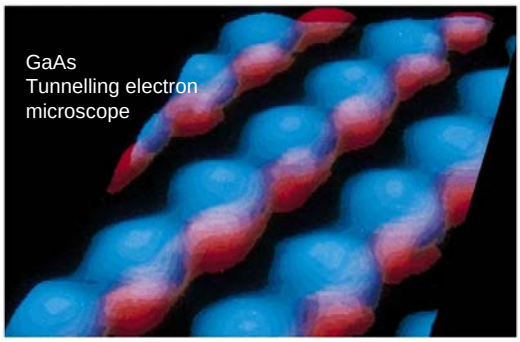
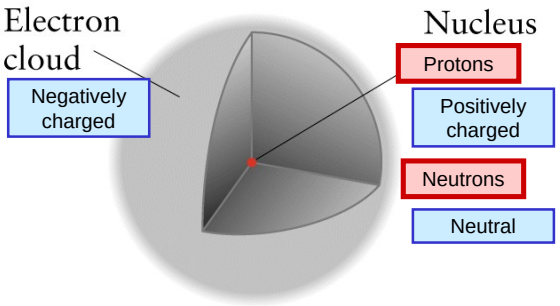
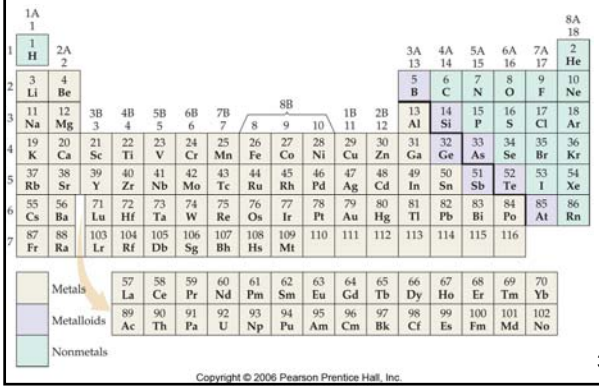
Some Things are Very Small: Atomic Theory and Bonding



1: Composition of atom



2: Atomic Number, Atomic Mass



2: Elemental Symbols

Atomic mass
= protons + neutrons

If Z = 6 and N = 6, what is the element and its atomic mass?

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

Atomic number
= # of protons

Defines the element

2: Elemental symbols continued

If the Atomic Number (Z) = 12 and
the Atomic mass (A) = 24,

then

(a) what is the element and
(b) list the number of protons, neutrons and electrons it contains.

$^{24}_{12}Mg$

protons = 12

electrons = 12

neutrons = 12

3: Isotopes

Recall: All atoms of a particular element always have the same number of protons and electrons.

However: Some atoms of some elements are found to have ***different numbers of neutrons***.

$^{35}_{17}Cl$ $^{37}_{17}Cl$

Isotopes

4: Molecules

Most atoms do not naturally exist in isolation.

Atoms combine in fixed ratios of whole numbers to form molecules.

Molecule: an electrically neutral assembly of two or more atoms bound tightly together.

5: Ions – charged particles

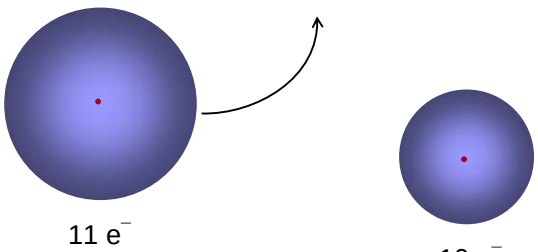
But…… the world is not just neutral !

An atom or a molecule can lose or gain electrons to form **ions**

Electrons lost, ion positively charged = **CATION**

5: Cations – positively charged particles

Sodium (Na): 11 protons



Sodium atom: Na

Sodium ion: Na^+

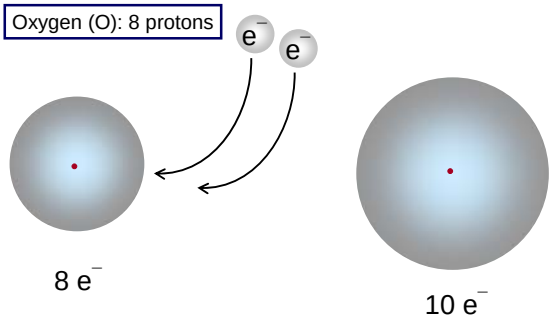
5: Ions – charged particles

An atom or a molecule can lose or gain electrons to form **ions**

Electrons lost, ion positively charged = **CATION**
Electrons gained, ion negatively charged = **ANION**

5: Anions – negatively charged particles

Oxygen (O): 8 protons



Neutral atom: O

Oxide ion: O^{2-}

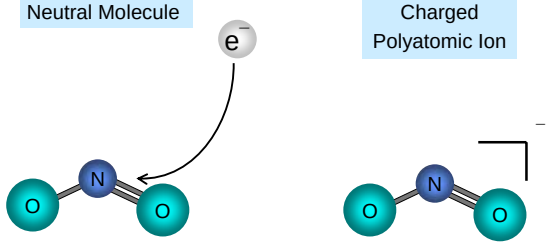
5: Ions – charged particles

Atom	Electrons gained or lost on forming ion	Ion formed
H	1 e^- lost	
Mg	2 e^- lost	
Cl	1 e^- gained	

5: Polyatomic ions – charged particles

Neutral Molecule

Charged Polyatomic Ion



Nitrogen dioxide molecule
NO_2

Nitrite ion
NO_2^-

6: Chemical bonds

What holds these molecules or polyatomic ions together?

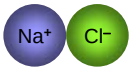
Chemical bonds are formed
by transferring of electrons from one atom to another
or
by sharing of electrons between two atoms

6: Ionic Bond

Electrons are completely transferred from one atom to another

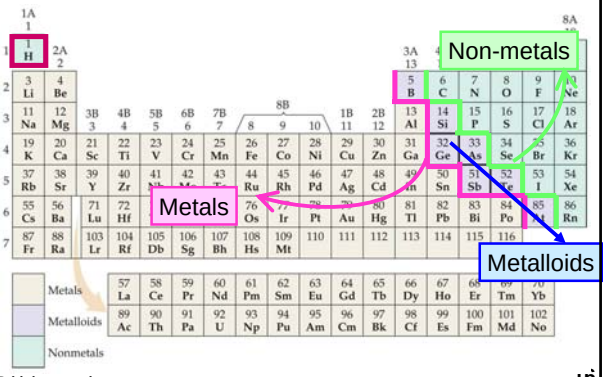
A metal loses electrons to form a cation, e.g. Na^+

A non-metal gains electrons to form an anion, e.g. Cl^-



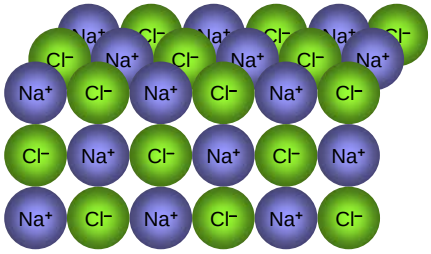
- The resulting electrostatic attraction between opposite charges is an **IONIC BOND**
- Usually forms between metals on LHS of periodic table and non-metals on RHS of periodic table

6: Using the Periodic Table



6: Ionic Bond

Ionic compounds consist of tightly packed array of cations & anions with overall charge neutrality.



6: Covalent bonding, Metallic bonding

Covalent Bonding: electrons are **shared**, not transferred, and usually occurs between non-metals

e.g., NO, Cl_2, O_3

Metallic Bonding: Type of bonding found in metals and alloys

e.g., Iron, Brass

7: Naming Chemical Compounds and Formulae

- Each chemical compound has a name and a formula.
- No two compounds have the same name
- The formula shows the number and identity of the atoms that are combined to form a molecule of the compound

$AlCl_3$

$CaBr_2$

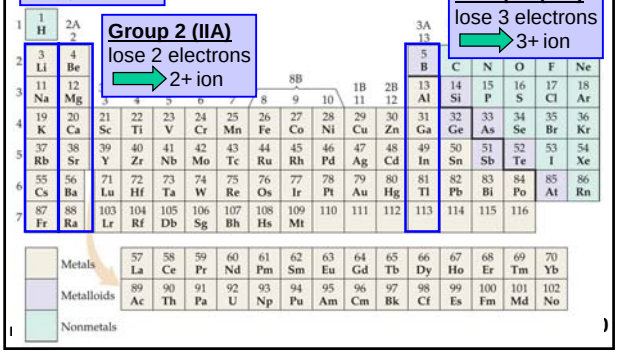
K_2O

7: Using the Periodic Table: Groups 1-3

Group 1 (IA)
lose 1 electron
1+ ion

Group 2 (IIA)
lose 2 electrons
2+ ion

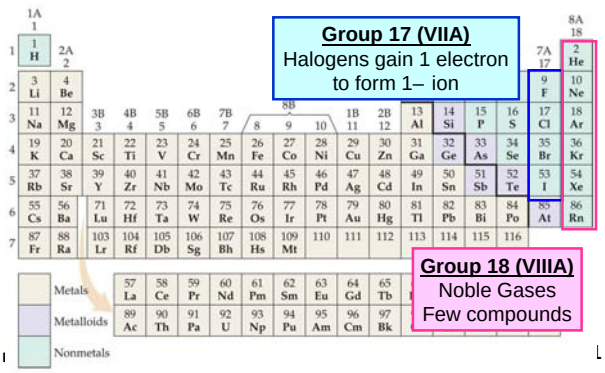
Group 3 (IIIA)
lose 3 electrons
3+ ion



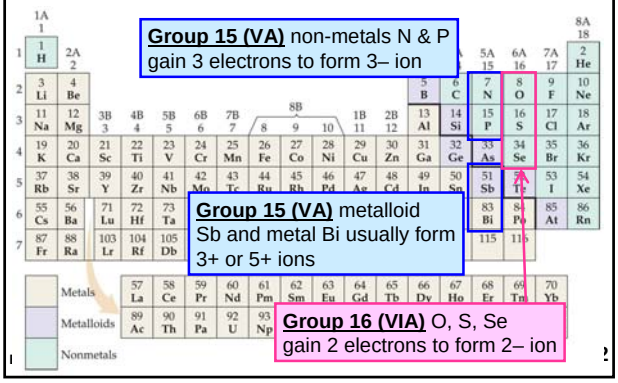
7: Using the Periodic Table: Groups 7 & 8

Group 17 (VIIA)
Halogens gain 1 electron
to form 1– ion

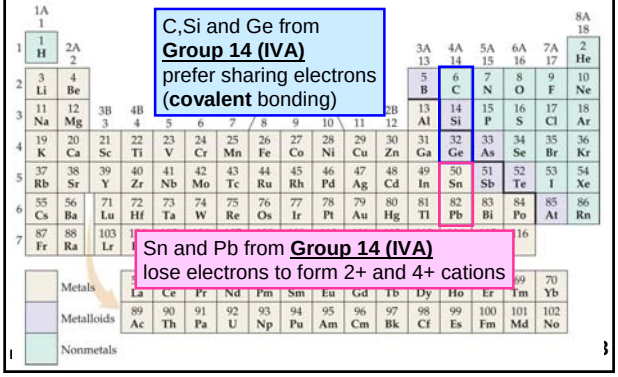
Group 18 (VIIIA)
Noble Gases
Few compounds



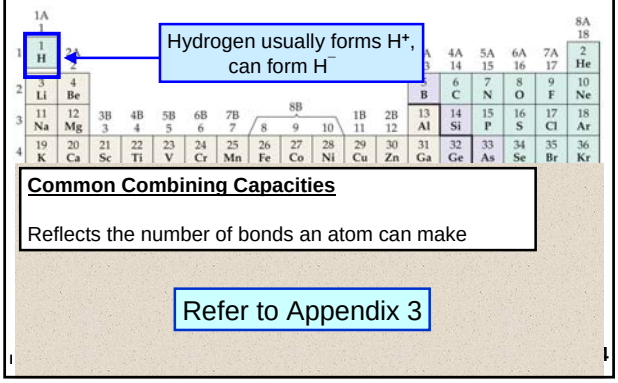
7: Using the Periodic Table: Groups 5 & 6



7: Using the Periodic Table: Group 4



7: Hydrogen: All on its own



8: Binary Ionic Compounds

Ionic compounds are formed from the reaction of metallic elements with non-metallic elements

E.g. sodium chloride
calcium oxide
aluminium bromide

Metal first — Non-Metal second

RULE for naming
most metallic element / space / anion with suffix -ide

8: Binary Ionic Compounds

Ionic compounds are formed from the reaction of metallic elements with non-metallic elements

E.g. sodium chloride
calcium oxide
aluminium bromide

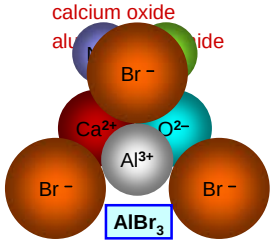
RULE for formula
Ionic compounds: Match the number of cations and anions so there is no overall charge

8:Binary Ionic Compounds: Constructing Formulae

RULE for formula
Ionic compounds: Match the number of cations and anions so there is no overall charge

E.g. sodium chloride
calcium oxide
alu…ide

NaCl



CaO

8:Binary Ionic Compounds: Constructing Formulae

RULE for formula
Ionic compounds: Match the number of cations and anions so there is no overall charge

Potassium Sulfide

K_2S

Bridging atomic

28