

NOTES on
Chapter 4
Elements and the
Periodic Table

4.4 Nonmetals
and Metalloids

Nonmetals

6 C Carbon 12.0107	7 N Nitrogen 14.0064	8 O Oxygen 15.9994	9 F Fluorine 18.9984032	10 Ne Neon 20.1797
15 P Phosphorus 30.973762	16 S Sulfur 32.06	17 Cl Chlorine 35.453	18 Ar Argon 39.948	
	34 Se Selenium 78.96	35 Br Bromine 79.904	36 Kr Krypton 83.798	
		53 I Iodine 126.90447	54 Xe Xenon 131.29	
		85 At Astatine 210	86 Rn Radon 222	
		117 Uus Ununseptium 289	118 Uuo Ununoctium 294	

- Nonmetals' properties are opposite those of metals.**
- 1. Most are poor conductors of electricity and heat.**
 - 2. Most are reactive with other elements.**
 - 3. Solid nonmetals are dull and brittle.**
 - 4. They have lower densities than metals.**

**10 of the 16 nonmetals are gases at room temperature.
The air we breathe is mostly a mixture of 2 nonmetals:
nitrogen and oxygen.**

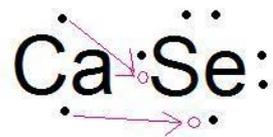
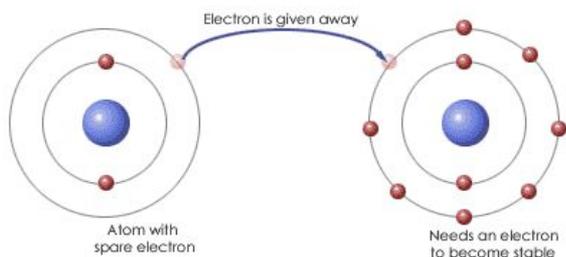
Carbon, iodine, and sulfur are solids at room temperature.

Bromine is the only nonmetal that is liquid at room temperature.

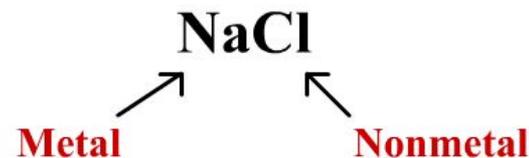
**Most nonmetals are reactive so they readily form compounds.
Fluorine is the most reactive element known.**

Atoms of nonmetals will usually gain or share electrons when they react with other atoms.

Electrons move from the metal atoms to the nonmetal atoms.

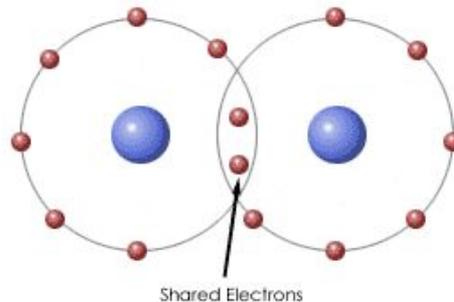


$\text{Ca}^{+2} \text{Se}^{-2}$
Ionic Bond between
Selenium and Calcium.



Sodium chlorine (salt) is a good example, as is rust , Fe_2O_3 .

When nonmetals bond with other nonmetals, they share electrons and become bonded.



Only group 18 contains elements that are all nonmetal. Groups 14-17 have a mix of nonmetals and other kinds of elements.

Group 14: The CARBON family

Each atom in this group can gain, lose, or share 4 electrons.

Only carbon is the only nonmetal in Group 14.

Long chains of carbon atoms are found in all living things.

Most fuels that are burned contain carbon, such as coal and gasoline. Makes sense since fossil fuels come from once-living creatures!

14	
6	
C	
Carbon	
14	
Si	
Silicon	
32	
Ge	
Germanium	
50	
Sn	
Tin	
82	
Pb	
Lead	



Group 15: The NITROGEN family

These usually gain or share 3 electrons when reacting with other elements. This group contains 2 nonmetals: nitrogen and phosphorus.

The atmosphere is nearly 80% nitrogen. Nitrogen doesn't readily react with other elements, so most of the nitrogen you breathe in, you breathe out again.

Nitrogen is a **diatomic molecule**. It occurs in nature as N_2 , consisting of 2 atoms. This makes it very nonreactive.



Some bacteria is able to use the nitrogen molecule to form compounds. This process is called nitrogen fixation. This then enables plants to use the nitrogen in the soil. Farmers will also use fertilizers that have nitrogen compounds added to them. All the nitrogen we get comes from the plants – whether it's directly or indirectly.



Phosphorus is much more reactive than nitrogen. In nature, it is always found in compounds. A compound containing phosphorus is used in making matches because it can react with oxygen in the air.

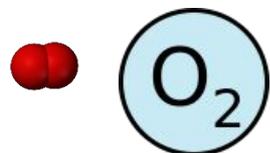
Fertilizer Bag



N Nitrogen
P Phosphorus
K Potassium

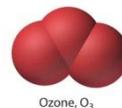
Group 16: The OXYGEN family

The atoms in this group usually gain or share 2 electrons.
This group contains 3 nonmetals: oxygen, sulfur, and selenium.



Oxygen is also a **diatomic molecule**.

Oxygen also form a triatomic atom called ozone.



In the upper atmosphere, it screens out harmful radiation, but at ground level it is a dangerous pollutant because it is highly reactive.

Oxygen is highly reactive and can combine with almost every other element. It is the **most abundant element in Earth's crust** and the **second-most abundant element in the atmosphere**. (Nitrogen is #1)

Sulfur has a distinctive odor.  It is also used to make rubber bands and tires. Sulfuric acid H₂SO₄ is one of the most important chemicals used in industry.

Group 17: The HALOGEN family

Fluorine, chlorine, bromine, iodine, and astatine are all known as halogens, which means “salt forming”. All are nonmetals, except for astatine (metalloid).

All of the halogens are VERY reactive, and the uncombined elements are dangerous to humans. Fluorine is so reactive that it reacts with almost EVERY other substance! Chlorine gas is extremely dangerous, but can be used in small amounts to kill bacteria in water.



Many of the halogen compounds are very useful and are used in our daily lives. Compounds of carbon and fluorine make up the non-stick coating on cookware. Small amounts of fluorine compounds are added to our drinking water to help prevent tooth decay.



Bromine reacts with silver to form silver bromide, which is used in photographic film. Oh, and don't forget table salt!



Group 18: The NOBLE GASES



They do not usually gain, lose, or share electrons. They are all very stable elements.

Noble gases are found in Earth's atmosphere, but in small amounts. They are so unreactive that they weren't even discovered until the late 1800s!. Helium was discovered when scientists were studying the



Neon lights are noble gases, but are often filled with argon or xenon rather than neon.

Hydrogen is all by itself up in the top left-hand corner. It has the simplest and smallest atom containing one proton and one electron. It makes up more than 90% of the atoms in the universe, but only 1% of the mass of Earth's crust, oceans, and atmosphere! Hydrogen is most often combined with oxygen to form water.

THE METALLOIDS

These have some characteristics of both metals and nonmetals.

All are solids at room temperature.

They are hard, brittle, and somewhat reactive.

Periodic Table of the Elements

1	IA	H	IIA																	0	He
2		Li	Be																		Ne
3		Na	Mg	IIIB	IVB	VB	VIB	VIB	VII	IB	IIB								Ar		
4		K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br	Kr		
5		Rb	Sr	Y	Zr	Nb	Mo	Tc	Ru	Rh	Pd	Ag	Cd	In	Sn	Sb	Te	I	Xe		
6		Cs	Ba	La	Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	Tl	Pb	Bi	Po	At	Rn		
7		Fr	Ra	Ac	Rf	Ha	Sg	Ns	Hs	Mt	110	111	112	113							

Metalloids

	13	14	15	16	17
2	B Boron	C Carbon	N Nitrogen	O Oxygen	F Fluorine
3	Al Aluminium	Si Silicon	P Phosphorus	S Sulfur	Cl Chlorine
4	Ga Gallium	Ge Germanium	As Arsenic	Se Selenium	Br Bromine
5	In Indium	Sn Tin	Sb Antimony	Te Tellurium	I Iodine
6	Tl Thallium	Pb Lead	Bi Bismuth	Po Polonium	At Astatine

Silicon combines with oxygen to form silicon dioxide (SiO_2) which is a main component in glass.

Boron and oxygen is added in process of glassblowing to make heat-resistant glass.

The most useful property of the metalloids is their varying ability to conduct electricity.

Temperature, exposure to light, or the presence of small amounts of impurities can affect the metalloid's ability to conduct electricity.

Silicon, germanium, and arsenic are used to make semiconductors. These are substances that can conduct electricity under some conditions but not under other conditions.