Chemical Formulas & Naming Simple Compounds

Lecture 8

Chemical formulas

The formula for a compound indicates the combination of the elements that compose it.

- Can be as simple as that for one or two atoms like H or H_2
- Or more complicated looking, if a molecule is larger like cholesterol: $C_{27}H_{46}O$.
- The subscripted numbers tell you how many atoms of that element a molecule of that substance has.

  Cholesterol has 27 atoms of carbon, 46 of hydrogen and 1 oxygen atom in a molecule.

Oxidation Numbers

These are given on the periodic table, they can be positive, negative or zero.

They are the electric charges atoms commonly have when combined.

Atoms have a common oxidation number, but it can differ.

When not using a periodic table this would be given information, written with a superscript on the right side seen in these examples: H^{+}, Al^{3+} O^{2-}, Cl^{-} . The number 1 is never written.

Oxidation numbers order the symbols as you write the formula.

They also create the ratio of atoms bonded.

Binary Compounds

- Atoms with negative oxidation numbers combine with atoms with positive oxidative numbers in such a way to cancel the charges. (algebraic sum=0)
- Example:

Na^{+} and F^{-} combine and create NaF

Generally, the item with a positive oxidative number is written first-not always.

How would you combine Ca^{2+} and O^{2-} ?

Answer: CaO

- How would you combine Ca^{2+} and F^{-} ?

Answer: CaF_2

How would you combine the following:

Li^{+} and O^{2-}

Fe^{3+} and S^{2-}

Al^{3+} and F^{-}

H^{+} and N^{3-}

Answers

Li^{+} and O^{2-} Li_2O

Fe^{3+} and S^{2-} Fe_2S_3 (here you need a number common to 2 and 3 which is 6: 3+ x 2 =6+ and 2- x 3 =6- the sixes cancel out.

Al^{3+} and F^{-} $Al F_3$

H^{+} and N^{3-} H_3N *but we actually write it* NH_3 *(ammonia)*

Naming Binary compounds:

- Binary compounds are named starting with the element with the positive oxidation number first.
- Followed by the element with the negative oxidation number.
- You use the first element's name and add –ide to the second element's name.
- Example: Li_2O Lithium Oxide

  Fe_2S_3 Iron Sulfide

Names of some elements with negative oxidative numbers:

H^- hydride

Br^- bromide

I^- iodide

Cl^- chloride

F^- fluoride (yes it is spelled uo)

S^{2-} sulfide

O^{2-} oxide

P^{3-} phosphide

N^{3-} nitride

C^{4-} carbide

Roman numerals in the name

- Many elements have more than 1 positive oxidation number and will combine in multiple ways with the same element.

For example : FeO and Fe_2O_3

- Roman numerals in the written name in parentheses indicate which oxidation state an element is in, since they can vary.

Iron (II) oxide tells you to use Fe^{2+}

iron (III) oxide tells you to use Fe^{3+}

Name these :

- Mg F
- KH
- NiI_2

Write the formula for these:

Copper (II) sulfide

Iron (III) bromide

Answers

- Mg F magnesium fluoride
- KH potassium hydride
- NiI_2 nickel (II) iodide

Copper (II) sulfide CuS

Iron (III) bromide $FeBr_3$

Polyatomic ions

A group of atoms can have an oxidation number too. Some common examples:

Carbonate	CO_3^{2-}	all 4 atoms have a net -2 charge
Hydroxide	OH^-	both atoms have a net negative charge
Nitrate	NO_3^-	all 4 atoms have a net negative charge
Ammonium	NH_4^+	all 5 atoms have a net positive charge

Polyatomic ions help with naming complex molecules

- Follow the same rules as before:

Write the formula for sodium phosphate:

Na^+ PO_4^{3-}

Phosphate has a negative 3 charge

Sodium has a positive 1 charge

(You need 3 sodium atoms to match the -3 charge of phosphate)

sodium phosphate's formula is written so:

Na_3PO_4

Try these

- How would you write calcium sulfate?

  Calcium is Ca+

  Sulfate is SO_4^-

- How would you write ammonium carbonate ?

  Carbonate is CO_3^{2-}

  Ammonium is NH_4^+

Answers

calcium sulfate:

Calcium is Ca+

Sulfate is SO_4^-

The charges are equal drop them and put the two together: $CaSO_4$

ammonium carbonate:

Carbonate is CO_3^{2-}

Ammonium is NH_4^+

You need 2 of the ammonium ion to cancel carbonates -2 charge: $(NH_4)_2CO_3$

Tip of the ice berg

- This is a good start, as molecules get larger and more complex you would need additional rules and information about how to name a compound.

- There are multiple ways that most chemicals can be named.