

CHAPTER
5

Chemicals in Action

What is Chemistry?

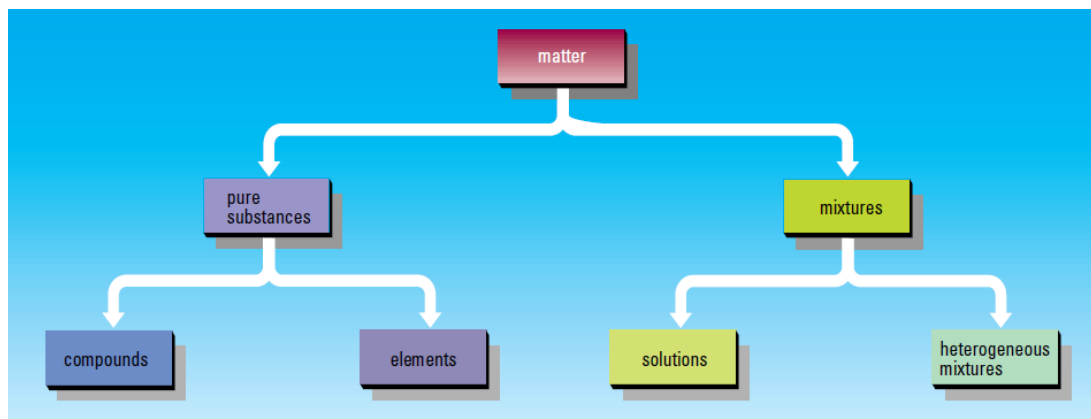
The study of matter, its properties, and its changes or transformations.

Matter

- Anything that has mass and takes up space.
- Physical Properties: State, colour, odour, luster, solubility, melting and boiling point, conductivity.
- Chemical Property: Chemical changes or transformations that substances may undergo (reactivity).

Pure Substance

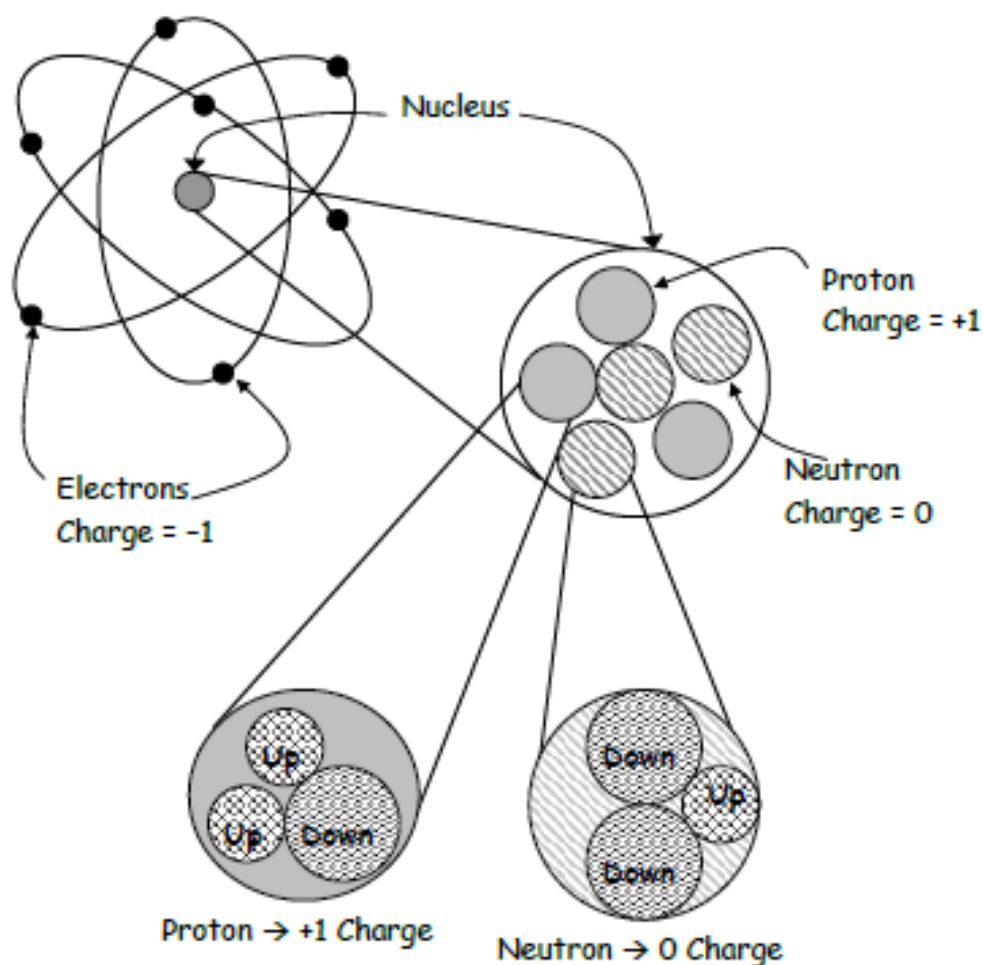
- All particles that make up the substance are the same.
- Constant properties.
- Elements or compounds.
- Elements can not be broken down in to smaller substances.
- All elements that make up matter in the universe come from stars during nuclear fusion and supernova explosions.



- Elements have a symbol and are arranged in the periodic table.
- Consist of Protons, Neutrons, and electrons.
- Elements are defined by the number of protons in their nucleus.

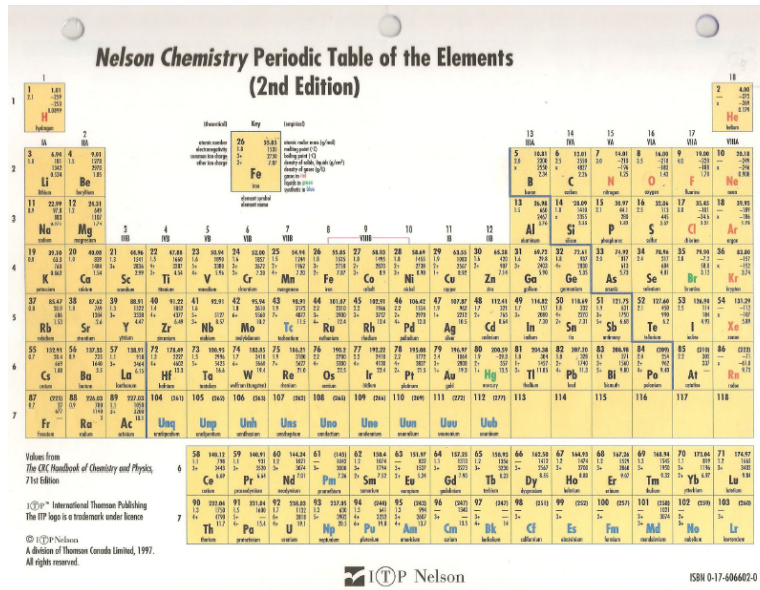
Build an Atom

Diagram of the 21st Century Atom



Elements and the Periodic Table

Carefully read pages 184 - 187.



Periodic Table

- Structured arrangement of elements that helps explain and predict physical and chemical properties by using the groups and rows of elements.
- Separated into metals and non-metals.

Table 1 Properties of Metals and Nonmetals

Property	Metals	Nonmetals
lustre	shiny	dull
malleability	malleable	brittle
conductivity	conductors	mostly insulators
reactivity with acid	mostly yes	no
state at room temperature	mostly solids	solids, liquids, and gases

Chemical Families: elements in the same vertical column have similar physical and chemical properties.

Alkali Metals

1	
1	1.01
2.1	-259
	-253
	0.0899
H hydrogen	
IA	
3	6.94
1.0	181
	1342
	0.534
Li lithium	
11	22.99
0.9	97.8
	883
	0.971
Na sodium	
19	39.10
0.8	63.3
	760
	0.862
K potassium	
37	85.47
0.8	38.9
	686
	1.53
Rb rubidium	
55	132.91
0.7	28.4
	669
	1.88
Cs cesium	
87	(223)
0.7	27
	677
Fr francium	

- Shiny, silvery metals.
- Very reactive with other elements and compounds - including water.
- Form compounds that are mostly white solids.
- Compounds formed are very soluble in water.

Alkaline Earth Metals

2	
IIA	
4	9.01
1.5	1278
	2970
	1.85
Be	
beryllium	
12	24.31
1.2	649
	1107
	1.74
Mg	
magnesium	
20	40.08
1.0	839
	1484
	1.54
Ca	
calcium	
38	87.62
1.0	769
	1384
	2.6
Sr	
strontium	
56	137.33
0.9	725
	1640
	3.5
Ba	
barium	
88	226.03
0.9	700
	1140
	5
Ra	
radium	

- Shiny, silvery metals but form compounds that are often insoluble in water.

Noble Gases

18	
2	4.00
—	-272
x	-269
	0.179
He	
helium	
VIII A	
10	
20.18	
—	-249
x	-246
	0.900
Ne	
neon	
18	
39.95	
—	-189
x	-186
	1.78
Ar	
argon	
36	
83.80	
—	-157
x	-152
	3.74
Kr	
krypton	
54	
131.29	
—	-112
x	-107
	5.89
Xe	
xenon	
86	
(222)	
—	-71
x	-61.8
	9.73
Rn	
radon	
118	

- Generally do not form compounds. The atoms are made up of just the right amount of electrons.

Halogens

17 VIIA	
9	19.00
4.0	-220 -188 1.70
F	
fluorine	
17	35.45
3.0	-101 -34.6 3.21
Cl	
chlorine	
35	79.90
2.8	-7.2 58.8 3.12
Br	
bromine	
53	126.90
2.5	114 184 4.93
I	
iodine	
85	(210)
2.2	302 337
At	—
astatine	
117	

- Nonmetals that are all poisonous elements that react readily (very reactive) with sodium and other alkali metals.

Atomic Structure

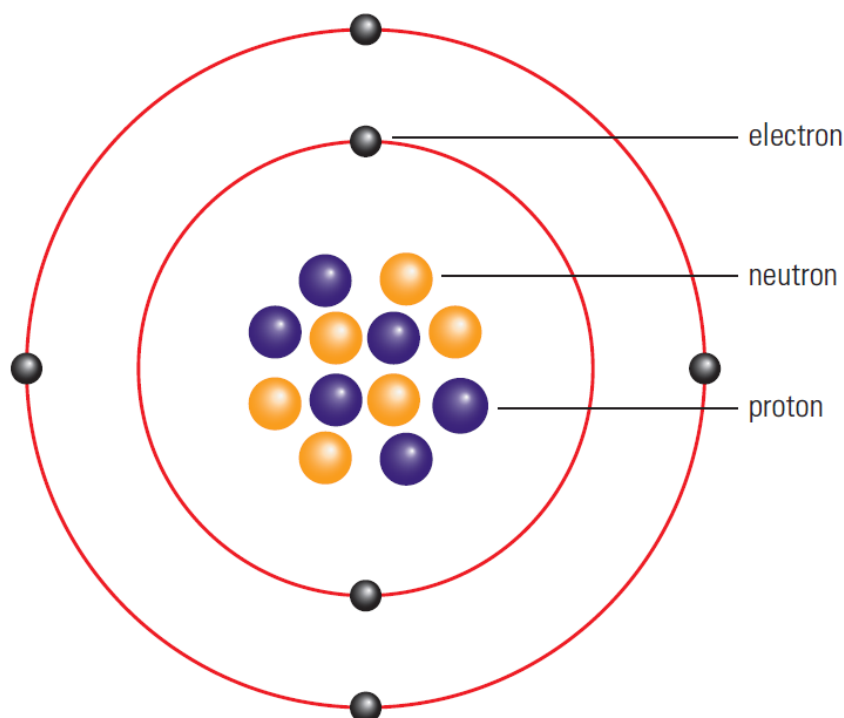


Figure 4

In the Bohr-Rutherford model of the atom, electrons travel in orbits about a positively charged nucleus. This is a model of a carbon atom (not to scale).

Protons: Massive (10^{-27}), positive particles found in the dense nucleus. Number of protons define an element on the periodic table.

Think about it: How can a nucleus of an atom even exist if positive charges repel each other?

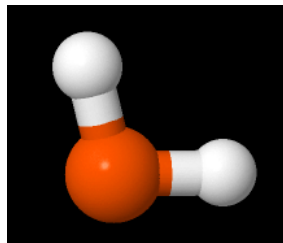
Neutrons: Massive, neutral particles found in the nucleus. Neutrons affect the "stability" of an atom.

Electrons: Negatively charged particles with almost no mass (10^{-31} kg) that "circle" the nucleus at different energy levels - called orbits or shells. These are the key to understanding all non-nuclear chemistry.

Bohr Diagrams

The electrons in the outermost orbit are involved in chemical reactions as they bond with other elements or compounds to create something completely different.

Consider water: H₂O



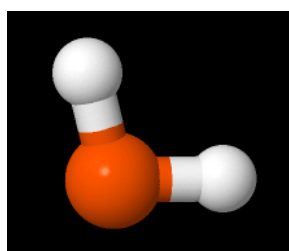
Hydrogen is a very explosive gas.



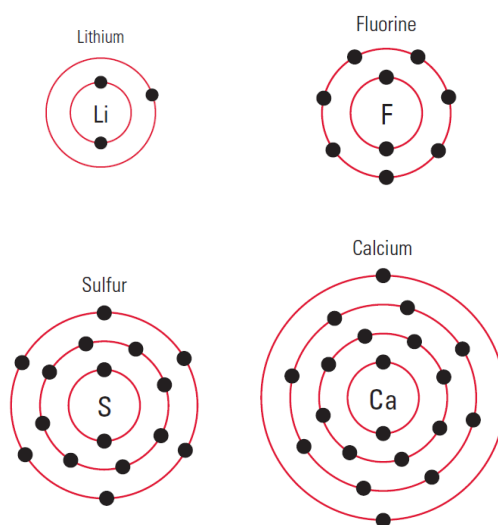
Oxygen is required to burn - it fuels fire and explosions.



But when oxygen shares two electrons - one each for a hydrogen - it forms a compound that puts out fires.



The outer electron shell of an atom is also called the **valence shell**, and the electrons in this shell are called valence electrons.



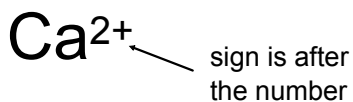
To form compounds the electrons get rearranged. Some reactions will see elements transferring electrons to another while other reactions will have elements that share electrons.

All of this happens so that atoms can have an electron arrangement like a noble gas.

When electrons are transferred the new arrangement of electrons forms an ion.

If the number of protons and electrons in an element are different then it is called an ion.

Positive ions have more protons than electrons. Many metals form positive ions. The symbol for a positive ion is the element symbol with the charge in the top right corner.



Negative ions have more electrons than protons. Many nonmetals form negative ions.



Positive ions are also called cations, and negative ions are also called anions. An easy way to remember these terms is that anions are negative and cations are +ve.

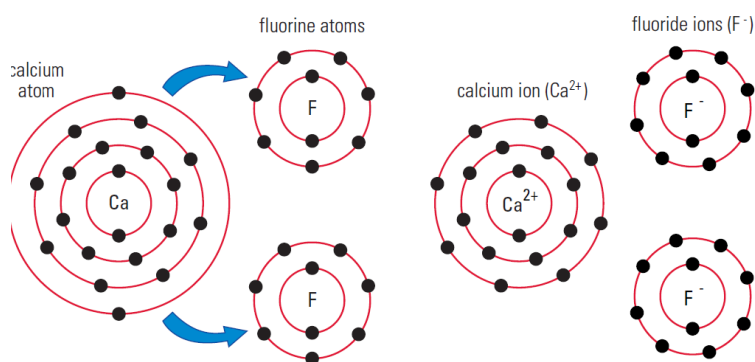
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How Elements Form Compounds

**Figure 1**

Sodium burns rapidly in chlorine gas to form the compound sodium chloride, a compound so harmless that you sprinkle it as salt onto your French fries. This reaction is too dangerous to carry out in a classroom. Each atom of sodium loses an electron to an atom of chlorine.

- NaCl, or table salt, is an example of an ionic compound.
- Ionic compounds are formed by atoms transferring electrons, leaving two charged atoms that are held together by the attraction of positive and negative charges.
- Metals and non-metals form these types of compounds.

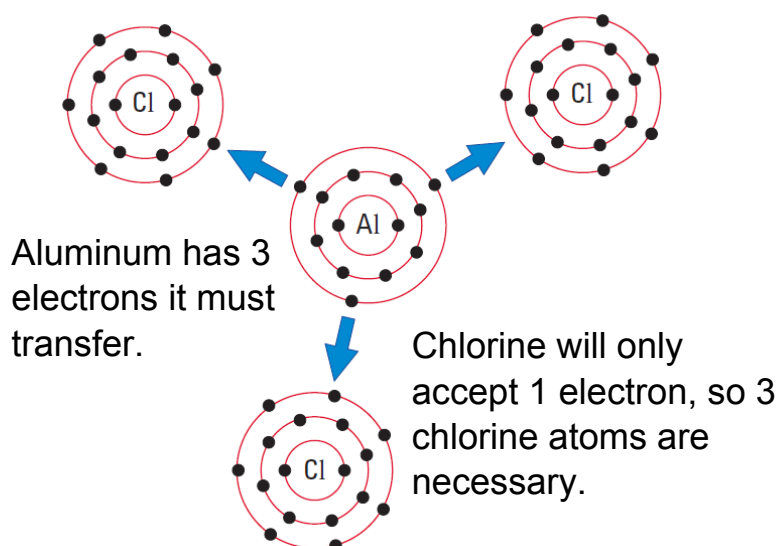


- Atoms will lose or gain electrons to have a stable electron configuration - an electron configuration of a noble gas.
 - > Atoms with more or less electrons than protons are not unstable - they just have a charge.
- Look at your periodic table:
 - > How many electrons does group 1 have to gain or lose to be stable?
 - > Group 2, 16, & 17?

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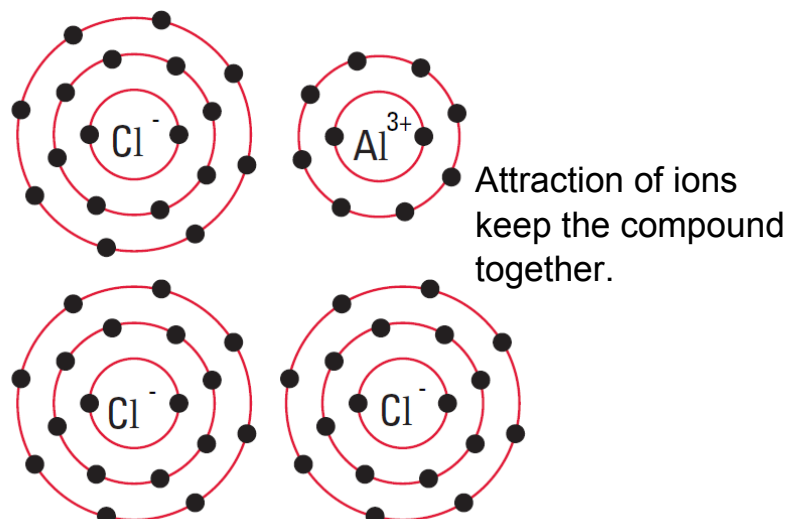
Ionic Compounds

- You will learn:
 - > How to create the chemical formula for ionic compounds.
 - > How to name ionic compounds.
- The compounds we will study will form to be a total charge of zero, or neutral.
- For example, if aluminum and chlorine form a compound then all the charges must add to zero.



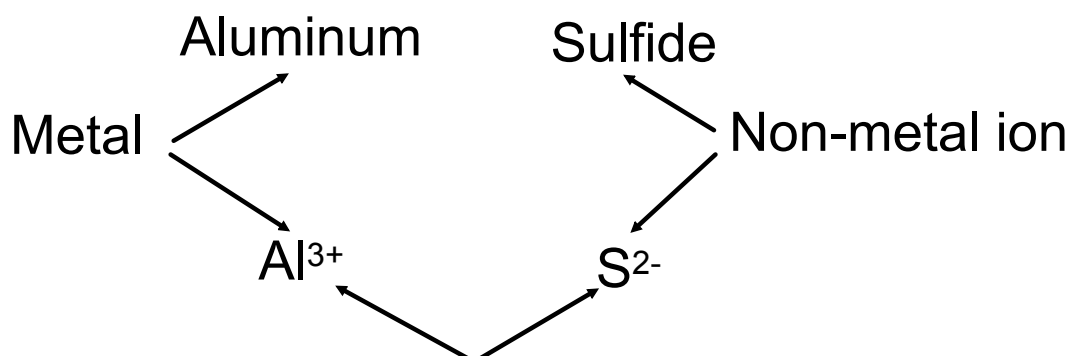
The formula is then: AlCl_3

If the # of atoms is 1, we don't write it. #of atoms



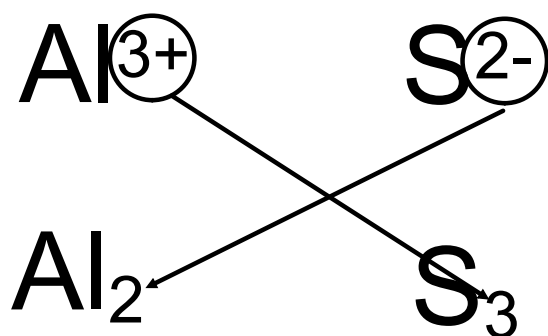
Creating Formulas for Ionic Compounds

Example: Create the formula for the compound aluminum sulfide.



Use the table of ions handout to find these symbols based on the compound's name.

The charges crisscross and become the number of atoms necessary to have a neutral compound. Do not cross over the sign.



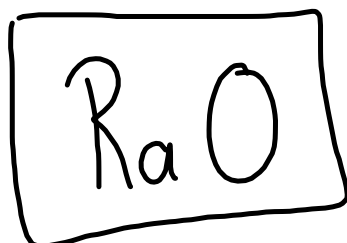
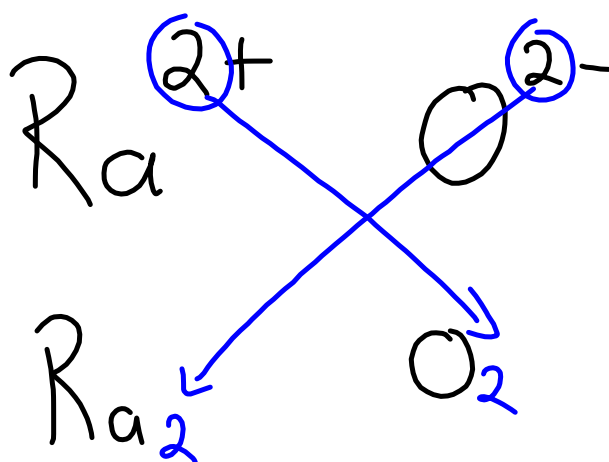
Write the compound with the atoms altogether:



Aluminum Sulfide

Another Example

Write the formula for Radium Oxide



Naming Ionic Compounds

The name of an ionic compound is the name of the metal followed by the name of the nonmetal ion (usually just the name of the element with the ending changed to *-ide*).

Table 1 Names and Ionic Charges of Some Nonmetals

Name of element	Symbol	Ionic charge	Name in compound
fluorine	F	1-	fluoride
chlorine	Cl	1-	chloride
bromine	Br	1-	bromide
iodine	I	1-	iodide
oxygen	O	2-	oxide
sulfur	S	2-	sulfide
nitrogen	N	3-	nitride
phosphorus	P	3-	phosphide

Examples



Names and Formulas for Atoms with More Than One Ionic Charge

Table 2 Names and Multiple Ionic Charges of Some Metals

Name of element	Symbol	Ionic charges	Roman numeral
copper	Cu	1+, 2+	I, II
iron	Fe	2+, 3+	II, III
lead	Pb	2+, 4+	II, IV
tin	Sn	2+, 4+	II, IV



Lead (IV) Sulfide

Iron (III) Phosphide

Attachments

Balancing Chemical Equations.jar

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