

Chapters 2 Atoms, Molecules and Ions

History

John Daltons Atomic Theory:

- 1) all matter is composed of small indivisible particles called atoms
- 2) all atoms in an element are same but different elements have different atoms
- 3) compounds are formed when different atoms combine in fixed proportion
- 4) in a chemical reaction, atoms are rearranged, no new atoms are created and none are destroyed.

History of Discovery of the Atom: Classical View

1895	Wilhelm Roentgen	Discovers X-rays
1896	Henri Becquerel	Discovers radioactivity
1897	J.J. Thomson	Measured deflection of cathode rays in magnetic and electric fields. Shows that deflections were same regardless of gas in cathode tube. Hence: Rays were not atoms but charged particle found in all matter. Measured the mass to charge ratio: found it to be -5.686×10^{-12} kg/Coulomb, thus smaller than a hydrogen ion (as known previously)
1909	Robert Milliken	Oil-drop experiment to determine the charge on electron. -1.602×10^{-19} C
Early 1900s	Ernest Rutherford	Develops the basic atomic model, establishing that there is a positive center (protons) to the atom which is surrounded by negative charge (electrons).
1932	James Chadwick	Discovers neutrons (have no charge and have same mass as protons).

Basic Structure

Central nucleus surrounded by electrons. Nucleus has protons and neutrons,

Particle	Found in	Charge	Mass
Neutron (n)	Nucleus	None	1 amu
Proton (p)	Nucleus	+	1 amu
Electron (e)	Shells outside nucleus	-	0.000545 amu 9.109×10^{-28} g

Every neutral atom has same number of electrons and protons.

$$\text{Mass number (M)} = n + p$$

$$\text{Atomic number (Z)} = p \text{ (or e)}$$

Isotopes: different mass number but same atomic number.

Allotropes: two or more forms of the same element.

History of the Periodic Table (PT)

1830 – 55 elements were known.

1869 – Dimitri Mendeleev, constructed the first what is now called Periodic Table

Initially PT was arranged by mass number. Most elements that came in a column had similar properties, however some did not. He moved those elements out of sequence to fit the trend.

Then PT was arranged according to atomic number.

Modern PT – Glenn Seaborg improved the old PT after he discovered majority of the lanthanide elements.

Molecules and Ionic Compounds

Ionic compounds – have cations (+) from metals, and anions (-) from non metals.

Covalent compounds/molecules – are made from non metals.

Binary compound – has two different elements in a compound.

Atomic ions – atoms that have lost or gained electrons

Polyatomic ions – are also compounds that are electrically positive or negative.

Naming/Nomenclature

Ionic Compounds: Made from cations (from metals) and anions (from non metals).

Cations – positively charged, formed from metals (main group and transition metals). Main group metals have a consistent charge (valency).

Transition metals can have more than one kind of cations. Have to write 2+ as roman numerals (II) or 3+ as (III) i.e. use roman numerals to show the charge of transition metals. Roman numerals have to be in parenthesis. This is ONLY for transition metals.

Anions – negatively charged, formed from non-metals.

Name metal as is and then the non-metal as “ide” (as in molecules above).

NaCl – sodium chloride

MgCl₂ – magnesium chloride (not magnesium dichloride!)

Covalent Compounds (Molecules): made from non metals only.

1) Name first element followed by second element and end the second element name with “ide:

e.g. HCl - hydrogen chloride

NO – nitrogen oxide

For polyatomic covalent molecules:

N₂O₄ – dinitrogen tetraoxide

2) Most common non-metal “ides” – carbide, nitride, oxide, phosphide, sulfide, fluoride, chloride, bromide, iodide and hydride.

3) Prefixes –

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

4) Always write the number of atoms in a molecule as subscripts.

Diatomic Molecules:

There are 7 diatomic molecules which are named as their element name, e.g. H₂ (hydrogen), O₂, N₂, F₂, Cl₂, Br₂, I₂.

Polyatomic Ions:

Polyatomic Ions: two or more non metals combine to form an ion.

Positive Polyatomic Cations

H_3O^+ hydronium ion (exists only in acidic solutions)

NH_4^+ ammonium ion (formed from NH_3 – ammonia)

Simple Polyatomic Anions

OH^- hydroxide

CN^- cyanide

Oxygen Containing Polyatomic Ions (all end in “ate” or “ite”)

Formula	Name
CO_3^{2-}	Carbonate
HCO_3^-	Hydrogen carbonate
SO_4^{2-}	Sulfate
HSO_4^-	Hydrogen sulfate
SO_3^{2-}	Sulfite
HSO_3^-	Hydrogen sulfite
NO_3^-	Nitrate
NO_2^-	Nitrite
PO_4^{3-}	Phosphate
HPO_4^{2-}	Hydrogen phosphate
H_2PO_4^-	Dihydrogen phosphate
$\text{C}_2\text{H}_3\text{O}_2^-$	Acetate
CH_3COO^-	

Formula	Name
CrO_4^{2-}	Chromate
$\text{Cr}_2\text{O}_7^{2-}$	Dichromate
MnO_4^-	Permanganate
SCN^-	Thiocyanate
$\text{S}_2\text{O}_3^{2-}$	Thiosulfate
ClO^-	Hypochlorite
ClO_2^-	Chlorite
ClO_3^-	Chlorate
ClO_4^-	Hypochlorate

Acids:

Acids: produce hydrogen ions and usually end in “ic” in their names. ([Web List](#))

Hydrates: association of ionic compounds with water molecules. Use mono, di, tri etc. to indicate number of water molecules.