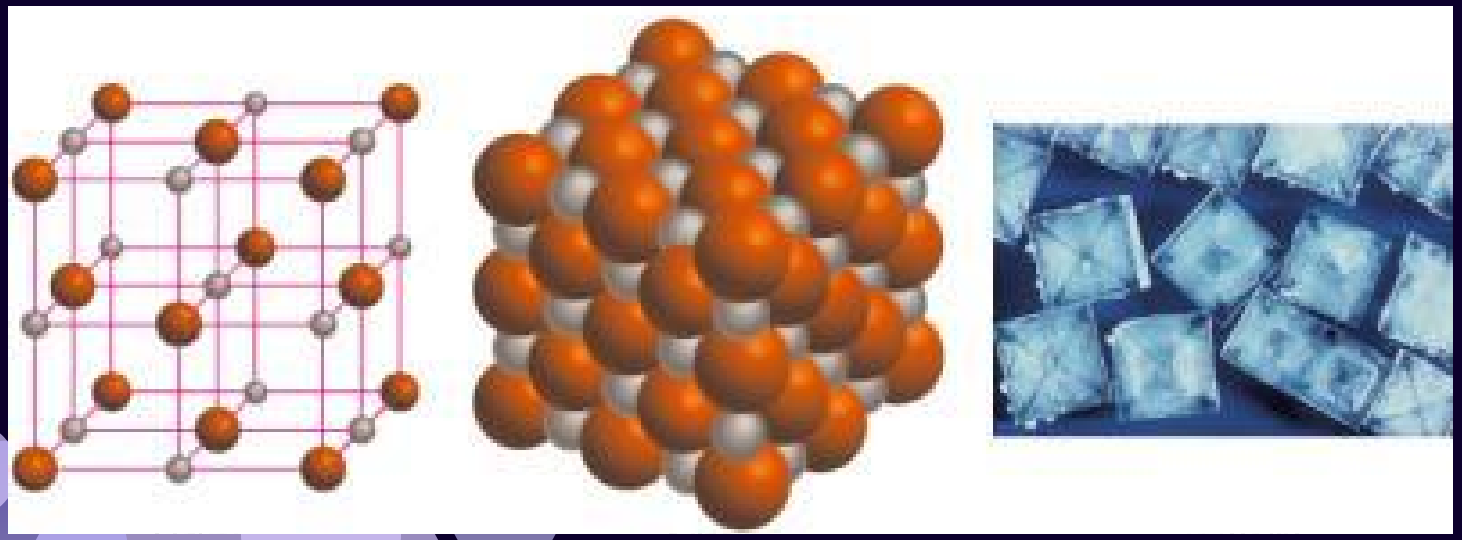
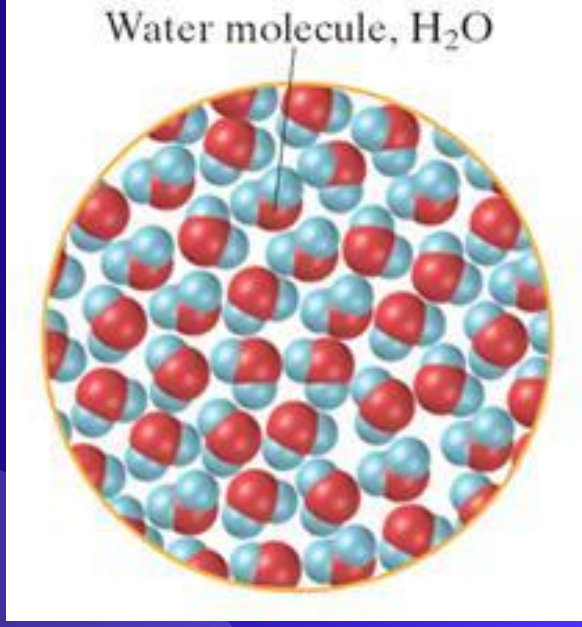
# Ionic Compounds

Why are they formed? How do we go about naming and writing formulae?



# Compounds




- Recall from the last section that compounds are:
  - Pure substances that contain more than one type of atom chemically combined in the same proportions
  - In other words compounds contain the same elements and always in the same whole number ratio

# Chemical Formulae

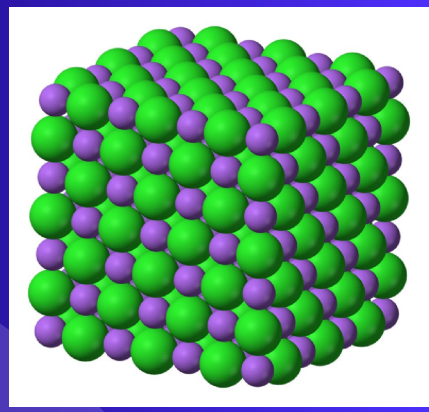

Like elemental symbols, scientists use **chemical formulae** to provide information about compounds:

- Describes what elements are present in a chemical compound
- Gives the relative proportions of those elements

**Examples:**

1. $CaCl_2$- contains one atom of calcium and 2 atoms of chlorine
2. $Mg(OH)_2$- contains one atom of magnesium, two atoms of oxygen, and two atoms of hydrogen

# Ionic Compounds



- Contain a metal (becomes a cation) and a non-metal (becomes an anion)
- Are held together by the attraction of oppositely charged ions, formed by an electron transfer
  - All of the positives and negatives organize nicely.
    - Negative-positive attract
    - Negative-negative and positive-positive repel

# Naming Ionic Compounds

- The name of an ionic compound = cation + anion-*ide*
  - For example, an ionic compound forms between magnesium and oxygen
    - The cation is the first part of the name, magnesium
- The anion forms part of the ending of the name, oxygen
- Add *-ide* to the end of the name to form
- MAGNESIUM OXIDE.

# Ionic formulas are based on the ions of the atoms involved!

- For example, what is the name of $Ca_3N_2$?
  - Ca, the cation, is calcium $Ca^{2+}$
  - N, the anion, is nitrogen $N^{3-}$
  - Drop the end of the anion and add *–ide*
  - The name of the compound is Calcium Nitride

*What do you notice about the number of positive charges and the number of negative charges based on its formula???*

# Writing formulas for ionic compounds

- As we just noticed, in ionic compounds the positive charges balance out the negatives so that the compound is neutral
  - The ratio of positive : negative charges gives the proper formula
    - The ratio is always written in reduced form
    - For example, what is the formula for <u>magnesium phosphide</u>?

# Magnesium Phosphide

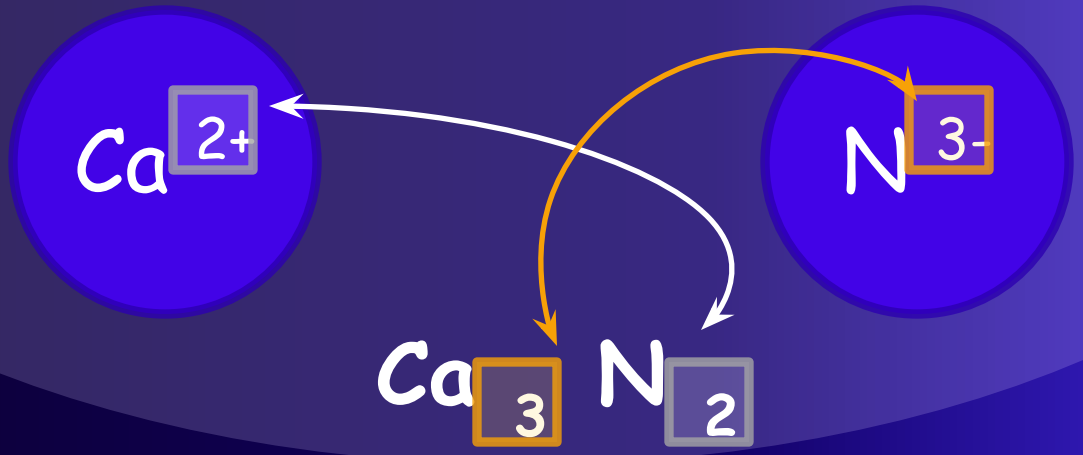
- Magnesium is $Mg^{2+}$ Phosphorous is $P^{3-}$
- Lowest common multiple of 2 and 3 is 6
- 3 $Mg^{2+}$ ions and 2 $P^{3-}$ ions

- $Mg_3P_2$


*Do you notice anything about the charge on the cation and the number of atoms of the anion? (and vice versa?)*

# A short-cut...
# The "Criss-cross Method"

- Another way to predict the formula is to "criss-cross" the charge on the cation to produce the number of anions required (i.e. the subscript behind the anion), and vice versa



# Now you try: Predict the formula for CALCIUM OXIDE

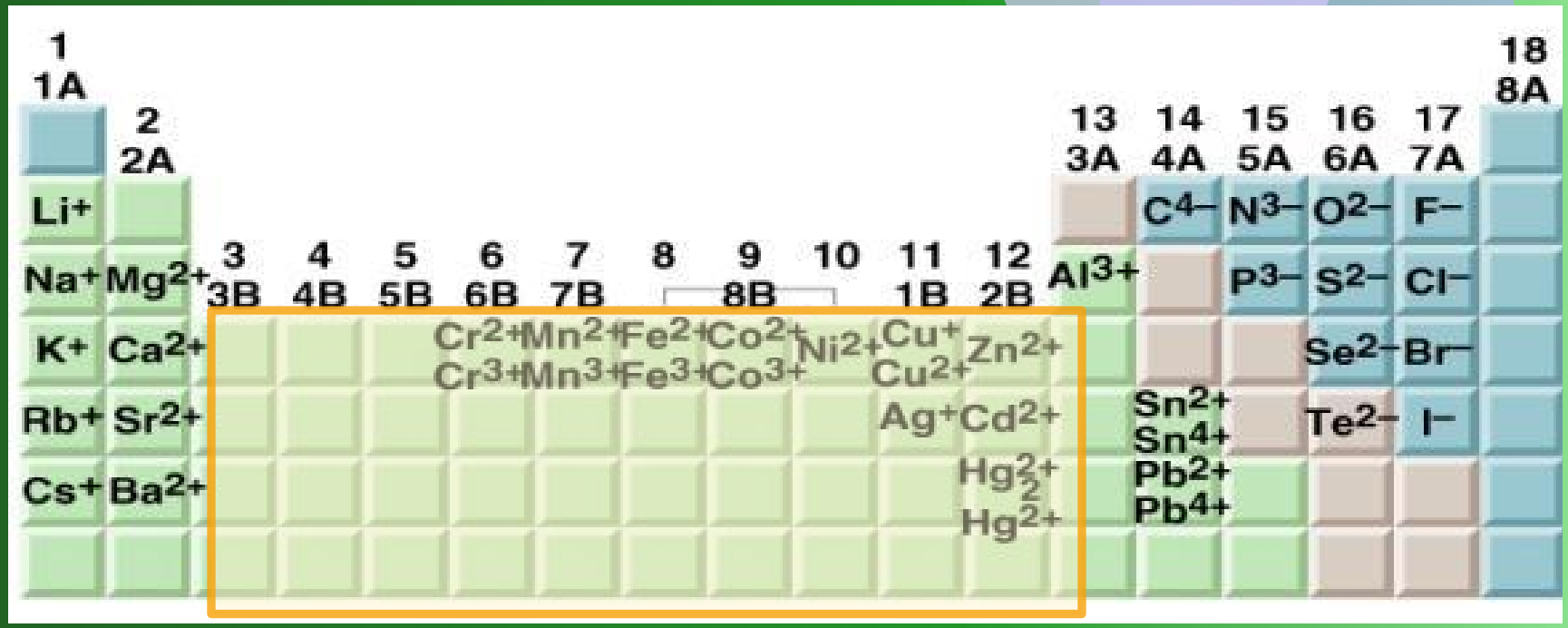
- Calcium is $Ca^{2+}$ oxygen is $O^{2-}$


- 1 $Ca^{2+}$ ion and 1 $O^{2-}$ ion
- Therefore the compound is CaO
- *If you were "criss-crossing" the charges on the ions you would predict:* $Ca_2O_2$,
  - This is simplified to CaO

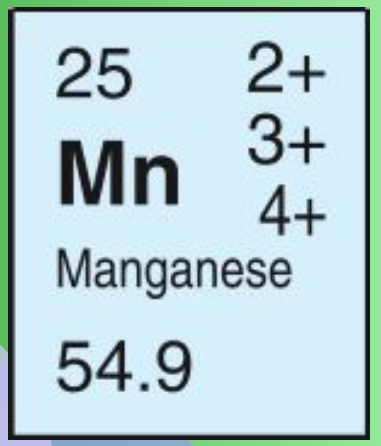
# Multivalent metals

Some transition metals are multivalent, meaning they have more than one ion form.

- In the name of the compound, Roman Numerals are used following the cation to indicate which ion was used



# Example: Formula for a multivalent Ionic compounds




For example:

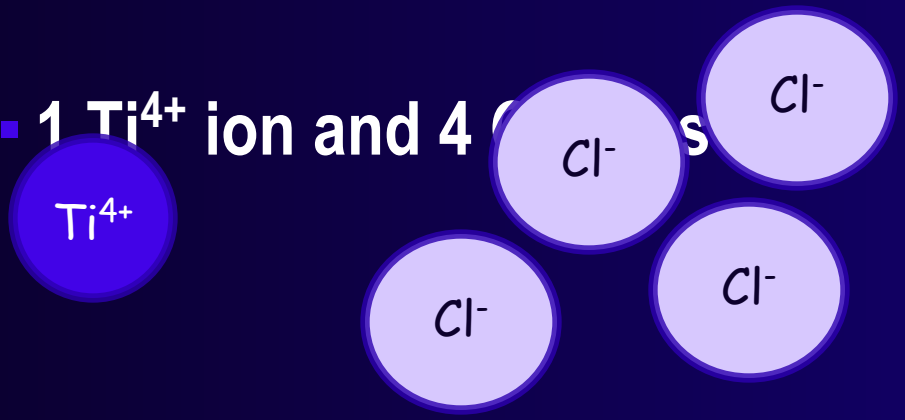
What is the formula for Manganese (III) sulphide?

- This manganese is $Mn^{3+}$ Sulphur is $S^{2-}$
- Lowest common multiple of 3 and 2 is 6
- 2 $Mn^{3+}$ ions and 3 $S^{2-}$ ions
- $Mn_2S_3$

# Now you try: Predict the name for the compound $TiCl_4$.

- Titanium is $Ti^{4+}$ or $Ti^{3+}$ Chlorine is $Cl^-$


- 1 $Ti^{4+}$ ion and 4 [illegible]s



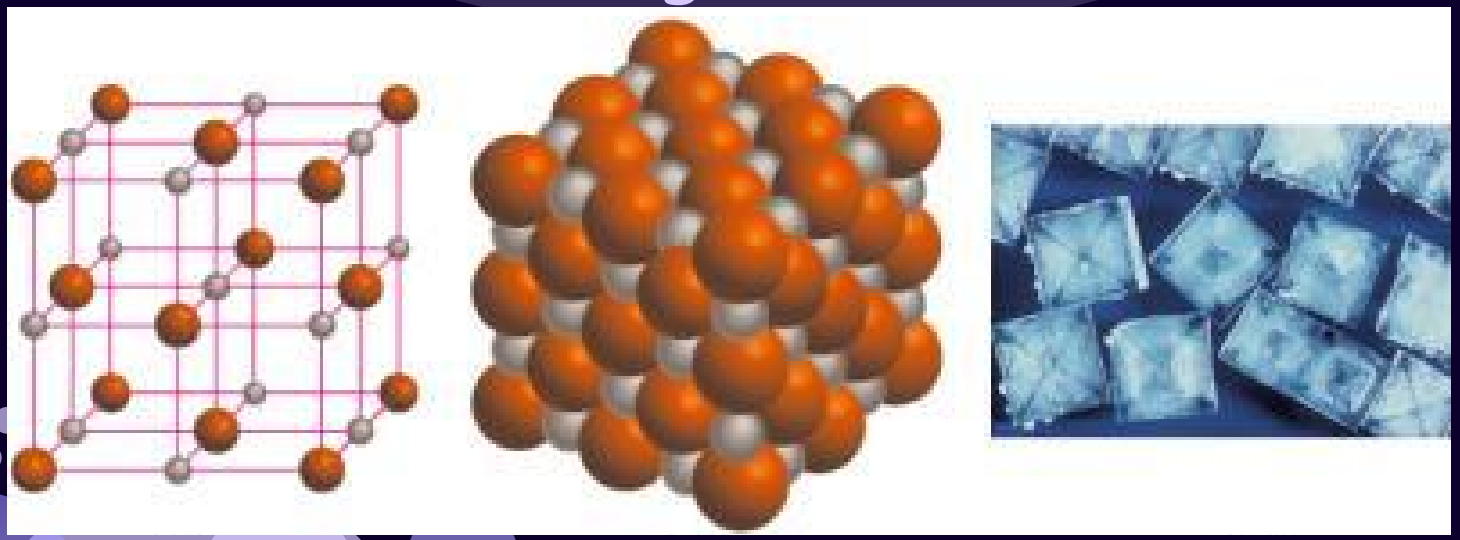

- Titanium (IV) chloride

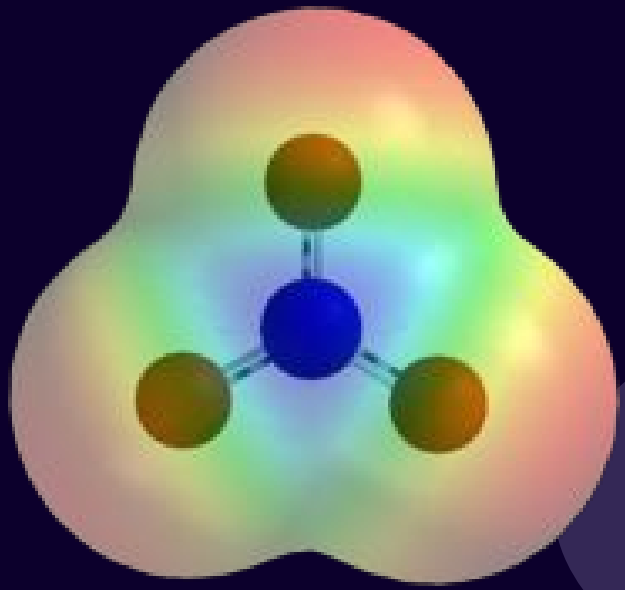
# Some Helpful Things!

- http://www.youtube.com/watch?v=fQx_sDvJyQA
- http://www.youtube.com/watch?v=sByxtSIHs34&feature=related
- http://www.youtube.com/watch?v=HETVLaQML5o&feature=related
- http://www.mpcfaculty.net/mark_bishop/ionic_nomenclature_tutorial.htm just do 1st 7 on each

# Ionic Compounds: Polyatomic Ions

Why are they formed? How do we go about naming and writing formulae?





# POLYATOMIC ION

- A group of atoms that tend to stay together and act as one charged ion

**Table 4.12** Names, Formulas, and Charges of Some Polyatomic Ions

| Positive Ions | Negative Ions | | |
|---|---|---|---|
| $NH_4^+$ ammonium | $CH_3COO^-$ acetate | $HCO_3^-$ hydrogen carbonate, bicarbonate | $NO_2^-$ nitrite |
| | $CO_3^{2-}$ carbonate | $HSO_4^-$ hydrogen sulphate, bisulphate | $ClO_4^-$ perchlorate |
| | $ClO_3^-$ chlorate | $HS^-$ hydrogen sulphide, bisulphide | $MnO_4^-$ permanganate |
| | $ClO_2^-$ chlorite | $HSO_3^-$ hydrogen sulphite, bisulphite | $PO_4^{3-}$ phosphate |
| | $CrO_4^{2-}$ chromate | $OH^-$ hydroxide | $PO_3^{3-}$ phosphite |
| | $CN^-$ cyanide | $ClO^-$ hypochlorite | $SO_4^{2-}$ sulphate |
| | $Cr_2O_7^{2-}$ dichromate | $NO_3^-$ nitrate | $SO_3^{2-}$ sulphite |

# Formulae containing polyatomic ions

- If more than one of a polyatomic ion is needed to balance charges, brackets are used to indicate you need more than one of the entire ion
  e.g. $Ca(OH)_2$ contains 2 hydroxide ($OH^-$) ions to balance $Ca^{2+}$

# Examples:

Predict the compound formed from:

$Na^+$ and $OH^-$ $NaOH$

$Mg^{2+}$ and $NO_3^-$ $Mg(NO_3)_2$

$NH_4^+$ and $SO_4^{2-}$ $(NH_4)_2SO_4$

# Naming compounds containing polyatomic ions

- If there is a formula which contains more than **two elements** you must go to the data sheet to determine the polyatomic ion(s) in the formula and the name the group is given

e.g. $Na_3PO_4$ contains **phosphate**

**The name of the polyatomic is written unchanged!**

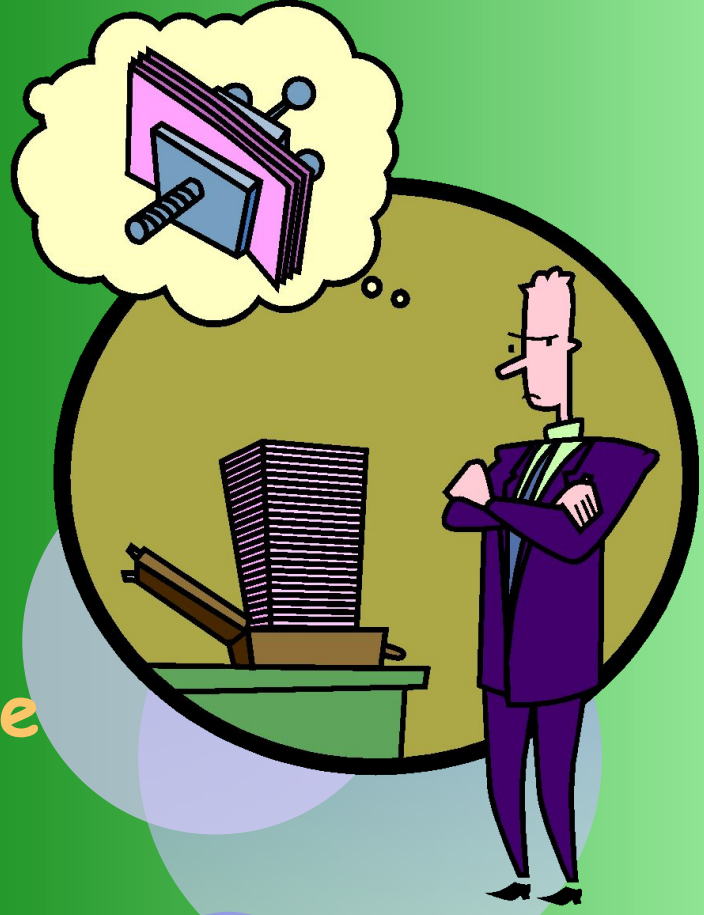
# Examples:

Predict the compound name:

$CaCO_3$ Calcium carbonate

KCN Potassium cyanide

$Ca_3(PO_4)_2$ Calcium phosphate



# IMPORTANT: You must always remember to check for multivalent ions!

- e.g. $Fe(OH)_2$
  Iron can be $Fe^{2+}$ or $Fe^{3+}$

So this compound is:

Iron (II) hydroxide