number of electrons involved lead to varying internal structures.
- Internal structures are summarized by an ion's ***coordination number***. That is the number of ions of opposite charge that surround it. In sodium chloride, they each have a coordination number of 6.



Other Crystalline Structures

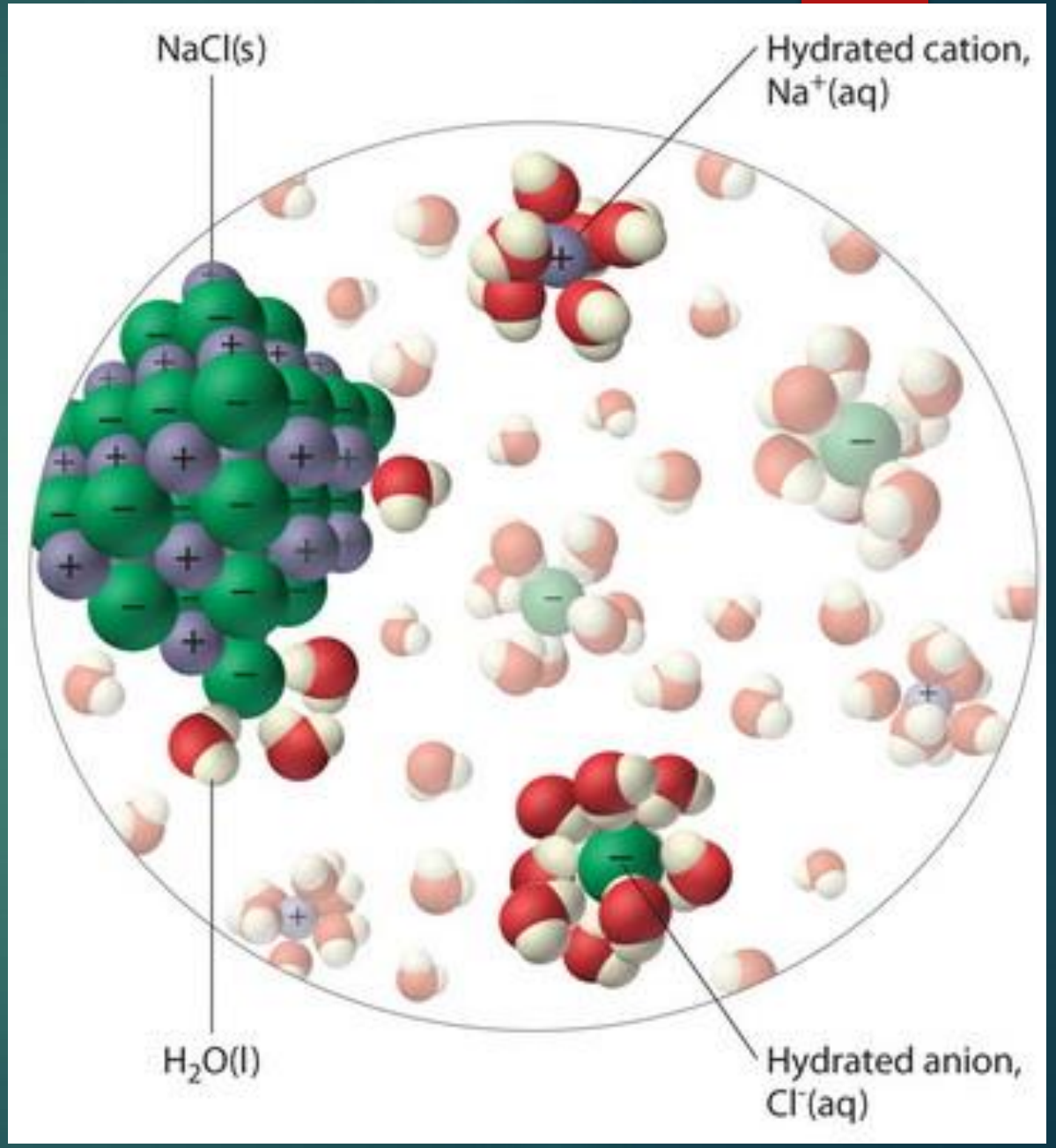






Conductivity When Melted and Dissolved

- Ionic compound separate into their ions when placed in water or melted.
- The ions are then capable of conducting an electric current as they orient within an electric field.



Bonding in Metals

- Valence e- in metals can be modeled as a sea of electrons.
  - They are mobile and change positions as needed.
- Explains the physical properties of metals.
  - High melting points (strong electrostatic bonds).
  - Malleable and ductile.

Sea of Electrons