

## Chapter 7

### Ionic Bonding

### Keeping Track of Electrons

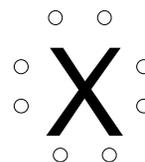
- The electrons responsible for the chemical properties of atoms are those in the outer energy level.
- Valence electrons - The s and p electrons in the outer energy level.
- Core electrons - those in the energy levels below.
- Basis for shorthand

### Keeping Track of Electrons

- Atoms in the same column
- Have the same properties because
- Have the same outer electron configuration.
- Have the same valence electrons.
- Found by looking up the group number on the periodic table.
- Group 2A - Be, Mg, Ca, etc.-
- 2 valence electrons

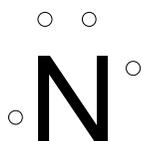
### Electron Dot diagrams

- A way of keeping track of valence electrons.
- How to write them
- Write the symbol.
- Put one dot for each valence electron
- Don't pair up until they have to



### The Electron Dot diagram for Nitrogen

- Nitrogen has 5 valence electrons.
- First we write the symbol.
- Then add 1 electron at a time to each side.
- Until they are forced to pair up.



### Write the electron dot diagram for

Na

F

Mg

Ne

C

He

O

### Electron Configurations for Cations

- Metals lose electrons to attain noble gas configuration.
- They make positive ions.
- Na  $1s^2 2s^2 2p^6 3s^1$  - 1 valence electron
- $Na^+$   $1s^2 2s^2 2p^6$  - noble gas configuration

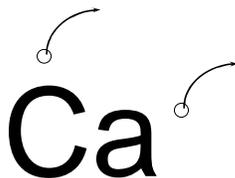
### Electron Dots For Cations

- Metals will have few valence electrons



### Electron Dots For Cations

- Metals will have few valence electrons
- These will come off



### Electron Dots For Cations

- Metals will have few valence electrons
- These will come off
- Forming positive ions

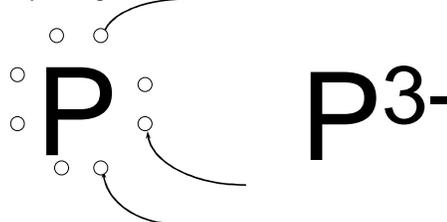


### Electron Configurations for Anions

- Nonmetals gain electrons to attain noble gas configuration.
- They make negative ions.
- S  $1s^2 2s^2 2p^6 3s^2 3p^4$  - 6 valence electrons
- $S^{2-}$   $1s^2 2s^2 2p^6 3s^2 3p^6$  - noble gas configuration.

### Electron Dots For Anions

- Nonmetals will have many valence electrons.
- They will gain electrons to fill outer shell.



### Practice

- Use electron dot diagrams to show how the following form ions
- Al
- Cl
- C

### Stable Electron Configurations

- All atoms react to achieve noble gas configuration.
- Noble gases have 2 s and 6 p electrons.
- 8 valence electrons .
- Also called the octet rule.



### Names of ions

- Cations keep the name of the metal
  - Ca calcium
  - $\text{Ca}^{2+}$  calcium ion
- Anions change ending to –ide
  - Cl Chlorine
  - $\text{Cl}^{-1}$  chloride ion

### Transition metals

- Form cations
- Hard to predict the charge
- Often will form more than 1 charge
- Can't form noble gas configuration
- Still try to fill up orbitals
- Some can make pseudo noble gas configurations with full orbitals

### Examples

- Zinc
- $1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10} 4s^2$
- $\text{Zn}^{2+}$
- $1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10}$
- Full 3<sup>rd</sup> energy level
- Fe  $1s^2 2s^2 2p^6 3s^2 3p^6 3d^6 4s^2$
- $\text{Fe}^{2+}$   $1s^2 2s^2 2p^6 3s^2 3p^6 3d^6 4s^1$
- $\text{Fe}^{3+}$   $1s^2 2s^2 2p^6 3s^2 3p^6 3d^5$

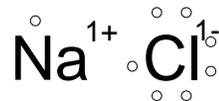
### Polyatomic ions

- Groups of atoms that stick together as a unit, and have a charge
- $\text{PO}_4^{3-}$  phosphate
- $\text{CO}_3^{2-}$  carbonate
- $\text{C}_2\text{H}_3\text{O}_4^{1-}$  acetate
- Names often end in –ate or –ite
- More later

### Ionic Bonding

- Anions and cations are held together by opposite charges.
- This is the bond
- Ionic compounds are called salts.
- Simplest ratio is called the formula unit.
- The bond is formed through the transfer of electrons.
- Electrons are transferred to achieve noble gas configuration.

### Ionic Bonding

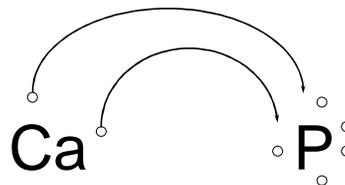


### Ionic Bonding

- All the electrons must be accounted for!



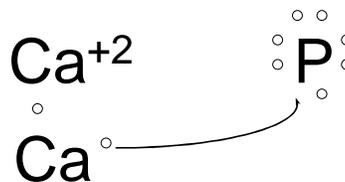
### Ionic Bonding

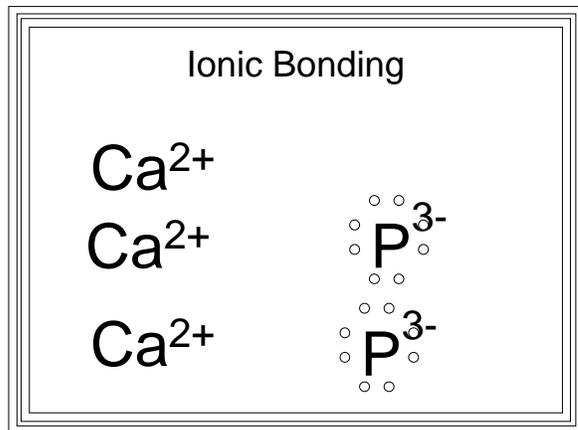
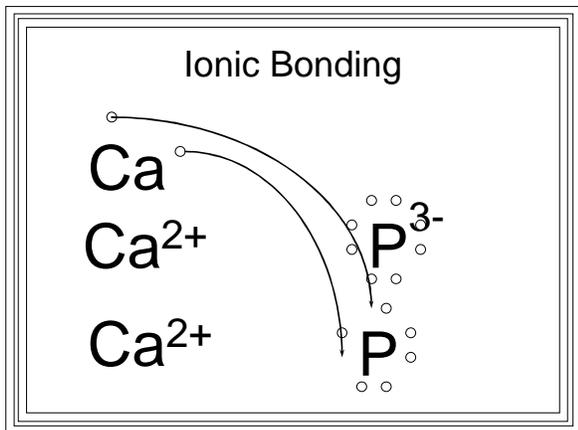
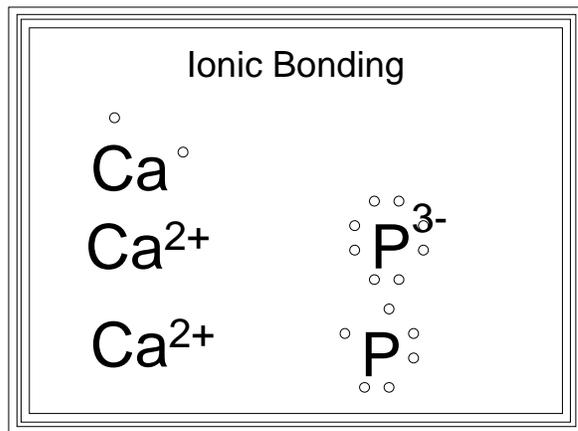
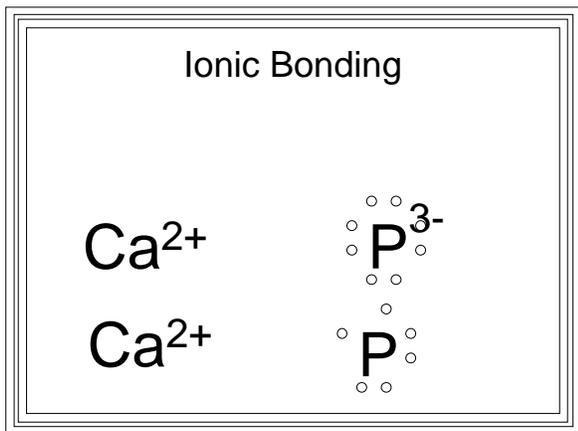
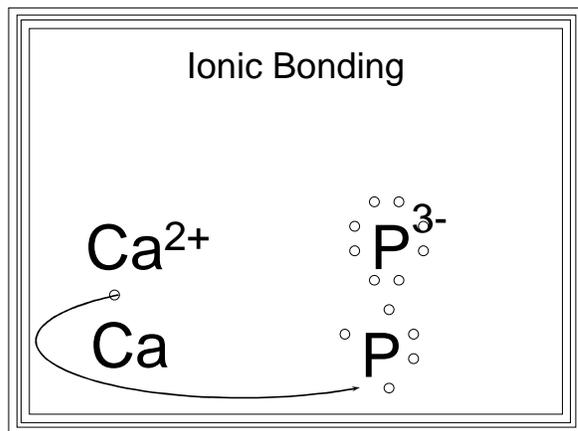
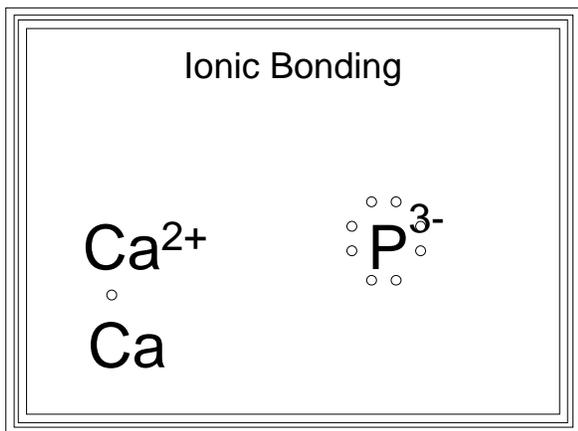


### Ionic Bonding



### Ionic Bonding





## Ionic Bonding



Formula Unit

## Practice

- Use electron dot diagrams to show how the following elements make an ionic compound and write the formula unit
- Mg and Cl

## Practice

- Na and N

## Practice

- Al and O

## Ionic Compounds

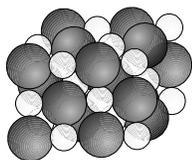
- Made up of
  - a positive and negative ion
  - a cation and an anion
  - a metal and a nonmetal
- Smallest repeating unit- formula unit

## Properties of Ionic Compounds

- Crystalline structure.
- A regular repeating arrangement of ions in the solid.
- Ions are strongly bonded.
- Structure is rigid.
- High melting points- because of strong forces between ions.

## Crystalline structure

3 dimension



## Do they Conduct?

- Conducting electricity is allowing charges to move.
- In a solid, the ions are locked in place.
- Ionic solids are insulators.
- When melted, the ions can move around.
- Melted ionic compounds conduct.
- First get them to 800°C.
- Dissolved in water they conduct.

## Writing formulas

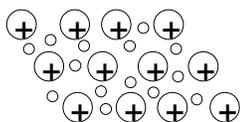
- The charges must add to 0
- Add the correct subscript to make them equal zero
- $\text{Na}^{1+} \text{O}^{2-}$
- $\text{Sr}^{2+} \text{Cl}^{1-}$
- $\text{Fe}^{3+} \text{O}^{2-}$
- Potassium bromide
- Beryllium fluoride

## Metallic Bonds

- How atoms are held together in the solid.
- Metals hold onto their valence electrons very weakly.
- Think of them as positive ions floating in a sea of electrons.

## Sea of Electrons

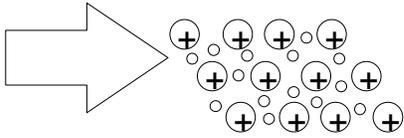
- Electrons are free to move through the solid.
- Metals conduct electricity.



## Metals are Malleable

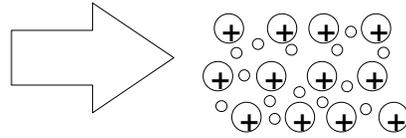
- Hammered into shape (bend).
- Ductile - drawn into wires.

### Malleable

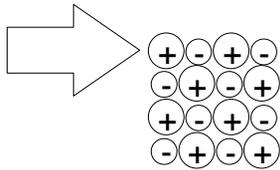


### Malleable

- Electrons allow atoms to slide by.

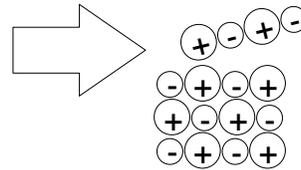


### Ionic solids are brittle



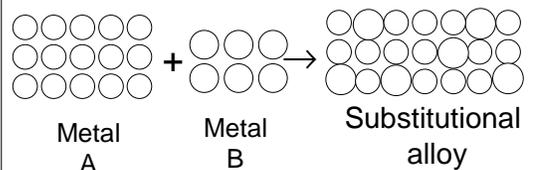
### Ionic solids are brittle

- Strong Repulsion breaks crystal apart.



### Alloys

- Solutions made by dissolving metal into other elements- usually metals.
- Melt them together and cool them.
- If the atoms of the metals are about the same size, they substitute for each other
- Called a substitutional alloy



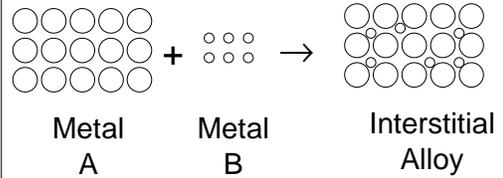
Bronze – Copper and Tin

Brass- 60 % Copper 39% Zinc and 1%Tin

18 carat gold- 75% gold, 25%Ag or Cu

## Alloys

- If they are different sizes the small one will fit into the spaces of the larger one
- Called an interstitial alloy



Steel – 99% iron 1 % C

Cast iron- 96% Iron, 4%C

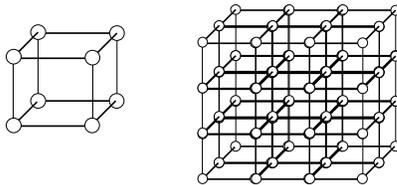
## Alloys

- Making an alloy is still just a mixture
- Blend the properties
- Still held together with metallic bonding
- Most of the metals we use daily are alloys.
- Designed for a purpose

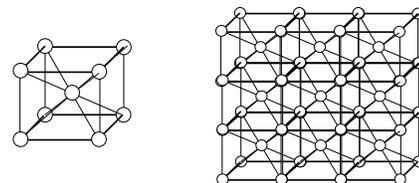
## Crystal Structures

- The repeating unit is called the unit cell

## Cubic



## Body-Centered Cubic



## Face-Centered Cubic

