PREDICTING ION CHARGES

In general

• metals (Mg) lose electrons → cations
• nonmetals (F) gain electrons → anions

See CD-ROM Screen 3.5 and book Figure 3.7

Charges on Common Ions

<table>
<thead>
<tr>
<th>+1</th>
<th>+2</th>
<th>-1</th>
<th>-2</th>
<th>-3</th>
<th>-4</th>
</tr>
</thead>
<tbody>
<tr>
<td>H</td>
<td>Li</td>
<td>Na</td>
<td>Mg</td>
<td>Al</td>
<td>Si</td>
</tr>
<tr>
<td>C</td>
<td>N</td>
<td>O</td>
<td>F</td>
<td>P</td>
<td>S</td>
</tr>
<tr>
<td>Cl</td>
<td>Ar</td>
<td>Kr</td>
<td>Xe</td>
<td>Cs</td>
<td>Ba</td>
</tr>
</tbody>
</table>

METALS

$M \rightarrow n\,\text{e}^- + M^{n+}$

where $n = \text{periodic group}$

• Na$^+$
• Mg$^{2+}$
• Al$^{3+}$
• Transition metals: $M^{2+}$ and $M^{3+}$ are common

NONMETALS

NONMETAL + $n\,\text{e}^- \rightarrow X^{n-}$

where $n = 8 - \text{Group no.}$

• C$^{4-}$ carbide
• N$^{3-}$ nitride
• O$^{2-}$ oxide
• F$^-$ fluoride
Polyatomic ions are groups of atoms with a charge.

**MEMORIZE** the names and formulas in Table 3.1, page 107.

- **HNO₃** - nitric acid
- **NO₃⁻** - nitrate ion
- **NH₄⁺** - ammonium ion
- **CO₃²⁻** - carbonate ion
- **HCO₃⁻** - bicarbonate ion

Many polyatomic ions are derived from acids. Notice that the negative charge symbol is written as a trailing superscript to the entire formula.

Ammonium is one of the few common polyatomic cations. These arise from carbonic acid, **H₂CO₃**.
Some Common Polyatomic Ions

$\text{PO}_4^{3-}$
phosphate ion

$\text{CH}_3\text{CO}_2^-$
acetate ion

$\text{SO}_4^{2-}$
sulfate ion

$\text{SO}_3^{2-}$
sulfite ion

$\text{NO}_3^-$
nitrate ion

$\text{NO}_2^-$
nitrite ion

A neutral compound requires equal numbers of + and - charges.

COMPOUNDS FORMED FROM IONS

CATION + ANION → COMPOUND

$\text{Na}^+ + \text{Cl}^- \rightarrow \text{NaCl}$
IONIC COMPOUNDS

ammonium chloride, NH₄Cl

Some Ionic Compounds

Ca²⁺ + 2 F⁻ → CaF₂
Name = calcium fluoride

Mg²⁺ + NO₃⁻ → Mg(NO₃)₂
magnesium nitrate

Fe²⁺ + PO₄³⁻ → Fe₃(PO₄)₂
iron(II) phosphate

(See CD-ROM screen 3.12 for naming practice)

Properties of Ionic Compounds

- A metal atom can transfer an electron to a nonmetal.
- The resulting cation and anion are attracted to each other by electrostatic forces.
- The pair of ions must have zero net charge, so the number of cations times their charge equals the number of anions times their charge.

Electrostatic Forces

The oppositely charged ions in ionic compounds are attracted to one another by ELECTROSTATIC FORCE.

This force is governed by COULOMB’S LAW.

KBr crystal

See screen 3.7 on the CD-ROM.
**Electrostatic Forces**

**COULOMB’S LAW**

\[
\text{Force of attraction} = \frac{\text{(charge on +)}(\text{charge on -})}{(\text{distance between ions})^2}
\]

As ion charge increases, the attractive force \text{**INCREASES**}.

As the distance between ions increases, the attractive force \text{**DECREases**}.

This law controls chemistry and thus forms the basis of what we’re doing!

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**Results of Coulomb’s Law**

- **NaCl, Na\(^+\) and Cl\(^{-}\)**, m.p. 804 °C
- **MgO, Mg\(^{2+}\) and O\(^{2-}\)**, m.p. 2800 °C