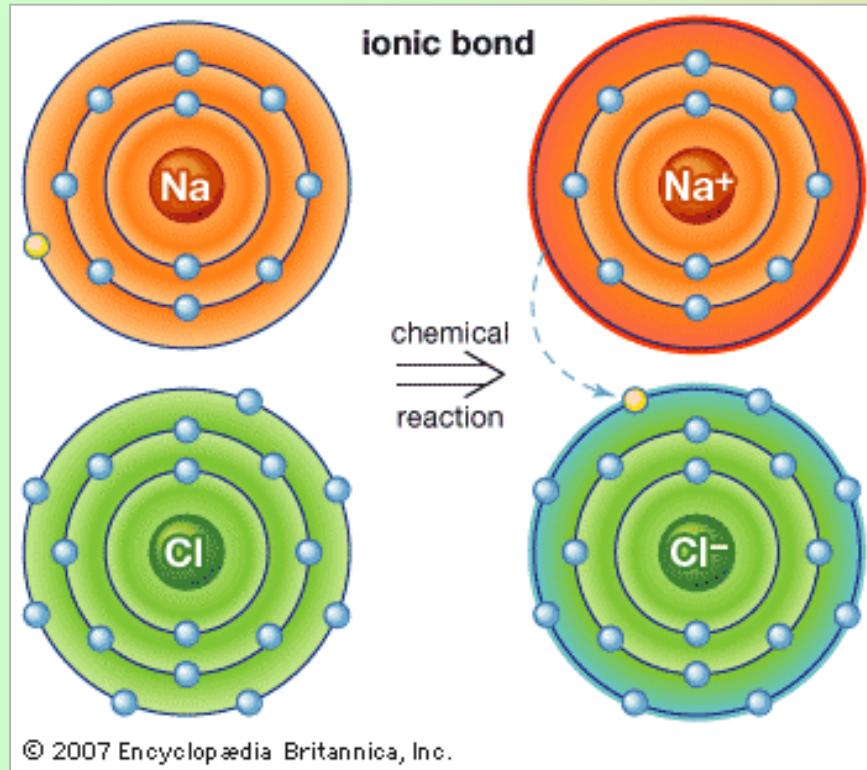


# Ionic Bonding

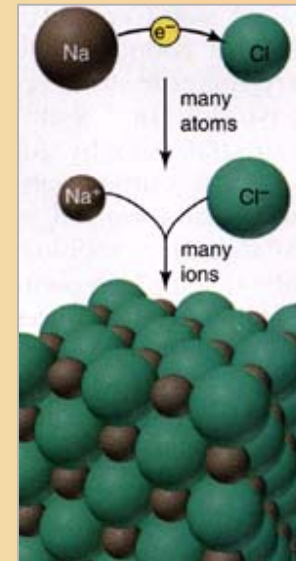


An atom of sodium (Na) donates one of its electrons to an atom of chlorine (Cl) in a chemical reaction. The resulting positive ion ( $\text{Na}^+$ ) and negative ion ( $\text{Cl}^-$ ) form a stable molecule (sodium chloride, or common table salt) based on this ionic bond.

## The Formation of an Ionic Bond

The central theme of the ionic bonding is the **transfer of electrons from metal to nonmetal** that come together in a solid ionic compound.

Look at the formation of sodium chloride.





# Ionic Bonding

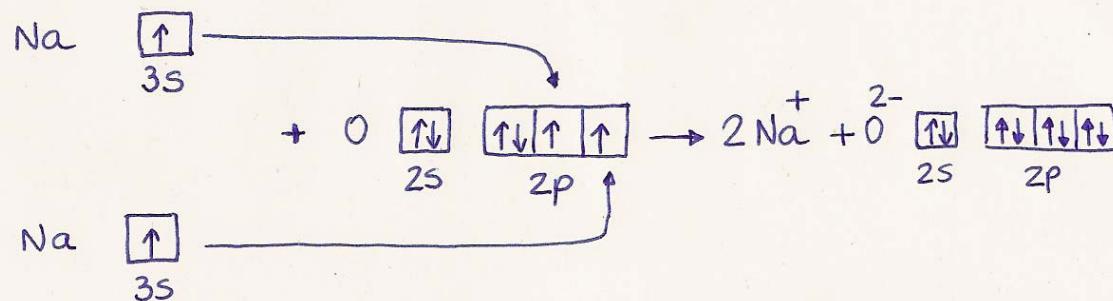
## Exercise #01

Use partial orbital diagrams and Lewis symbols to depict the formation of ions from the the atoms and determine the formula of the compound.

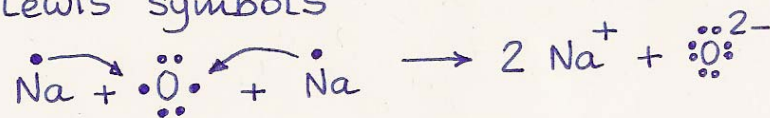
1. K + F;
2. Ca + O
3. Al + S

Example: Na + O

a) partial orbital diagrams

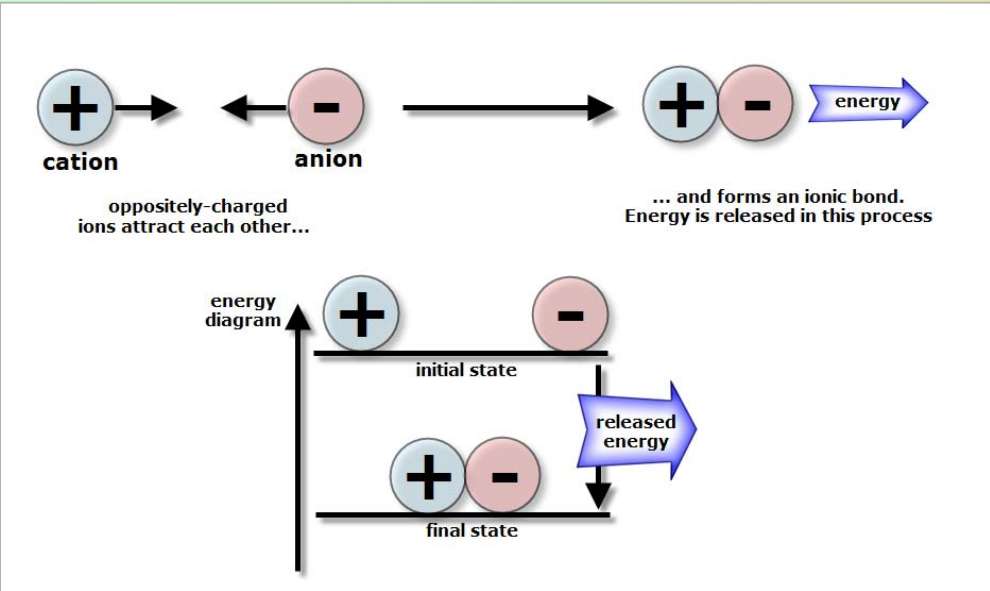


b) Lewis symbols



The formula is Na<sub>2</sub>O

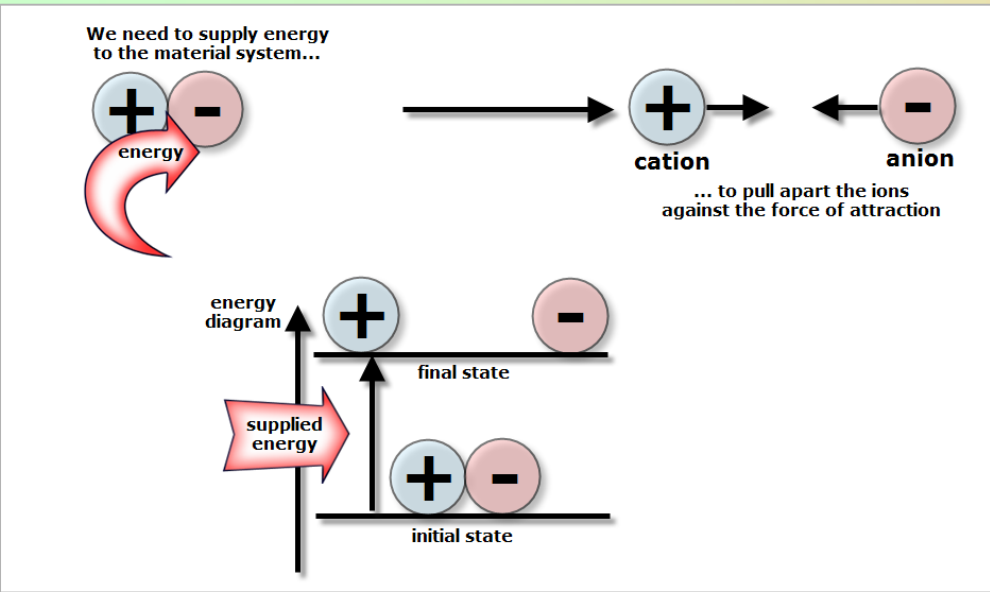
# Ionic Bonding



## Energy considerations

When two opposite charged particles attract each other, energy is released in the process.

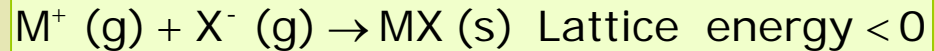
If we want to break apart two ions, we need to supply energy.



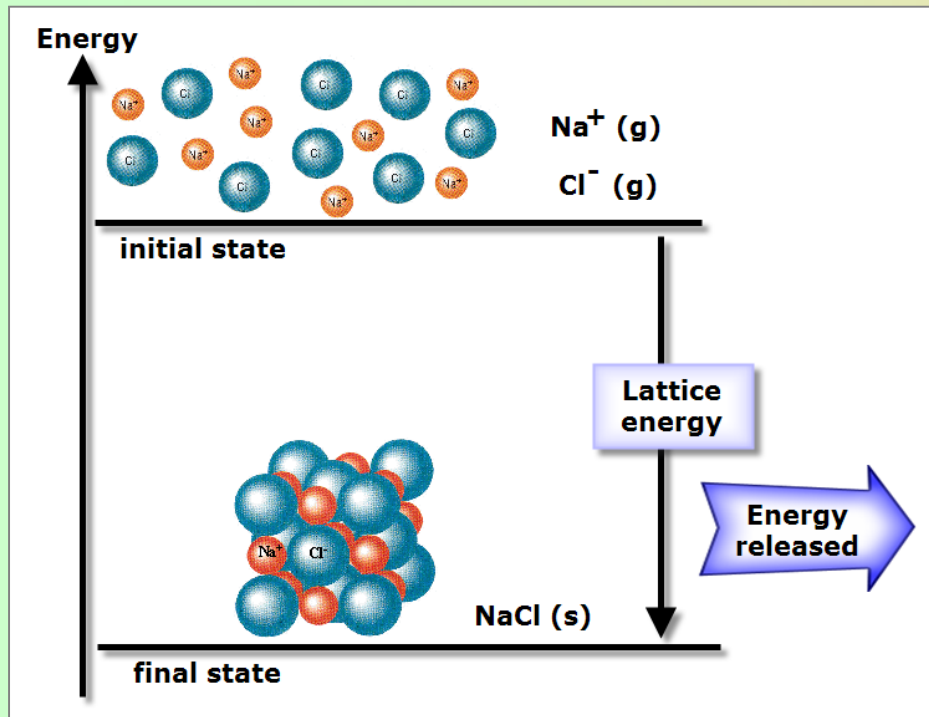
# Ionic Bonding

## Energy considerations

**Lattice energy** is the energy (enthalpy) change (energy **released**) that accompanies gaseous ions (isolated ions) coalescing into an ionic solid:



Since this process is exothermic (releases energy) lattice energy is always negative.



$$\begin{aligned} \text{Lattice energy} &= \text{Energy (final state)} - \text{Energy (initial state)} \\ &= \text{Energy} [NaCl(s)] - \text{Energy} [Na^+ (g) + Cl^- (g)] < 0 \text{ (negative)} \end{aligned}$$

# Ionic Bonding

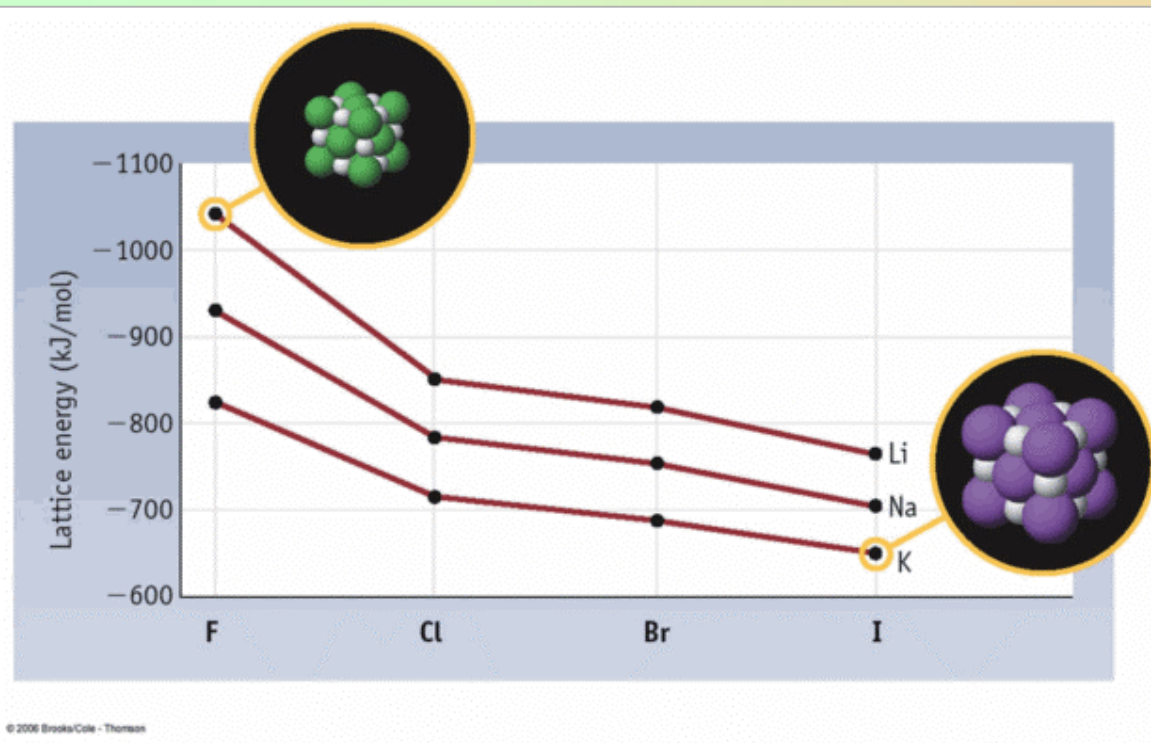
## Energy considerations

Since the lattice energy is the result of electrostatic interactions among ions, its magnitude to depends on several factors, including

- ionic size
- ionic charge
- ionic arrangement in the solid

according to the following equation:

$$\text{Electrostatic energy} \propto \frac{\text{charge ion A} * \text{charge ion B}}{\text{distance}}$$

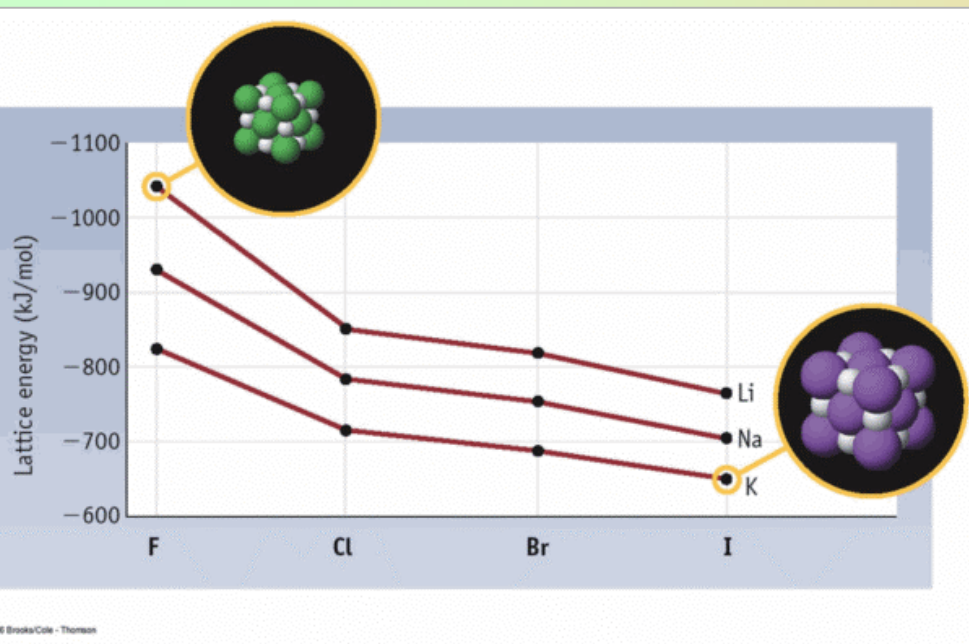


# Ionic Bonding

## Energy considerations

• **Effect of ionic size.** When the size of ions (anions and cations) increase (as we move down a group) the energy of attraction decreases and the lattice energy decreases.

• **Effect of ionic charge.** When the charge of ions increase the energy of attraction increases and the lattice energy increases.



ionic size ↓  
ionic charge ↑ } attraction energy ↑ and lattice energy ↑