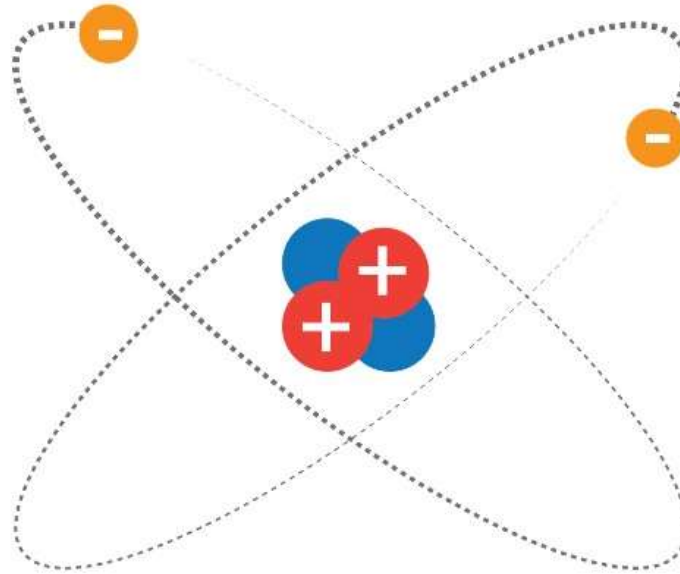
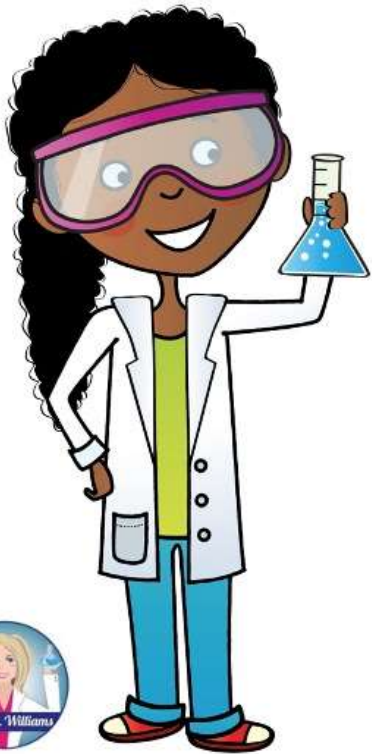


Atoms, Elements, Molecules, and Compounds



By Lynda R. Williams



What is matter?

- ❖ Matter is anything that has mass and occupies space (volume).

Water



Flower

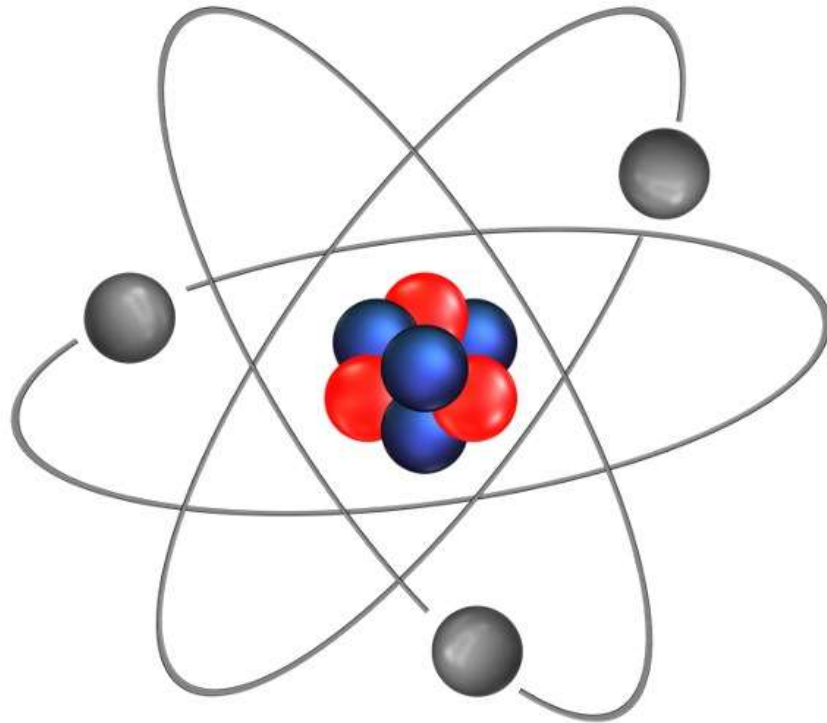


Tiger



The nucleus is the center of the atom. The nucleus is small and dense. It contains protons and neutrons.

The Atom



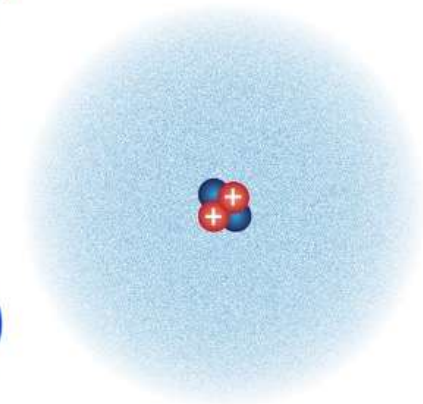
Protons have a positive charge.



Neutrons have no charge (neutral).



Electrons orbit the nucleus. Electrons have a negative charge.

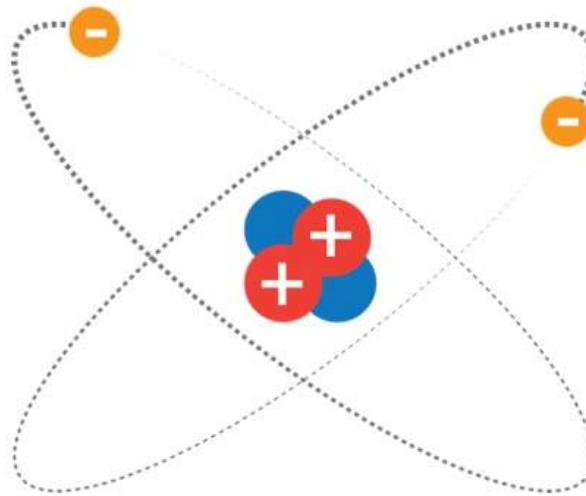


The *electron cloud* is the area around the nucleus that contains electrons

An Atom is the smallest 'building block' of matter.

The Particles of an Atom

The nucleus is made up of 2 types of particles called protons and neutrons.



Protons: Positive Charge, Mass of 1

Neutrons: Neutral Charge, Mass of 1

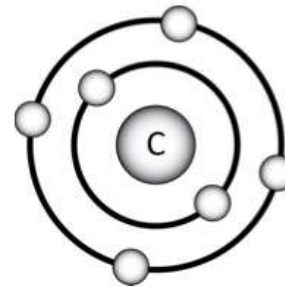
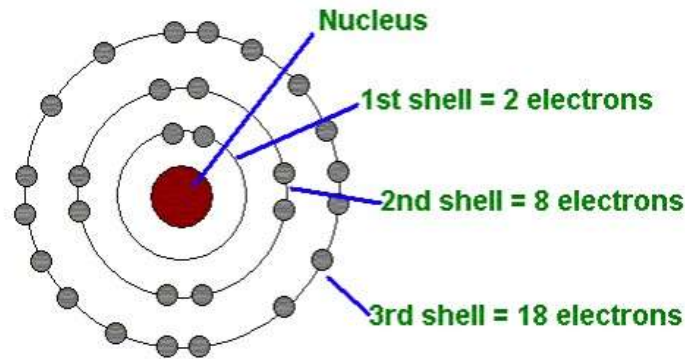
Electrons orbit the nucleus. Electrons have a negative charge.

Electrons are very tiny compared to protons and neutrons. They are about $1/1840$ the mass of a proton or neutron.

In other words, you'd need 1840 electrons to have the mass of one proton or neutron.



Neils Bohr



Although electrons do orbit the nucleus, they don't orbit in the way that planets orbit the sun.

Neils Bohr was a Danish scientist who discovered that electrons orbit the nucleus in defined orbits.

In this diagram of an atom of carbon (using the Bohr Model) you can see that there are two electrons in the orbit or shell closest to the nucleus and 4 electrons in the outer orbit.

The **Bohr model** shows that the electrons in atoms are in orbits of differing energy around the nucleus. **Bohr** used the term energy levels (or shells) to describe these orbits of differing energy.

Nuclear Formula

Atomic Mass

Usually, we measure mass in grams or kilograms. When we're dealing with the tiny particles in the atom, we use atomic mass units (AMU).

A proton and neutron each have a mass of 1 AMU.

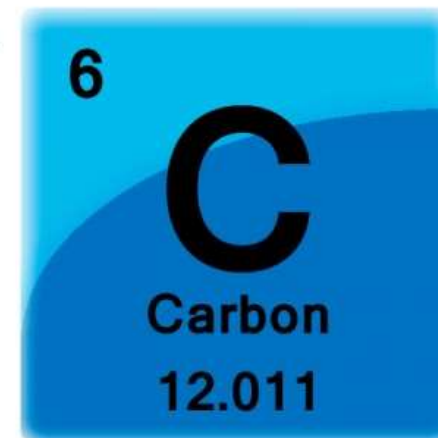
An electron has a mass of $1/1840$ AMU.

The mass of an atom is the mass of the protons and neutrons added together (we can ignore the mass of the electrons as they have such a small mass).

Atomic Number

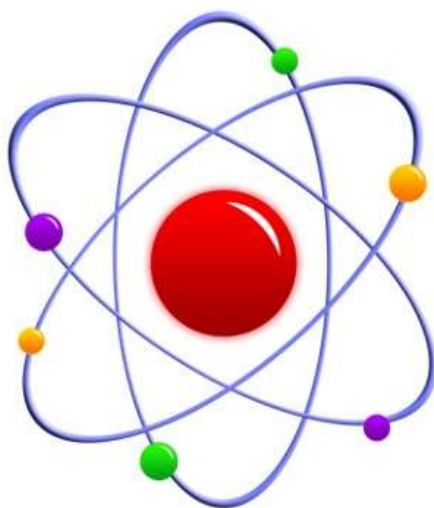
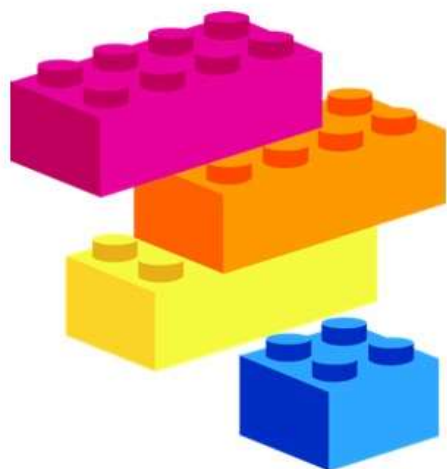
The atomic number of an atom is the number of protons in the atom.

Atomic
Number
[the number
of protons]



Mass Number
[the number of
protons + neutrons]

The Building Blocks of Matter

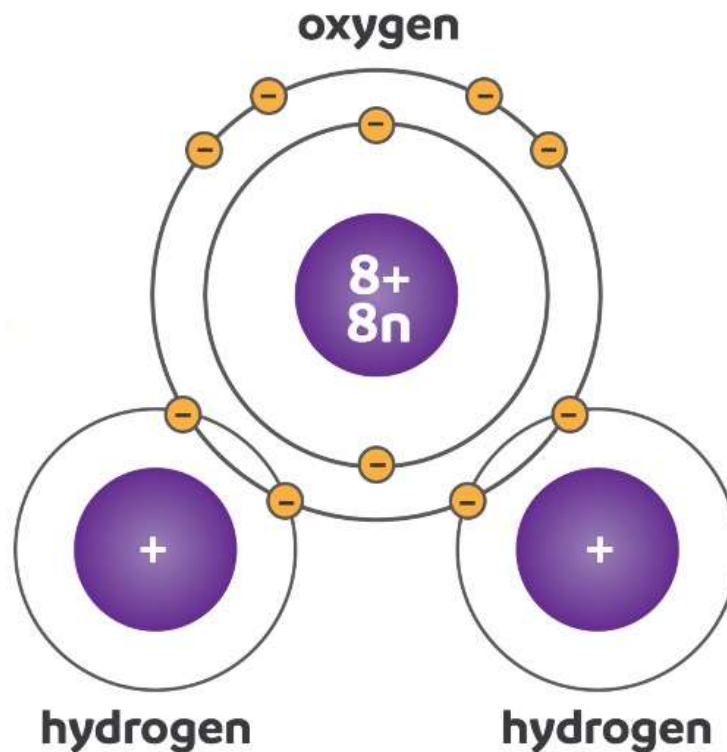
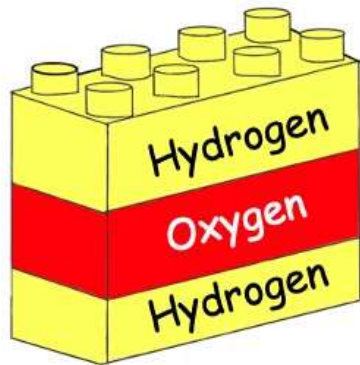


Each droplet of water contains thousands of H_2O molecules; each H_2O molecule contains hydrogen atoms and oxygen atoms. Atoms are the building blocks of matter.

An ***element*** is a substance that cannot be broken down into simpler substances by chemical means; hydrogen and oxygen are elements. All of the elements can be found in the ***Periodic Table of Elements***.

An ***atom*** is the smallest part of an element.

Building Blocks of Matter Continued...



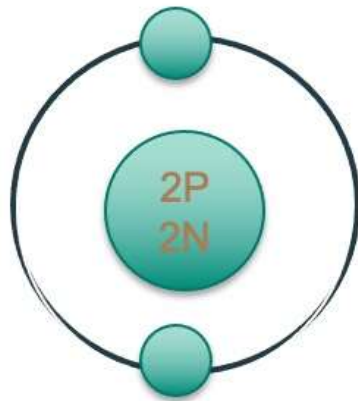
A water molecule is made up of one Oxygen atom chemically bonded to two Hydrogen atoms.

These atoms are the 'building blocks' that create the water molecule.

Properties of Substances

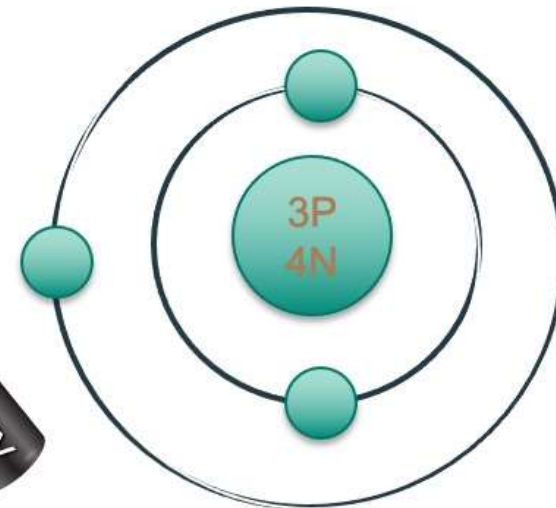
Each of these substances has different properties. Their atomic structures are different.

Helium has only two protons and two neutrons. It has two electrons.



Helium

Lithium has three protons and four neutrons. It has three electrons.



Lithium

Changing the number of protons and neutrons in an atom gives them very different properties.

The Periodic Table of Elements

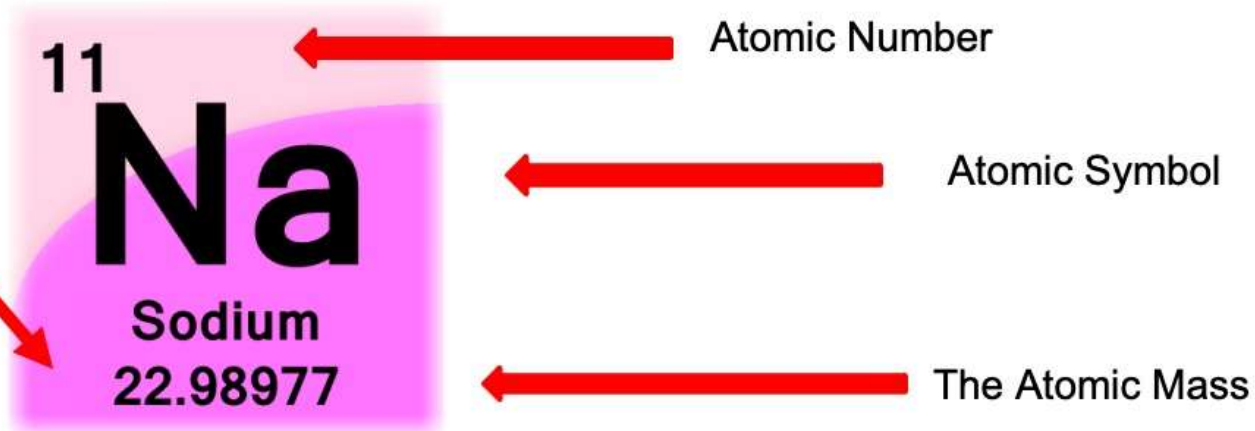
Proton is a positively charged sub-atomic particle (+). The number of protons is the same as the atomic number.

In an atom the number of electrons is equal to the number of protons.

On the Periodic Table of Elements, it looks something like this.

This number is often rounded.

So, you will see something like 23.



The Periodic Table of Elements

The Periodic Table of Elements lists all of the known elements that make up matter, including, hydrogen (H), oxygen (O), Chlorine (Cl), and Sodium (Na).

Periodic Table of Elements

BACKGROUND		CHEMICAL SYMBOL																																	
metals	■	solid	Na																																
metalloids	■	liquid	Hg																																
nonmetals	■	gas	⊙																																
hydrogen 1 H 1.0079				helium 2 He 4.0026																															
lithium 3 Li 6.941	beryllium 4 Be 9.0122				boron 5 B 10.81																														
sodium 11 Na 22.990	magnesium 12 Mg 24.305				carbon 6 C 12.011																														
potassium 19 K 39.098	calcium 20 Ca 40.078	scandium 21 Sc 44.956	titanium 22 Ti 47.867	vanadium 23 V 50.942	chromium 24 Cr 51.996	manganese 25 Mn 54.938	iron 26 Fe 55.845	cobalt 27 Co 58.933	nickel 28 Ni 58.693	copper 29 Cu 63.546	zinc 30 Zn 65.38	gallium 31 Ga 69.723	germanium 32 Ge 72.64	arsenic 33 As 74.922	selecnium 34 Se 78.96	bromine 35 Br 79.904	krypton 36 Kr 83.798																		
rubidium 37 Rb 85.468	strontium 38 Sr 87.62	yttrium 39 Y 88.906	zirconium 40 Zr 91.224	niobium 41 Nb 92.906	molybdenum 42 Mo 95.94	technetium 43 Tc [98]	ruthenium 44 Ru 101.07	rhodium 45 Rh 102.91	palladium 46 Pd 106.42	silver 47 Ag 107.87	cadmium 48 Cd 112.41	indium 49 In 114.82	tin 50 Sn 118.71	antimony 51 Sb 121.76	tellurium 52 Te 127.60	iodine 53 I 126.90	xenon 54 Xe 131.29																		
caesium 55 Cs 132.91	barium 56 Ba 137.33				hafnium 72 Hf 178.49	tantalum 73 Ta 180.95	tungsten 74 W 183.84	rhenium 75 Re 186.21	osmium 76 Os 190.23	iridium 77 Ir 192.22	platinum 78 Pt 195.08	gold 79 Au 196.97	mercury 80 Hg 200.59	thallium 81 Tl 204.38	lead 82 Pb 207.2	bismuth 83 Bi 208.98	polonium 84 Po [209]	astatine 85 At [210]	radon 86 Rn [222]																
francium 87 Fr [223]	radium 88 Ra [226]				rutherfordium 104 Rf [261]	dubnium 105 Db [262]	seaborgium 106 Sg [266]	bohrium 107 Bh [264]	hassium 108 Hs [277]	meitnerium 109 Mt [268]	darmstadtium 110 Ds [271]	roentgenium 111 Rg [272]	copernicium 112 Cn [285]	nihonium 113 Nh [284]	flerovium 114 Fl [289]	moscovium 115 Mc [290]	tennessine 116 Lv [293]	oganesson 118 Og [294]																	
																		bohrium 107 Bh [264]	hassium 108 Hs [277]	meitnerium 109 Mt [268]	darmstadtium 110 Ds [271]	roentgenium 111 Rg [272]	copernicium 112 Cn [285]	nihonium 113 Nh [284]	flerovium 114 Fl [289]	moscovium 115 Mc [290]	tennessine 116 Lv [293]	oganesson 118 Og [294]							
																		lutetium 71 Lu 174.97	ytterbium 70 Yb 173.05	thulium 71 Tm 168.93	erbium 68 Er 167.26	holmium 67 Ho 164.93	dysprosium 66 Dy 162.50	terbium 65 Tb 158.93	gadolinium 64 Gd 157.25	europtium 63 Eu 151.96	europium 63 Eu 151.96	gadolinium 64 Gd 157.25	terbium 65 Tb 158.93	dysprosium 66 Dy 162.50	holmium 67 Ho 164.93	erbium 68 Er 167.26	thulium 69 Tm 168.93	ytterbium 70 Yb 173.05	lutetium 71 Lu 174.97
																		actinium 89 Ac [227]	thorium 90 Th 232.04	protactinium 91 Pa 231.04	uranium 92 U 238.03	neptunium 93 Np [237]	plutonium 94 Pu [244]	americium 95 Am [243]	curium 96 Cm [247]	berkelium 97 Bk [247]	californium 98 Cf [251]	einsteinium 99 Es [252]	fermium 100 Fm [257]	mendelevium 101 Md [258]	nobelium 102 No [259]	lawrencium 103 Lr [260]			

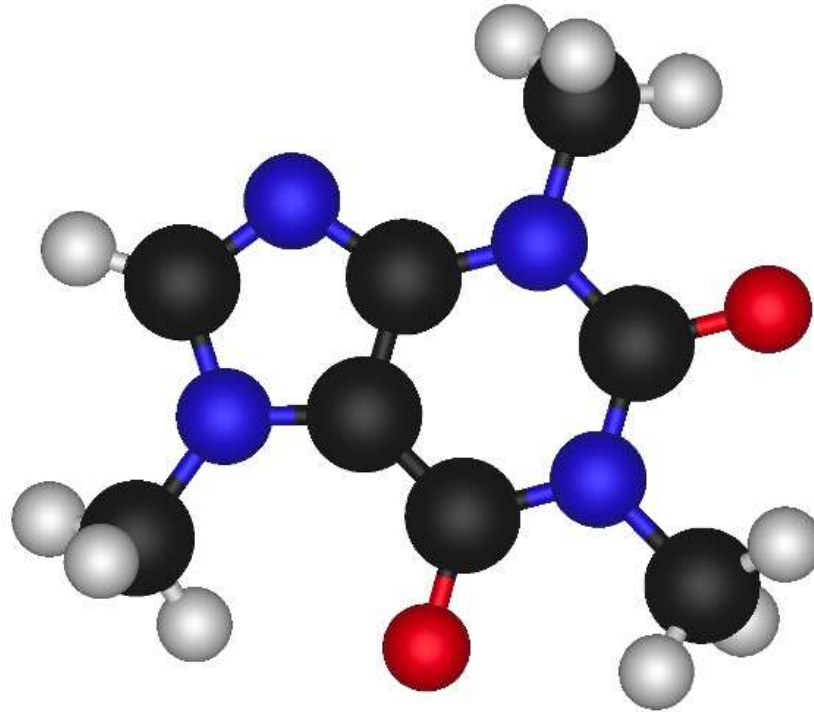
When a substance is made up of only one type of atom it is called an element.

<https://www.youtube.com/watch?v=uPkEGAHo78o>

<https://www.youtube.com/watch?v=yQP4UJhNn0I>

Molecules

Atoms can join together chemically. When this happens, they form a molecule. The atoms that form the molecule can be the same or different.



Elements and Molecules

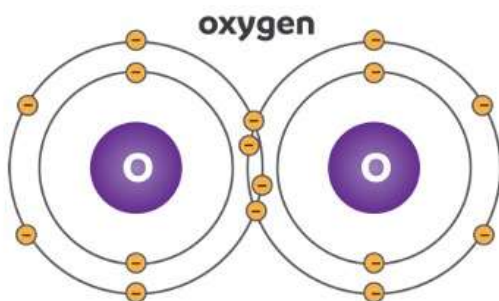
When a substance is made up of only one type of atom it is called an element.

Oxygen is a molecule of 2 oxygen atoms joined (bonded) together.

We write oxygen as O_2 .

Is oxygen an element?

Yes, because it is made up of one type of atom.

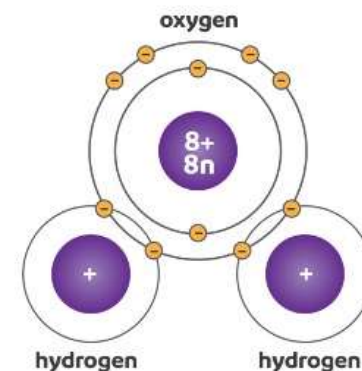


A molecule is the smallest unit of a substance that still has the chemical and physical characteristics of that substance.

The chemical name for water is H_2O . This means that each molecule of water is made up of 2 hydrogen atoms joined to 1 oxygen atom.

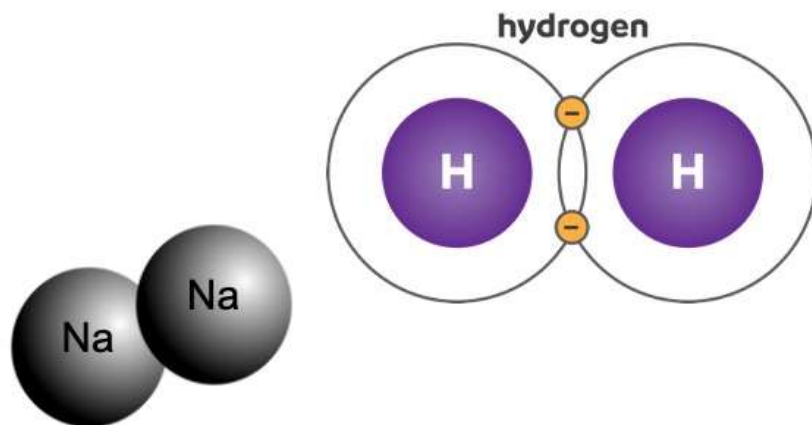
Is water an element?

No, because it is made up of more than one type of atom.

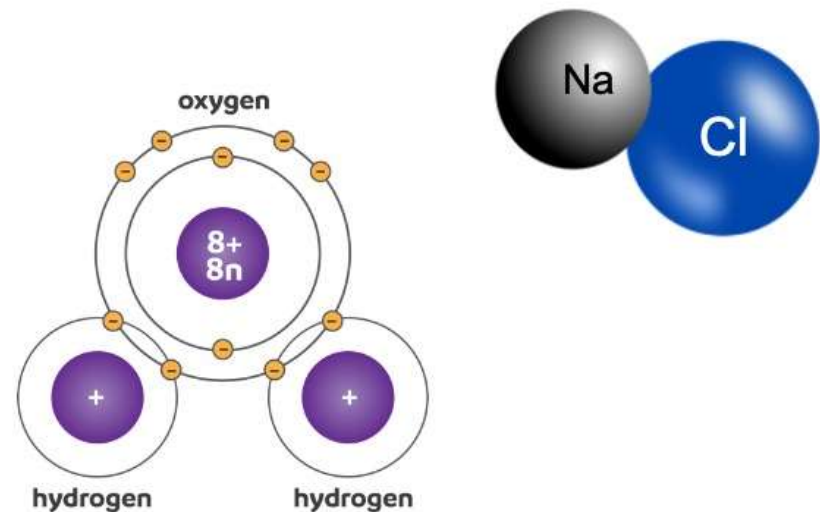


Molecules vs. Compounds

A **molecule** is made up of two or more atoms bonded together.



A **compound** is made up of two or more different types of atoms bonded together.



All compounds are molecules, but not all molecules are compounds.

Compounds

Sodium chloride is more commonly called salt. It is a compound made from sodium and chlorine.

Properties of Sodium (Na)

Really reactive metal

Reacts with water to produce hydrogen gas and sodium hydroxide (drain cleaner!)

Used in streetlights



Properties of Chlorine (Cl)

Green poisonous gas

Used in WW1 in gas attacks

Used to kill germs in swimming pools

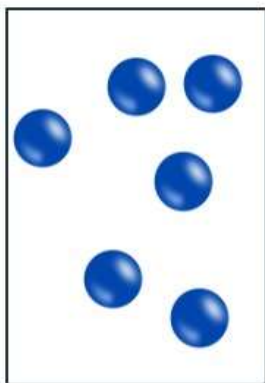
Sodium and **chlorine** combine to form a compound named **sodium chloride**. The individual properties of sodium and chlorine no longer exist. The reaction between sodium and chlorine results in sodium chloride (table salt). This is the reason **NaCl** is **not harmful** because the compound does **not** show the properties of the individual components.

Molecular Models

- ❖ There are many different ways to represent molecules. Scientists use models to help them understand the structure of molecules and how they interact with each other.
- ❖ Molecules can range in size from two to thousands of atoms.
- ❖ Molecules can have simple structures, or they can form extended (more complex) structures.
- ❖ The properties of all types of matter depend on their composition (atoms/elements/molecules), and how these atoms are arranged.
- ❖ Molecules are made of different kinds, proportions and quantities of atoms.

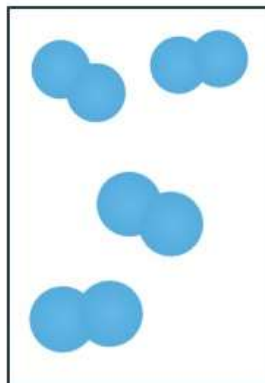
Some Simple Structures

Helium Gas



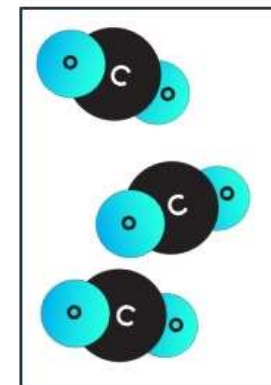
Individual atoms that are not attracted to each other

Chlorine Gas



Molecules of the same type of atom that are not attracted to each other

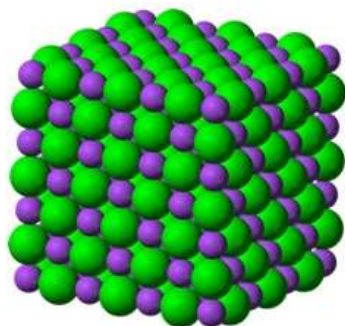
Carbon Dioxide Gas



Molecules of different types of atoms that are not attracted to each other

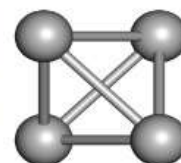
Some Extended Structures

Sodium Chloride



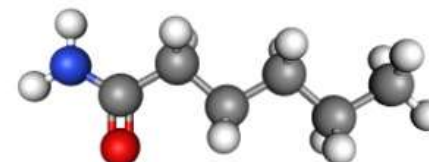
Individual atoms of different types that repeat to form extended structures

Silver Metal



Individual atoms of the same type that are connected to form extended structures

Nylon



Molecules of different types of atoms that are attracted to each other and connect to form extended structures