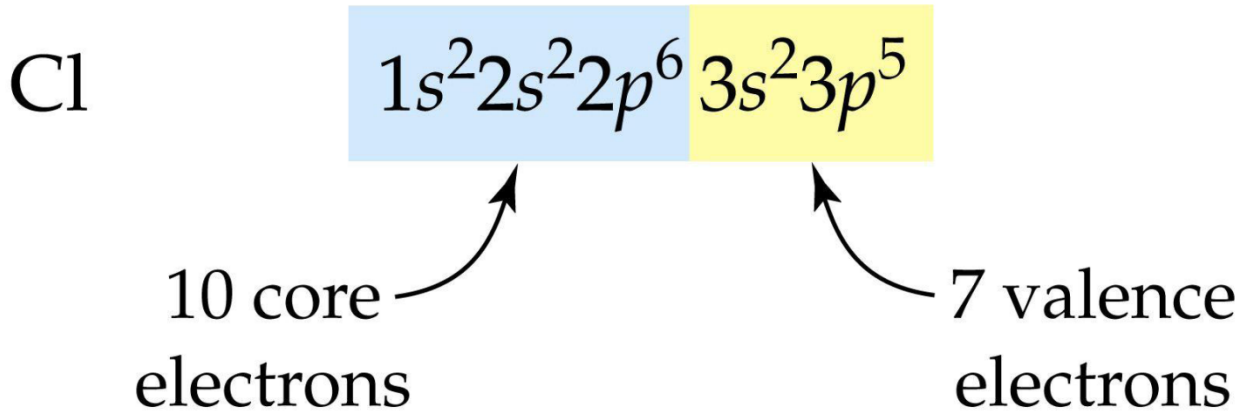
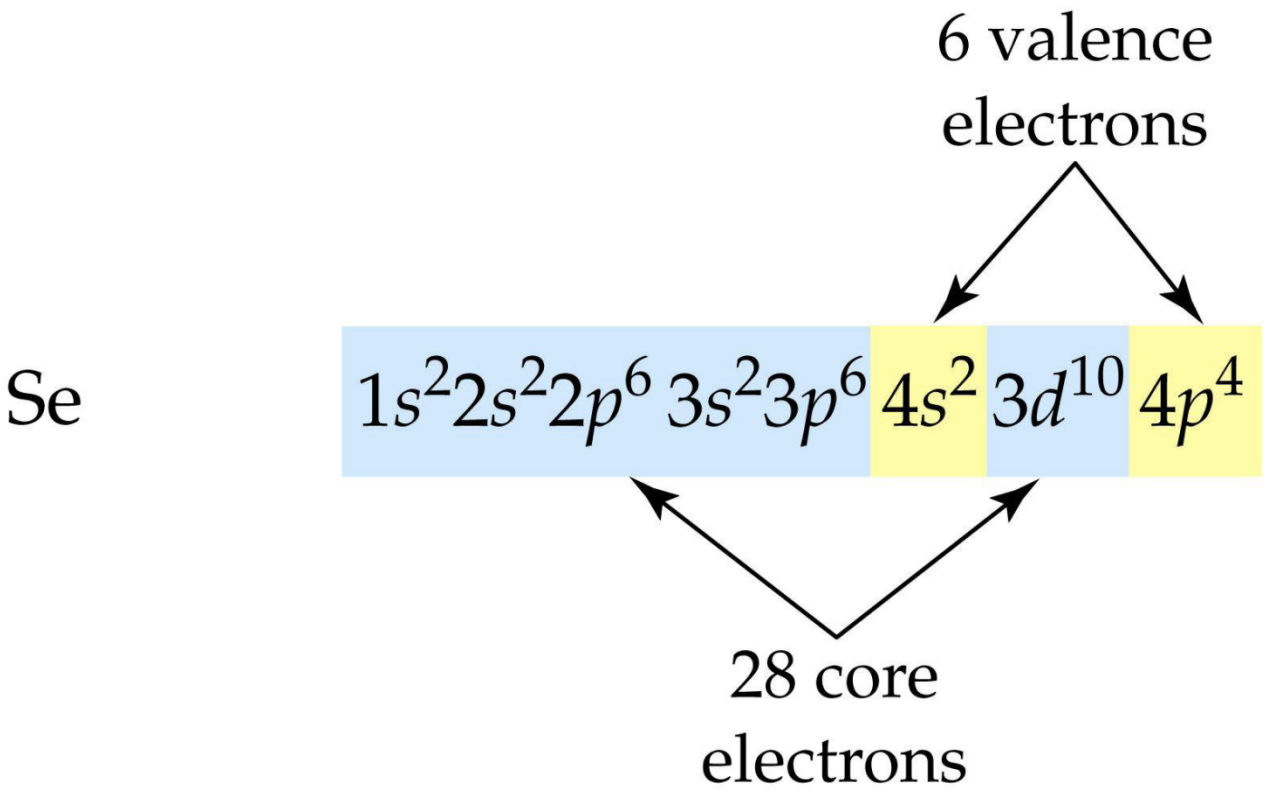
Valence electrons are the electrons in the highest occupied energy level of an element's atoms.





To find the number of valence electrons in an atom of a representative element, simply look at its group number.

Remember representative elements are groups 1A-7A.

Electron dot structures are diagrams that show valence electrons as dots. (He exception)

Table 7.1

Electron Dot Structures of Some Group A Elements

Period	Group 1A	2A	3A	4A	5A	6A	7A	8A
1	H·							He:
2	Li·	·Be·	·B·	·C·	·N·	:O·	:F·	:Ne:
3	Na·	·Mg·	·Al·	·Si·	·P·	:S·	:Cl·	:Ar:
4	K·	·Ca·	·Ga·	·Ge·	·As·	:Se·	:Br·	:Kr:

Octet "rule": In forming compounds, atoms tend to achieve the electron configuration of a noble gas. This is the lowest energy configuration.

Atoms will either gain electrons or lose electrons until they have noble gas configuration.

Atoms of metals: tend to lose their valence electrons, leaving a complete octet in the next-lowest energy level.

Atoms of some non-metals: tend to gain electrons or to share electrons with another nonmetal to achieve a complete octet.

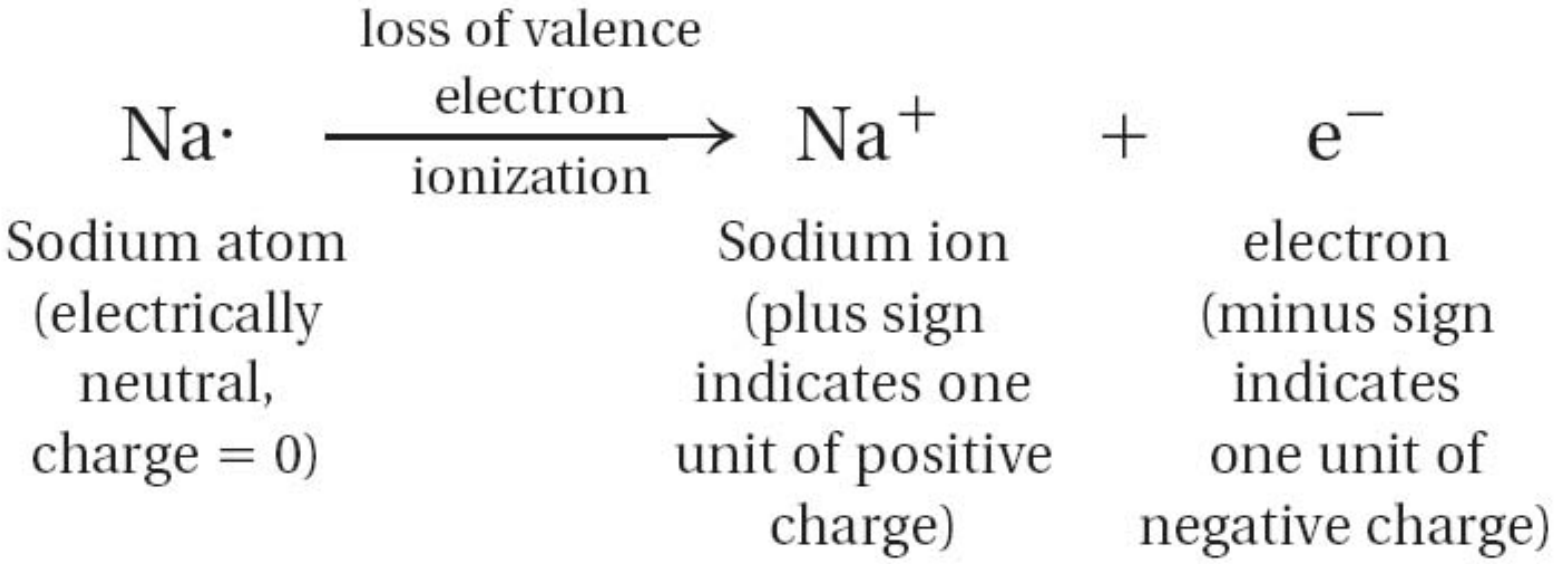
Formation of Cations

An atom's loss of valence electrons produces a cation, or a positively charged ion.

The most common cations are those produced by the loss of valence electrons from metal atoms.

$$\mathrm{Na}\ \ 1s^2 2s^2 2p^6 3s^1 \xrightarrow{-e^-} \mathrm{Na}^+\ \ 1s^2 \underbrace{2s^2\,2p^6}_{\text{octet}}$$

Using electron dot structures, you can show the ionization more simply.



$$\cdot Mg\cdot \longrightarrow Mg^{2+} + 2e^-$$

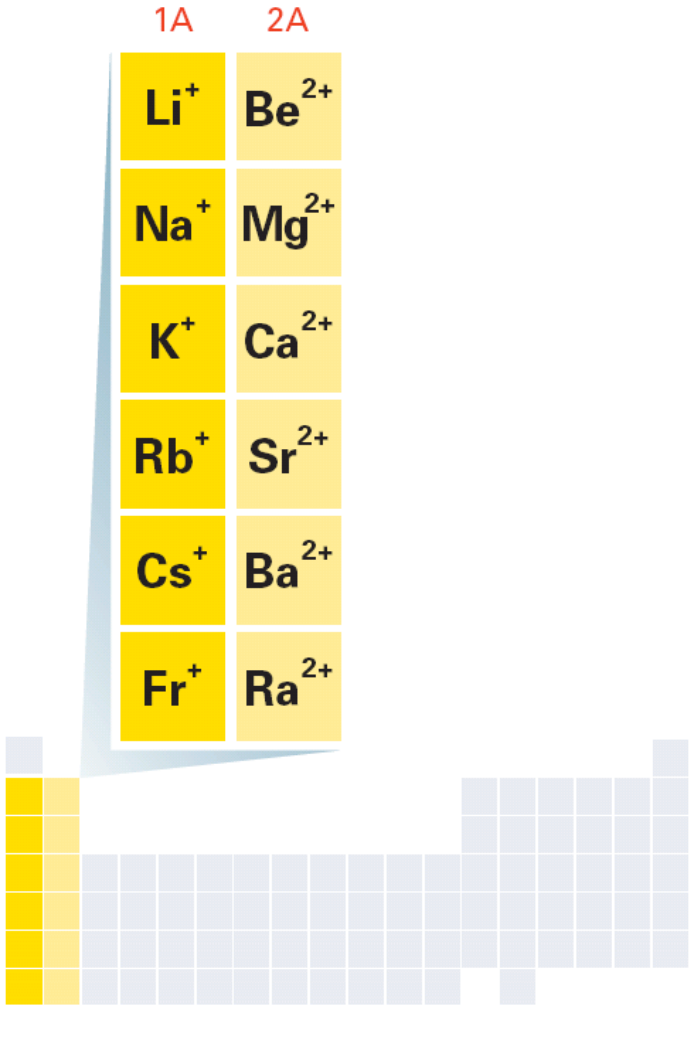
Magnesium atom (electrically neutral, charge = 0)

Magnesium ion (2+ indicates two units of positive charge)

(2 in front of e^- indicates two units of negative charge)

So what is true about the electron dot structure of cations?

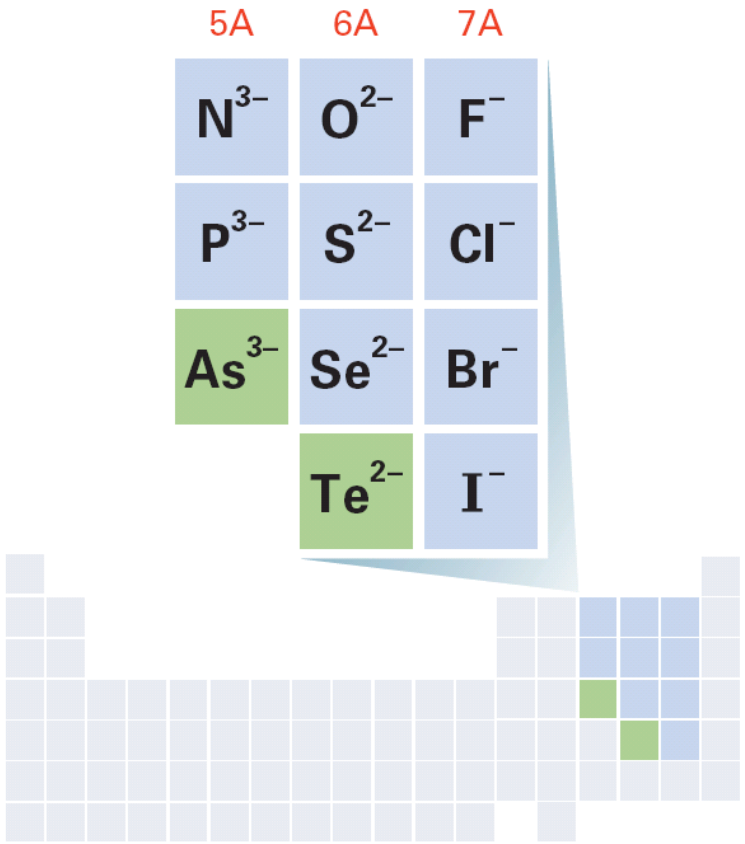
Cations of Group 1A elements always have a charge of 1+. Cations of group 2A elements always have a charge of 2+.



Formation of Anions

The gain of negatively charged electrons by a neutral atom produces an anion.

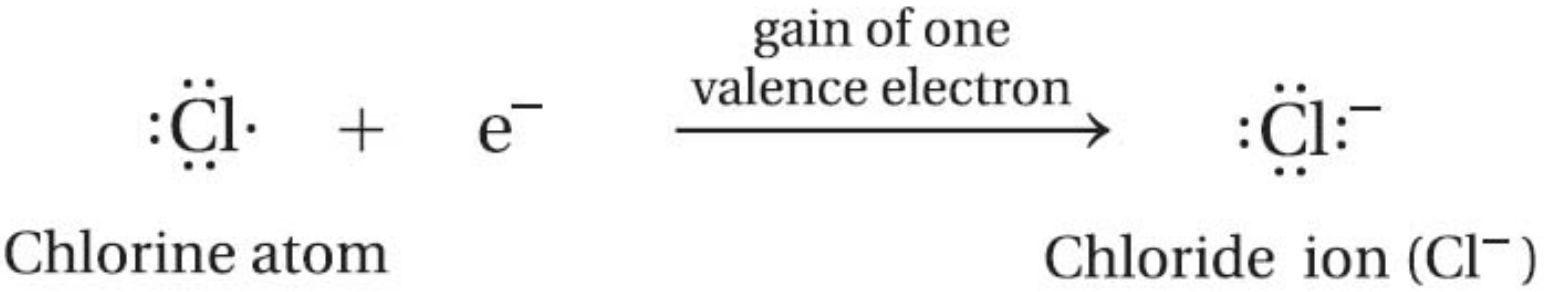
The figure shows the symbols of anions formed by some elements in Groups 5A, 6A, and 7A.



A gain of one electron gives chlorine an octet and converts a chloride ion. It has the same electron configuration as the noble gas argon.

$$\text{Cl} \quad 1s^2 2s^2 2p^6 3s^2 3p^5 \xrightarrow{+e^-} \text{Cl}^- \quad 1s^2 2s^2 2p^6 \underbrace{3s^2 3p^6}_{\text{octet}}$$

$$\text{Ar} \quad 1s^2 2s^2 2p^6 \underbrace{3s^2 3p^6}_{\text{octet}}$$



So what is true about the electron dot structure of anions?

Transition Metals: Many can lose different numbers of electrons (multivalent)

Example: Iron can be Fe^{2+} or Fe^{3+}

Summary:

1. Groups 1A- 7A have the same number of valence electrons as their group number.

2. Groups 1A-3A lose their valence electrons to form cations. Nonmetals in group 5A-7A gain electrons to get to 8.

3. Most transition metals can vary in the number of electrons they lose.

4. Metals only form cations.

Octet Rule: Is it easier to gain to get to 8 or lose to get to 0?

Group 1: 1 valence electron: loses 1 e^- to become $^{+1}$ Example: Li^{+1}

Group 2: 2 valence electrons: loses 2 e^- to become $^{+2}$ Example: Ca^{+2}

Group 3: 3 valence electron: loses 3 e^- to become $^{+3}$ Example: Al^{+3}

***Group 4: C, Si and Ge don't tend to ionize. Sn and Pb are metals so they form cations. Either $^{+2}$ or $^{+4}$.**

Is it easier to gain to get to 8 or lose to get to 0?

Group 5: (nonmetals) 5 valence electron: gains 3 e^- to become $^{-3}$ Example: N^{-3}

Group 6: (nonmetals) 6 valence electrons: gains 2 e^- to become $^{-2}$ Example: O^{-2}

Group 7: (nonmetals) 7 valence electrons: gains 1 e^- to become $^{-1}$ Example: Cl^{-1}

***Group 8:Noble gases don't ionize.**

Ionic compounds: opposites attract

Cations and anions **attract each other** with the same number of opposite charges forming **ionic compounds**.

The electrostatic forces that hold ions together in ionic compounds are called **ionic bonds**.

Properties of Ionic Compounds:

- Most are crystalline solids at room temperature. (very organized solid form).
- Many dissolve in water easily
- High melting points
- Conducts electricity when melted or dissolved in water (not in solid state)

Ionic compounds are electrically neutral because the number of (+) and (-) charges is the same.

Example:

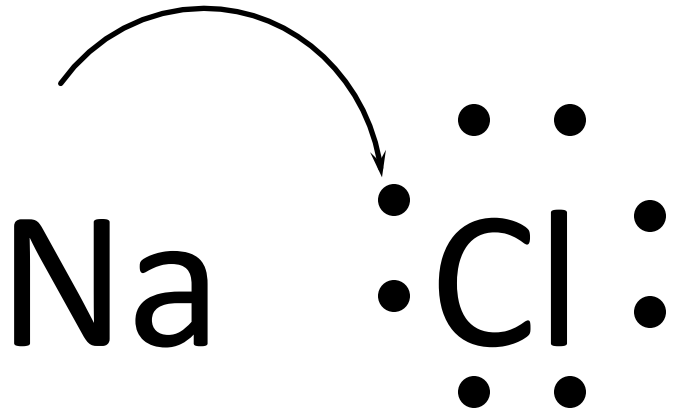
$$Na^{1+} + Cl^{1-} \rightarrow NaCl$$

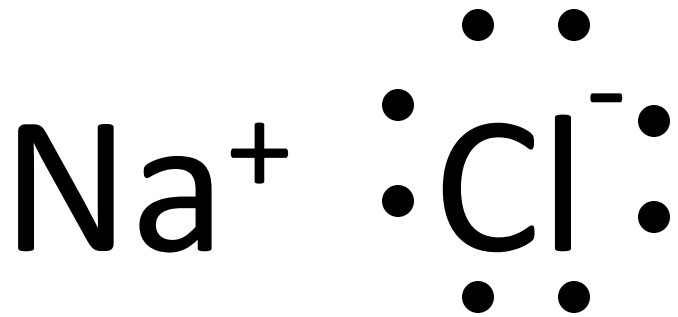
sodium cation + chloride anion → sodium chloride

Key Point: Ionic compounds are neutral!

Positive charges equal negative charges.

Using Electron Dot Structure to Show ionic bonding:





Na lost 1 electron to form 1^+ cation
Cl gains 1 electron to form a 1^- anion
The + and – attract (force of attraction is called an ionic bond) holds the ions together.
The ratio is 1:1 so the formula is NaCl

Counting Electrons

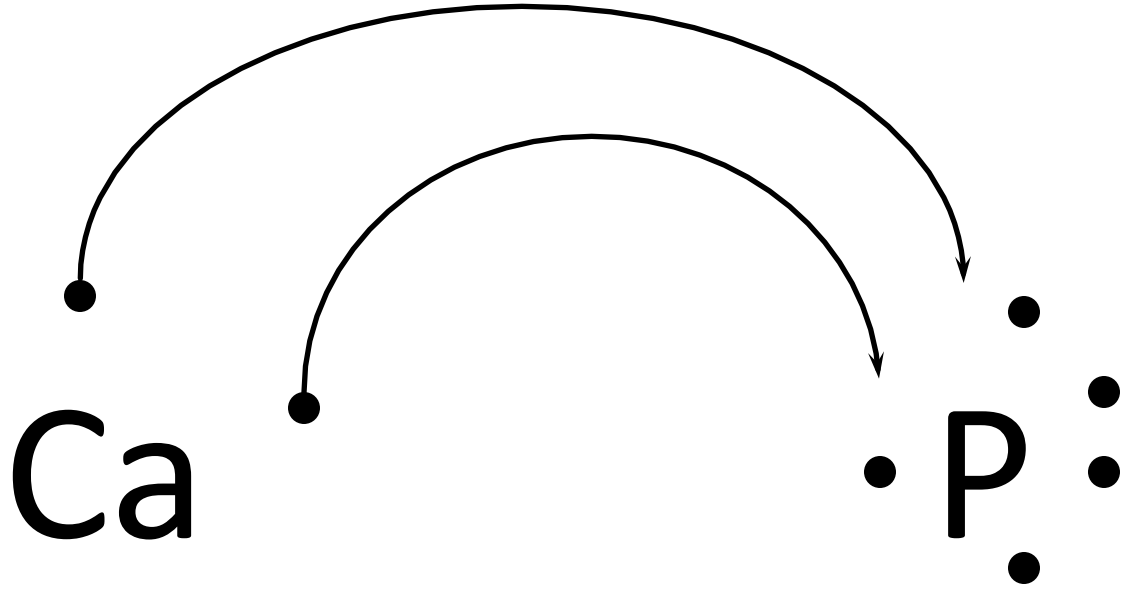
During the formation of an ionic compound the total number of electrons lost (by metals in forming cations) must equal the total number of electrons gained (by non-metals in forming anions).

Example: Find the formula for calcium phosphide:

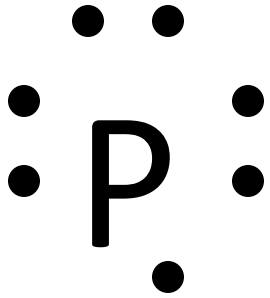
Ca Group 2A loses 2 e^-

P Group 5A gains 3e^-

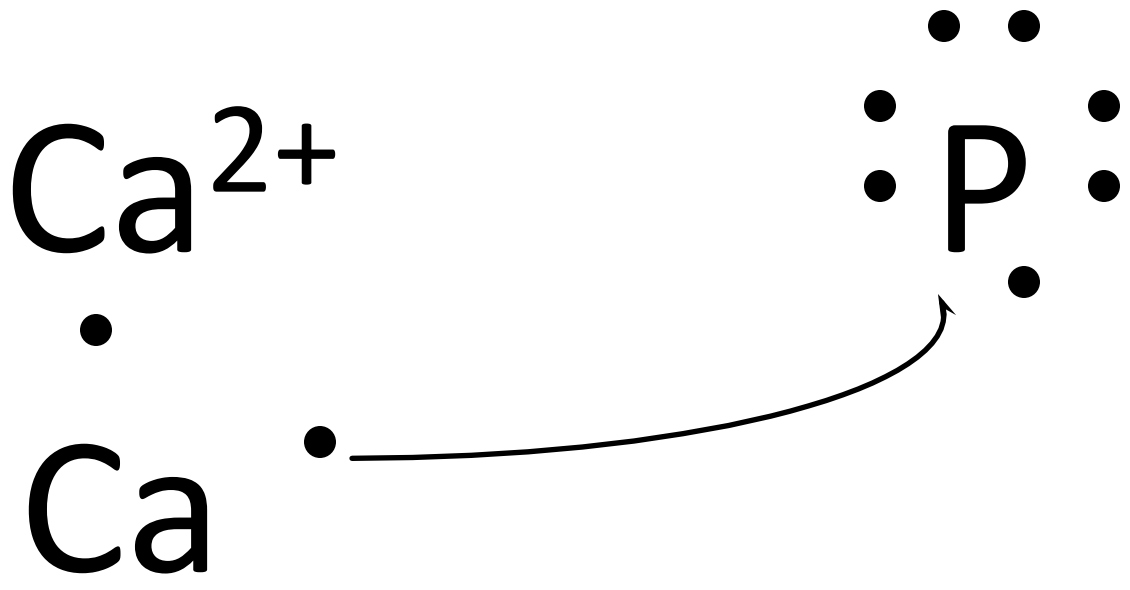
All the electrons must be accounted for, total lost = total gained!



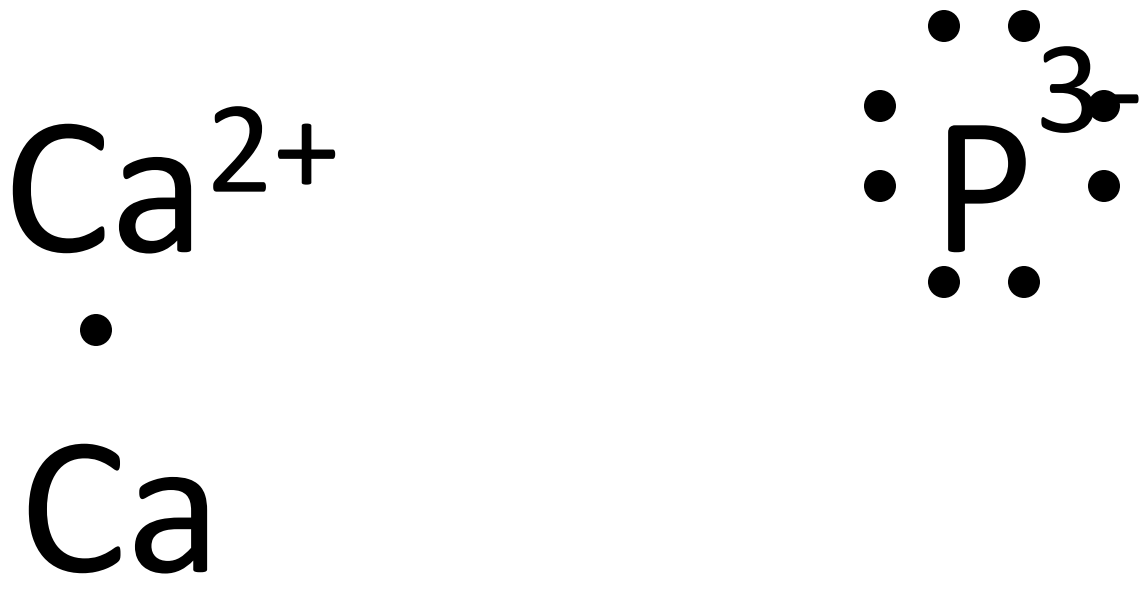
Ca^{2+}



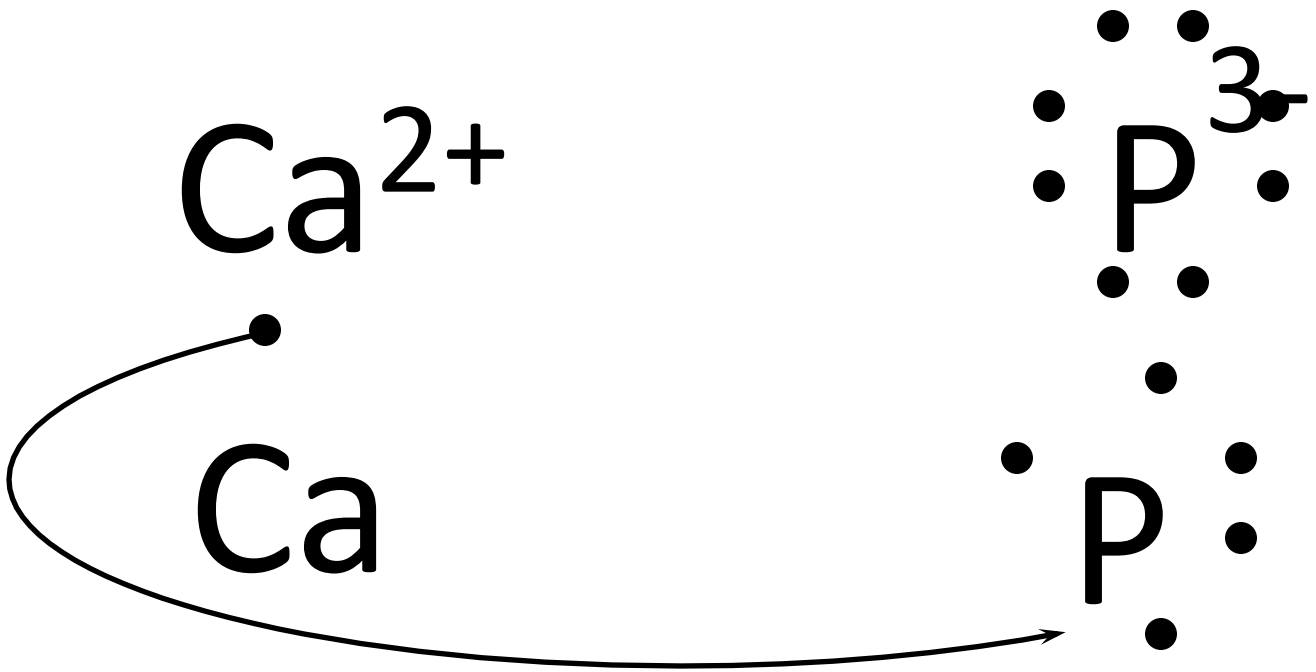
Ionic Bonding



Ionic Bonding



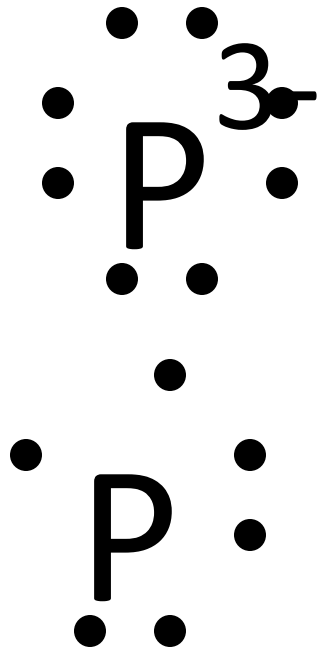
Ionic Bonding



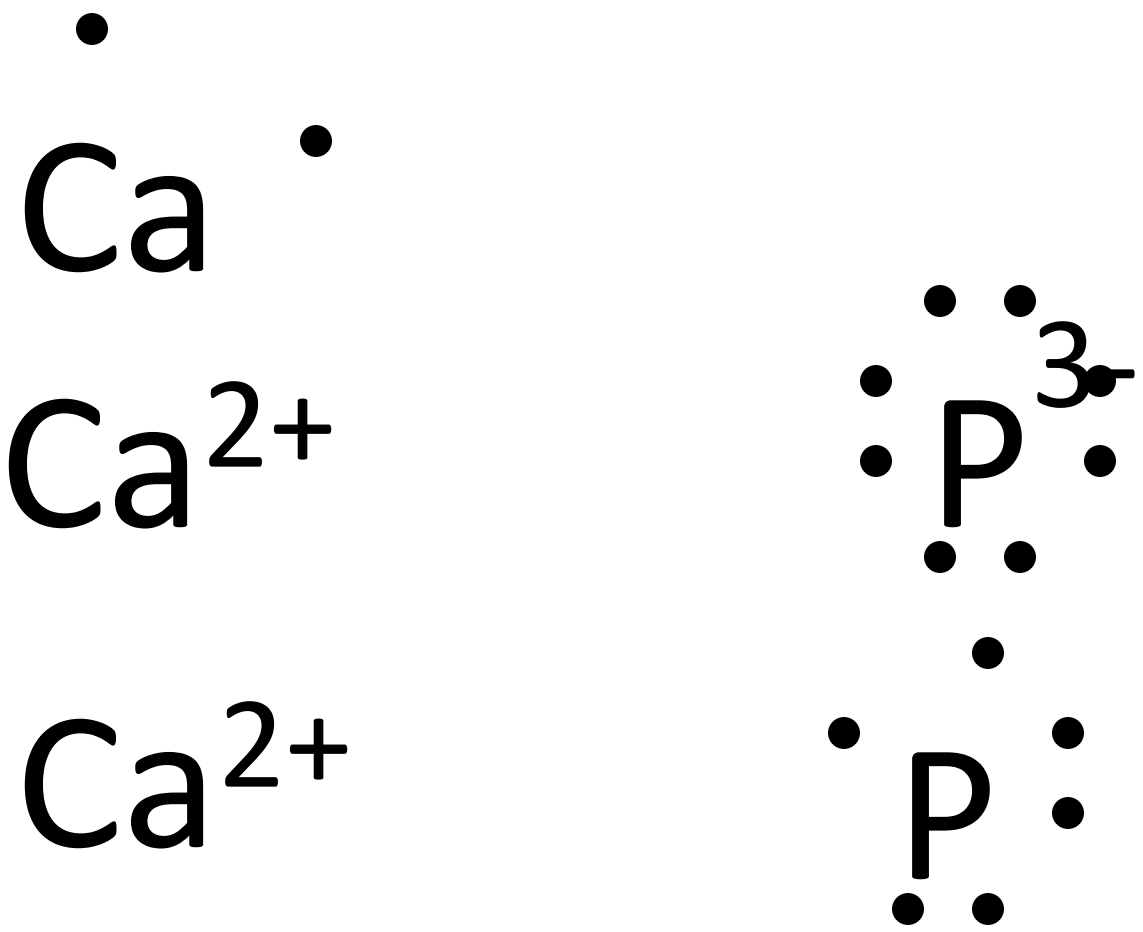
Ionic Bonding

Ca^{2+}

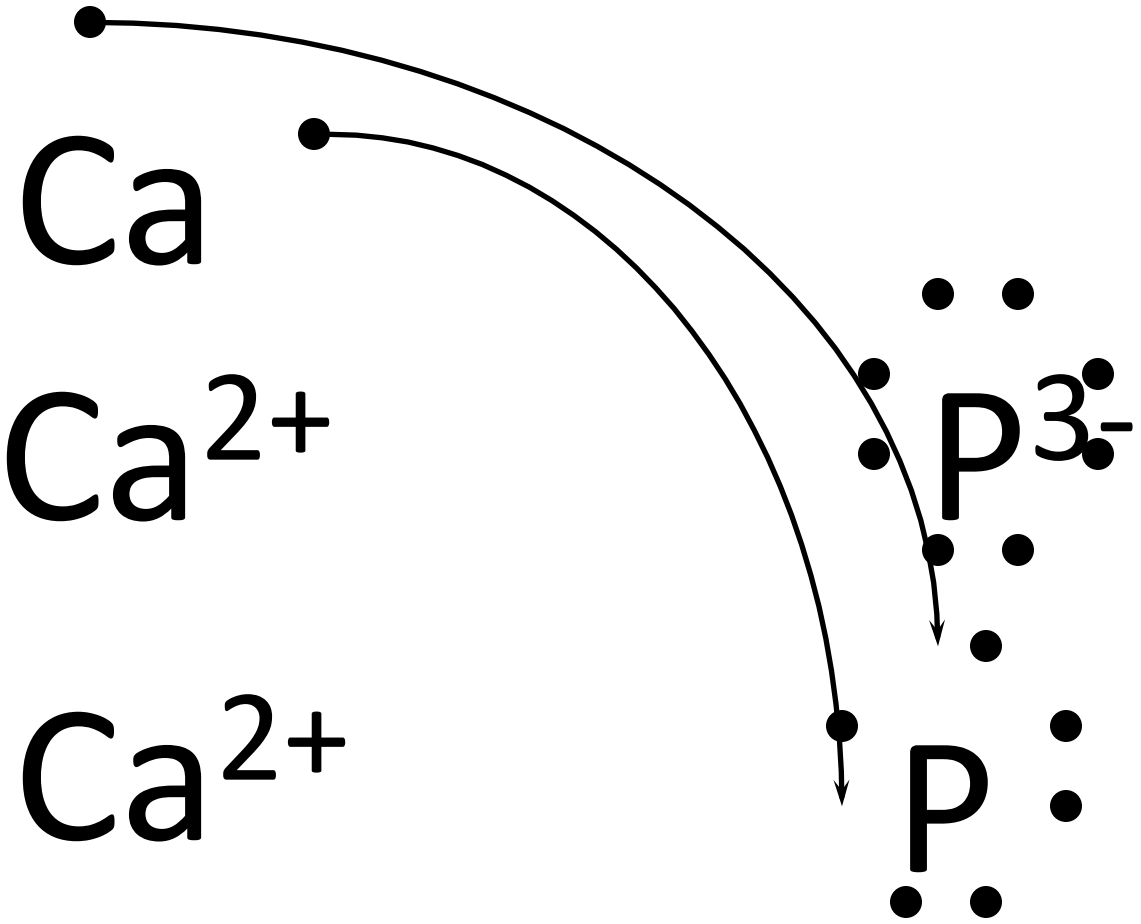
Ca^{2+}



Ionic Bonding



Ionic Bonding

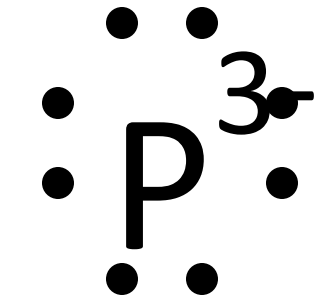


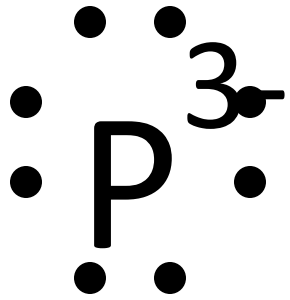
Ionic Bonding

Ca^{2+}

Ca^{2+}

Ca^{2+}





Ionic Bonding

The Ca to P ratio is 3:2 so:

Formula Unit

Ca_3P_2

(# e^- lost = # e^- gained)