Chapter 1

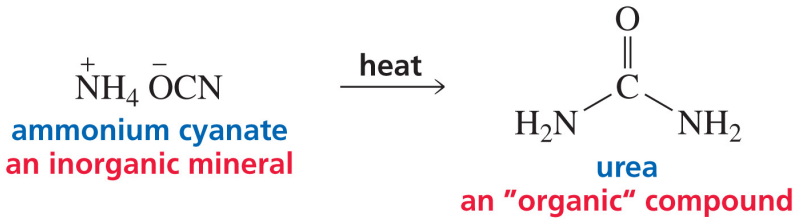
Review of General Chemistry:

Electronic Structure and Bonding

What is Organic Chemistry?

Organic compounds: from living organisms

Inorganic compounds: from minerals



ammonium cyanate
an inorganic mineral

urea
an "organic" compound

Organic compounds are compounds that contain carbon.

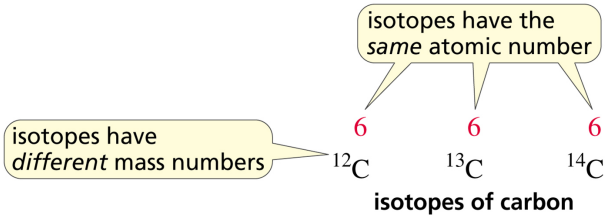
Isotopes

Isotopes: atoms of the same element with different mass

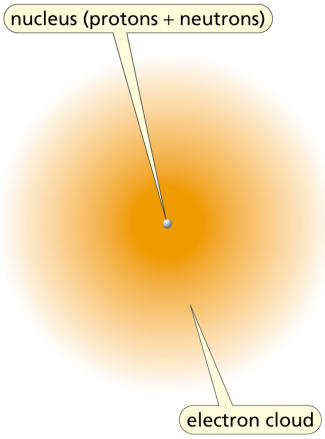
All Carbon Atoms Have the Same Atomic Number = # of protons

Carbon Atoms Can Have the Different Mass Numbers

Mass Number = # of protons + # of neutrons



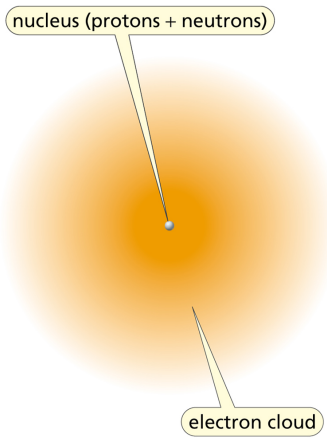
The Structure of an Atom



an atom

Protons are positively charged.
Neutrons have no charge.
Electrons are negatively charged.

The Structure of an Atom



an atom

Protons are positively charged.
Neutrons have no charge.
Electrons are negatively charged.

N, atomic number = # of protons
N for carbon = 6

carbon atom has
six protons and six electrons.

The Distribution of Electrons in an Atom

Table 1.1 Distribution of Electrons in the First Four Shells

	First shell	Second shell	Third shell	Fourth shell
Atomic orbitals	*s*	*s, p*	*s, p, d*	*s, p, d, f*
Number of atomic orbitals	1	1, 3	1, 3, 5	1, 3, 5, 7
Maximum number of electrons	2	8	18	32

- The first shell is closest to the nucleus.
- The closer the atomic orbital is to the nucleus, the lower its energy.
- Within a shell, *s* < *p*.

Table 1.2 The Electronic Configurations of the Smallest Atoms

Atom	Name of element	Atomic number	1*s*	2*s*	2p_x	2p_y	2p_z	3*s*
H	Hydrogen	1	↑					
He	Helium	2	↑↓					
Li	Lithium	3	↑↓	↑				
Be	Beryllium	4	↑↓	↑↓				
B	Boron	5	↑↓	↑↓	↑			
C	Carbon	6	↑↓	↑↓	↑	↑		
N	Nitrogen	7	↑↓	↑↓	↑	↑	↑	
O	Oxygen	8	↑↓	↑↓	↑↓	↑	↑	
F	Fluorine	9	↑↓	↑↓	↑↓	↑↓	↑	
Ne	Neon	10	↑↓	↑↓	↑↓	↑↓	↑↓	
Na	Sodium	11	↑↓	↑↓	↑↓	↑↓	↑↓	↑

- Aufbau principle: An electron goes into the atomic orbital with the lowest energy.

  $1s < 2s < 2p < 3s < 3p < 3d$

- Pauli exclusion principle: No more than two electrons can be in an atomic orbital.
- Hund's rule: An electron goes into an empty degenerate orbital rather than pairing up.

Atoms in the First Column of the Periodic Table Lose an Electron

An atom is most stable if its outer shell is either filled or contains 8 electrons.

Lithium and sodium achieve a filled outer shell by losing an electron.

lithium has 1 valence electron... | ...so it loses an electron... | to form a ion with a filled outer shell

$Li\cdot \longrightarrow e^- + Li^+$

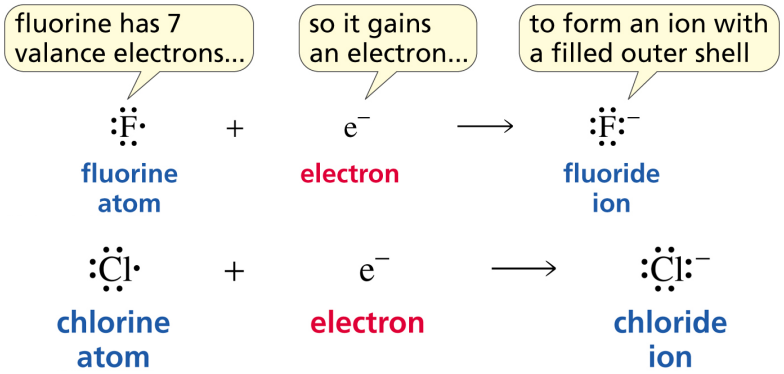
lithium atom → electron + lithium ion

$Na\cdot \longrightarrow e^- + Na^+$

sodium atom → electron + sodium ion

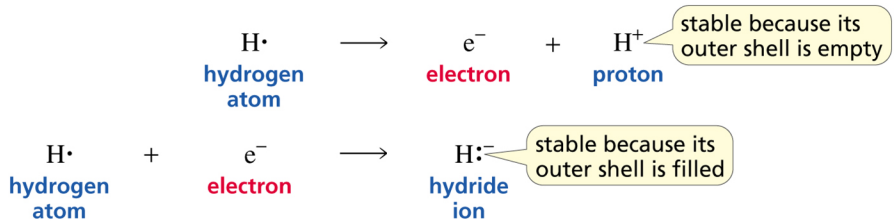
Atoms on the Right Side of the Periodic Table Readily Gain an Electron

Fluorine and chlorine achieve a filled outer shell by gaining an electron.

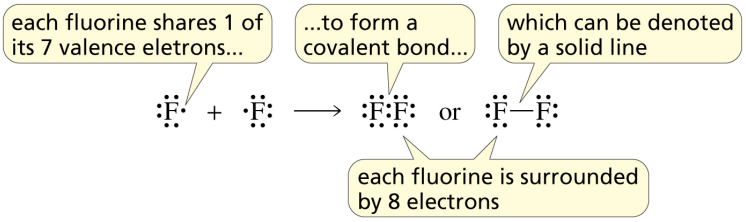


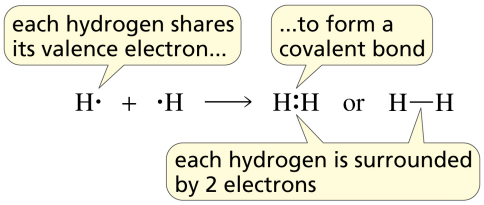
A Hydrogen Atom Can Lose or Gain an Electron

A hydrogen atom achieves an empty shell by losing an electron or a filled outer shell by gaining an electron.



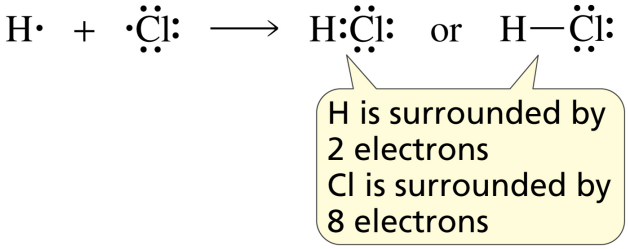
Achieving a Filled Outer Shell by Sharing Electrons



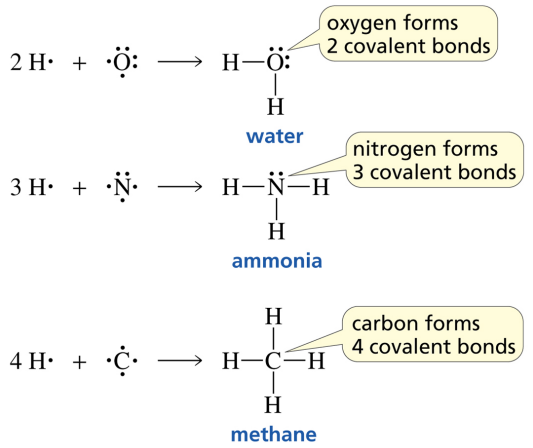


A bond formed by sharing electrons is called a covalent bond.

Achieving a Filled Outer Shell by Sharing Electrons



How Many Bonds Does an Atom Form?



notice that each O, N, C is surrounded by 8 electrons, and each H is surrounded by 2 electrons

Nonpolar and Polar Covalent Bonds

Nonpolar covalent bond = bonded atoms are the same or have similar electronegativities.

H—H F—F C—C C—H

Polar covalent bond = bonded atoms have different electronegativities.