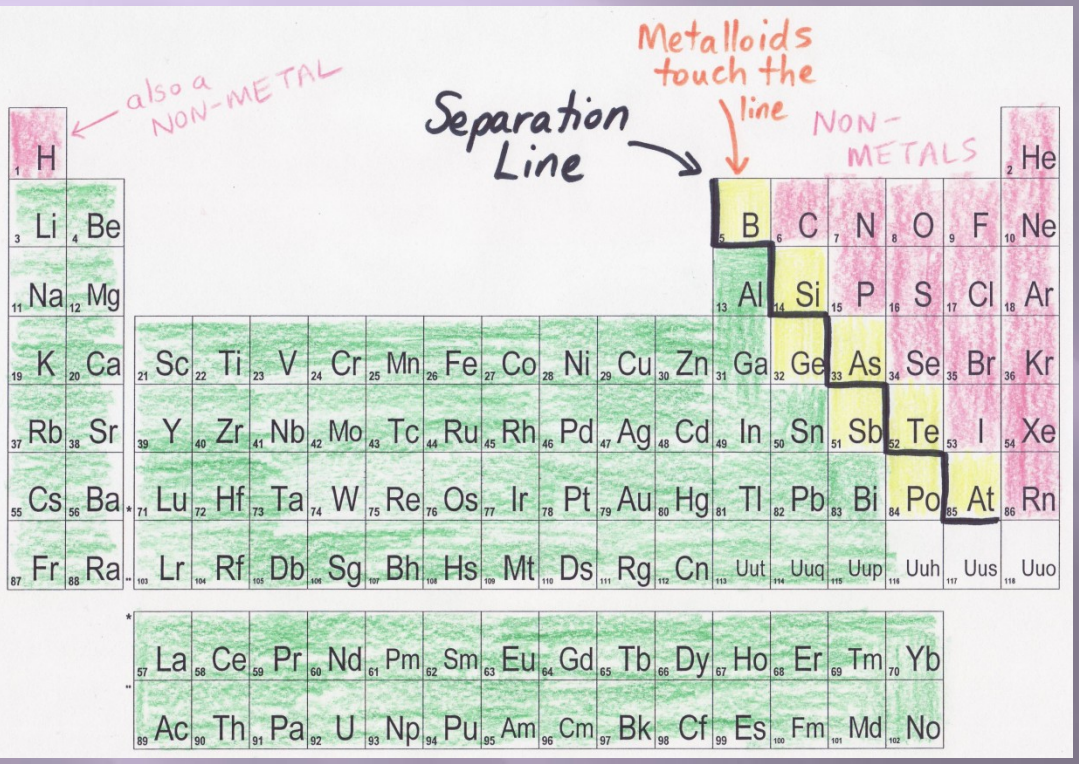
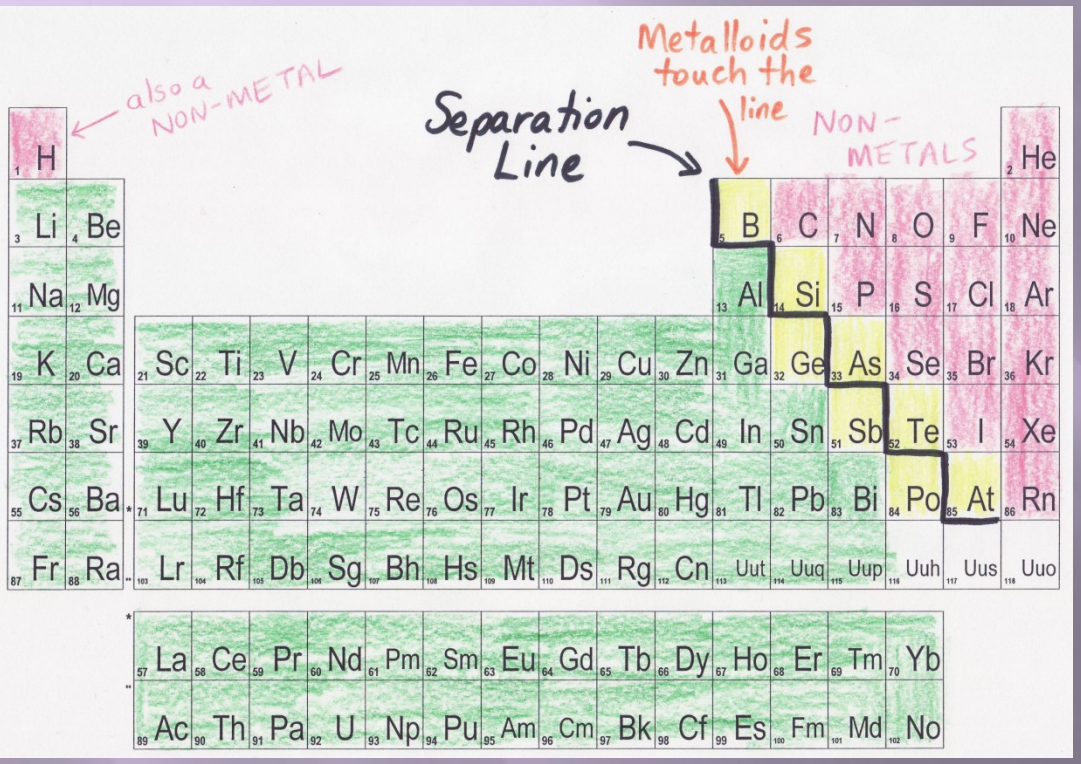
Trends of the Periodic Table
and
Atomic Bonds

Periodic Table Trends



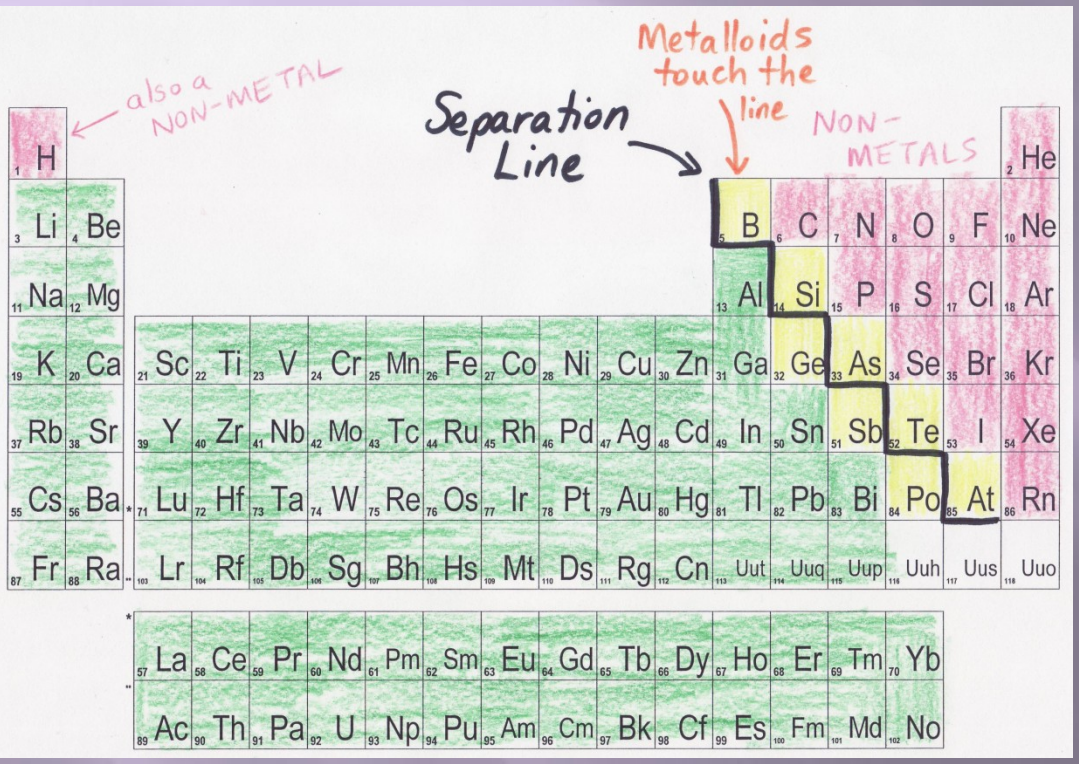
- **Periodic Table was developed looking for trends amongst the elements**
  - **<u>Arranged in order of increasing atomic number</u>**
  - **Properties of atoms are displayed in their arrangement**
  - **Periodic Table is a repeating set of trends**

From Left to Right Across the Table



- Metals to metalloids to non-metals
- Atomic Numbers and Atomic Masses increase
- Number of valence electrons increases
- General reactivity decreases

From top to bottom



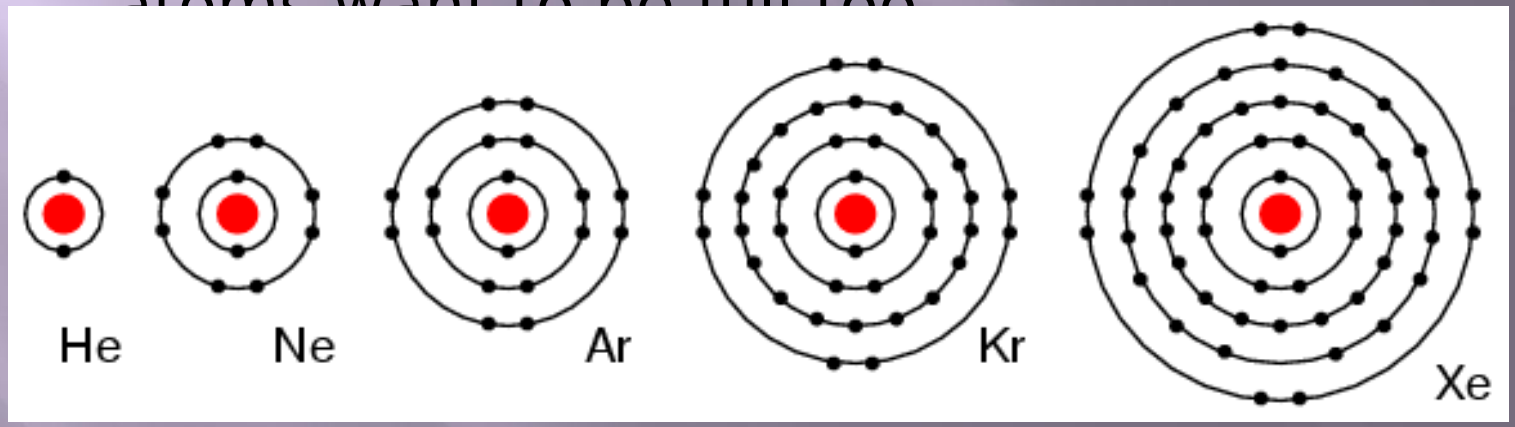
- Atomic Numbers and Atomic Masses increase
- Number of electron shells/orbitals/rings increases

Bonding

- Remember **Isotopes** are atoms with extra or fewer neutrons
- **Ions** are charged particles that form when an atom gains or loses electrons
  - Electrons are negatively charged
  - When an atom gains extra electrons it gains a negative charge
  - When an atom loses electrons it has a positive charge because there are more protons than electrons

Bonding

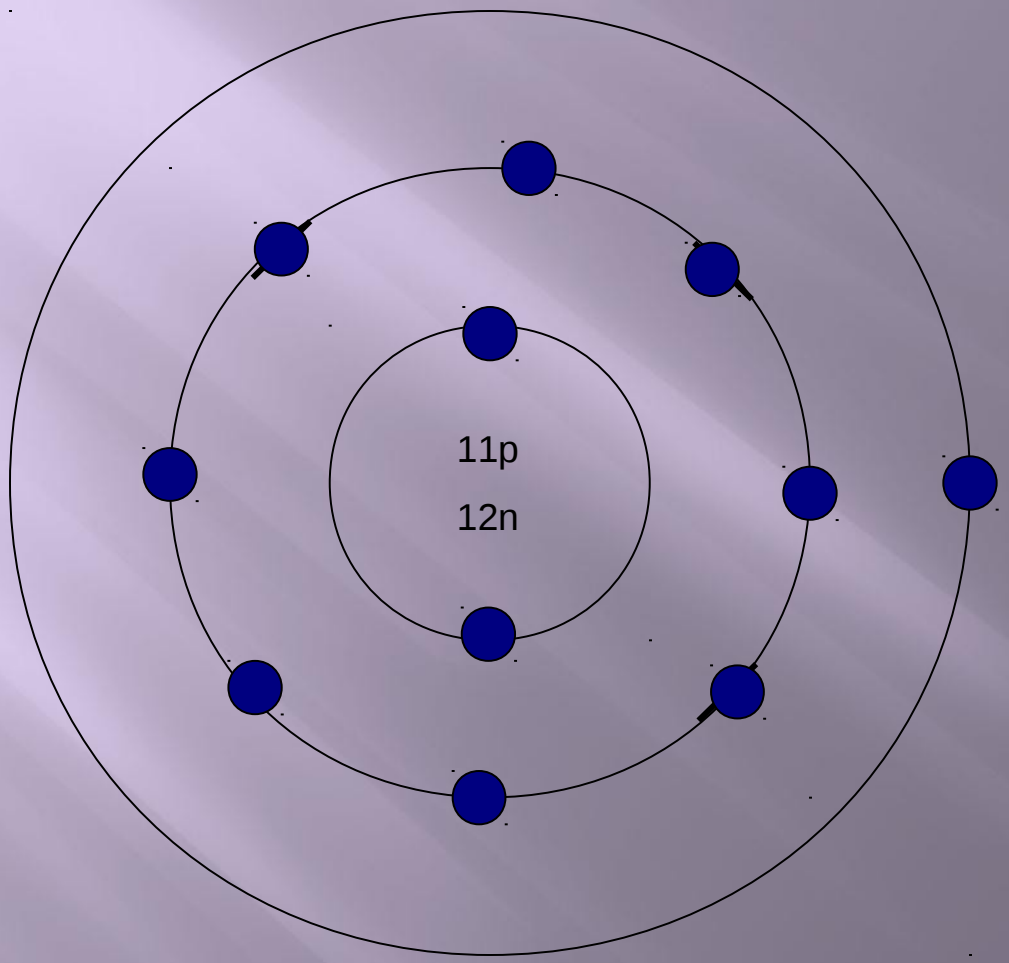
- Atoms want to have a full valence shell
  - For hydrogen and helium this is 2 valence electrons
  - For all others it is 8 valence electrons
  - These atoms all have full outer shells- other atoms want to be full too



IONIC Bonding

- Atoms with less than four electrons in their outer shell tend to lose electrons easily. This makes them positive ions
- Atoms with more than four valence electrons tend to gain electrons more easily making them negative ions
- If an element loses 1 electron it is a +1 charge. If it loses 2 it is a +2 and three is a +3.
- If an element gains 1 electron it is a -1 charge. If it gains 2 it is a -2 and three is a -3.
- Positive and negative ions attract each other and are bonded by this attraction- called an **ionic bond**

IONIC BONDING



Sodium

Na

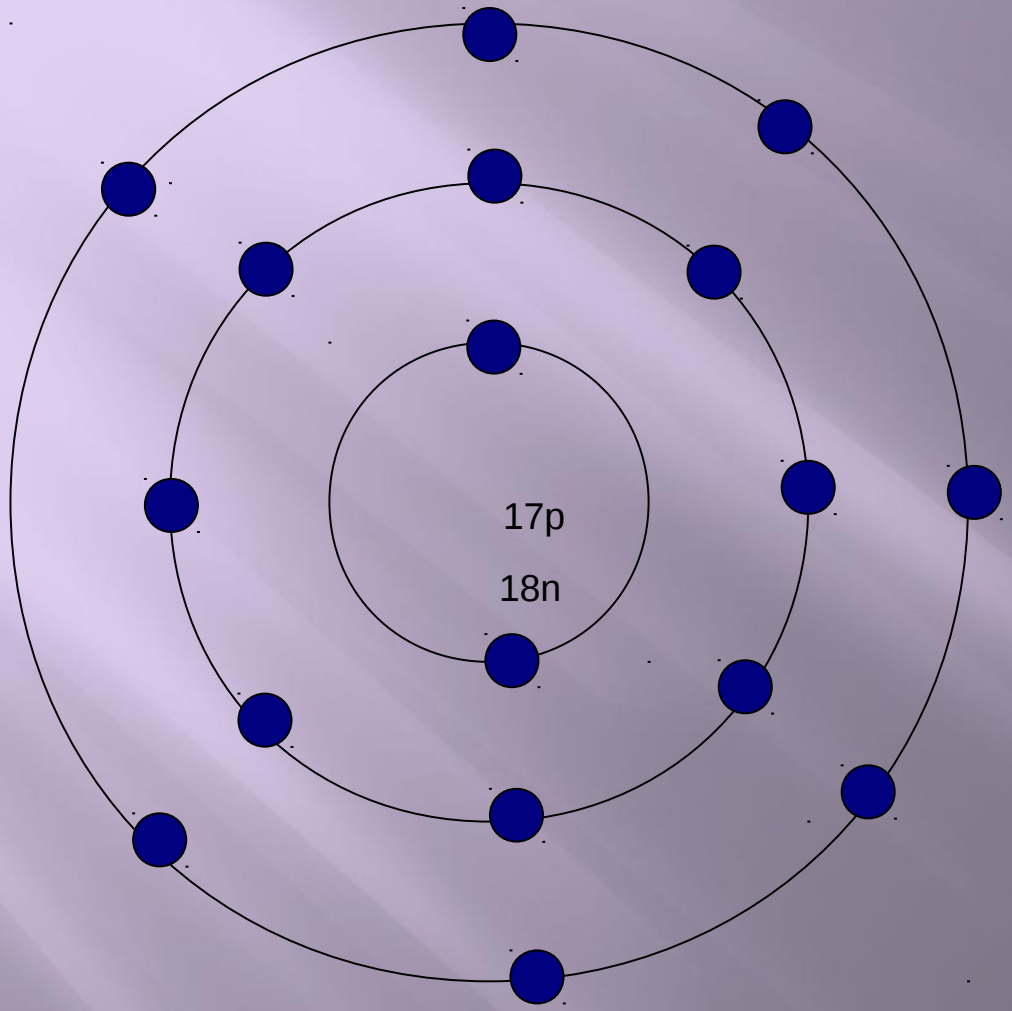
11 protons

12 neutrons

11 electrons

Metals like sodium have fewer than four electrons and can lose their valence electrons so that the remaining shell is full. This would be written as Na+

IONIC Bonding



Chlorine

$_{1}$ Cl

17 protons

18 Neutrons

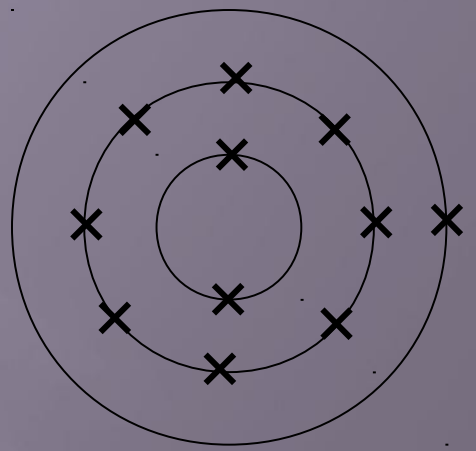
17 electrons

Non-Metals like chlorine have more than four valence electrons and can gain electrons to develop a negative charge to make their outer shell full. This would be written as Cl-

The Sodium atom has 1 Electron in it's outer shell.

Na

Atom

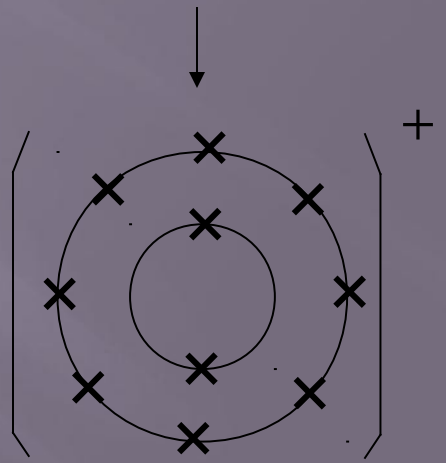


The Sodium loses 1 electron to leave a complete outer shell.

It is now a Sodium ion with a charge of 1 +

(Na^{+})

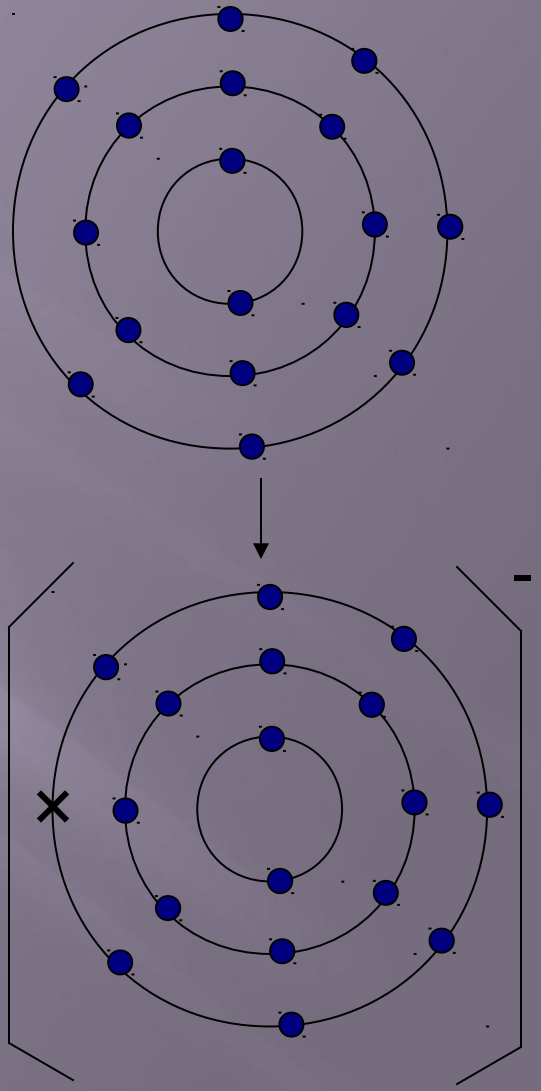
Ion



The Chlorine atom has 7 electrons in it's outer shell.

Cl

Atom



The Chlorine gains 1 electron to gain a complete outer shell.

It is now a Chlorine ion with a charge of 1 -

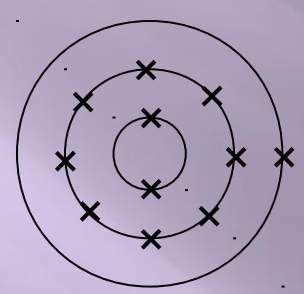
(Cl^-)

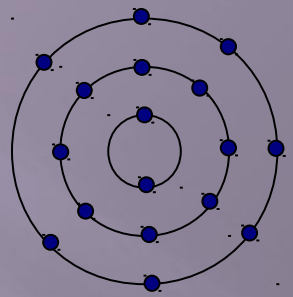
Ion

The Ionic Bond

Sodium atom

Na



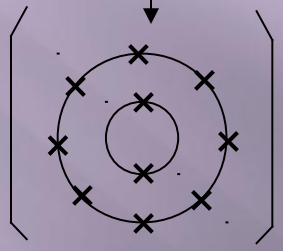


Chlorine atom

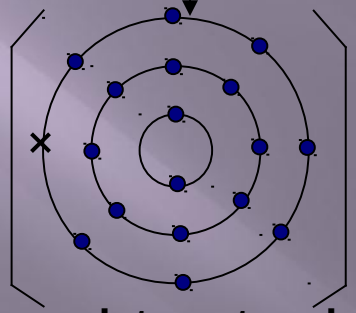
Cl

Sodium ion

(Na^+)



+



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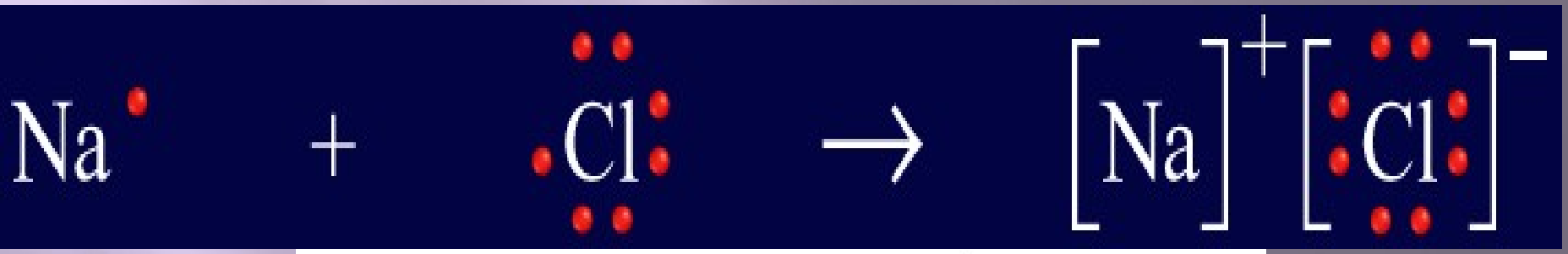
Chlorine ion

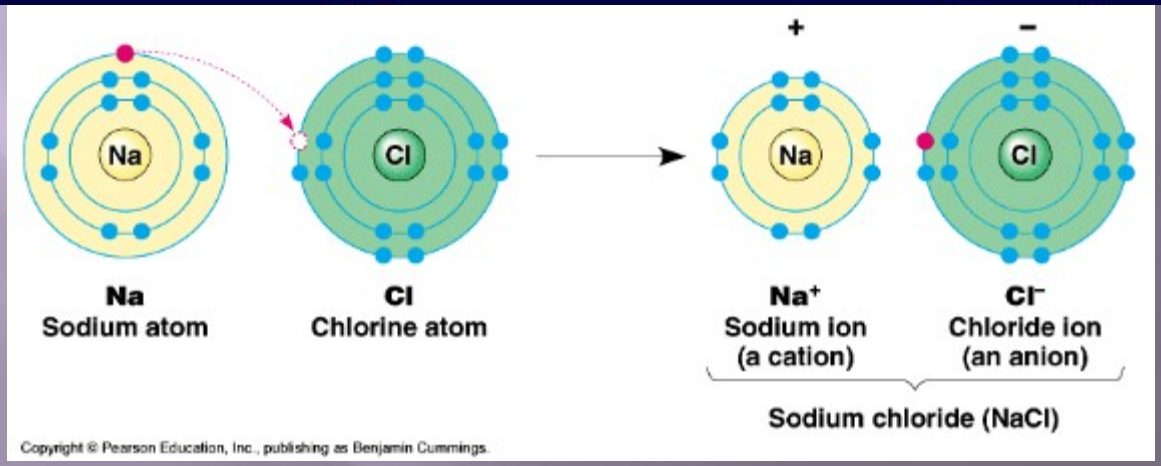
(Cl^-)

The sodium atom loses one electron to attain a complete outer shell and become a positive ion (Na^+).
The Chlorine atom gains one electron to attain a complete outer shell and become a negative ion (Cl^-).
Strong forces attract the positive sodium and negative chlorine ions. (positive and negative attract)

Sodium Chloride, the new molecule, is neutrally charged because the single negative charge cancels out the single positive charge

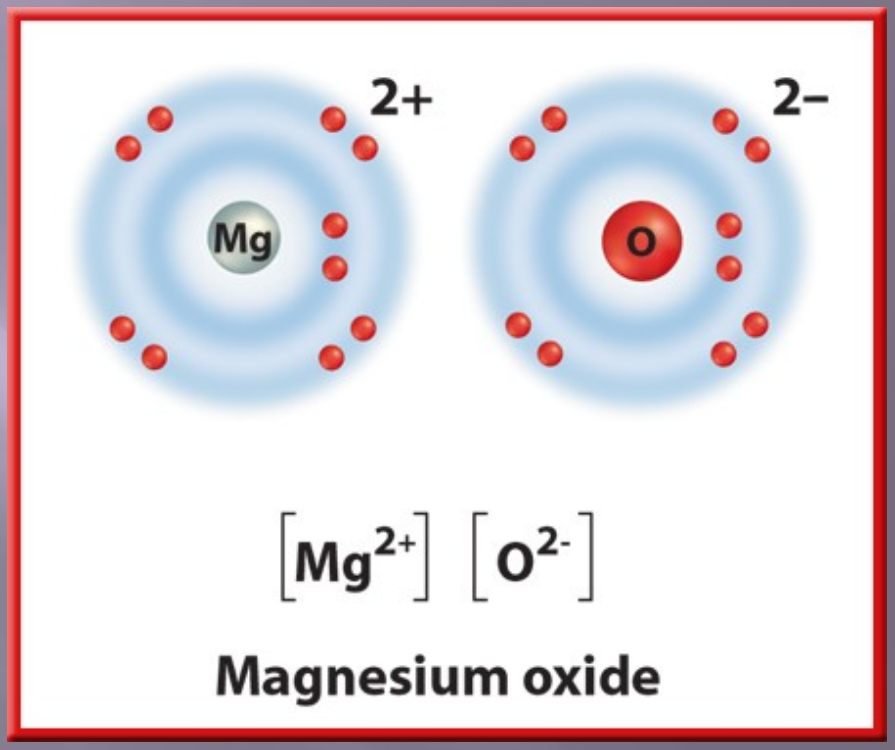
- This can also be shown with electron dot diagrams.





More Gains and Losses

- Can elements lose or gain more than one electron?
- The element magnesium, Mg, in Group 2 has two electrons in its outer energy level.



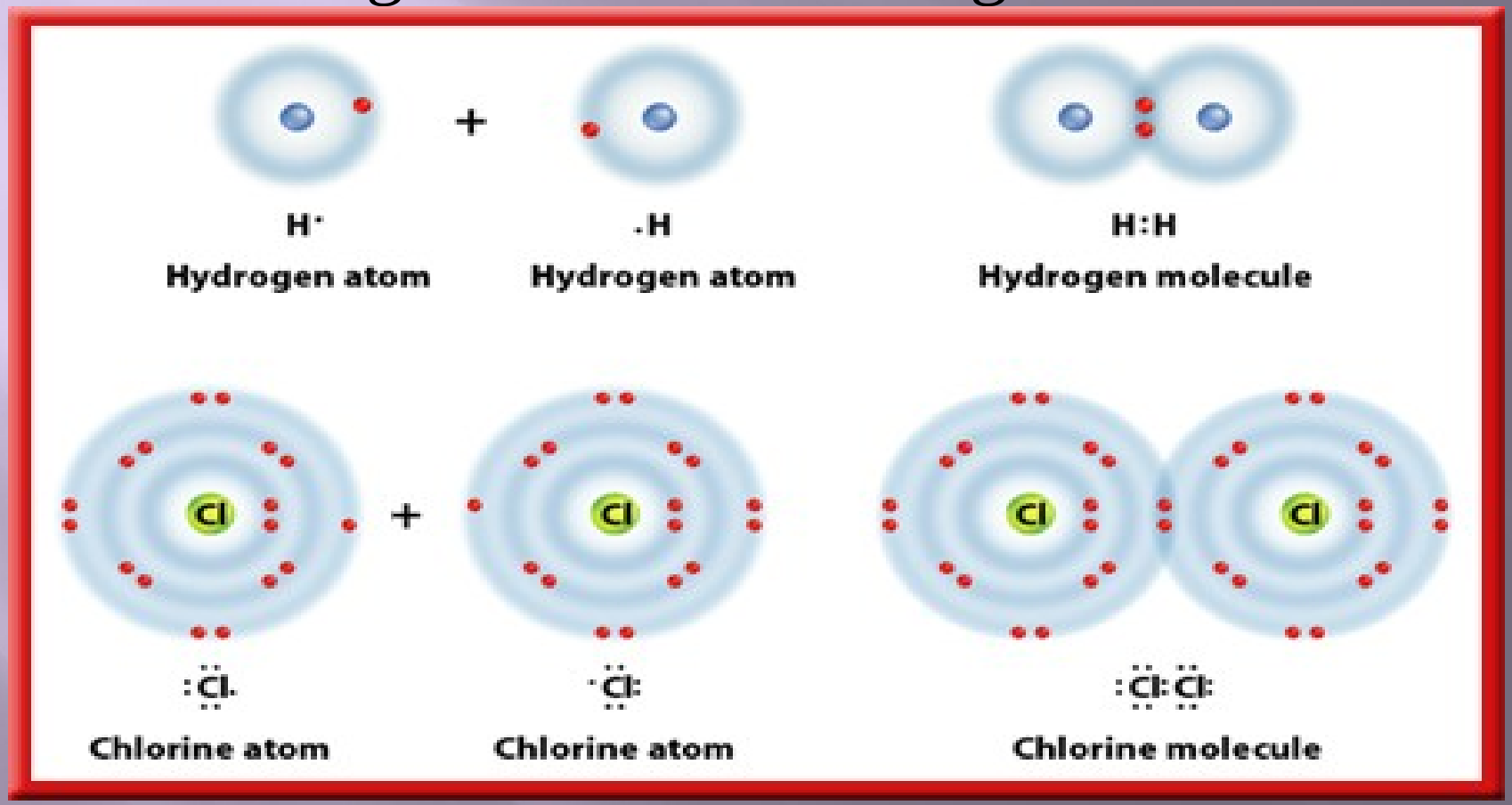
- Magnesium can lose these two electrons and achieve a completed energy level.

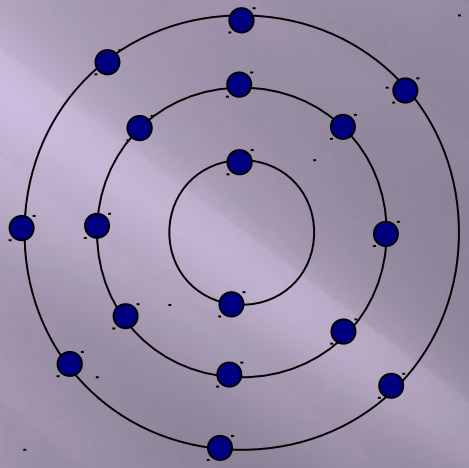
Covalent Bonding

- Much of the world is made up of covalent bonds
- In covalent bonds, atoms share some valence electrons to feel as though their valence shell is full.
- Covalent bonds occur between non-metals sharing valence electrons
- Covalent bonds are often illustrated with electron dot diagrams or by showing only the valence shells

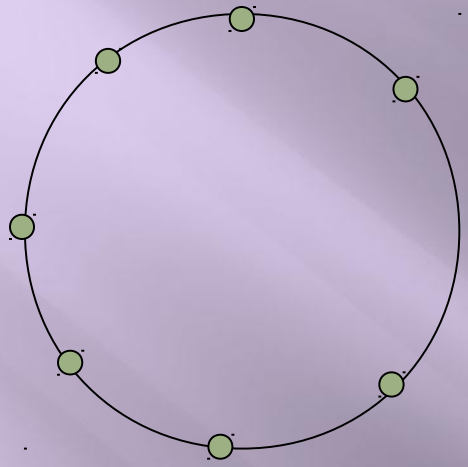
The Covalent Bond

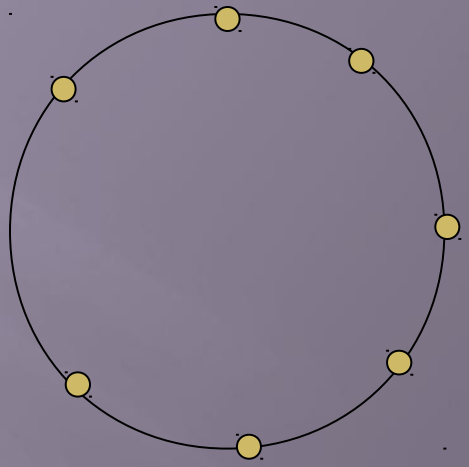
- You can see how molecules form by sharing electrons in this figure.





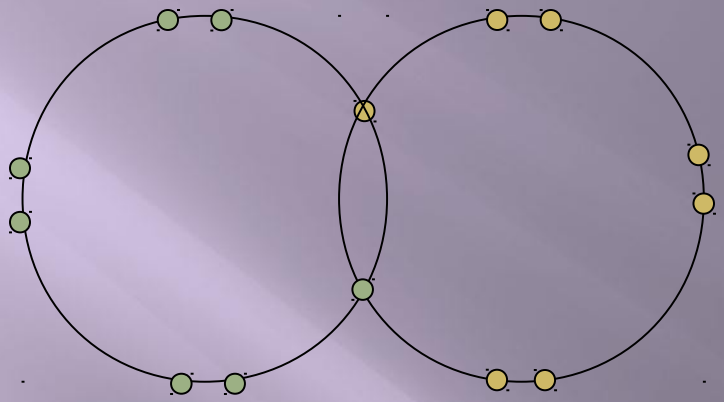
Chlorine atom





2 Chlorine atoms

Outer shells only



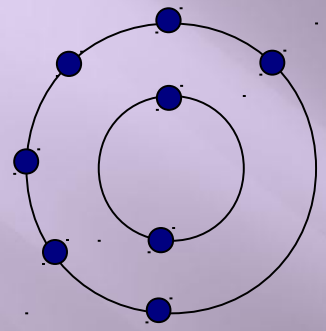
Chlorine molecule Cl_2

Electrons shared

Each outer shell has 8 electrons

Molecular or covalent compounds are usually gases or liquids – they have low melting points and low boiling points

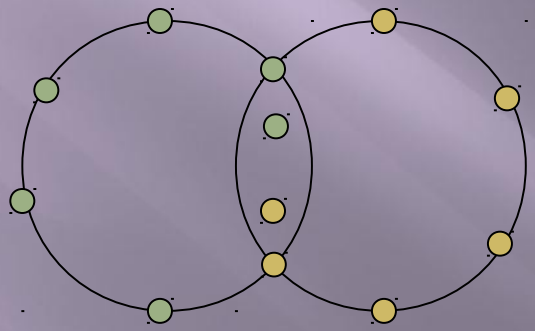
Molecules have no overall electric charge



Oxygen atom 2,6

Oxygen O_{8}^{16}

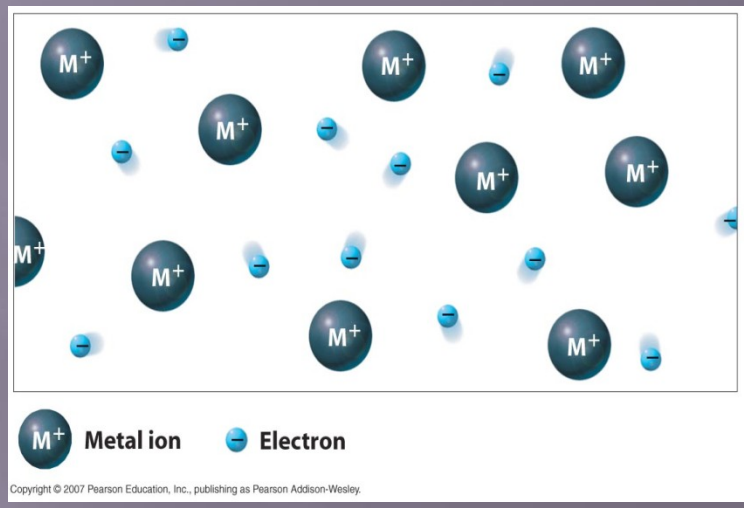
2 Oxygen atoms (outer shells only)

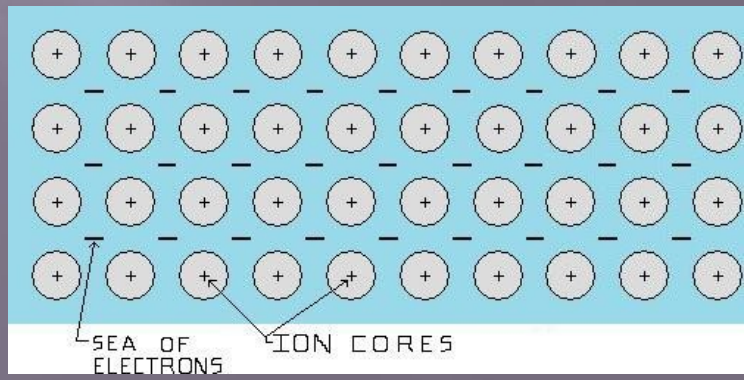


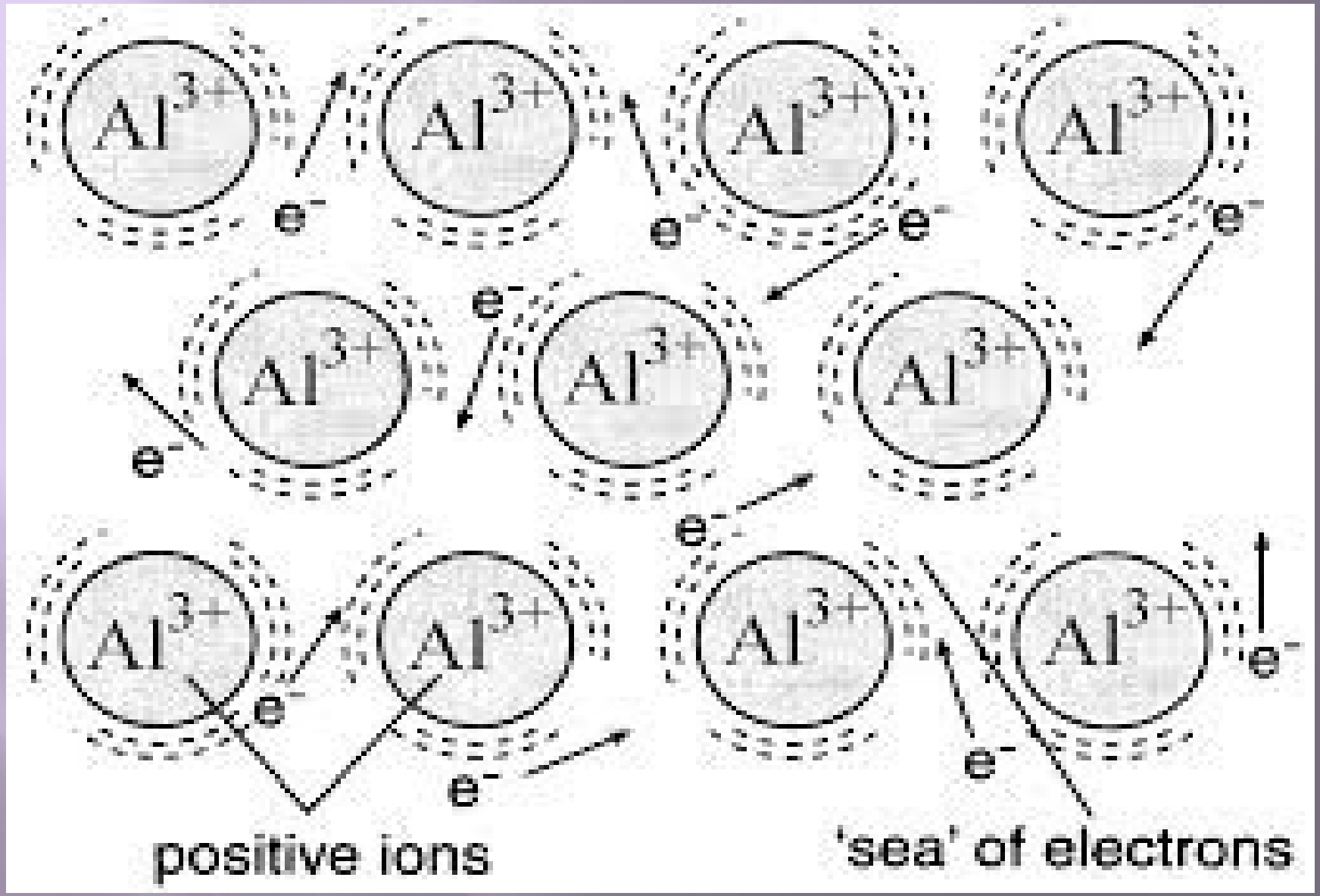
covalent bond

Metallic Bonds

- Special kind of bond that occurs with metals
- Metals have few valence electrons which they can lose easily
- Electrons can separate from multiple metal atoms an form an electron cloud that contains the atoms and the free floating electron
- The cloud is negative and this attracts the now positively charged metal atoms
- This kind of bond is what makes metals malleable and ductile
- The free movement of the electrons allow for metals to be good conductors






Al3+
e−
positive ions
'sea' of electrons