2.5 The modern view of atomic structure

what is an atom?

- **The basic unit of an element**
- **Combines with other atoms to form: molecules**
- **Atoms keep their identity during chemical reaction**

What atoms consist of?

Nucleus: Protons: (+ve) particles, determine identity of an element.

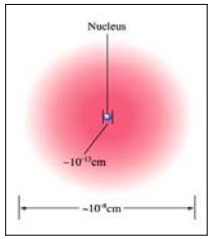
Neutrons: non-charged particles

Electrons: (-ve) particles and around the nucleus (10^{-8} cm diameter)

Particles	Mass	Charge
Electron	9.11×10^{-31} kg	$(-1.60 \times 10^{-19}$ C)
Proton	1.67×10^{-27} kg	$(+1.60 \times 10^{-19}$ C)
Neutron	1.67×10^{-27} kg	None

Nucleus: very small

Highly dense



Electrons: Cover most atomic volume

Electrons determine the chemical behavior of an element.

-e > p ….. -ve atom

-e < p ….. +ve atom

-e = p ….. Neutral atom

Atomic symbol

To represent an atom:

$${}^{A}_{Z}X$$

A: mass number (total number of protons and neutrons)

Z: atomic number (number of protons)

A – Z = number of neutrons

Example:

	${}^{39}_{19}K$	${}^{23}_{11}Na$	${}^{24}_{11}Na$
Protons	**19**	**11**	**11**
Neutrons	**20**	**12**	**13**
Electrons	**19**	**11**	**11**

Isotopes

- ✓ **Atoms with the same number of protons and different number of neutrons**
- ✓ **Isotopes show identical chemical properties**

	${}^{14}_{7}N$	${}^{15}_{7}N^{3-}$
Protons	**7**	**7**
Neutrons	**7**	**8**
Electrons	**7**	**10**
	Neutral atom	**Negative atom (-3)**

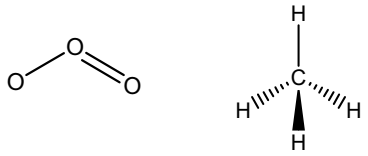
Negative ions have larger size than the neutral atom e.g Cl^- > Cl.

Positive ions have smaller size than the neutral atom e.g Na > Na^+.

2.6 Molecules and ions

- **Atoms combine to form molecules by chemical bonds**
- **Sharing electrons between two atoms makes a covalent bond**
- **Covalent molecules such as: H_2, CO_2, H_2O.**

Structural formula:



Chemical formula: **O_3** **CH_4**

Ions:

- **An atom or a group of atoms that has a net positive or negative charge**

  Lose –e → + ve charge → cation. e.g. Mg^{2+}, Na^{2+}

  Gain –e → - ve charge → anion. e.g. Cl^-, NO_3^-

- **A compound of anions and cations is called: Inoic compound**

  $Na^+ + Cl^- \rightarrow NaCl$

- **Transfer of electrons between two atoms makes an ionic bond**
- **Ionic bond: force of attraction between oppositely charged ions.**
- **Ionic compounds such as: NaCl, MgF_2.**
- **Ions can be:**
  a. **Monatomic, such as Na^+, Cl^-...**
  b. **Diatomic, such as OH^-, O_2^{2-}…**
  c. **Polyatomic, such as NH_4^+, NO_3^-…**

2.7 Periodic table

- **Way of arranging elements so that those with similar properties are grouped together.**
- **Elements counted by their atomic number**
- **Rows are called Periods**
- **Columns are called Family or Group.**

- **Most elements are metals (left side of table)**
- **Physical properties conduct, malleable, ductile and often lustrous**
- **Form positive ions**

- **Non-metals (upper right side of table)**
  Form negative ions with metals to form ionic compounds.
  Bond to other non-metals to form covalent molecules.

Groups of periodic table

Groups (columns) – elements with similar properties

Group 1 or 1A – Alkali metals – very reactive, form (+1) ions

Group 2 or 2A – Alkaline earth metals – form (+2) ions

Group 17 or 7A– Halogens – form (–1) ions and diatomic molecules

Group 18 or 8A – Noble gases – monatomic gases-little chemical activity

Groups 3 to 12 – Transition metals –form many oxidation states

2.8 Naming Simple Compounds

Type I: Binary ionic (MX – metal and non-metal)

- **Name cation first, then anion**
- **Monatomic cation, name of element.**

  Ca^{2+} = calcium
- **Monatomic anion, root + *ide***

  Cl^- = chlor*ide*

d. E.g. $CaCl_2$ = Calcium chloride.

(Table 2.3)

Name:

NaBr	**Ag_3N**
Mg_3P_2	**LiH**
CaO	**Al_2O_3**

Type II: Binary ionic compounds (with transition metals)

- **Metals that form more than one cation such as the transition metals**

  Co^{2+} or Co^{3+}
- **Use Roman numerals (I, II, III, IV…)**

  $CoCl_2$ = Cobalt(II) chloride.

(Table 2.4)

Name:

Fe_2O_3	**SnO_2**
FeO	**$PbBr_2$**
Hg_2O	**CuS**

Ionic compounds with polyatomic ions

- **Have special names and MUST be memorized.**

(Table 2.5)

- **E.g. $(NH_4)_2CO_3$ = ammonium carbonate**

Name:

$Ca(ClO_4)_2$	**$Mg(H_2PO_4)$**
$FeSO_4$	**$MgHPO_4$**
$NaHCO_3$	**CaO_2**
NaOH	**$Cu(CO_3)_2$**

Type III: Binary Covalent Compounds (two non-metals)

- **First element in formula names first**
- **Second element named as anion**
- **Use prefixes to donate number present**
- **Never use mono on first element**
- **Drop a/o of prefix when element begins with vowel**

E.g. P_2O_5 = diphosphorous pentaoxide

(Table 2.6)

Mono = 1, di = 2, tri = 3, tera = 4, penta = 5, hexa = 6 ….etc.

Name:

N_2O_4	**PBr_5**
CO	**N_2O**

Hydrogen (H)

- ✓ **Forms two ions:**

Cation: H^+	**Anion: H^-**
e.g polyatomic anions:	**e.g. ionic compounds containing**
CO_3^{2-}, HCO_3^-	**hydrogen and Group 1 or 2 metals**
$LiHCO_3$	**KH, BaH_2**

- ▪ **Forms binary covalent compounds with non-metals, only one compound with each non-metal (except Carbon); e.g. H_2O, NH_3, H_2S, HCl and HF.**

Acids

- ▪ **Compounds which give H^+ when dissolved in water**
- ▪ **Recognized by a (H) that appears *first* in the formula**

Naming acids:

- ✓ **Anion *does not* contain Oxygen:**
- ✓ **Formula must contain (aq) - aqueous or dissolved in water**
  - o **Name starts with *hydro* and ends with *ic*.**

    HCl = hydrogen monochloride
    $HCl_{(aq)}$ = hydrochloric acid

- ✓ **Anion contains Oxygen:**
  - o **If anion name ends with *ate*, acid name ends with *ic*.**
  - o **If anion name ends with *ite*, acid name ends with *ous*.**

    e.g. H_2SO_4 (root is sulf*ate*) → sulfur*ic* acid

    H_2SO_3 (root is sulf*ite*) → sulfur*ous* acid