# Chemical Bonding
# Ionic Bonding

Unit 1 Chapter 2

# Valence Electrons

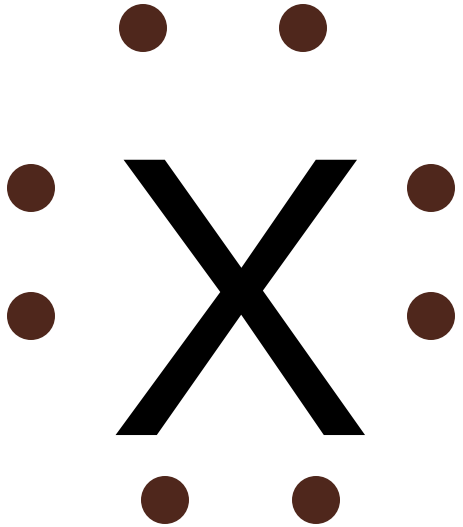
- The electrons responsible for the chemical properties of atoms are those in the outer energy level.
- Valence electrons - The ***s*** and ***p*** electrons in the outer energy level
- the highest occupied energy level
- Core electrons -those in the energy levels below.

# Group and Electrons

- Atoms in the same column...
  - Have the same outer electron configuration.
  - Have the same valence electrons.
- Easily found: group number on the periodic table for representative elem.
- Group 2:  Be, Mg, Ca, etc.
  - 2 valence electrons

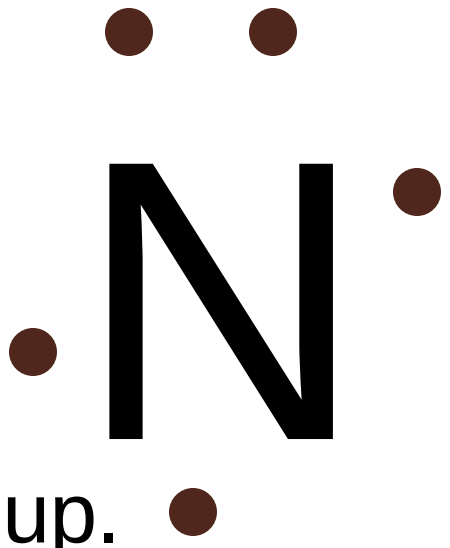
# Electron Dot diagrams

- How to write them?
- Write the symbol.
- Put one dot for each valence electron in the valence shell
- Inner orbital electrons are not shown
- Don’t pair up until they have to (Hund’s rule in orbitals)



# 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 electron dot diagrams:

- Na
- Mg
- C
- O
- F
- Ne
- V

# Electron Configurations for Cations

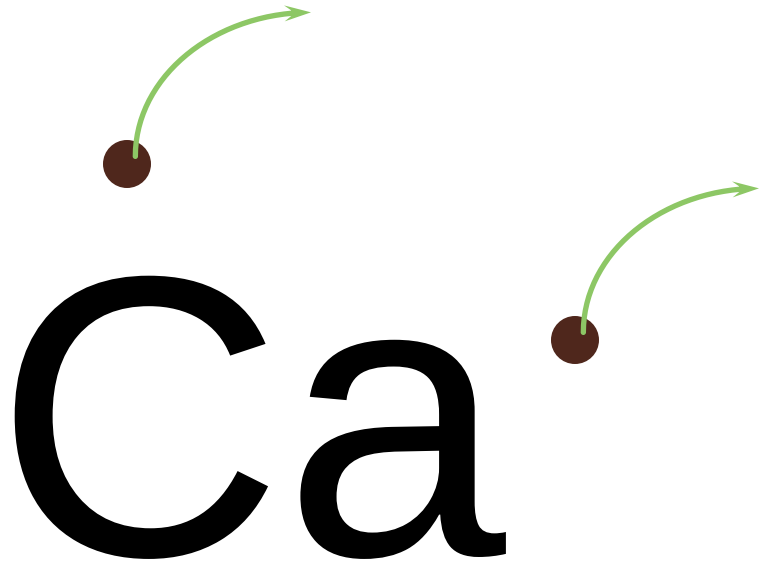
- Metals lose electrons to attain noble gas configuration.
- They make positive ions (Cations)
- If we look at the electron configuration, it makes sense to lose electrons:
- Na $\mathbf{1s^2 2s^2 2p^6 3s^1}$ 1 valence electron
- $Na^{1+}$ $\mathbf{1s^2 2s^2 2p^6}$ noble gas configuration

# Electron Dots For Cations

- Metals will have few valence electrons (usually 1 to 3)

# 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

$Ca^{2+}$

Pseudo-noble gas configuration

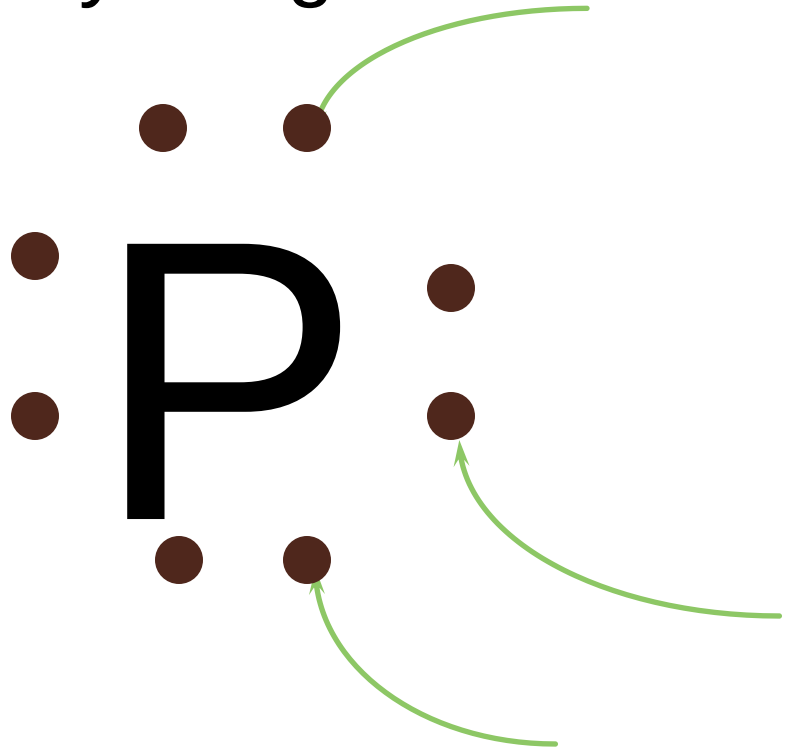
Now make Sc an ion.

# Electron Configurations for Anions

- Nonmetals gain electrons to attain noble gas configuration.
- They make negative ions (anions)
- Halide ions- ions from chlorine or other halogens that gain electrons
- 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

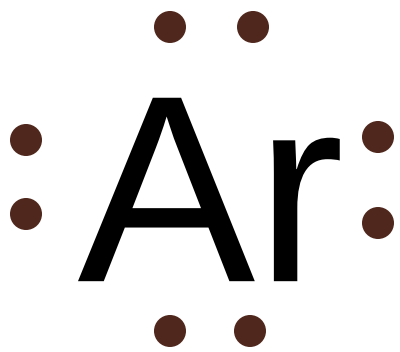
- Nonmetals will have many valence electrons (usually 5 or more)
- They will gain electrons to fill outer shell.




$P^{3-}$

# 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.



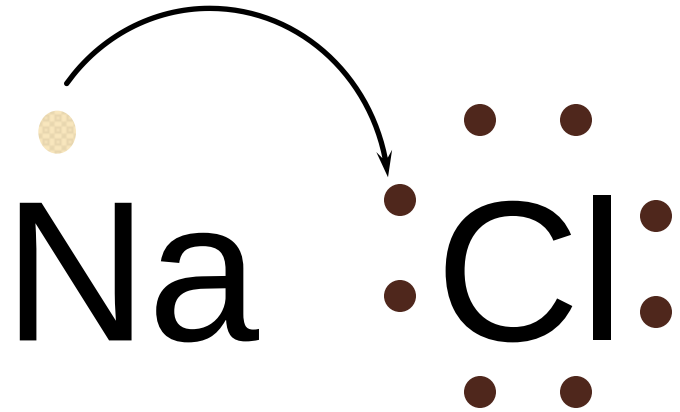
# Ionic Bonds

- OBJECTIVES:
  - Use the characteristics of ionic compounds to explain the electrical conductivity of ionic compounds when melted and when in aqueous solution.

# Ionic Bonding

- Anions and cations are held together by opposite charges.
- 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



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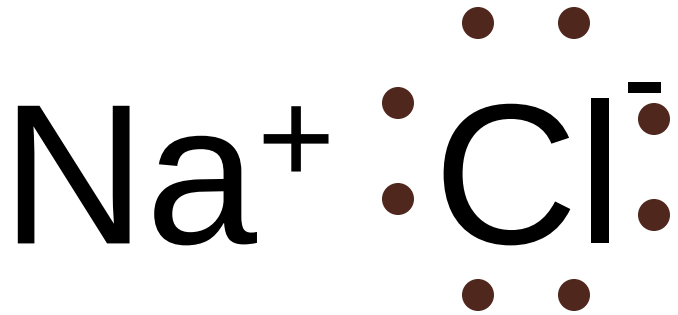
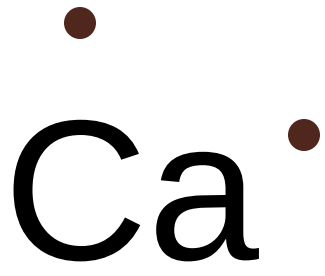
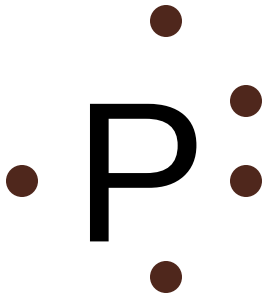


# Ionic Bonding

- All the electrons must be accounted for!



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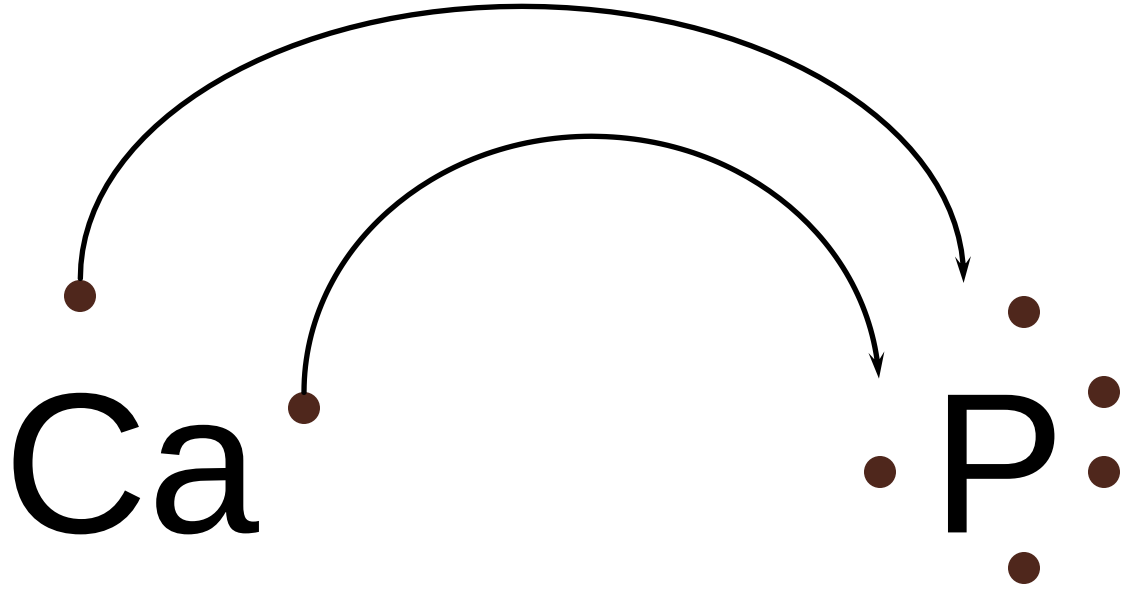
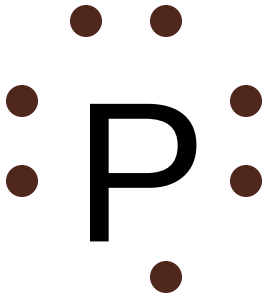


# Ionic Bonding

$Ca^{2+}$



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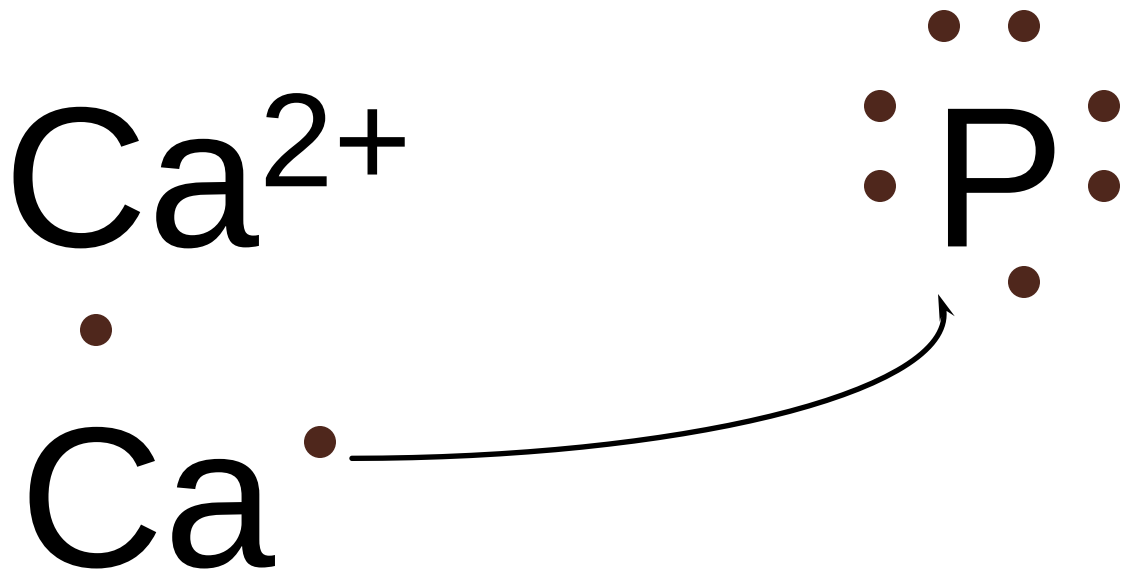

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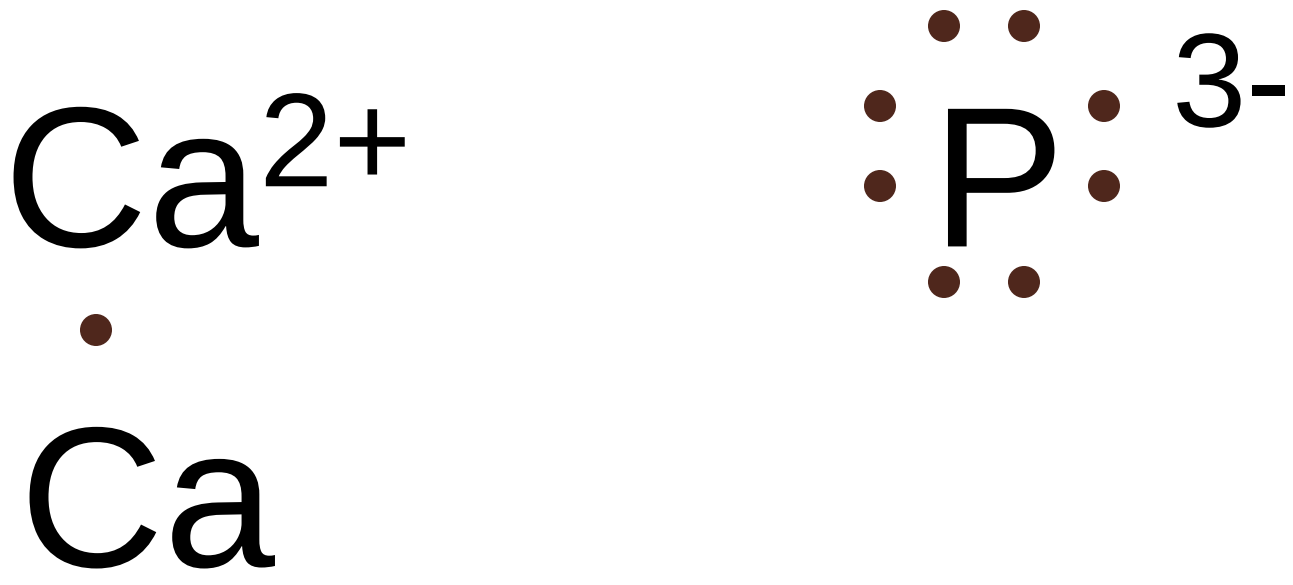

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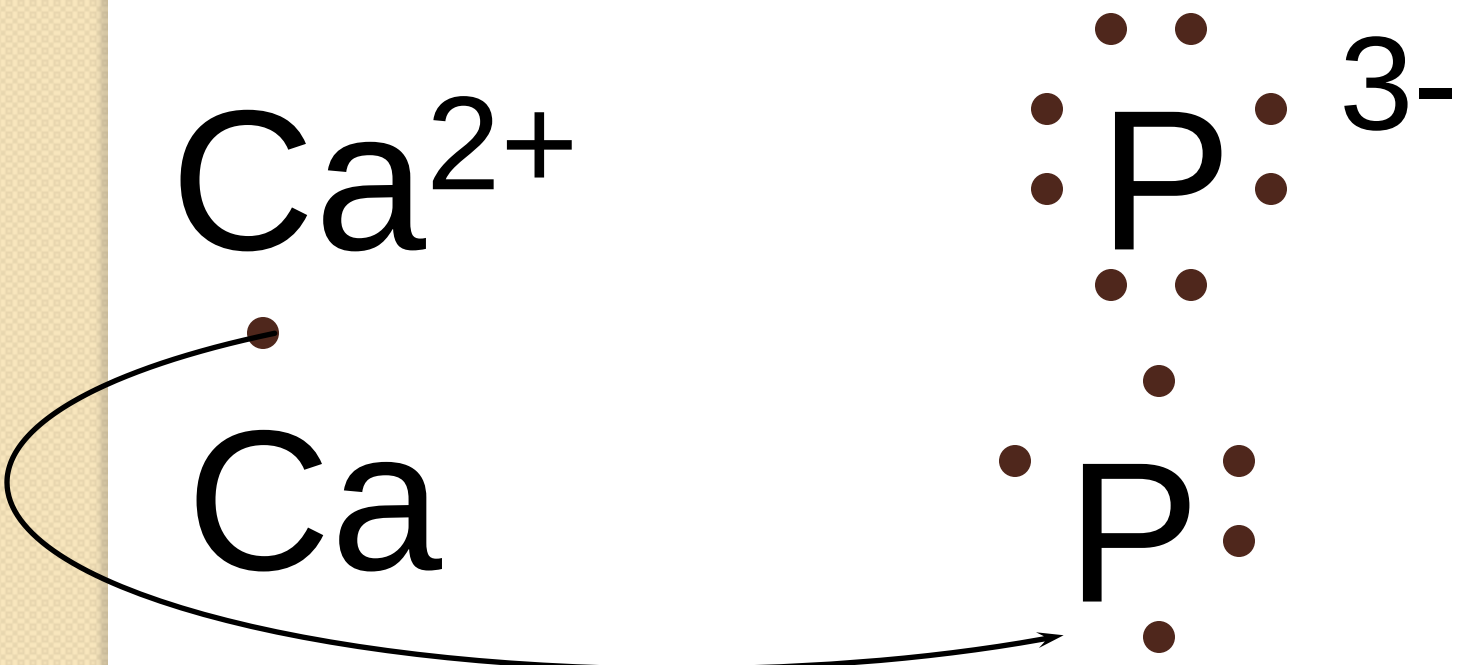

# Ionic Bonding

$Ca^{2+}$

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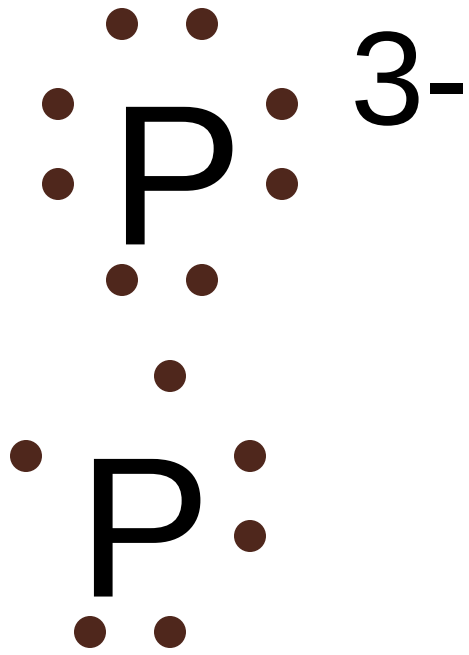

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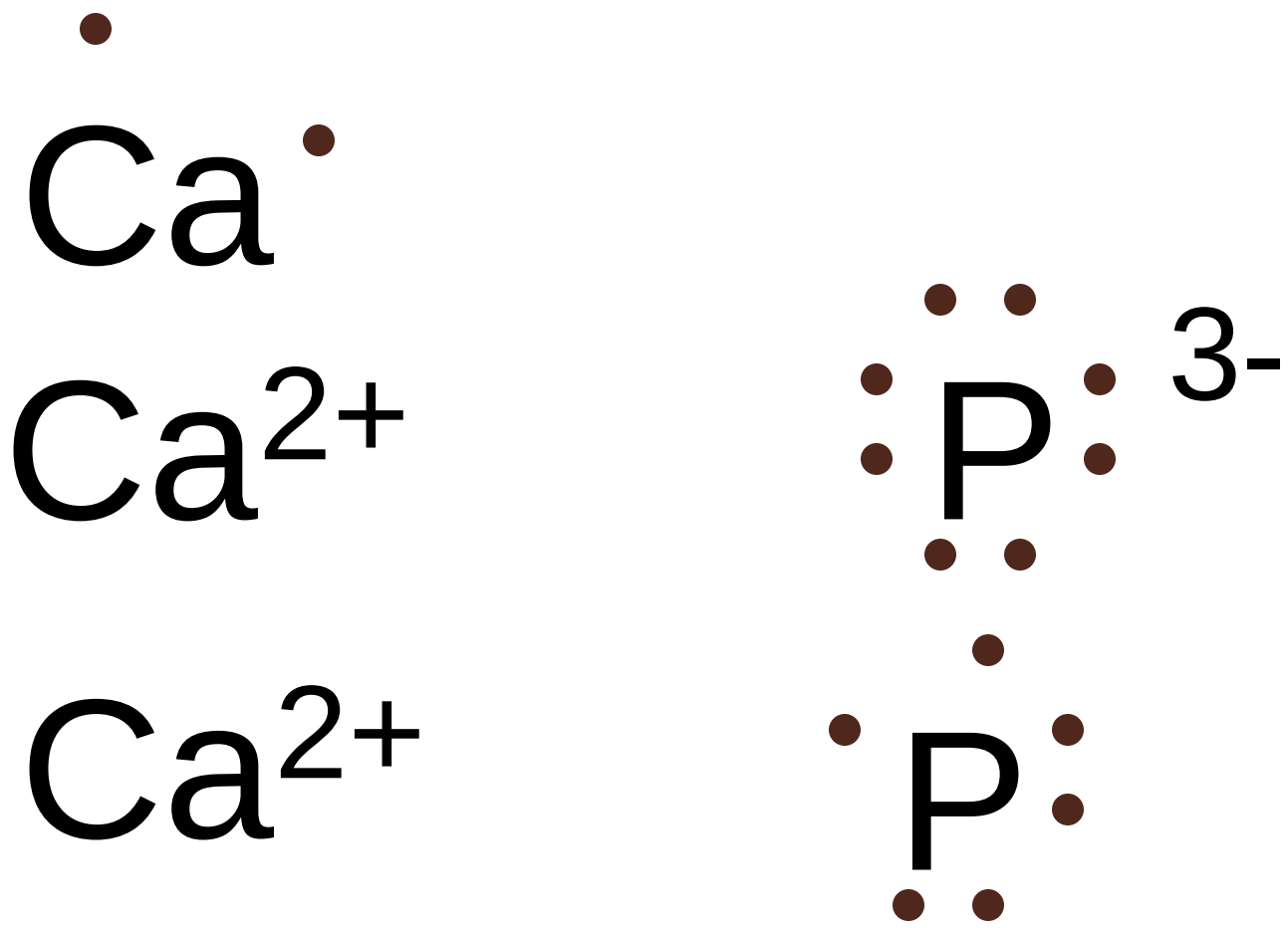

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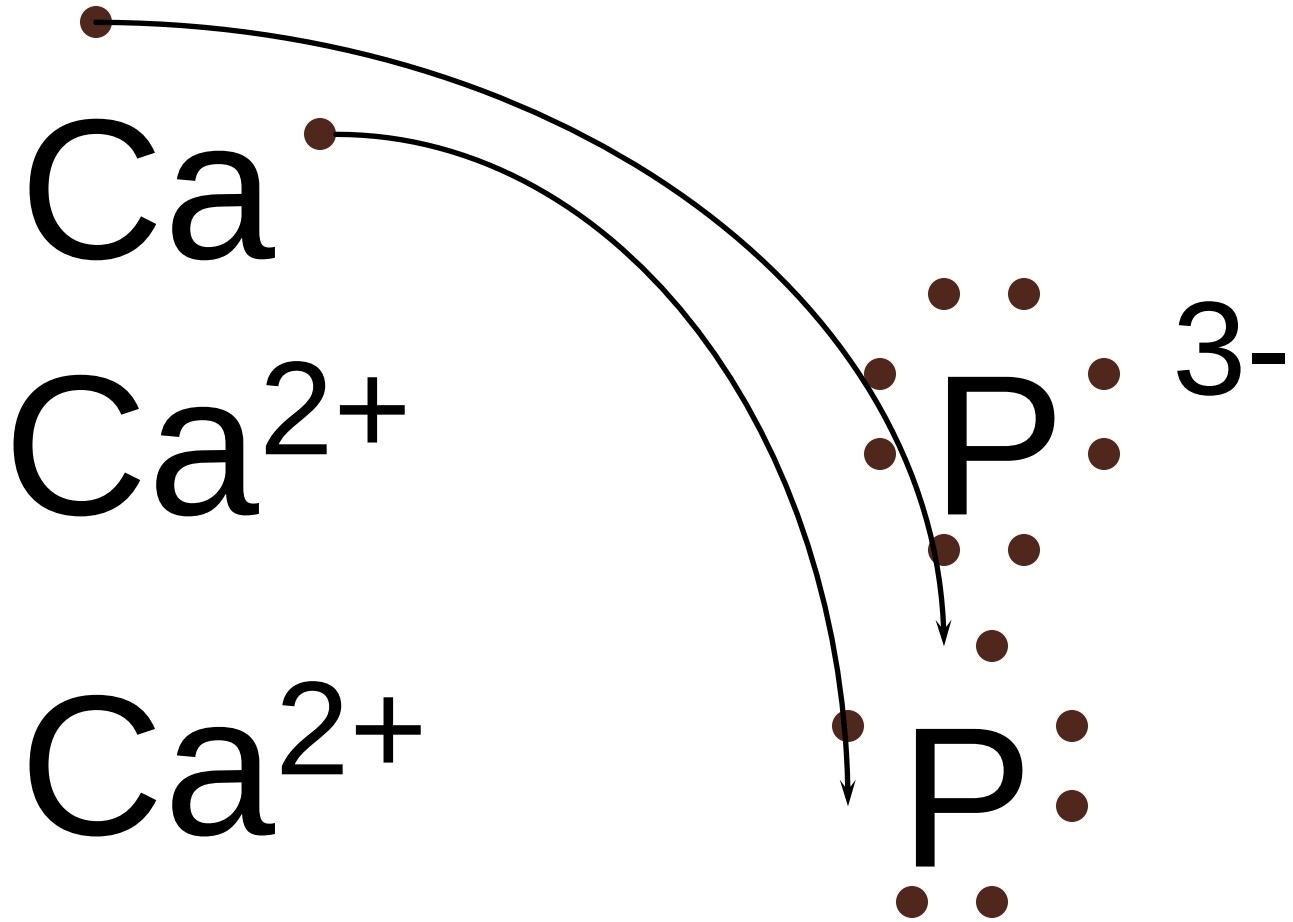

# Ionic Bonding

$Ca^{2+}$

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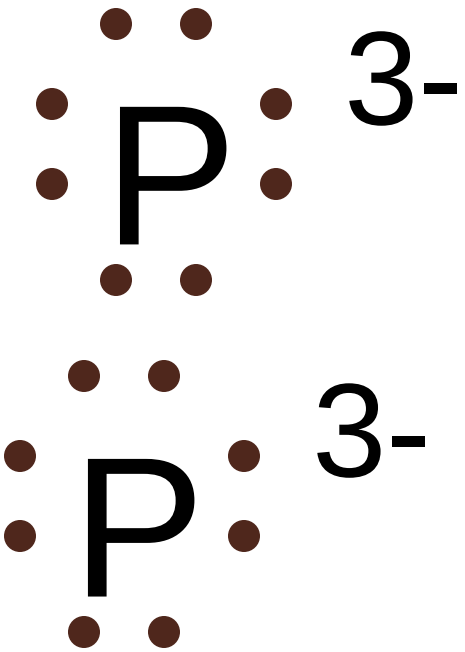


# Ionic Bonding

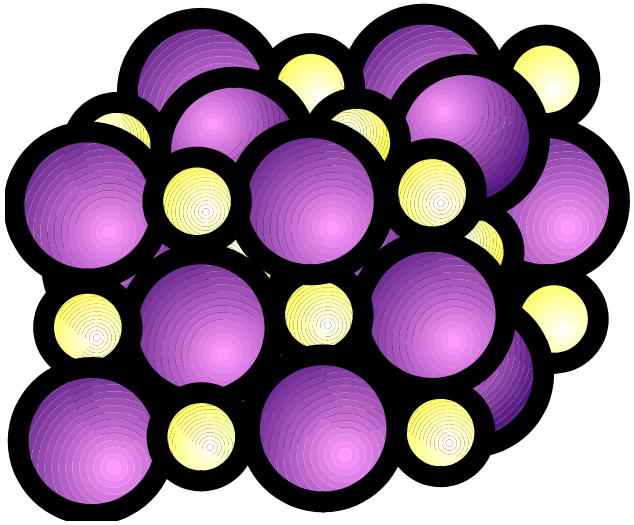
$= Ca_3P_2$ Formula Unit

Sample Problem 15-1, page 421

# Properties of Ionic Compounds

- Crystalline structure, usually solids
- A regular repeating arrangement of ions in the solid: Fig. 15.9, p.423
- Ions are strongly bonded together.
- Structure is rigid.
- High melting points
- Coordination number- number of ions of opposite charge surrounding it

# Crystalline structure



# Do they Conduct?

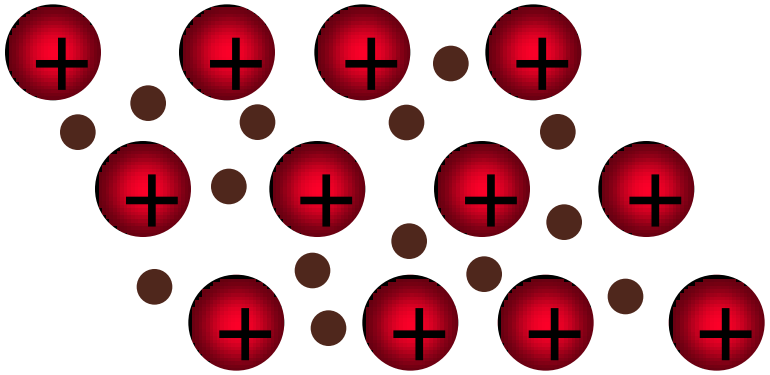
- Conducting electricity is allowing charges to move.
- In a solid, the ions are locked in place.
- Ionic solids are insulators.
- When melted, the ions can move around.
- Melted ionic compounds conduct.
  - NaCl: must get to about 800 ºC.
- Dissolved in water they conduct (aqueous)

# Metallic Bonds

- How atoms are held together in the solid.
- Metals hold on to their valence electrons very weakly.
- Think of them as positive ions (cations) floating in a sea of electrons: Fig. 15.13, p.427

# Sea of Electrons

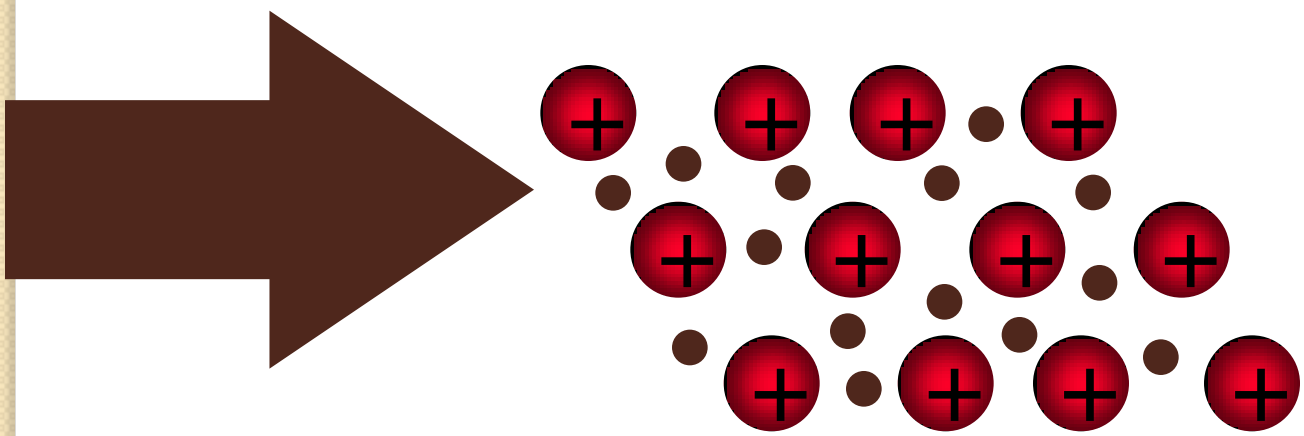
- Electrons are free to move through the solid.
- Metals conduct electricity.



# Metals are Malleable

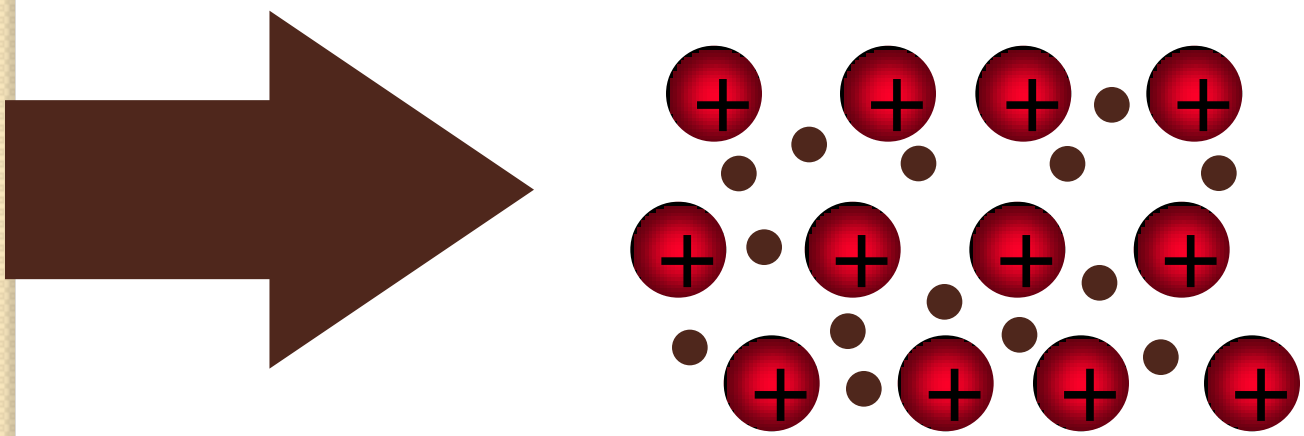
- Hammered into shape (bend).
- Also ductile - drawn into wires.
- Both malleability and ductility explained in terms of the mobility of the valence electrons
- Fig. 15.14, p.427

# Malleable

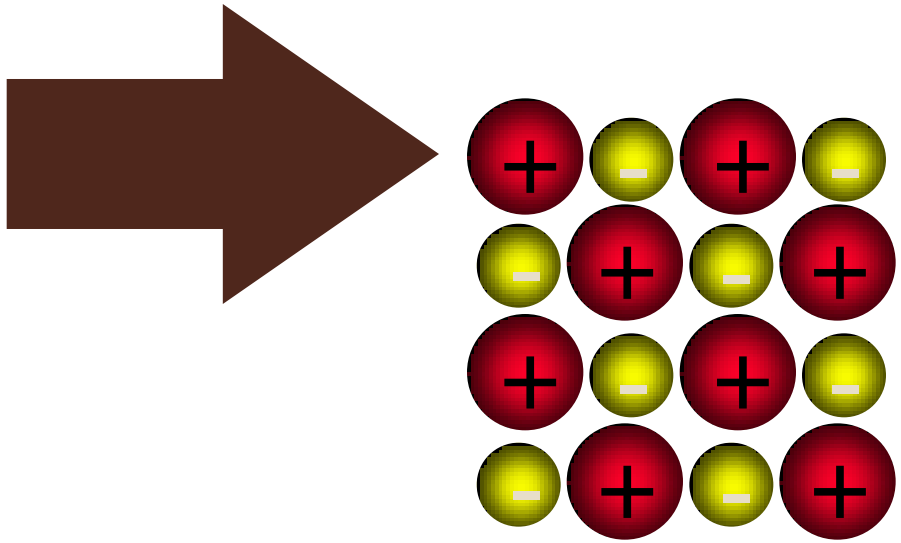


# Malleable

- Electrons allow atoms to slide by.

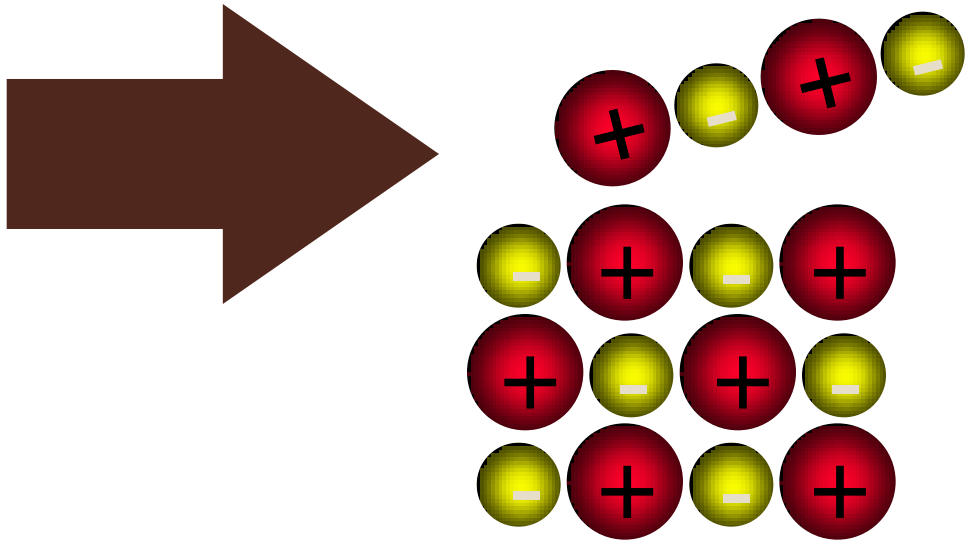


# Ionic solids are brittle



# Ionic solids are brittle

- Strong Repulsion breaks crystal apart.



# Crystalline structure of metal

- If made of one kind of atom, metals are among the simplest crystals
- Types of crystals

1. Body-centered cubic: bcc
   - every atom has 8 neighbors
   - Na, K, Fe, Cr, W

# Crystalline structure of metal

2. Face-centered cubic: fcc
   - every atom has 12 neighbors
   - Cu, Ag, Au, Al, Pb
3. Hexagonal close-packed: hcp
   - every atom also has 12 neighbors
   - different pattern due to hexagonal
   - Mg, Zn, Cd