

Cations and Anions



- Atoms of the metallic elements have relatively weak attractions for their electrons, so they tend to lose electrons and form monatomic cations (cations composed of one atom, such as Na^+).
- Atoms of the nonmetallic elements have relatively strong attractions for electrons, so they tend to gain electrons and form monatomic anions (anions composed of one atom, such as Cl^-).
- Therefore, when metallic and nonmetallic atoms combine, they usually form ions and ionic bonds.

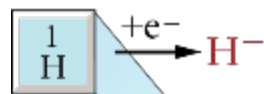
Predicting Ion Charges



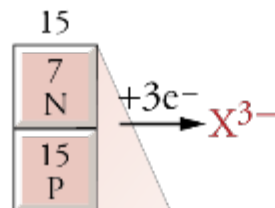
- Noble gas atoms are very stable, so when the nonmetallic atoms form anions, they gain enough electrons to get the same number of electrons as the nearest larger noble gas atom.
- When the aluminum and the metallic atoms in Groups 1, 2, and 3 form cations, they lose enough electrons to get the same number of electrons as the nearest smaller noble gas atom.

The Making of an Anion

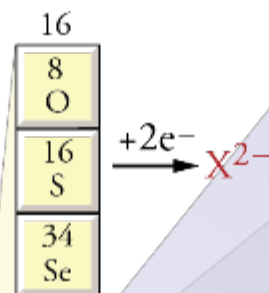
When a hydrogen atom gains one electron,



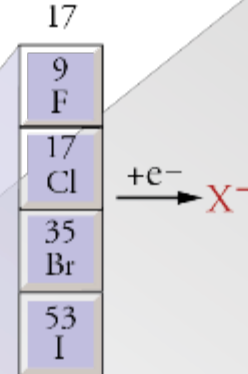
or when an atom in group 15 gains three electrons,



or when an atom in group 16 gains two electrons,



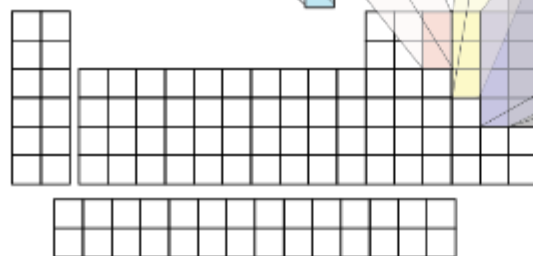
or when an atom in group 17 gains one electron,



it has the same number of electrons as an atom of the nearest noble gas.

18
2 He
10 Ne
18 Ar
36 Kr
54 Xe

Atomic number equals number of electrons.



The Making of a Cation

When an atom in group 1 loses one electron,

1
3 Li
11 Na
19 K
37 Rb
55 Cs
87 Fr

$-e^- \rightarrow X^+$

or when an atom in group 2 loses two electrons,

2
4 Be
12 Mg
20 Ca
38 Sr
56 Ba
89 Ra

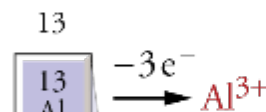
$-2e^- \rightarrow X^{2+}$

or when an atom in group 3 loses three electrons,

3
21 Sc
39 Y

$-3e^- \rightarrow X^{3+}$

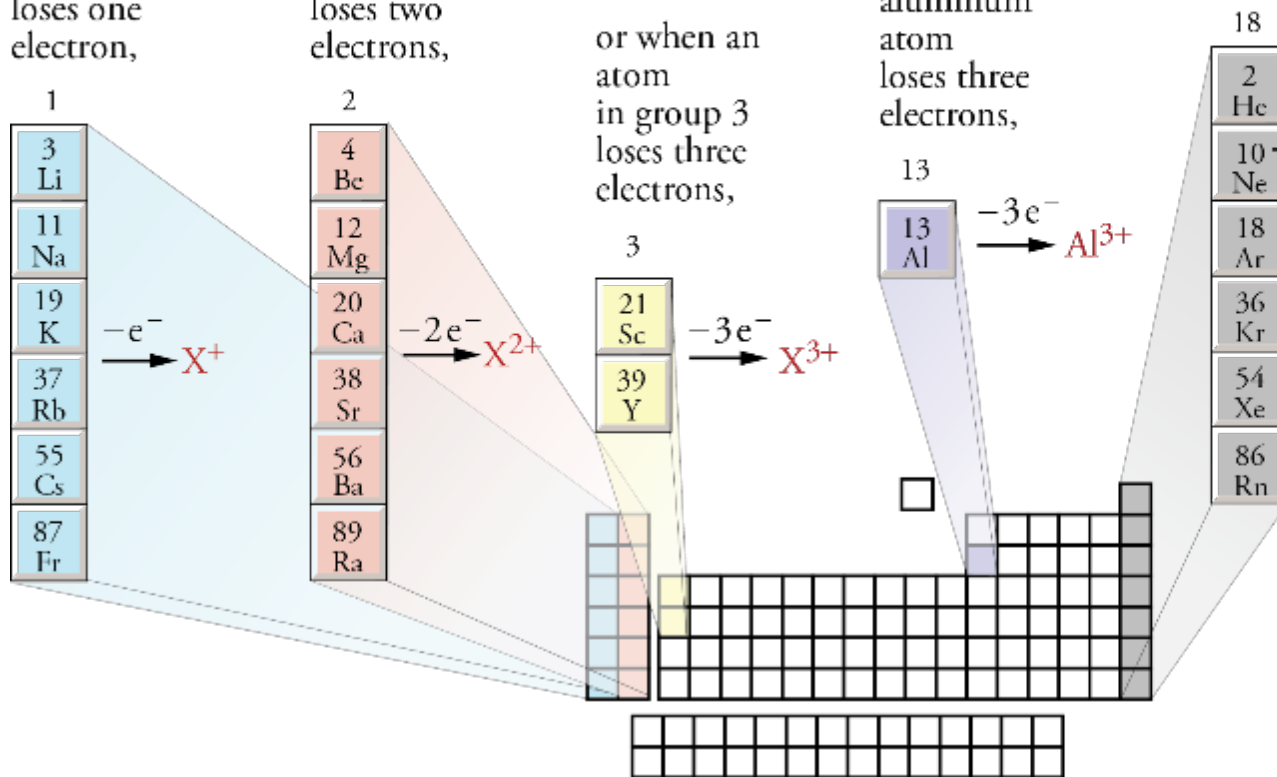
or when an aluminum atom loses three electrons,



it has the same number of electrons as an atom of the nearest noble gas.

18
2 He
10 Ne
18 Ar
36 Kr
54 Xe
86 Rn

Atomic number equals number of electrons.

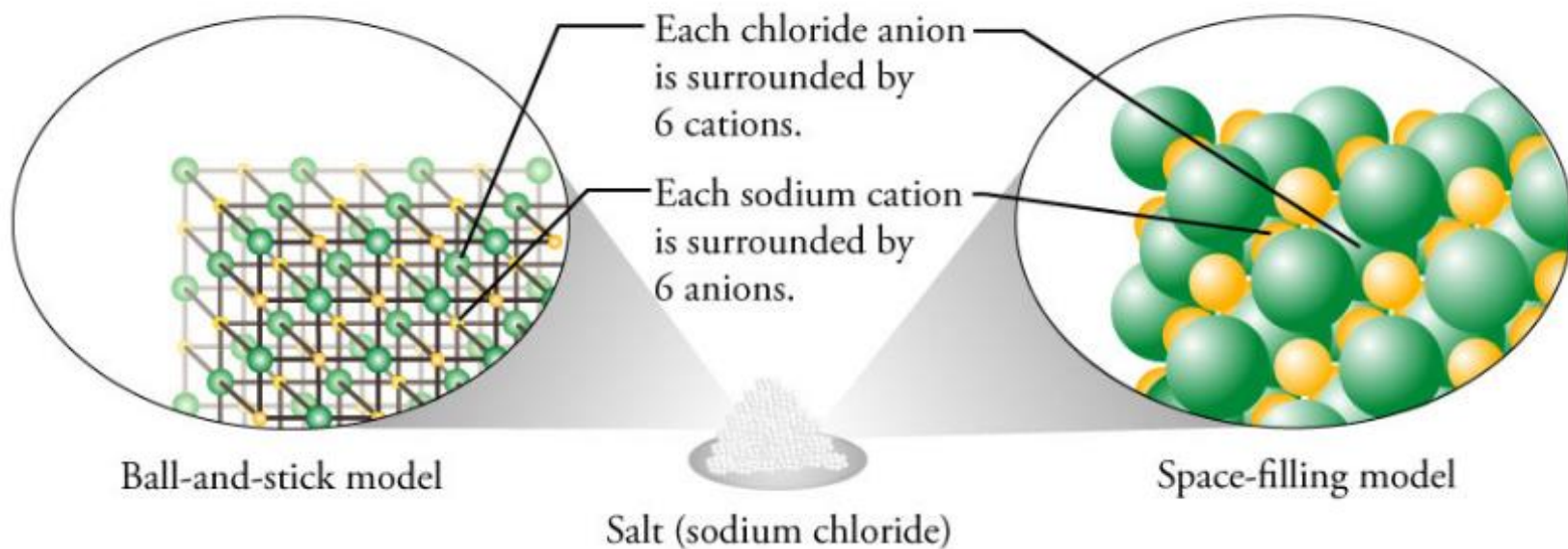


Monatomic Ions

1 1A	2 2A											13 3A	14 4A	15 5A	16 6A	17 7A	18 8A
Li ⁺	Be ²⁺													N ³⁻	O ²⁻	F ⁻	
Na ⁺	Mg ²⁺	3 3B	4 4B	5 5B	6 6B	7 7B	8 8B	9 8B	10 8B	11 1B	12 2B	Al ³⁺		P ³⁻	S ²⁻	Cl ⁻	
K ⁺	Ca ²⁺	Sc ³⁺					Fe ²⁺ Fe ³⁺			Cu ⁺ Cu ²⁺	Zn ²⁺				Se ²⁻	Br ⁻	
Rb ⁺	Sr ²⁺	Y ³⁺								Ag ⁺	Cd ²⁺					I ⁻	
Cs ⁺	Ba ²⁺																
Fr ⁺	Ra ²⁺																

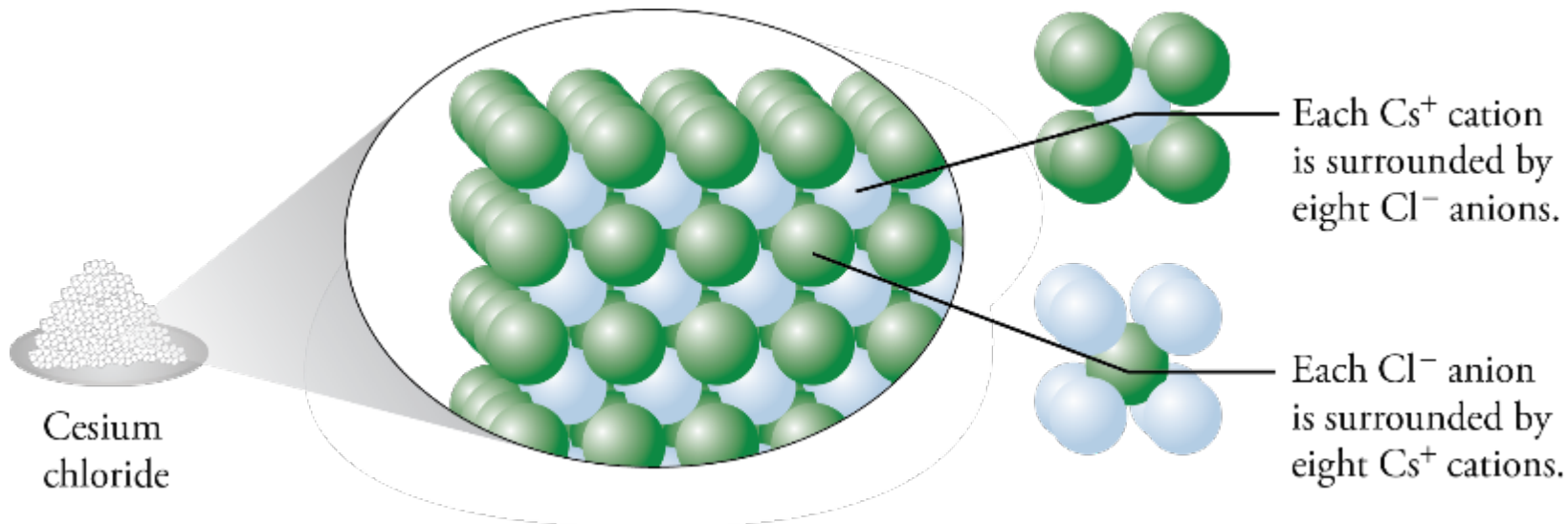


Sodium Chloride, NaCl, Structure



Cesium chloride, CsCl , Structure

- Because the cesium ions are larger than sodium ions, there is room for eight chloride ions around each cesium ion and eight cesium ions around each chloride ion.

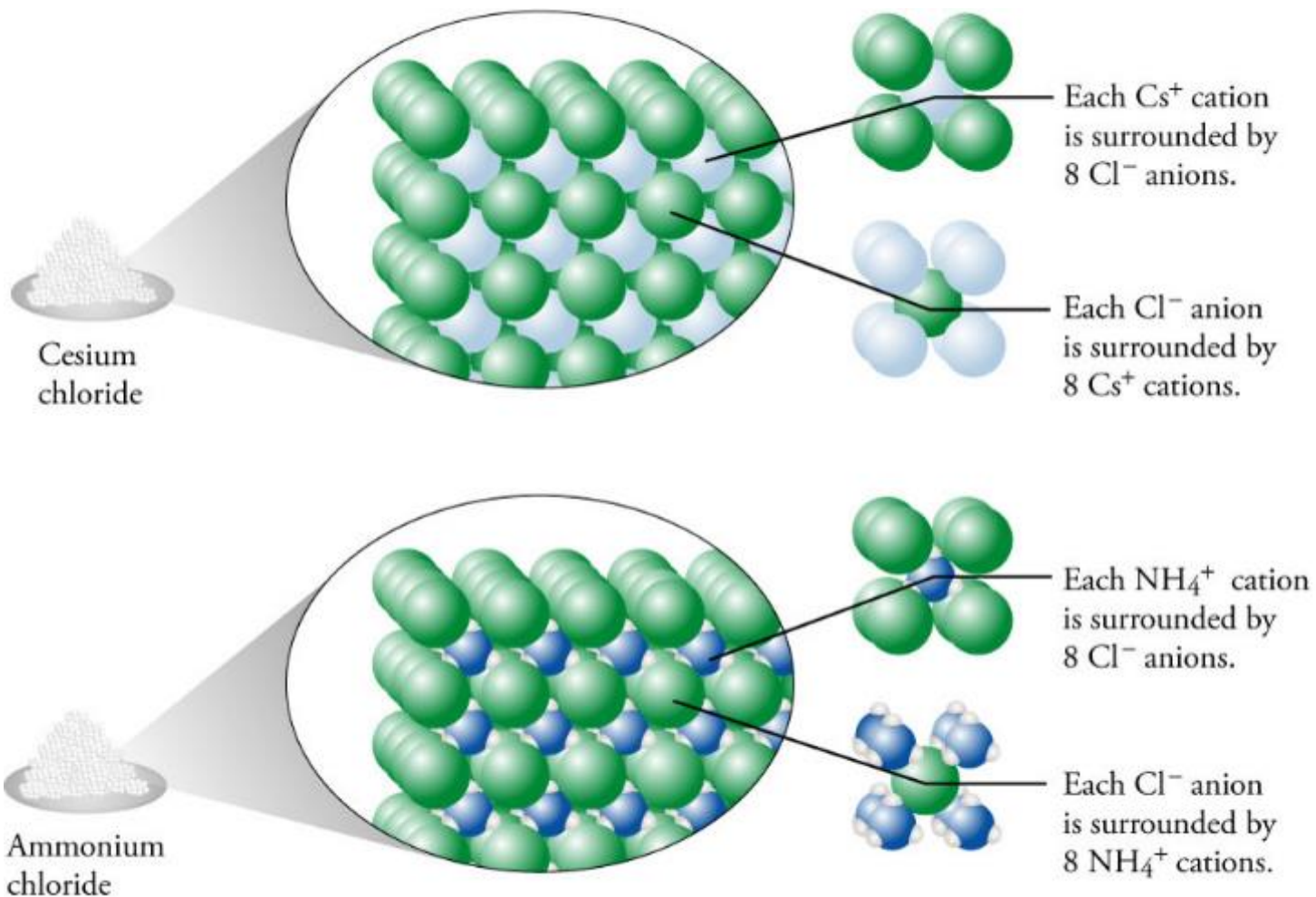


Polyatomic Ions



- Some anions and cations contain more than one atom.
- **Polyatomic ion** = a charge collection of atoms held together by covalent bonds
- For example, it is possible for a nitrogen atom to form covalent bonds to four hydrogen atoms, but to make this possible the nitrogen atom has to lose an electron, giving the collection of atoms a plus one charge. This will be explained in more detail in a later lesson. This collection of atoms with the formula NH_4^+ is called the ammonium ion.

CsCl and NH₄Cl structure



Polyatomic Ions

Ion	Name	Ion	Name
NH_4^+	ammonium	NO_3^-	nitrate
OH^-	hydroxide	SO_4^{2-}	sulfate
CO_3^{2-}	carbonate	$\text{C}_2\text{H}_3\text{O}_2^-$	acetate
PO_4^{3-}	phosphate		