Chapter Sixteen: Compounds

- 13.1 Chemical Bonds and Electrons
- 13.2 Chemical Formulas
- 13.3 Molecules and Carbon Compounds

Chapter 13.2 Learning Goals

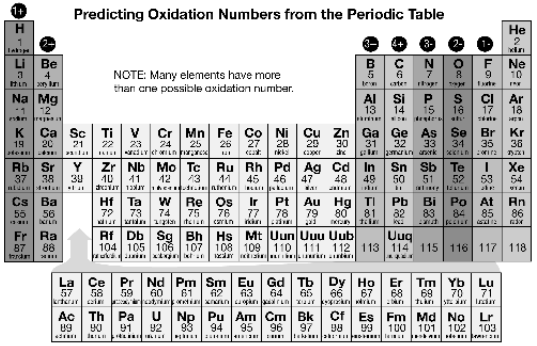
- Use the periodic table to make predictions about whether atoms will most likely form ionic or covalent bonds.
- Describe how oxidations numbers can be used to write chemical formulas of compounds.
- Correctly name chemical compounds.

Investigation 13B

Chemical Formulas

- **Key Question:**

  Why do atoms combine in certain ratios?

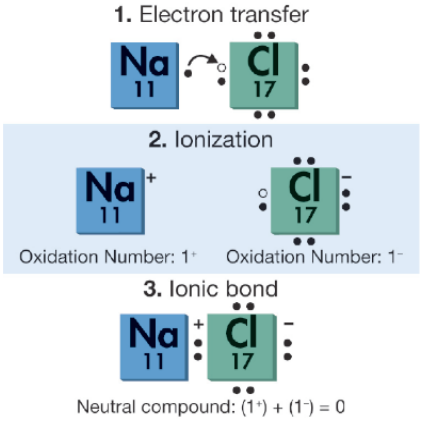


13.2 Chemical Formulas and Oxidation Numbers

- All compounds have an electrical charge of zero (they are neutral).
- An oxidation number indicates the charge on the atom (or ion) when electrons are lost, gained, or shared in chemical bonds.

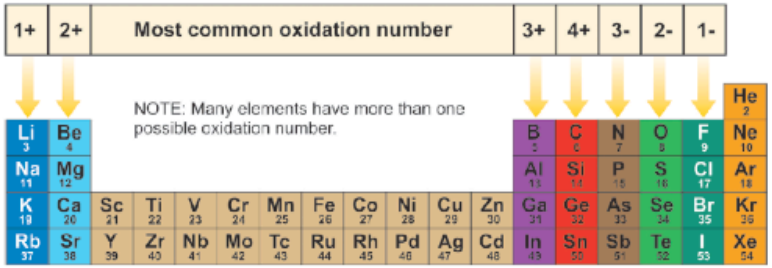
13.2 Oxidation Numbers

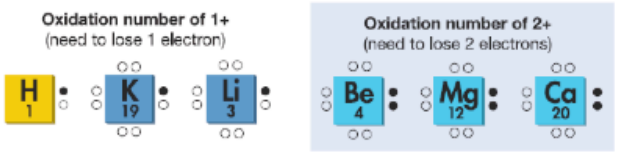
- A sodium atom always ionizes to become Na^+ (a charge of +1) when it combines with other atoms to make a compound.
- Therefore, we say that sodium has an oxidation number of 1^+.

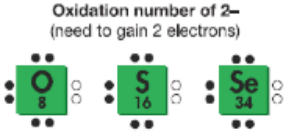


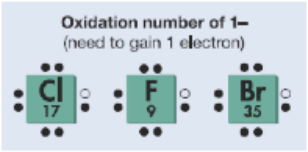
What is chlorine's oxidation number?

Oxidation Numbers



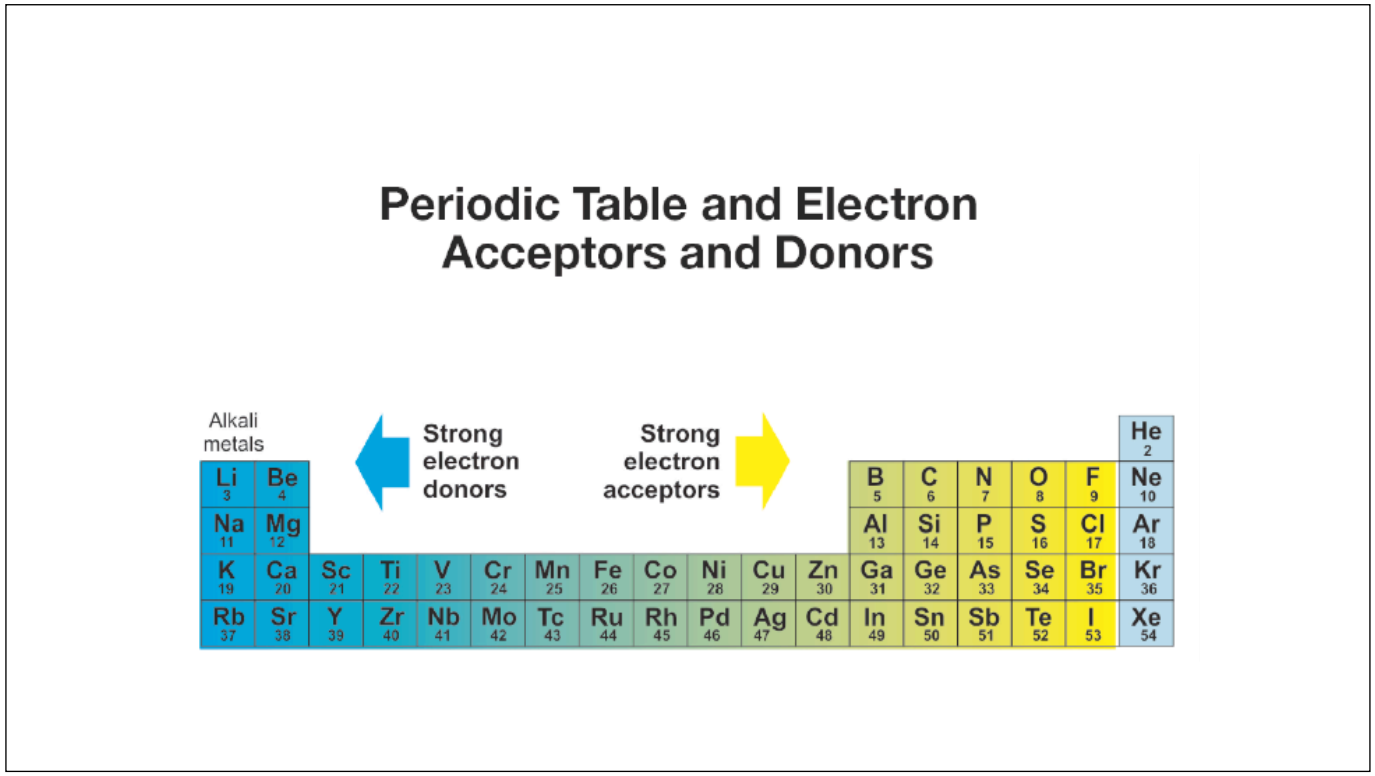






13.2 Ionic bonds

- On the periodic table, strong electron donors are the left side (alkali metals).
- Strong electron acceptors are on the right side (halogens).
- The further apart two elements are on the periodic table, the more likely they are to form an ionic compound.



As heat energy is added to ice, the temperature increases until it reaches 0°C.

Then *the temperature stops increasing.*

As you add more heat, more ice becomes liquid water but the temperature stays the same.

This is because the added energy is being used to break the intermolecular forces and change solid into liquid.

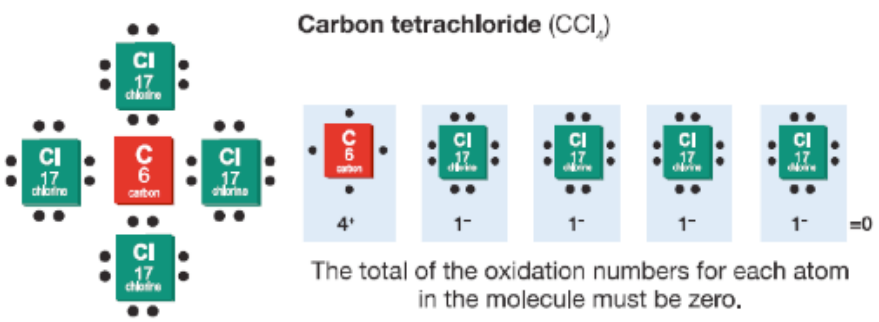
Once all the ice has become liquid, the temperature starts to rise again if more energy is added.

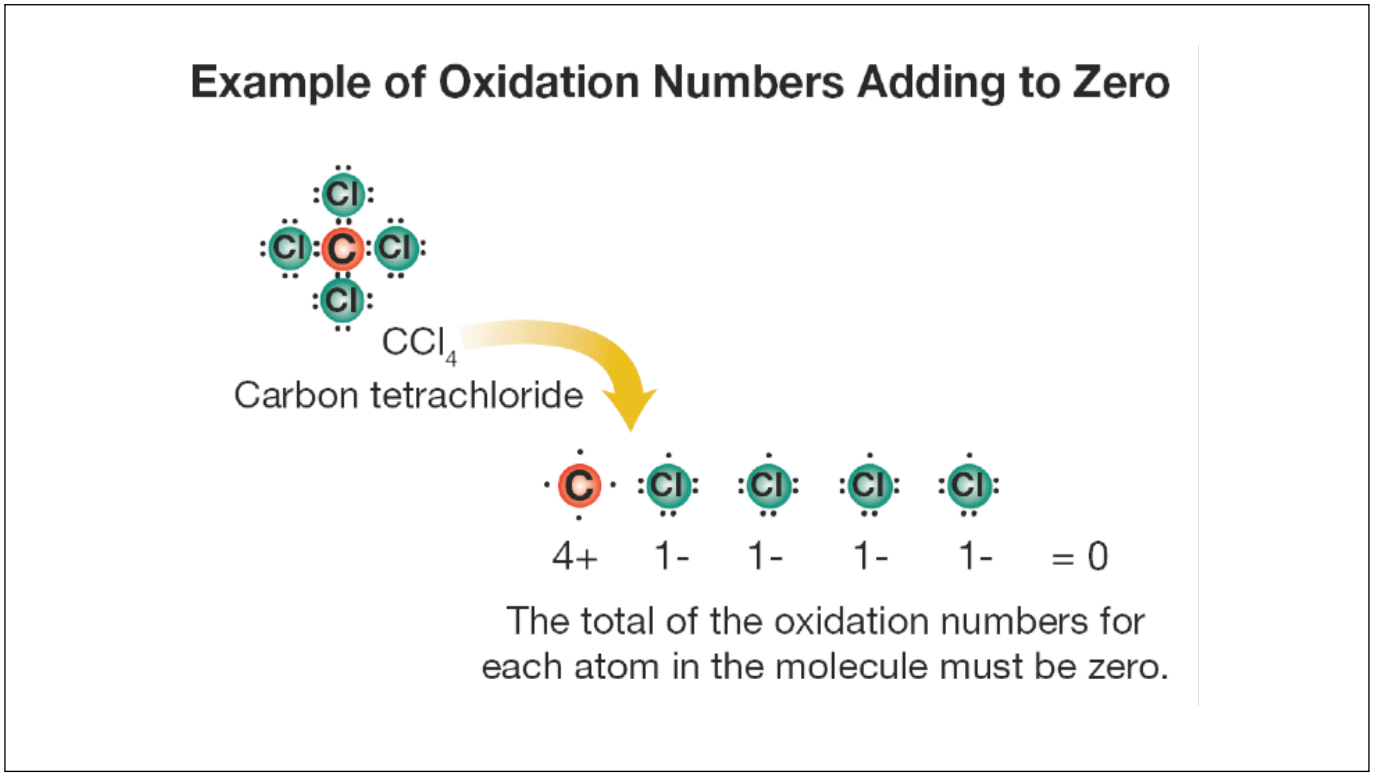
13.2 Covalent bonds

- Covalent compounds form when elements have roughly equal tendency to accept electrons.
- Elements that are both nonmetals and therefore close together on the periodic table tend to form covalent compounds.

13.2 Oxidation numbers and chemical formulas

- **Remember, the oxidation numbers for all the atoms in a compound must add up to zero.**





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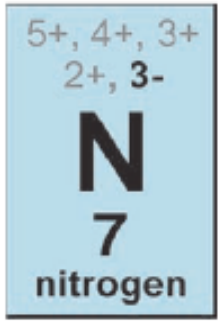
13.2 Oxidation numbers

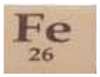
- Some periodic tables list multiple oxidation numbers for most elements.
- This is because more complex bonding is possible.



Solving Problems

Iron and oxygen combine to form a compound. Iron (Fe) has an oxidation number of 3+. Oxygen (O) has an oxidation number of 2–.

Predict the chemical formula of this compound.



Solving Problems

1. **Looking for:**
   - …formula for a binary compound
2. **Given**
   - … Fe^{3+} and O^{2-}
3. **Relationships:**
   - Write the subscripts so that the sum of the oxidation numbers equals zero.
4. **Solution**
   - Two iron atoms = 2 × (3+) = 6+
   - Three oxygen atoms = 3 × (2–) = 6–

Solving Problems

Fe^{3+} O^{2-}

3 x 2 = 6

Solving Problems

Fe^{3+} + Fe^{3+} = +6

O^{2-} + O^{2-} + O^{2-} = -6

+6

-6

0

Solving Problems

$$Fe^{3+}_{2}\ O^{2-}_{3}$$

13.2 Polyatomic ions

- Compounds can contain more than two elements.
- Some of these types of compounds contain polyatomic ions.
- A polyatomic ion has more than one type of atom.
- The prefix poly means “many.”

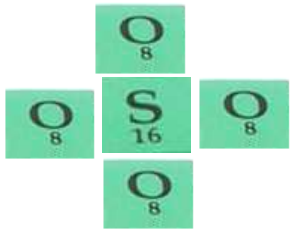
13.2 Some polyatomic ions

Oxidation Number	Name of Ion	Formula
1+	ammonium	NH_4^+
1–	acetate	$C_2H_3O_2^-$
2–	carbonate	CO_3^{2-}
2–	chromate	CrO_4^{2-}
1–	hydrogen carbonate	HCO_3^-
1+	hydronium	H_3O^+

Oxidation Number	Name of Ion	Formula
1–	hydroxide	OH^-
1–	nitrate	NO_3^-
2–	peroxide	O_2^{2-}
3–	phosphate	PO_4^{3-}
2–	sulfate	SO_4^{2-}
2–	sulfite	SO_3^{2-}

Solving Problems

- Al^{3+} combines with sulfate $(SO_4)^{2-}$ to make aluminum sulfate.
- Write the chemical formula for aluminum sulfate.



Solving Problems

1. **Looking for:**
   - …formula for a ternary compound
2. **Given**
   - … Al^{3+} and SO_4^{2-}
3. **Relationships:**
   - Write the subscripts so that the sum of the oxidation numbers equals zero.
4. **Solution**
   - Two aluminum ions = 2 × (3+) = 6+
   - Three sulfate ions = 3 × (2–) = 6–

Solving Problems

$$Al_2^{3+}(SO_4)_3^{2-}$$

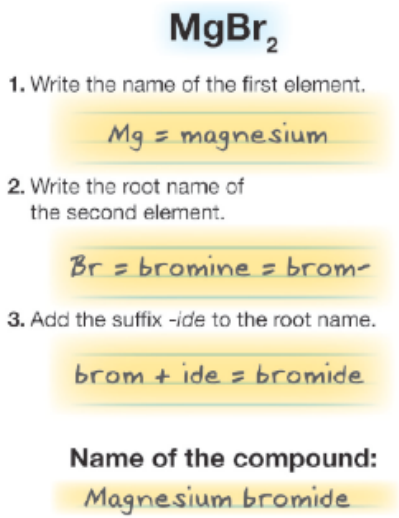
Naming Binary Compounds

- A binary ionic compound is held together by ionic bonds.
- Binary molecular compounds consist of covalently bonded atoms.
- Each type of compound has its own naming rules.

Naming Binary Ionic Compounds

- To name a binary ionic compound:
  1. Write the name of the first element.
  2. Write the root name of the second element.
  3. Add the suffix -ide to the root name.

Naming Binary Ionic Compounds



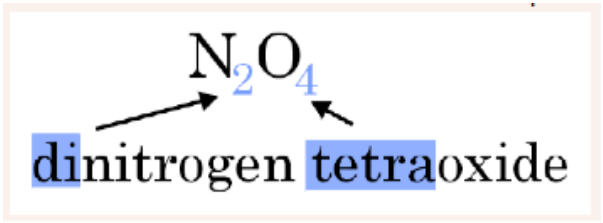
- $MgBr_2$ is magnesium (name of first element) + brom (root name of second element) + ide suffix = magnesium bromide

Naming Binary Molecular Compounds

- To name a binary molecular compound, specify the number of each type of atom using the Greek prefix.
- The Greek prefixes are, from 1 to 10: mono, di, tri, tetra, penta, hexa, hepta, octa, nona, deca.

Naming Binary Molecular Compounds

- As with binary ionic compounds, the ending of the name of the second element in the compound is modified by adding the suffix –ide.



Naming Compounds with Polyatomic ions

1. **Write the name of the first element or polyatomic ion first. Use the periodic table or ion chart to find its name.**

2. **Write the name of the second element or polyatomic ion second. Use the periodic table or ion chart to find its name. If the second one is an element, use the root name of the element with the suffix -ide.**

Naming Compounds with Polyatomic ions

- NH_4Cl is ammonium (the name of the ion from chart) + chlor (root name of the second element) + ide suffix = ammonium chloride.