More on ions (Chapters 2.1 and 3.5 – 3.7)

Ion: an atom or molecule that has a net electrical charge. Examples: Na^+(sodium ion), Cl^- (chloride), NH_4^+ (ammonium).

Anion: a negative ion, formed when electrons are added to a neutral atom or molecule.

An anion of an atom is given a new name. The new name is based on the element name and given the "-ide" ending.
Examples: Cl^- (chlor-ide), O^{2-} (ox-ide).

Cation: a positive ion, formed when electrons are removed from a neutral atom or molecule.

A cation of an atom is not given a new name. Instead the word "cation" is added.
Examples: Na^+ (sodium cation), Mg^{2+} (magnesium cation)

Polyatomic ion: an ion composed of more than one atom, an ion of a molecule (Table 3.7).
Examples: SO_4^{2-} (sulfate), NH_4^+ (ammonium).

Like charges repel each other (positive charge repels positive charge, negative charge repels negative charge), so a collection of only cations (positives) or only anions (negatives) is unstable.

Opposite charges attract each other (positive charge attracts negative charge, and vice versa), so a collection of cations and anions is stable.

Ionic compound: a compound composed of cations and anions, commonly called a salt, usually exists as a solid, is a neutral compound.

Example: sodium chloride (NaCl)

$2Na(s) + Cl_2(g) \rightarrow 2NaCl(s)$

Neutral sodium atom (Na) becomes sodium cation (Na^+) by releasing an electron.

$$Na \rightarrow Na^+ + e^-$$

Neutral chlorine atom (Cl) in the chlorine molecule (Cl_2) becomes chloride (Cl-) by accepting an electron.

$$Cl + e^- \rightarrow Cl^-$$

The positive charge on the sodium cation is balanced by the negative charge on the chloride, so the ionic compound is neutral.

Common charges of atomic ions can be found from the group in the periodic table.

Alkali earth metals:

Alkaline earth metals:

Halogens:

Oxygen group:

Practice: Write the chemical formulas for magnesium chloride and magnesium oxide.

Main categories of substances

1. Molecular: components are all non-metals, no ions. (Chapter 3.1 – 3.4)

Examples:
CO_2

HCl

but not NH_4Cl

2. Ionic: components are cations and anions, usually has a metal cation, can have non-metal ions (NH_4^+ and SO_4^{2-}). (Chapter 3.5 – 3.7)

Examples:
NaCl

NH_4Cl

3. Metallic: components are metals,
   can have traces of non-metals. (CHEM 102)

Examples: iron (Fe), Cu, brass (Cu and Zn),
steel (Fe and trace C).

Ions in solution: a solution containing dissolved cations and anions, often called electrolyte solution. Example: NaCl(aq).

Molecules in solution: a solution containing dissolved molecules, often called non-electrolyte solution. Example: sucrose(aq) = $C_{12}H_{22}O_{11}$(aq).

Naming substances (Chapter 3.1 – 3.6)

Representations of substances:
H_2O, NaCl, acetic acid.

1. Chemical formula
   (molecular formula, or formula unit)

2. Models
   (nanoscale, ball & stick, space-filling)

3. Structural formula
   (condensed formula, line drawings)

Writing formulas and names

1. Recognize compound as molecular or ionic. Watch out for polyatomic ions.

2. Molecular compounds (Chapter 3.2)

N_2O_5

H_2O

carbon monoxide

3. Ionic binary compounds (Chapter 3.5 & 3.6)

$Ca(OH)_2$

CuO

copper(I) nitrate

iron (III) oxide

Review

Avogadro's number is a ratio (Chapter 2.7)

$N_A = 6.022 \times 10^{23}$ items/mol

Molar mass is a ratio

(Chapters 2.7, 2.8, and 3.8)

$$MM = \frac{g}{mol}$$

More on mass percent: Percent Composition

(mass percent, percent composition by mass)

What is the mass percent composition of water?

$$\text{Mass \%} = \frac{\text{mass of component in substance (grams)}}{\text{mass of substance (grams)}} \times 100$$

So we need mass % for H component
and mass % for O component.

Given 10.00 g of water, what is the mass % composition of water?

MM (H_2O) = 18.0152 g/mol MM (H) = 1.0079 g/mol MM (O) = 15.9994 g/mol

If you have 18.015 g of water, what is the mass % composition of water?

If you have (2 x 18.015 g) = 36.030 g of water, what is the mass % composition of water?

Does mass % composition of a substance depend on the amount of substance you have? Why?

You have 100 grams of a compound, and you find out it has a mass % composition of:
75.7% C
8.8% H
15.5% O.

How many moles of C, H, and O do you have?