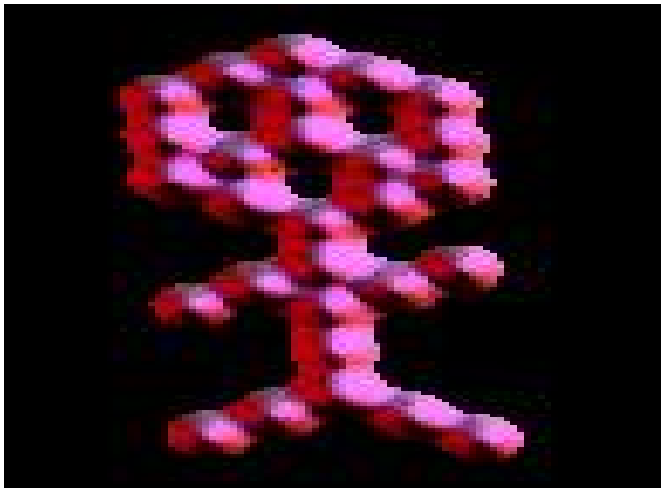
Some Important Points to Note about CHEM 102B

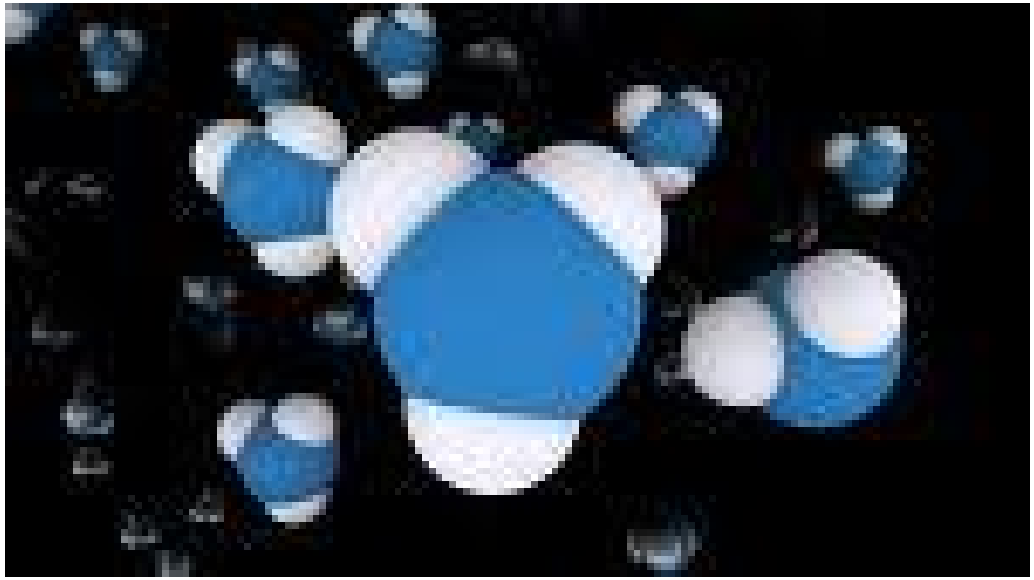
Homework on Assignments handout means Online Homework (Lon Capa)

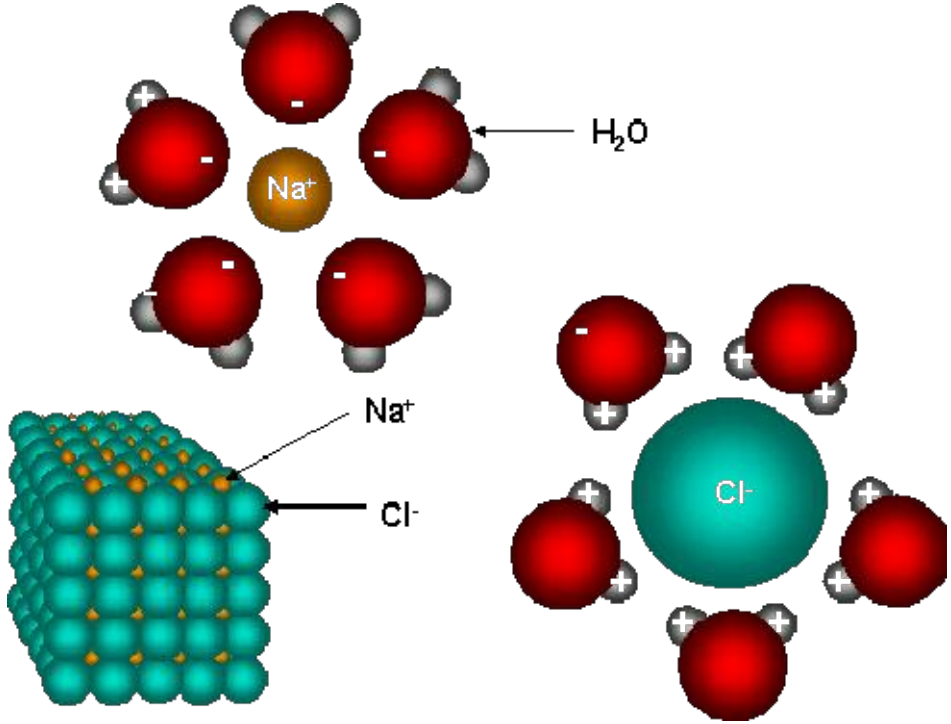
Homework 1 due Tuesday, Jan 25, 9a.m.

Problems listed on Assignments handouts from text must be done because some of these problems will reappear on your quizzes. Chemistry is **NOT** a spectator subject; the more problems you attempt; the better grade you will get!

Worksheets on course worksheet must be completed before attending the discussion so you can get assistance with any problems you do not understand at the discussion section. Some of the worksheet problems will also reappear on quizzes.







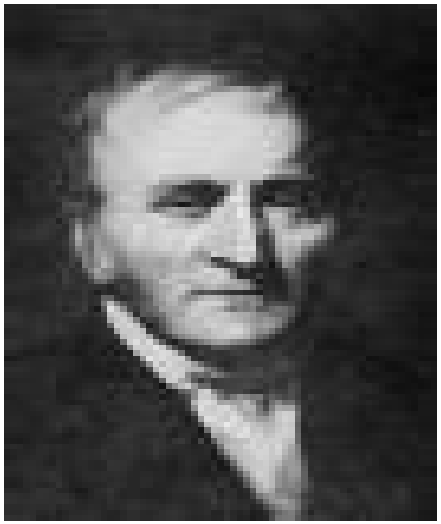
ATOMS, MOLECULES AND IONS

Atoms

Atoms are the building blocks of matter.

Understanding the structure and properties of atoms is critical as combinations of atoms lead to the formation of unlimited number of chemical compounds, some of which are essential for life.

Dalton's Atomic Theory



John Dalton

1. Matter is composed of indivisible atoms.
2. All atoms of a given chemical element have identical properties.
3. Different chemical elements are composed of different atoms of different masses.
4. Atoms are indestructible and chemical reactions are a rearrangement of atoms.
5. A compound forms from its elements through the combination of atoms of unlike elements in small whole number ratios.

1. Matter is composed of indivisible atoms

We now know that atom have **subatomic particles called electrons, neutrons and protons.**

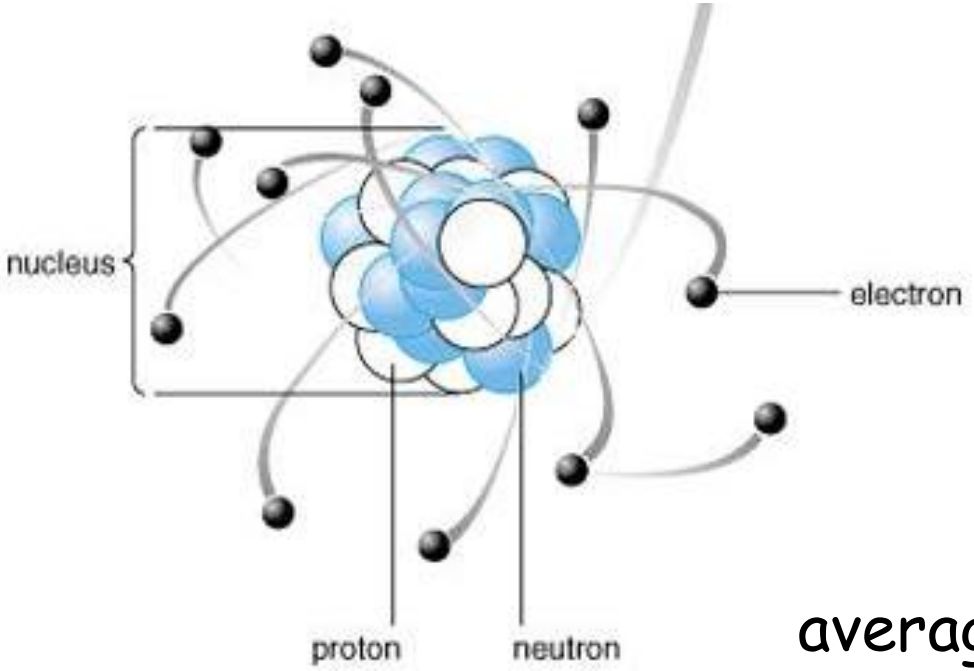
Particle	Symbol	Absolute Charge (C)	Relative Charge	Absolute mass (kg)
Electron	e^-	-1.60×10^{-19}	-1	9.11×10^{-31}
Proton	p^+	1.60×10^{-19}	+1	1.673×10^{-27}
Neutron	n^0	0	0	1.675×10^{-27}

1. Matter is composed of indivisible atoms

The nucleus of an atom contains protons and neutrons.

The nucleus contains nearly all of the mass of the atom,

but it occupies only a tiny fraction of the space inside the atom



Electrons move around the nucleus.

This electron "cloud" makes up the volume of the atom.

average diameter of atom = 10^{-10} m

An atom is **electrically neutral because # protons = # electrons**

2. All atoms of a given element have identical properties ✖

Each **element** has a unique number of protons in its atoms.

This **number of protons** within the atom is called the **atomic number (abbreviated Z)**.

All carbon (C) atoms contain 6 protons, **Z = 6**

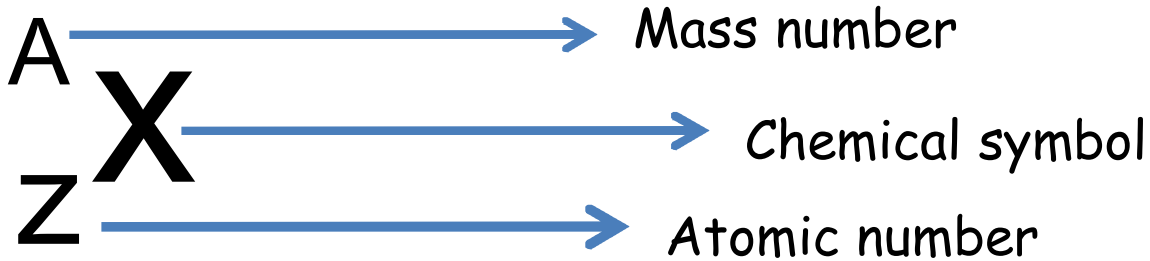
A neutral carbon atom contains 6 electrons and 6 protons

There are atoms of the same element that differ in the number of neutrons they contain and **collectively** they are called **isotopes**, individually they are called **nuclides**.

2. All atoms of a given element have identical properties ✖

The mass number (abbreviated A) is **the total number of protons and neutrons** in the nucleus of an atom.

Mass number = Total number of protons + Total number of neutrons



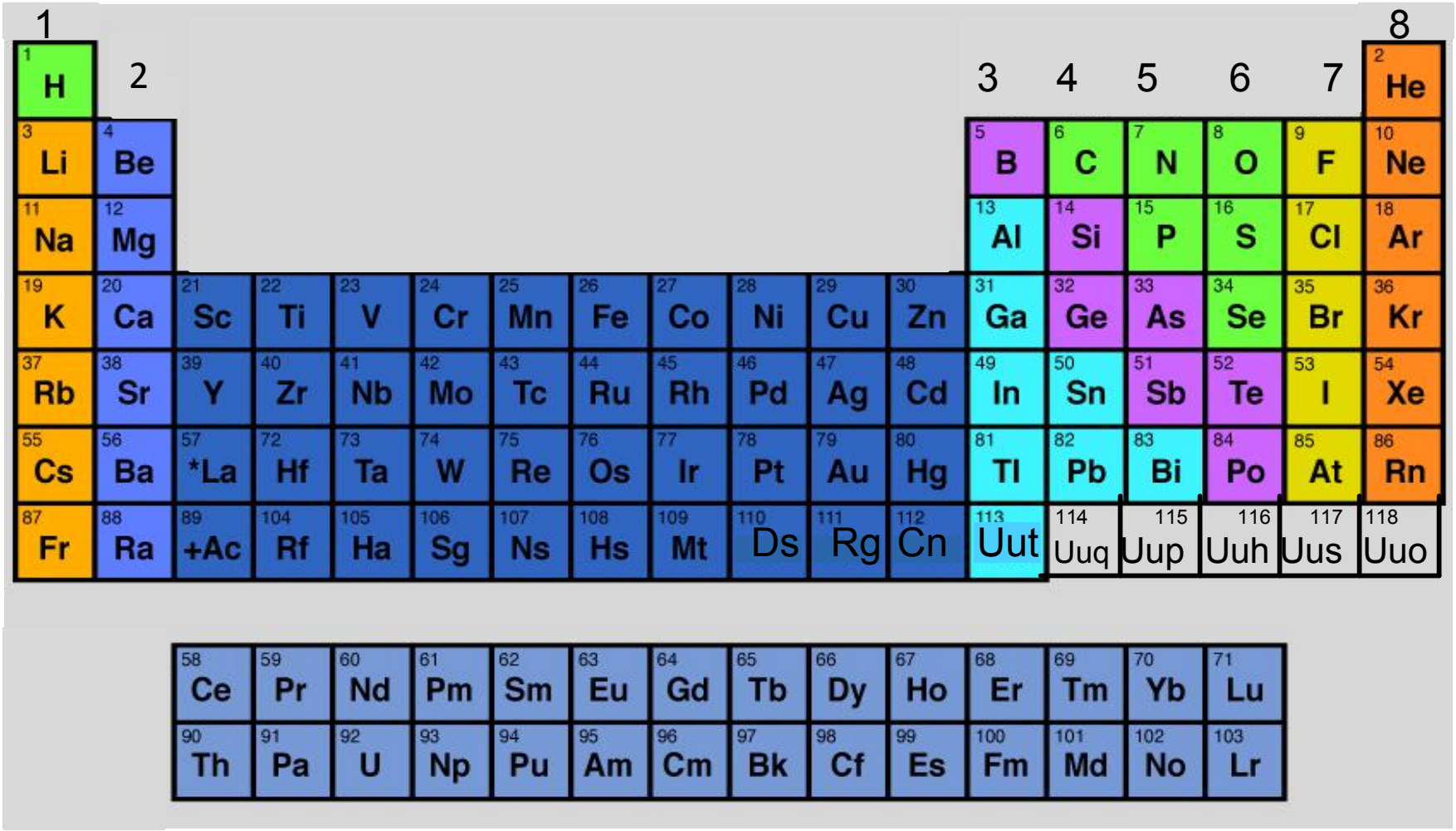
Nuclide general symbol

6 protons + 6 neutrons

Most abundant nuclide of carbon: $^{12}_{6}C$

6 protons

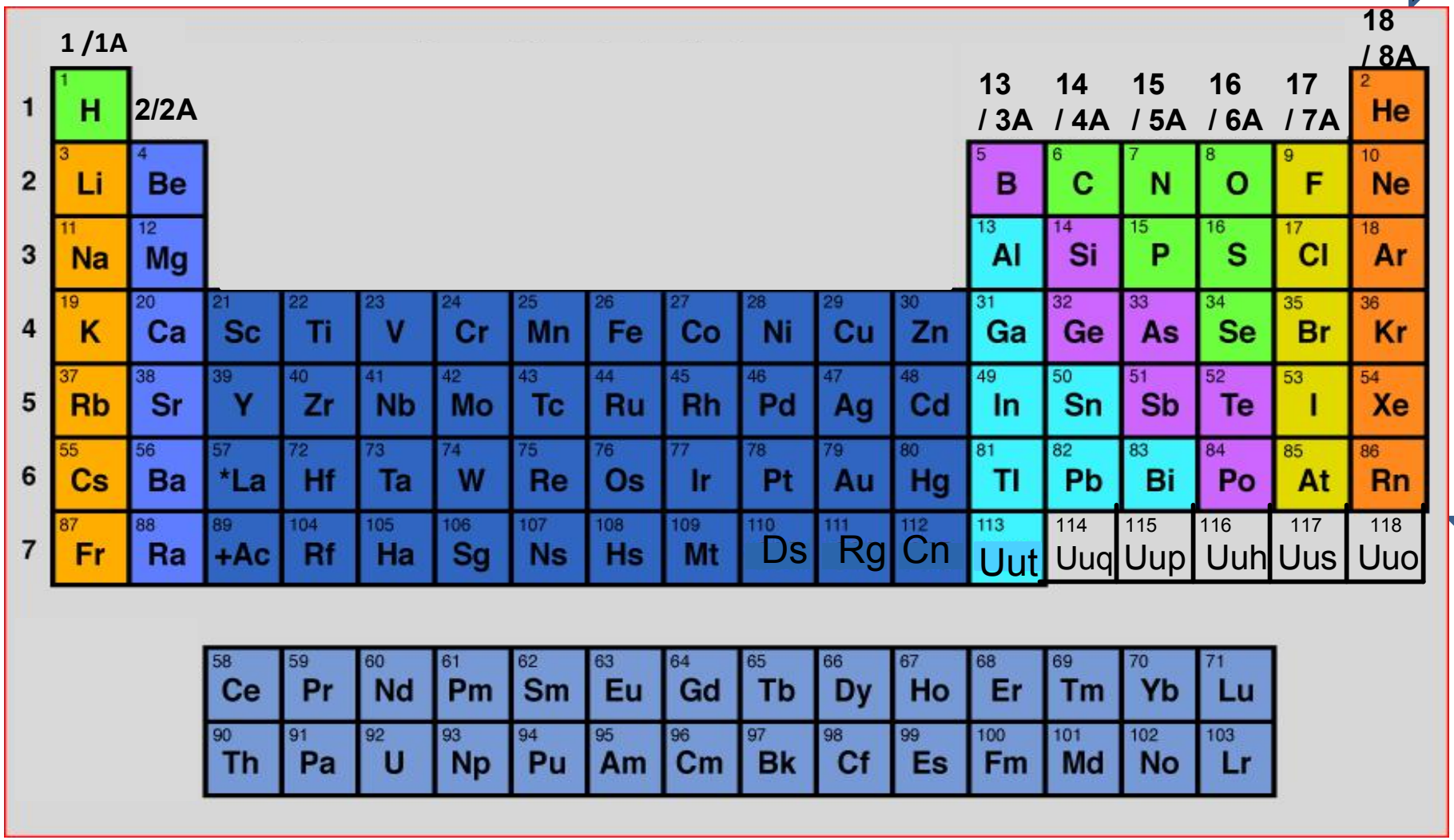
Nuclide of carbon used in carbon-14 dating: $^{14}_{6}C$ + 8 neutrons



4. Atoms are indestructible and chemical reactions are a rearrangement of atoms

↓

Not in chemical reactions but in nuclear reactions



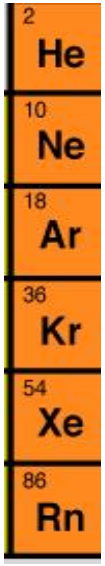
Atoms with similar chemical properties are in the same **Group** of the Periodic Table.

Vertical columns = Groups

Horizontal rows = periods

The Periodic Table has seven periods

Group 8A /18



Noble gases

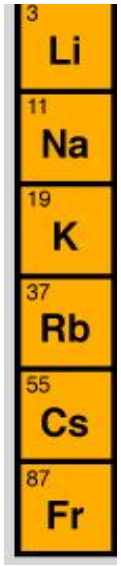
unreactive

8 valence electrons (Except He 2 valence e^-)

monatomic gases

Alkali metals

Group 1A /1



soft solids

Very reactive

1 valence electron

lose 1 electron when taking part in chemical reactions

$K \rightarrow K^+$

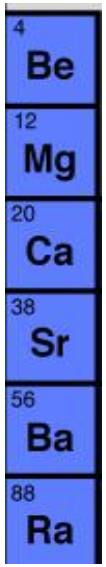
19 protons 19 protons

19 electrons 18 electrons

K^+ is a cation (positively charged ion)

Group 2A /2

Alkaline earth metals



Reactive solids

2 valence electrons

lose 2 electrons when taking part in chemical reactions

$Ca \longrightarrow Ca^{2+}$

20 protons 20 protons

20 electrons 18 electrons

Group 7A / 17

Halogens X_2

very reactive non-metals

7 valence electrons

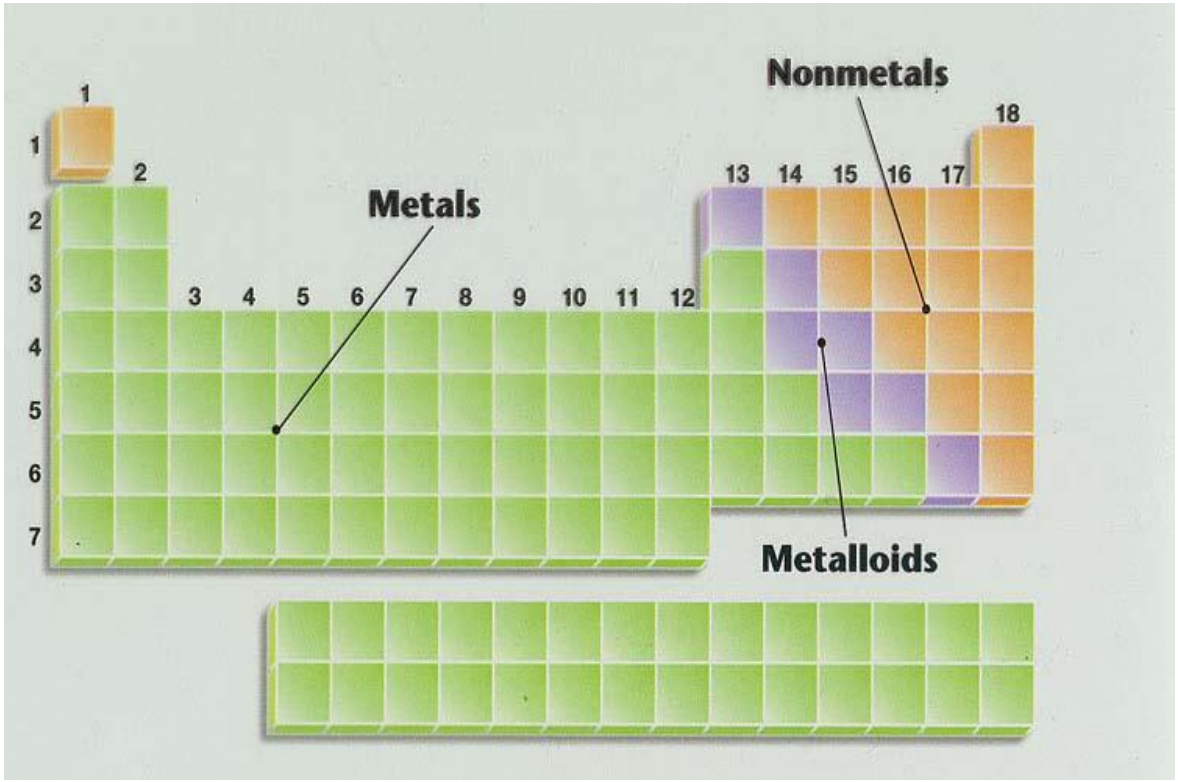
gain 1 electron when taking part in chemical reactions

$Cl \longrightarrow Cl^-$

17 protons 17 protons

17 electrons 18 electrons

Anions are ions with negative charges



3A	4A	5A	6A	7A
B 5	C 6	N 7	O 8	F 9
	Si 14	P 15	S 16	Cl 17
	Ge 32	As 33	Se 34	Br 35
		Sb 51	Te 52	I 53
				At 85

Metalloids exhibit both metallic and nonmetallic properties

Metals : conduct heat, electricity

solids (Hg is the exception)

lose electrons

Non-metals: poor conductors

solids, liquids, gases

Hydrogen is an Anomaly

H 1 Can **lose or gain** an electron

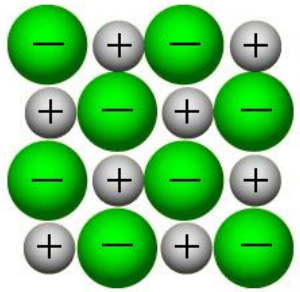
$H \xrightarrow[\text{lose } e^-]{} H^+$ proton

1 proton	1 proton
1 electron	0 electron

$H \xrightarrow[\text{gain } e^-]{} H^-$ hydride

1 proton	1 proton
1 electron	2 electrons

5. Compounds contain a definite and small number of atoms



Ionic solids metal + non-metal
cation + anion

sodium + chlorine

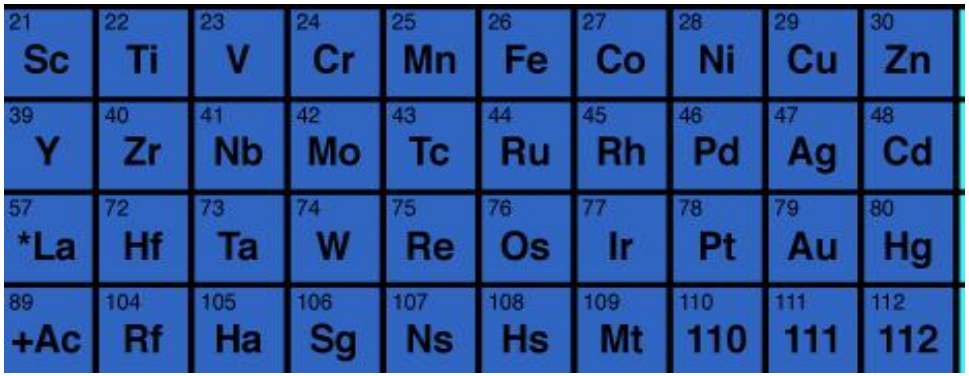
Na^+ Cl^- NaCl sodium chloride

magnesium + nitrogen

Mg^{2+} N^{3-} Mg_3N_2 magnesium nitride

Statement 5 is not true in complex organic compounds like sugar $C_{12}H_{22}O_{11}$.

Transition Metals



21 Sc	22 Ti	23 V	24 Cr	25 Mn	26 Fe	27 Co	28 Ni	29 Cu	30 Zn
39 Y	40 Zr	41 Nb	42 Mo	43 Tc	44 Ru	45 Rh	46 Pd	47 Ag	48 Cd
57 *La	72 Hf	73 Ta	74 W	75 Re	76 Os	77 Ir	78 Pt	79 Au	80 Hg
89 +Ac	104 Rf	105 Ha	106 Sg	107 Ns	108 Hs	109 Mt	110 110	111 111	112 112

These metals form **multiple ions** except Ag^{+}

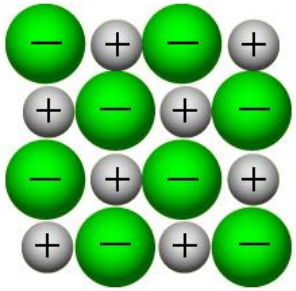
Zn^{2+}

Cd^{2+}

For example:

Ions of manganese : Mn^{2+}, Mn^{3+}, Mn^{4+}

How to Write and Name Ionic Compounds



An ionic compound consists of ions held together by attractive forces.

The **Criss Cross Method** enables the formula of compounds that **contain ions** to be determined.

Steps of the Criss Cross Method

i. Write the ions (with their charges) for your compound side by side, **starting with the cation**.

ii. If either ion is a polyatomic ion, **place it in brackets**.

iii. **Circle ONLY** the number of the charge of **both** ions.

Steps of the Criss Cross Method (cont'd)

iv. Now write the formula of the compound that would be created if the numbers that you just "moved" were now **subscripts** of the corresponding ion.

If the number 1 was the number "moved", do not write this number as a subscript.

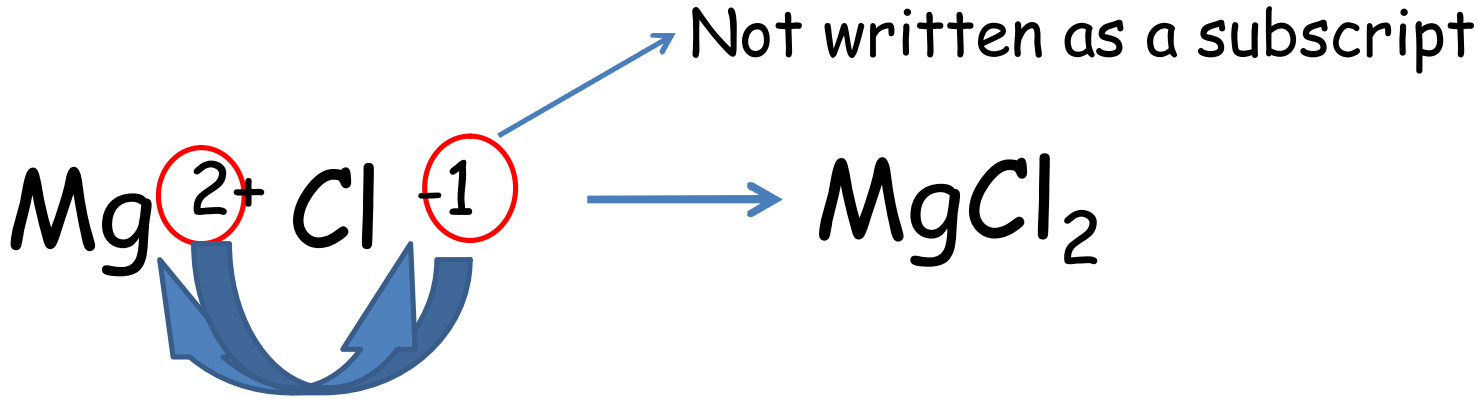
v. If the numbers moved are the same, **do not write them as part of your formula** as they will cancel each other out.

What is the chemical formula of magnesium chloride ?

1. Identify the ions present:

magnesium cation: Mg^{2+} Chlorine anion: Cl^{-1}

2. Using Criss Cross method:

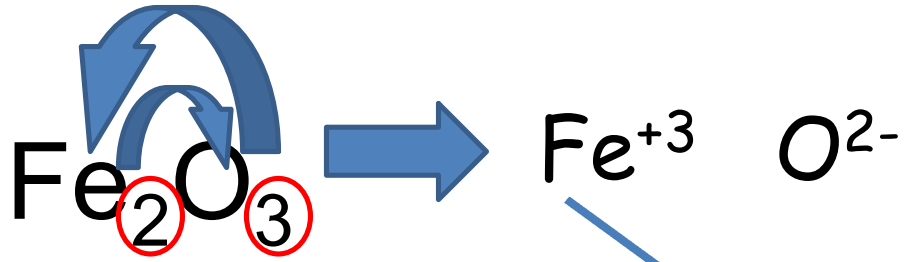


What is the name of this ionic compound: Fe_2O_3?

1. Identify the ions present

Oxygen anion: O^{2-} iron cation: charge?

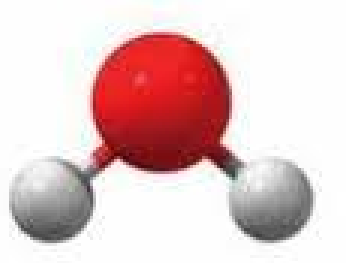
2. Reverse the Criss Cross method to obtain the charge of the cation



Metal with multiple cations

Name: iron (III) oxide

Naming Covalent Compounds



Covalent compounds contain two **non**-metals.

The more non-metallic element is **written second** in the chemical formula.

Order for writing the elements in a compound:

C, P, N, H, S, I, Br, Cl, O, F

Hydrogen is in the centre so compounds containing H and these elements will be written as follows:

CH_4, PH_3, NH_3, H_2S, HI, HBr, HCl, H_2O, HF

Naming Covalent Compounds

The first part of the name of a molecular or covalent compound consists of the **entire name** of the first element in the formula of the compound.

Notice in the name of covalent molecules the **suffix –ide** is used in naming the **second element** in the molecular formula.

The number of each atom present is represented using a prefix

List of Prefixes to be used

# of Atoms	Prefix	# of Atoms	Prefix
1	Mono-	6	Hexa-
2	di-	7	Hepta-
3	Tri-	8	Octa-
4	Tetra-	9	Nona-
5	Penta-	10	Deca-

Examples of Naming Covalent Compounds

Molecular Formula	Name	Explanation
CO	carbon monoxide	Carbon is named first as it appears first in the formula. The word mono means one and there is only one oxygen atom in this molecule.
NO_2	nitrogen dioxide	Nitrogen is named first as it appears first in the formula. There are two oxygen atoms and di- means two.
P_4S_3	tetraphosphorus trisulfide	There are four (tetra) phosphorus atoms and three (tri) sulfur atoms.

Covalent compounds (anomalies)

NH_3 ~~nitrogen trihydride~~ ammonia

H_2O ~~dihydrogen monoxide~~ water

Table 2.5 p. 62

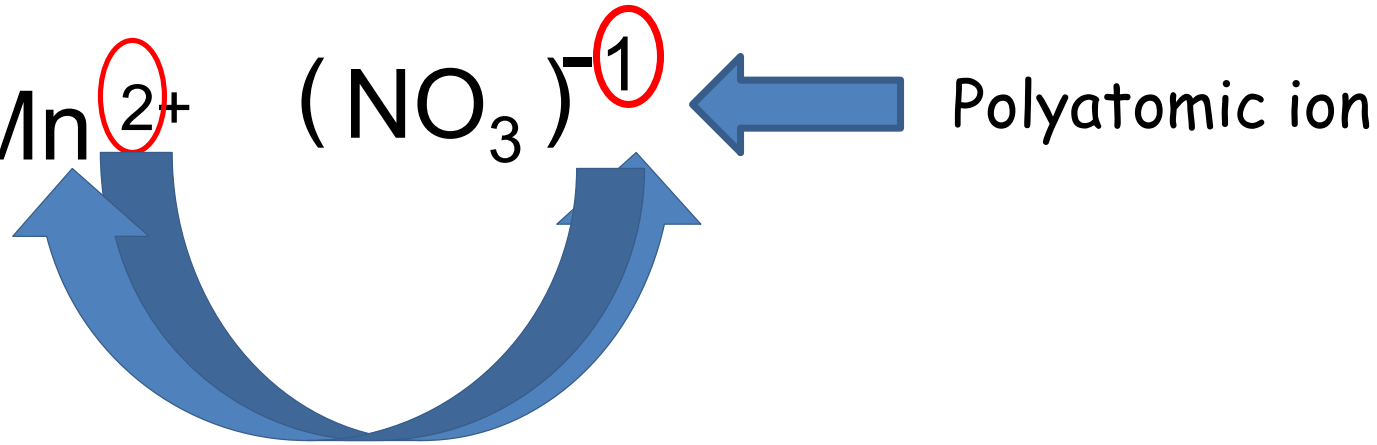
Polyatomic ions

NH_4^+	ammonium	ClO_3^-	chlorate
OH^-	hydroxide	MnO_4^-	permanganate
NO_3^-	nitrate	CrO_4^{2-}	chromate
SO_4^{2-}	sulfate	CO_3^{2-}	carbonate
PO_4^{3-}	phosphate		

Example of using the Criss-Cross Method

Write the formula of the neutral compound created from manganese 2^+ ions and nitrate ions and name the compound.

Step 1:



Step 4

$Mn_1(NO_3)_2$

Cation of metal that can have multiple cations

Name: Manganese (II) nitrate