These notes are posted on my site for the following reasons:

- for students to copy in their own hand-writing
  - in order to complete their class notes
  - if student did not have enough time in class
  - if student was away and missed this section
- for assistants and tutors to follow progress of the concepts taught

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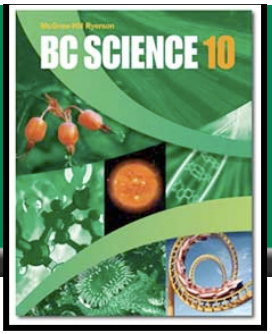
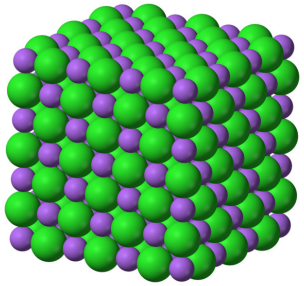
4.2 Names and Formulas of Compounds

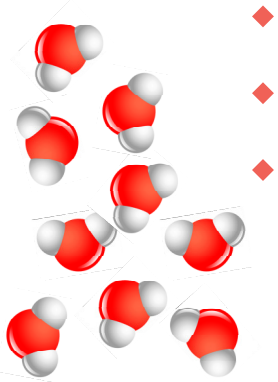


- **Ionic compounds are made up of positive and negative ions.**
  - All of the positives and negatives organize nicely.
    - Negative-positive attract
    - Negative-negative and positive-positive repel
  - Ionic compounds form from the inside-out as solid crystals
  - Ionic compounds are like a solid stack of bricks!
    - A salt shaker contains thousands of small pieces of NaCl



Salt, NaCl

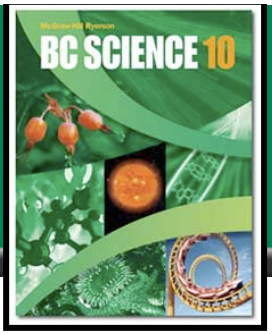
- **Covalent molecules share electrons.**
  - There is generally no order to the formation of covalent molecules
  - These molecules clump together as solids, liquids or gases
  - Covalent molecules are like a play-pit full of plastic balls
    - Each plastic ball = 1 covalent molecule of H_2O
    - Pit full of balls = swimming pool full of water



Water, H_2O

See pages 184 - 185

The Chemical Name and Formula of an Ionic Compound



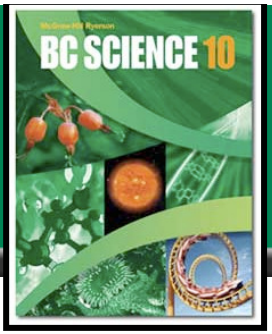
- **Ionic compounds are composed of cations and anions.**
  - **The name of an ionic compound = cation + anion-*ide***
  - **For example, an ionic compound forms between magnesium and oxygen**
    - **The cation is the first part of the name, magnesium**
    - **The anion forms part of the ending of 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**
  - **Remember the naming principles above**
  - **For example, what is the name of Ca_3N_2?**
    - **Ca, the cation, is calcium**
    - **N, the anion, is nitrogen**
    - **Drop the end of the anion and add *-ide***
    - **Calcium nitride**

Magnesium oxide is used as a drying agent.

Photo courtesy of the U.S. Department of Energy

See pages 186 - 187

The Chemical Name and Formula of an Ionic Compound (continued)



- **Writing formulas for ionic compounds.**
  - In an ionic compound, the positive charges balance out the negatives
  - 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 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
  - Try the formula for calcium oxide
    - calcium is Ca^{2+} oxygen is O^{2-}
    - 1 Ca^{2+} ion and 1 O^{2-} ions
    - Ca_2O_2, which is simplified and written as CaO

Calcium oxide, aka "quicklime" was produced by cooking limestone in ancient kilns.

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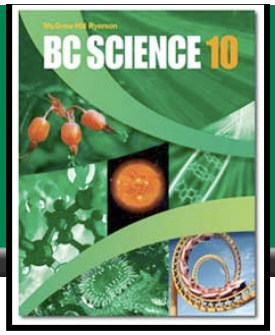
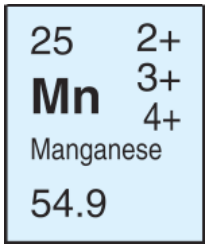
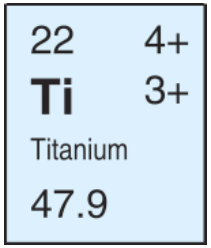
Formula of an Ionic Compound with a Multivalent Metal



- **Some transitional metals are multivalent, meaning they have more than one ion form.**
  - On the periodic table, the most common form of the ion is listed on top
  - In the name of the compound, roman numeral are used following the cation to indicate which ion was used
  - For example, what is the formula 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_2P_3
  - Try the name for TiF_4
    - titanium is Ti^{4+} or Ti^{3+} fluorine is F^-
    - 1 Ti^{4+} ion and 4 F^- ions
    - Titanium (IV) fluoride





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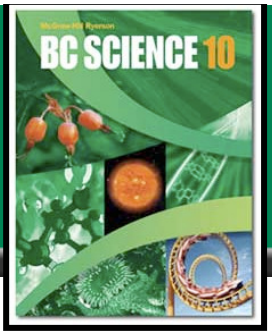
Polyatomic Ions



- **Some ions, called polyatomic ions, are made up of several atoms joined together (ironically, joined with covalent bonds).**
  - **The whole group has a + or – charge, not individual atoms.**
  - **What is the formula of sodium sulphate?** Na^+ and SO_4^{2-} Na_2SO_4
  - **What is the name of the compound KClO?** K^+ = potassium ClO^- = hypochlorite

    Potassium hypochlorite

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

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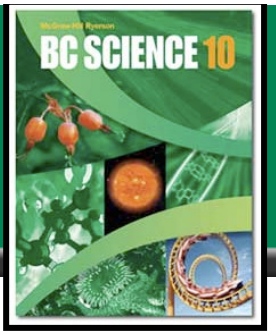
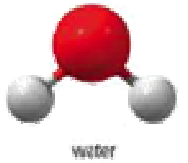
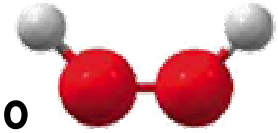
Names and Formulas of Covalent Compounds



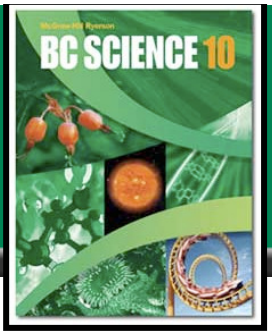
- **Covalent compounds, also called <u>molecules</u>, rely on the chemical formula to reveal the components of the molecule.**
  - Covalent compounds are made up of two or more non-metals.
  - Names may reveal the components, but often do not
  - Subscripts mean something different in covalent compounds
    - Ionic compounds subscripts show smallest whole-number ratio between the ions in the compound
    - Covalent molecules have subscripts that show the actual number of atoms in the molecule
  - What is the chemical formula for the molecule ethanol?
    - C_2H_6O, a name that must be memorized or looked up when needed
  - What is the name of the molecule $C_{12}O_{22}H_{11}$
    - Sucrose, aka table sugar


water


hydrogen peroxide

See page 193

Naming Binary Covalent Compounds



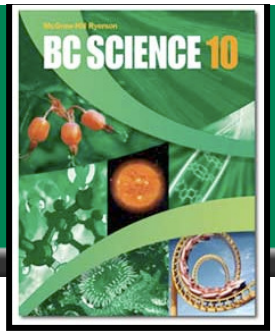
- **Binary covalent compounds (two non-metal atoms) use a system of prefixes.**
  - Covalent compounds may have many or few atoms sharing electrons
    - CH_4 = methane and $C_{25}H_{52}$ = candle wax
  - Prefixes are often used before the atom name to indicate the number of atoms in the molecule.
    - CO = carbon monoxide, CO_2 = carbon dioxide
  - Write the most metallic atom (furthest left) first
    - Ad *-ide* to end of the second atom's name
  - What is the chemical formula for the molecule trinitrogen tetrachloride?
    - N_3Cl_4
  - What is the name of the molecule Si_3P_6
    - Trisilicon hexaphosphide

Table 4.13 Prefixes Used in Naming Binary Covalent Compounds

Prefix	Number
mono-	1
di-	2
tri-	3
tetra-	4
penta-	5
hexa-	6
hepta-	7
octa-	8
nona-	9
deca-	10

See pages 194 - 195

Comparing Ionic and Covalent Compounds



- **To determine whether a compound is ionic or covalent:**
  1. **Examine the formula**
     - **Ionic compounds start with a metal or the ammonium ion**
     - **Covalent compounds start with a non-metal**
  2. **If the compound is covalent…**
     - **Use the prefix system of naming if the compound is binary and does not start with hydrogen**
     - **If there are more than two different elements, or it starts with H, there is probably a different, simpler name for the covalent molecule**
  3. **If the compound is ionic**
     - **Check the metal to see if it is multivalent (add a roman numeral if it is multivalent). Naming starts with the name of the metal atom.**
     - **If it ends with a single non-metal, naming will just end in *-ide***
     - **If it ends in a polyatomic ion, look up the name/formula**

See pages 196 - 197

Take the Section 4.2 Quiz