Chemistry 1010

Small Molecules

Review

What are the two most common types of physical changes that we encounter in chemistry?

changes of state and dissolving

What are the three most common types of nuclear changes, and where do we encounter them?

fusion – stars, particle accelerators

fission – nuclear bombs, nuclear power plants

radioactivity – naturally occurring radioactive elements, nuclear power plants, nuclear waste, nuclear medicine

What are the clues that can indicate that a chemical reaction has occurred?

bubbling, precipitate, color change, heat released

What does it mean to balance a chemical equation?

add coefficients to tell how many of each compound or element is involved in each side of the equation

$2\,H_2 + O_2 \rightarrow 2\,H_2O$ (if there is no number, "1" is implied)

Why is it important to balance a chemical equation?

atoms can't be lost or gained during a chemical reaction so that it shows what amounts are needed

Balance the following equation:

$2\,K + 2\,H_2O \rightarrow 2\,KOH + H_2$

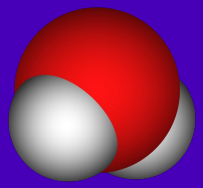
K	H	O	K	H	O
1	2	1	1	3	1
2	4	2	2	4	2

What if you get this?

$4\,K + 4\,H_2O \rightarrow 4\,KOH + 2\,H_2$ reduce it!

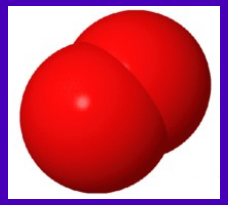
Introduction

Write the formulas and description for each molecule.

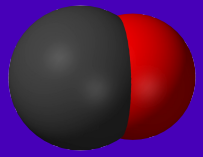


H_2O

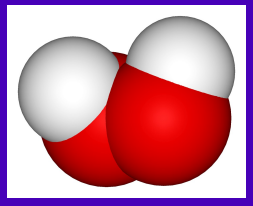
CO_2



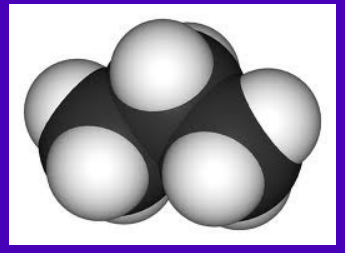
O_2



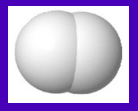
CO



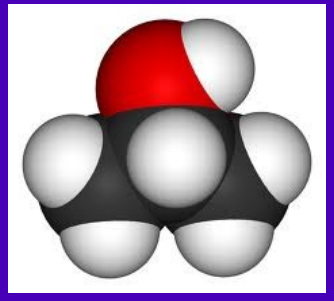
H_2O_2



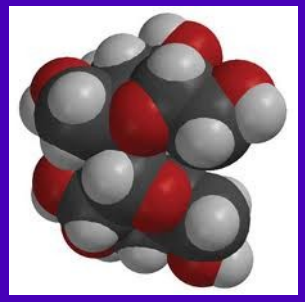
C_3H_8



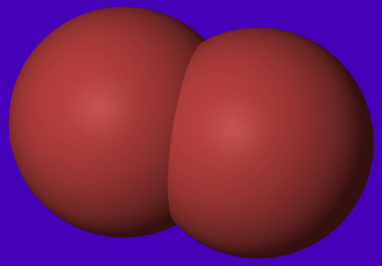
H_2



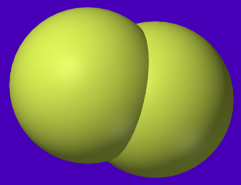
C_3H_8O



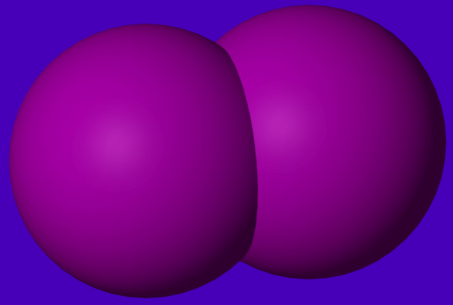
$C_{11}H_{22}O_{11}$



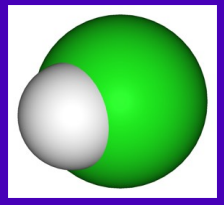
Br_2



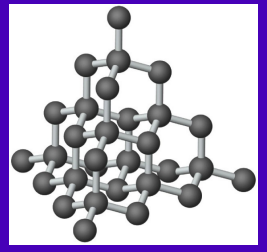
F_2



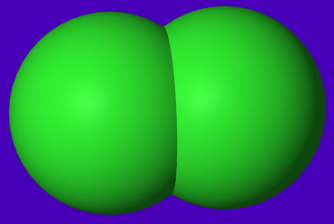
I_2



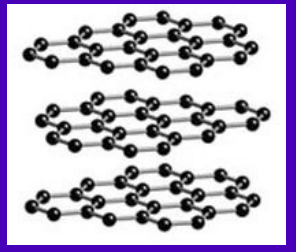
HCl



diamond

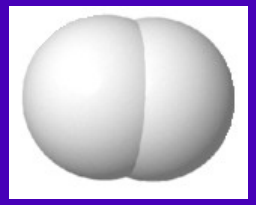
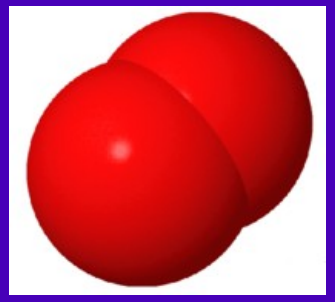
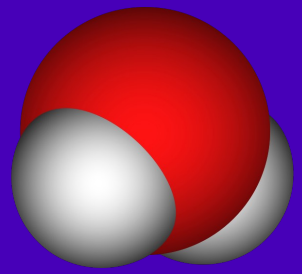


Cl_2



graphite

So far, we've been using space filling models to represent molecules.

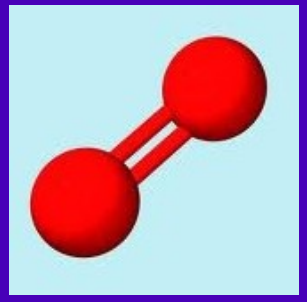





What information can we get by looking at these models?

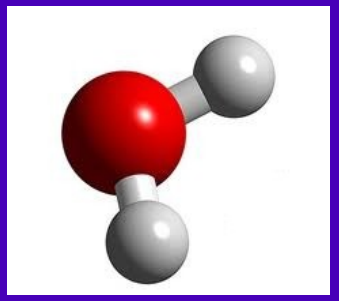
what atoms are present
the shape of the molecules
relative sizes of atoms and molecules

Space filling models give a pretty good picture. But something's missing. Here are some ball and stick models.

one bond



two bonds



single bonds

double bonds

How are the ball and stick models different? What do they show that the space-filling models do not?

the atoms are pulled apart to show the bonds

There are a number of questions that we haven't answered yet:

What holds these atoms together?

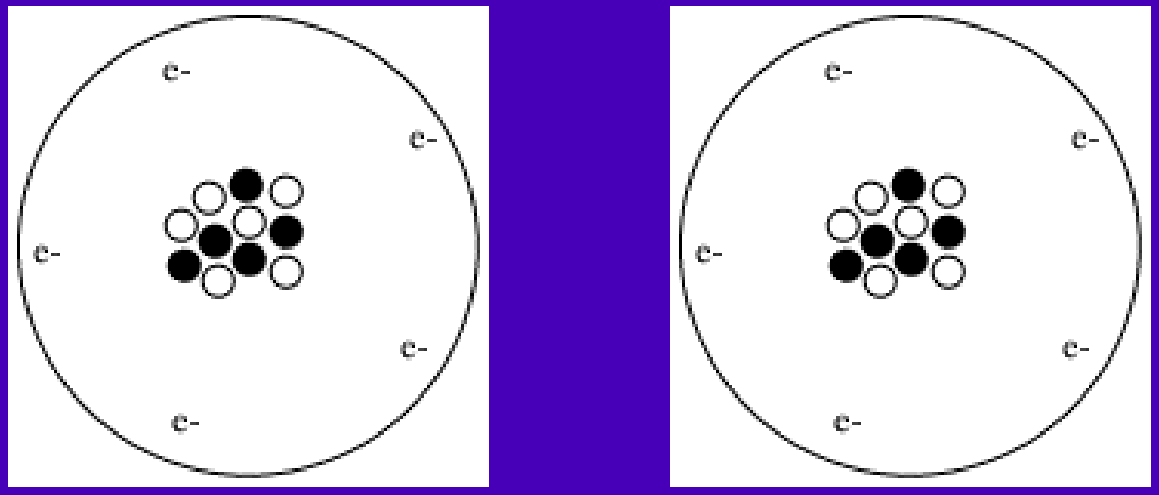
Why are some elements diatomic, and some are not?

Why is water bent, but CO_2 straight?

Today we will find answers to these questions.

1 – How are electrons organized?

When atoms form chemical bonds, which of the elementary particles are involved? Why?



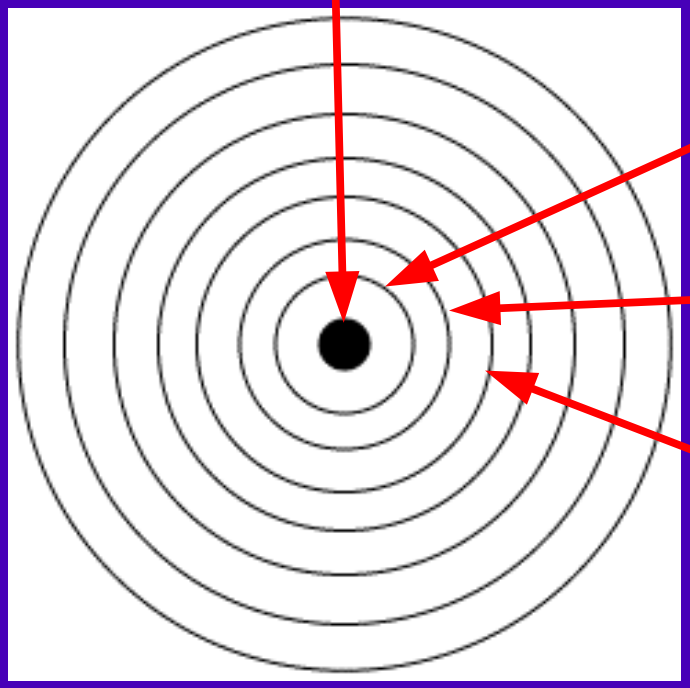
electrons – they are on the outside of the atom

Are all of the electrons involved in forming bonds? no

Which ones do we need to worry about?

To answer this question, we need to know how the electrons are organized in an atom.

Electrons are organized into: seven energy levels



Each energy level holds a certain number of electrons.

1st level – 2 electrons

2nd level – 8 electrons

and so on...

Electrons fill up the lowest energy level first, then go to the next, and so on.

Example: electrons in a sodium atom

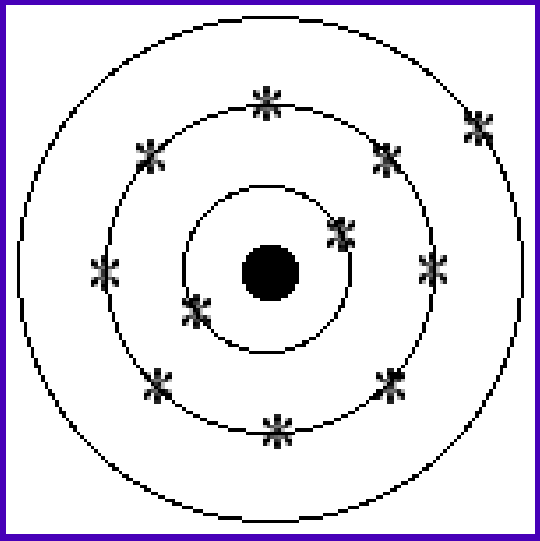
number of electrons in a neutral atom: 11

electrons in the 1st energy level: 2

electrons in the 2nd energy level: 8

electrons in the 3rd energy level: 1

the rest of the energy levels: empty

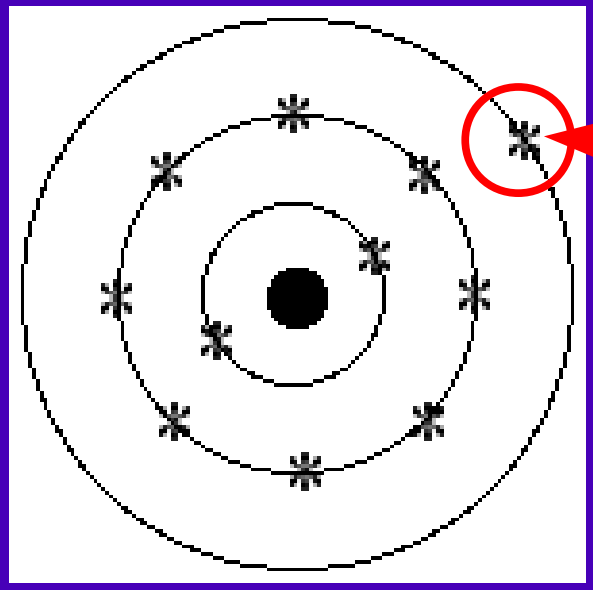


So, which of these electrons are involved in forming chemical bonds?

the ones in the highest energy level

these are called the valence electrons

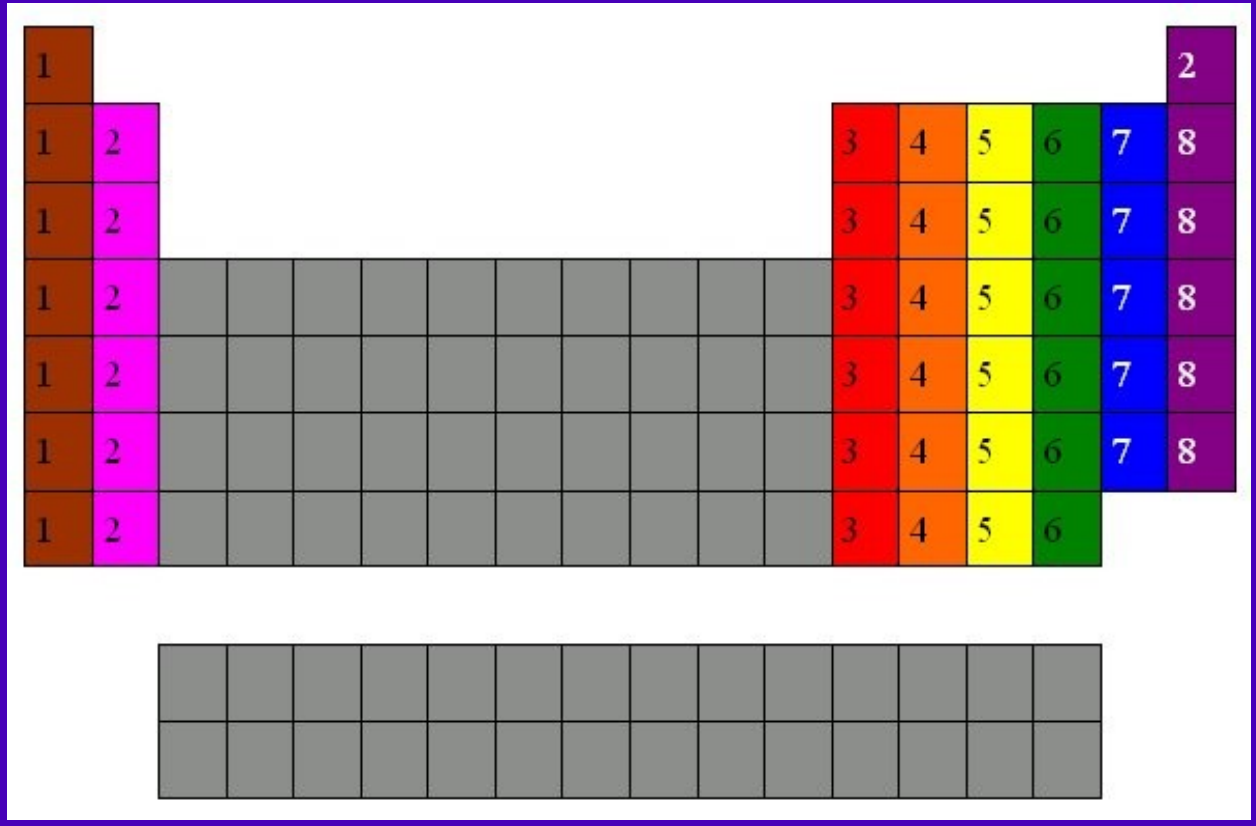
Which are the valence electrons in a sodium atom?



only this one

In order to predict how an atom will react, we need to know how many valence electrons it has.

You can determine the number of valence electrons for nonmetals and main group metals by counting across on the Periodic Table.



What pattern do you see here?

(The number of valence electrons in the transition and inner transition metal atoms is harder to predict. We will worry about them later.)

How many valence electrons do the following atoms have?

oxygen	6	neon	8
potassium	1	hydrogen	1
fluorine	7	nitrogen	5
aluminum	3	bromine	7
carbon	4	sulfur	6
magnesium	2	bismuth	5

An American chemist named **Gilbert Lewis** proposed an easy way to represent the valence electrons. They are called **Lewis structures**.

lithium 1	beryllium 2	boron 3	carbon 4
Li •	• Be •	• B •	• C •

nitrogen 5	oxygen 6	fluorine 7	neon 8
• N •	• O •	: F •	: Ne :

2 – How do atoms form bonds?

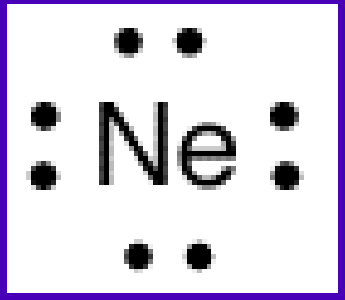
Now we are ready to talk about why atoms form bonds. The key to understanding how atoms behave it this:

Atoms are most stable when they have 8 valence electrons.

This is called the octet rule.

If atoms don't have this, they can form chemical bonds.

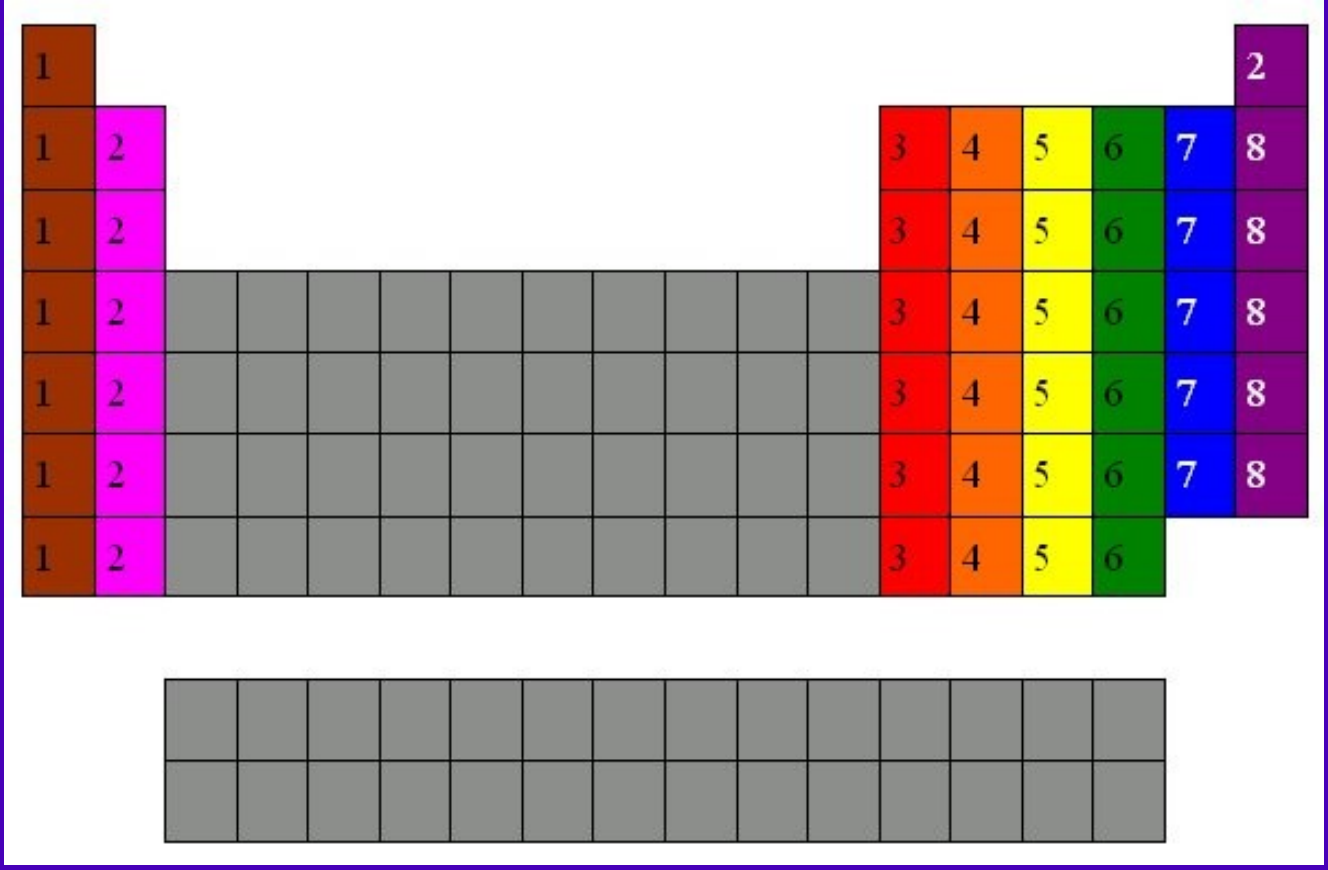
Using this information, can you explain why noble gases are always found as individual atoms?



they already have 8 valence electrons
don't need to form chemical bonds

We will first be looking at covalent bonds, which always involve nonmetal atoms bonding with other nonmetal atoms.

What do the nonmetal atoms have in common?

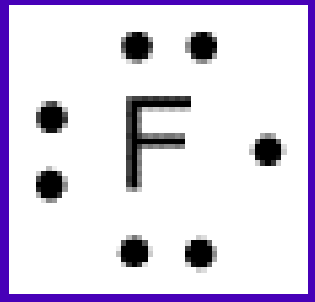


They are short a few electrons to fill the octet rule.

To solve this problem, atoms can share their electrons with each other.

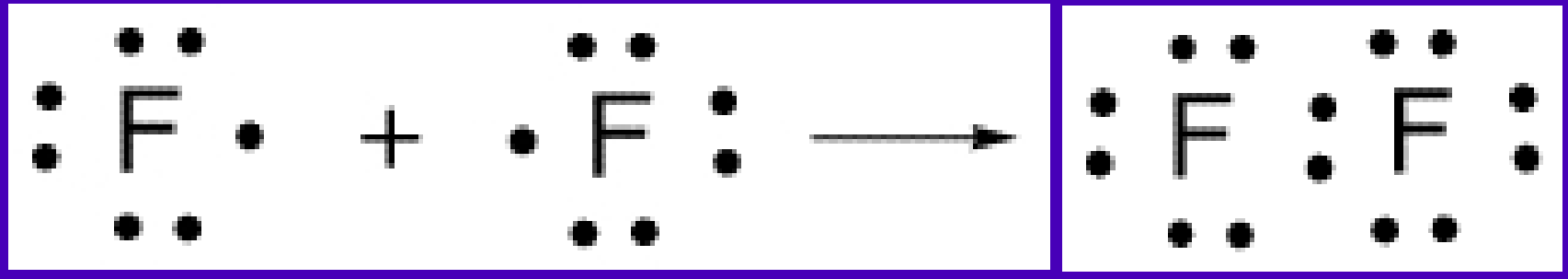
Example: F_2

Lewis structure of a fluorine atom:



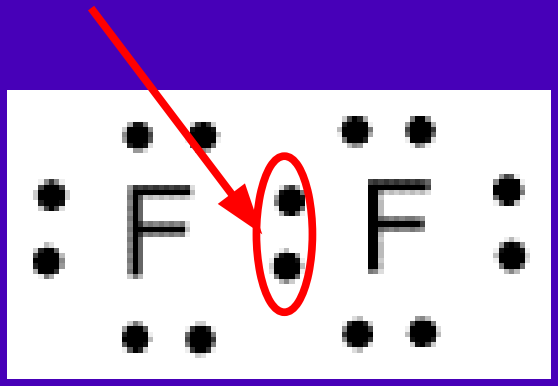
a fluorine atom all by itself has only seven valence electrons

if two fluorine atoms get together, they can share two of their electrons between them



Now each fluorine has 8 valence electrons around it, and satisfies the octet rule.

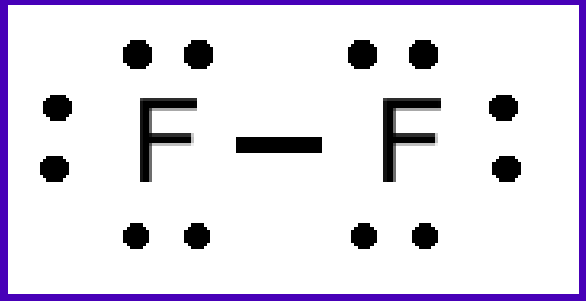
A pair of electrons shared between two atoms is called a **covalent bond**.



It holds the atoms together because **if they came apart they wouldn't have enough electrons to fill the octet rule**.

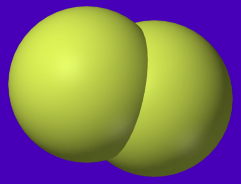
To show this, the shared electrons are replaced with **a line**, linking the two atoms together.

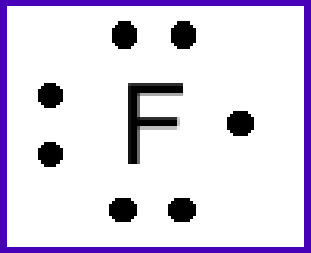
Lewis structure for F_2:

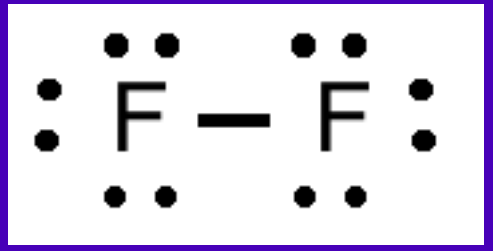


Why are all of the halogens diatomic?

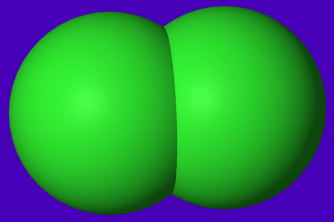
F_2

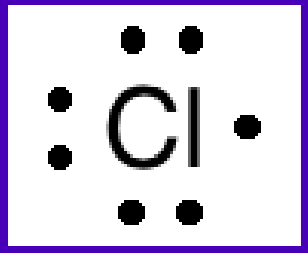




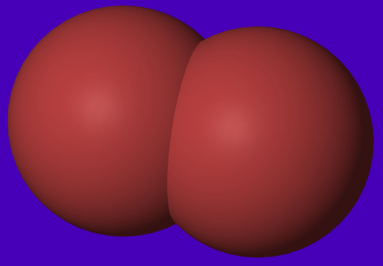


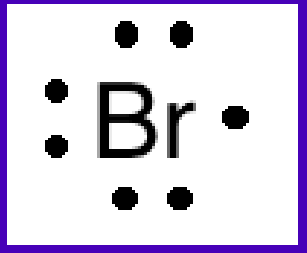
Cl_2

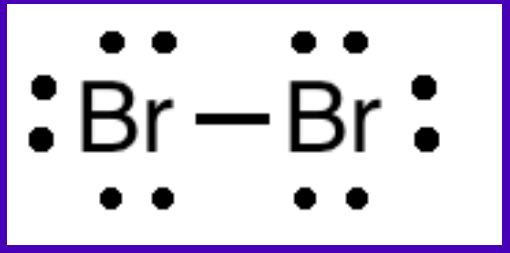




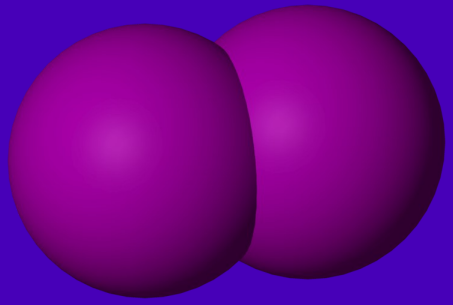
Br_2

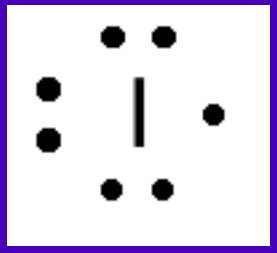


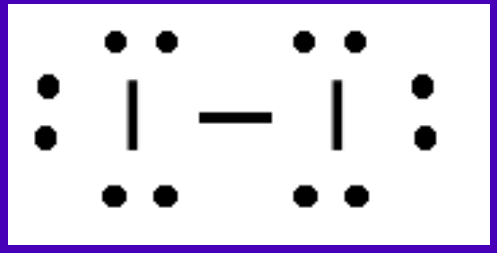




I_2



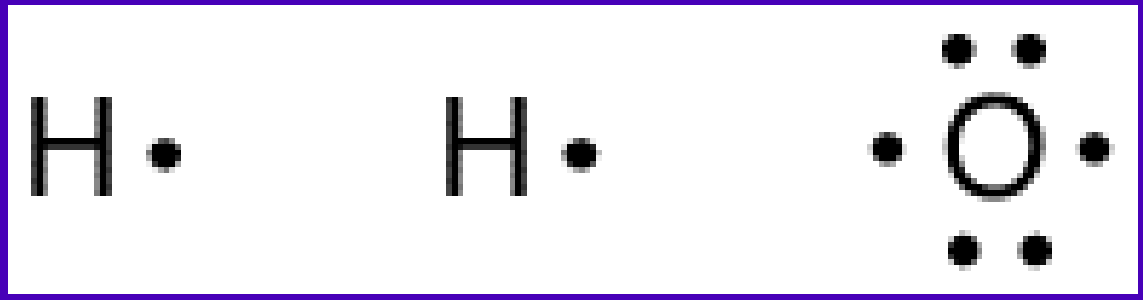




They all have 7 valence electrons, and only need one more.

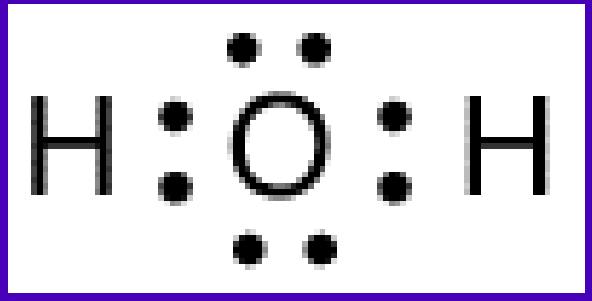
Example: water (H_2O)

Lewis structures for two H's and one O:

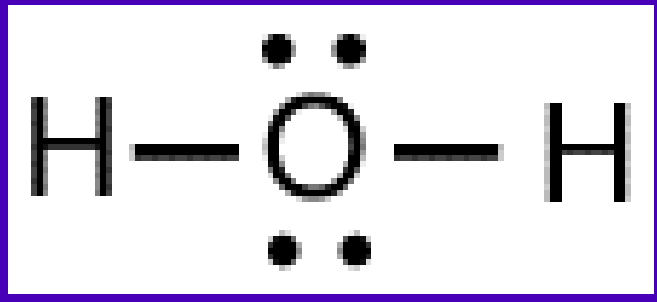


Hydrogen is an exception to the octet rule. It only needs 2 electrons to be stable.

How could you put these atoms together so that the oxygen has 8 electrons and the two hydrogens have 2 electrons?



Lewis structure for water:



Every time there is a single electron on a side, it must be joined with a single electron on another atom to form a bond.