General and Organic Chemistry

Lecture 2

Ch2: Atoms, Molecules and Ions

20/10/2024

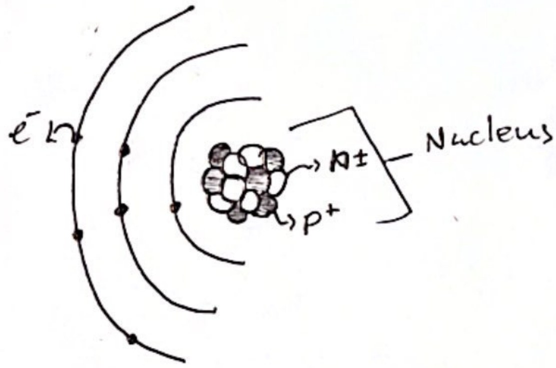
★ General & organic Chemistry: Chapter 2: Atoms, Molecules and Ions
L2

The Atom

Contains

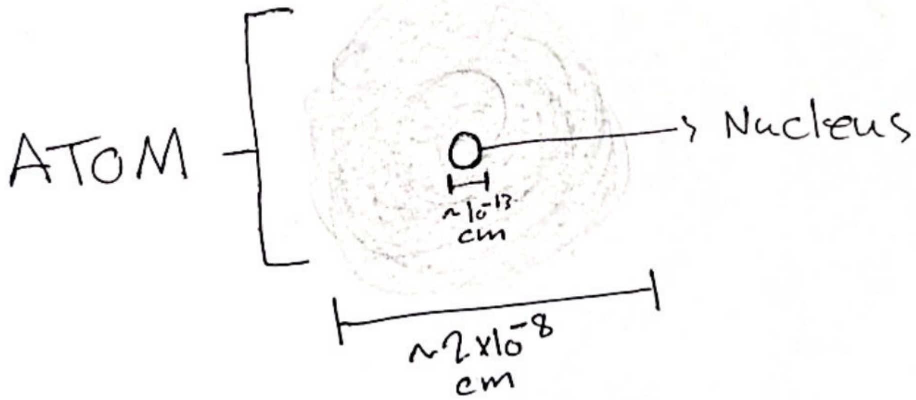
- **Electrons: (e^-)**
  - Found outside the nucleus
  - Has a (−) charge
- **Protons: (p^+)**
  - Found in the nucleus
  - Has a (+) charge
- **Neutrons ($n^\pm$)**
  - Found in the nucleus
  - Has NO charge
  - Has the same mass as the Proton (virtually)

Electrons & Protons → The Positive charge is equal in magnitude to the negative charge



★ The nucleus is small compared with the size of the atom, but it is Extremely Dense

- It accounts for almost the whole mass of the atom



* Isotopes: Atoms with the same number of **Protons** but different numbers of **Neutrons**

- They show almos identical chemicl properties, because the chemistry of the atom is due to its electrons

- In nature, most elements contain mixtures of isotopes

For an Element:

* The number of $p^+ = e^-$

* To get how many neutrons:

$A - Z = n$

A ~ Mass number [No. of $p^+ + n^{\pm}$]

X

Z ~ Atomic Number [No. of p^+]

For isotopes:

ex:

$^{23}_{11}Na$ → $n = A - Z$, $n = 23 - 11$, **$n = 12$**

$^{24}_{11}Na$ → $n = A - Z$, $n = 24 - 11$, **$n = 13$**

Same # of **Protons** and **electrons**

They have different # of neutrons even though its the same element

✩ Chemical Bonds :

we are gonna study about

- الروابط الأيونية Ionic Bonds
- الروابط التساهمية Covalent Bonds

★ Covalent Bonds :

- Between non-metals [non-metal and a non-metal]
- They are bonds between atoms that form by :
  Sharing Electrons (e^-)
- Resulting collection of atoms are called a **Molecule**

ex: H—F̈:

There are :

- Polar Covalent bonds : ex: $H^{+\delta}$ — $F^{-\delta}$ [There is a difference in Electro negativity, that's why it's Polar]
- Non-Polar Covalent bonds : ex: H—H (Two identical atoms) [There is no difference in Electronegativity, that's why it isn't Polar]

ex:

H—H H—C H—N N—O H—F

- H—H → Non-Polar (No difference) in E.N
- H—C → Least Polar (Least difference) in E.N
- H—F → most Polar (most difference) in Electro Negativity

* Ionic Bonds:

- Between Metal and Non-Metal
- Bonds form due to force of attraction between oppositly charged ions

ions → An atom or group of atoms that has a net (+) or (-) charge
ex: Na^+, Cl^-

- Cation: A Positive ion (lost an e^-)
- ~~Anion~~ Anion: A Negative ion (gained an e^-)

Ex:

$$Na \curvearrowright :\ddot{F}: = Na^+F^-$$

* Here, bonds are made by Completely losing or gaining e^-'s unlike covalent bonds where you share e^-'s and have Partial (-) or (+)

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* The Concept Check:

Dalton's atomic theory has some statements that are still true, which ones are they:

1. Elements are made of tiny Particles called atoms ✓ [This is true]
2. All atoms of a given element are identical ✗ [They have different mass]
3. A given Compound always has the same relative numbers and types of atoms ✓ [This is true]
4. Atoms are indestructible ✗ [They are destructible, we can use fusion and fission to do that or create some]

✲ The Periodic table :

Groups or Families : Elements in the same vertical Columns ↕
- Have similar Chemical Properties

Periods : Horizontal rows of elements ⟷

- The common charges when creating ionic compounds :

Group	Charge
Alkali Metals (1A)	+1
Alkaline Earth Metals (2A)	+2
Halogens (7A)	-1
Noble Gasses (8A)	0

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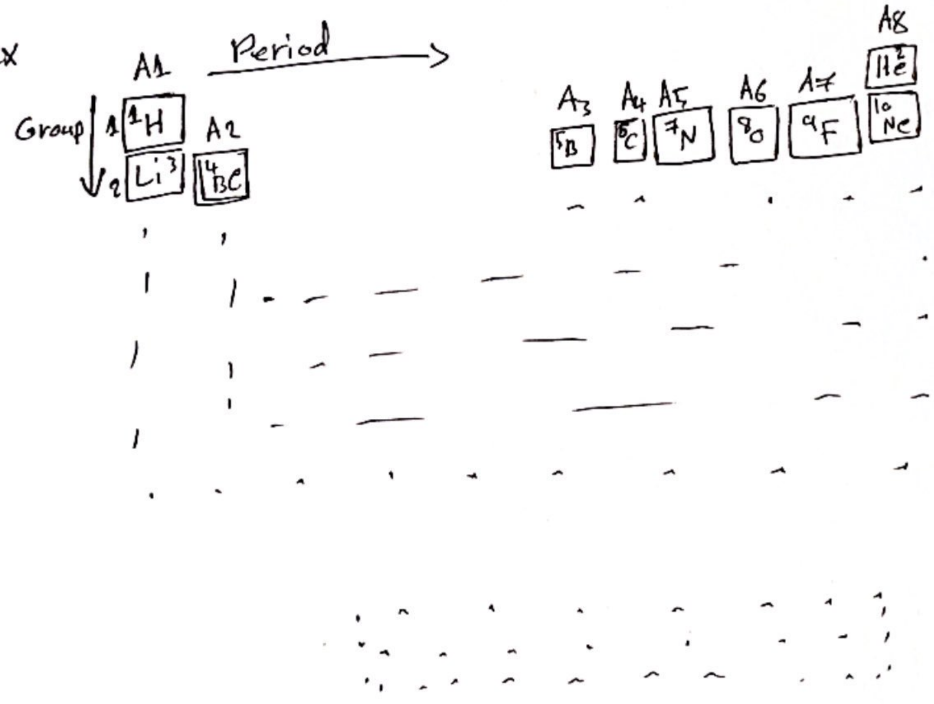
ex



★ Naming Compounds :

- Binary Compounds : Composed of two elements
- Ionic and Covalent Compounds included

Binary Compounds

- Binary Ionic Compounds → Between a metal and a Non-metal
- Binary Covalent Compounds → Between a Non-metal and a Non-metal

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① Binary Ionic Compounds [Type 1] :

↳ Metal & Non-Metal

- The Cation (↳ the (+) ion) is named first then the anion (↳ the (−) ion)
- A monoatomic (↳ ion with only 1 atom) Cation (+) takes its name from the name of the Parent element
- A monatomic anion (−) is named by taking the root of the element name and adding [-ide]

ex:

KCl → Potassium (+) Cloride (−)
↳ K^+ (cation) Cl^- (↳ anion)

$MgBr_2$ → Magnesium bromide

★ The elements involved are the metals from Group 1 & 2 + Aluminum
bc they have only 1 form ! ex: Na → can be only Na^+ → can't be Na^{2+} Na^{3+} ✗

② Binary Ionic Compounds [Type II]

↳ Metal & Non-metal ↳ 2

- Metals in these compounds form more than one type of Positive ions [Can be found in transition metals]
- The charge on the metal ion must be specified using Roman numerals. ex: [I, II, III, IV, V, VI ...]
  (I = 1, II = 2, III = 3, IV = 4, V = 5, VI = 6)
- Transition metals cations (+) usually require a Roman numeral
- Elements that form only one type of Cations do NOT need a roman numeral ... we use type 1 Going back

ex: Cu can form: Cu^{+} and Cu^{2+}

So: ~~[illegible]~~

~~[illegible]~~

$CuBr$ → Copper(I) Bromide

$CuBr_2$ → Copper(II) Bromide

PbO_2 → Lead(IV) oxide

★ Polyatomic ions:
↳ ions that have multiple atoms

Hint: less O → ~ite
more O → ~ate

Must be memorized:

★ NO_2^- Nitrite	★ OH^- Hydroxyde	★ ClO^-/or OCl^- Hypochlorite
NO_3^- Nitrate	★ CN^- Cyanide	ClO_2^- Chlorite
★ SO_3^{2-} Sulfite	★ PO_4^{3-} Phosphate	ClO_3^- Chlorate
★ SO_4^{2-} Sulfate	★ CO_3^{2-} Carbonate	ClO_4^- Perchlorate
	★ $C_2H_3O_2^-$ Acetate	★ CrO_4^{2-} Chromate
		$Cr_2O_7^{2-}$ Dichromate

③ Binary Covalent Compounds [Type III]
Non-Metal & Non-Metal — 3

- Formed between two Non-metals
- The first element in the formula is named first using its full name
- The second element is named as if it were an anion
  - ↳ take root + ide
- Use Prefixes to denote the number of atoms present but the Prefix *mono- should **Never** be used to name the first element

Prefixes:

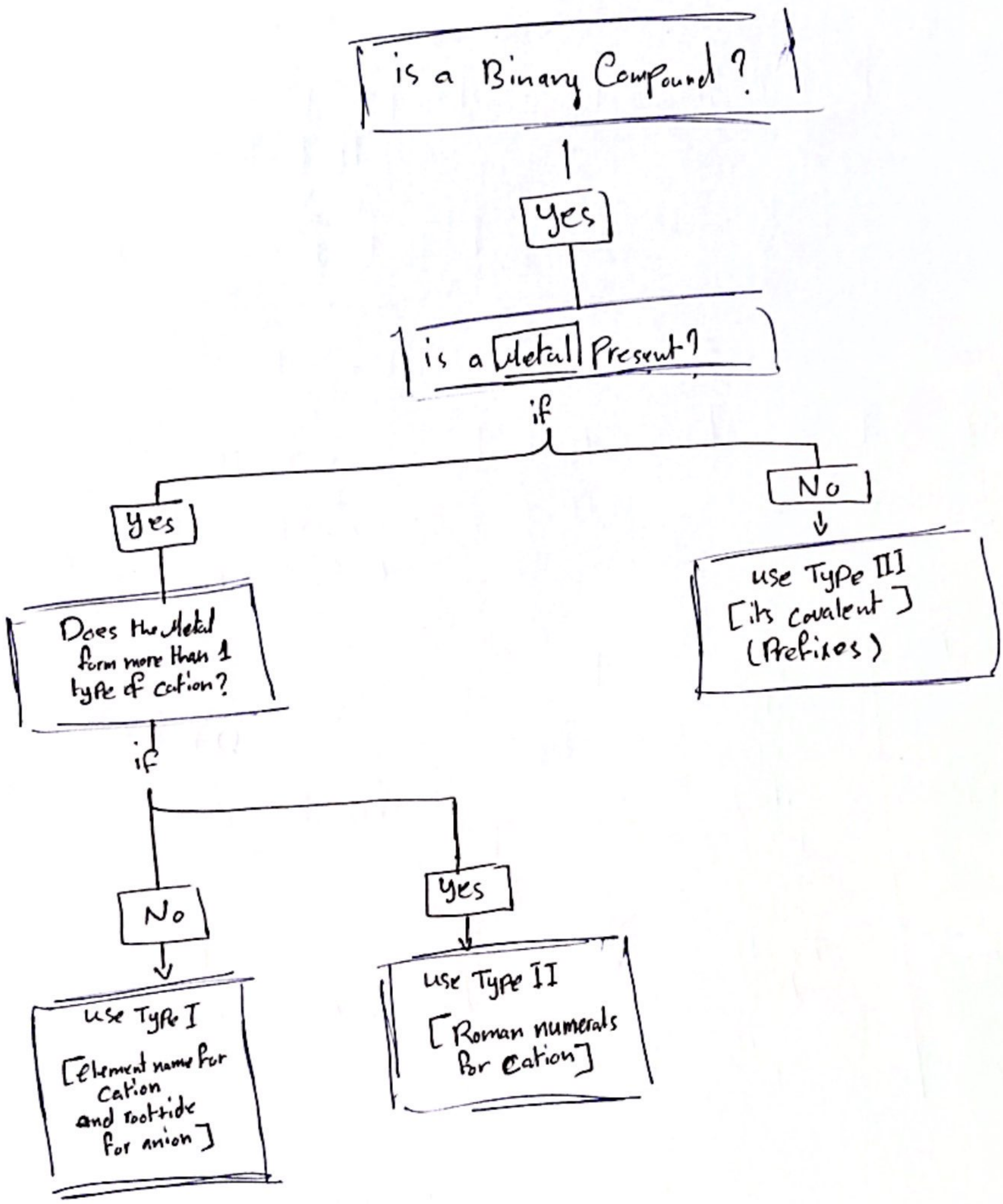
mono-	1
di-	2
tri-	3
tetra-	4
Penta-	5
hexa-	6
hepta-	7
octa-	8
nona-	9
deca-	10

ex: CO_2
↓
Carbon dioxide

SF_6
↓
sulfur hexaflouride

N_2O_4
↓
dinitrogen tetraoxide

* Flow Chart for naming Binary Compounds :



* For the second Flow chart :
- if there is Polyatomic ion/s present we name the compound using similar methods to naming binary ionic compounds

Naming Acids :

Acid : Molecule with one or more H^+ ions attached to an anion

- you can recognize an acid by the Hydrogen that appears first in the formula ex: HCl

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1) if the anion (-) doesn't contain oxygen then.
the acid is named with the Prefix [hydro-] + suffix [-ic] with the anion : so → hydro(anion root name)ic acid

ex:
HCl → Hydrochloric acid
HCN → HydroCyanic acid

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2) if the anion contains oxygen :

- if the anion name ends with -ate we add -ic to the root name

ex: HNO_3 → Nitric acid (Nitrate)
H_2SO_4 → sulfuric acid (sulfurate)

- if the anion name ends with -ite we add -ous to the root name

ex:
HNO_2 → Nitrous acid (Nitrite)
H_2SO_3 → Sulfurous acid

*Flow chart for naming acids :