Welcome to O Chem 1

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At its heart - Organic Chemistry is the science of Carbon-containing molecules

Organic Chemistry is the study of carbon-containing molecules.

This class has two points.

The first point of the class is to understand the organic chemistry of living systems. We will teach you how to think about and understand the most amazing things on the planet!!

Water is essential for life, you will learn why water has such special properties.

You will learn the secret structural reason proteins, the most important molecular machines in our bodies, can support the chemistry of life.

You will learn why when you take Advil for pain, exactly half of what you take works, and the other half does nothing.

You will learn how toothpaste works.

You will learn how a single chlorofluorocarbon refrigerant molecule released into the atmosphere can destroy many, many ozone molecules, leading to an enlargement of the ozone hole.

You will learn how medicines like Benadryl, Seldane, and Lipitor work.

You will learn how Naloxone is an antidote for an opioid overdose.

You will learn why Magic Johnson is still alive, decades after contracting HIV.

You will learn how MRI scans work.

The second point of organic chemistry is the synthesis of complex molecules from simpler ones by making and breaking specific bonds.

You will learn how to understand movies of reaction mechanisms like alkene hydration.

You will learn reactions that once begun, will continue reacting such that each product molecule created starts a new reaction until all the starting material is used up.

You will learn reactions that can make antifreeze from vodka.

You will learn a reaction that can make nail polish remover from rubbing alcohol.

You will learn how to look at a molecule and accurately predict which atoms will react to make new bonds, and which bonds will break during reactions.

You will learn how to analyze a complex molecule's structure so that you can predict ways to make it via multiple reactions starting with less complex starting molecules.

The ability to rationally synthesize new molecules changed human destiny and drives the economies of the world by enabling:

1. The synthesis of new drugs to cure disease and dramatically increase human life span
2. The development of lubricants and components for virtually all machines
3. The creation of new methods for integrated circuit production enabling faster computation
4. The creation of new materials for millions of uses including 3d printing and biodegradable plastics
5. The synthesis of new pigments for dyes, paints and cosmetics
6. The synthesis of all synthetic clothing fibers
7. The production of highly refined and cleaner burning fuels and batteries
8. …to name just a FEW applications.

In other words, essentially everything that we associate with what makes life in 2022 so incredible.

"Everything should be made as simple as possible, but not simpler"

"The only real valuable thing is intuition"

A. Einstein

The most important thing is to find the most important thing

In this class:
The most important thing is "Where are the electrons?"

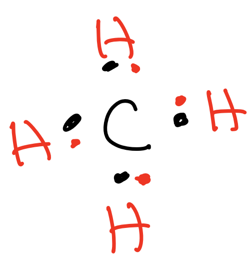
The most important question in Chemistry

First Golden Rule of Chemistry:

"In most stable molecules all of the atoms have filled valence shells"

Lewis Structures → when drawing a Lewis structure it is most helpful to remember how many valence electrons are around each kind of neutral atom

⇒ Make multiple bonds if that avoids unnecessary charges or unpaired electrons → fill those valence shells



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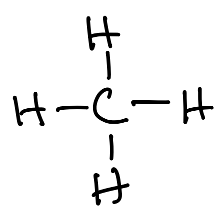
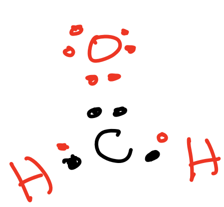
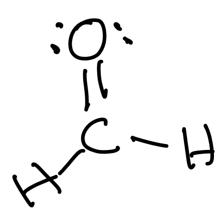






Formal Charge → Unequal number of protons and electrons around an atom

(+) ← protons   electrons → (−)

→ Always assign half of the electrons in a bond to each atom of the bond

N → atomic #7
so 7 protons

$2e^-$ $1s^2$
$4e^-$ valence shell
$6e^-$

so +1 formal charge

Much better way to calculate formal charge:

⇒ Keep track of the number of bonds vs. lone pairs on each atom → compare to the table below:

*A stepwise approach to perfect Lewis structures**

Step 1: Arrange atoms in space based on connectivity given in molecular formula.

Step 2: Add single bonds to all atoms that are connected to each other.

Step 3: Identify all carbon atoms without a filled valence shell. For each such carbon atom, look for an adjacent atom that is also without a filled valence and connect with one or two multiple bonds.

Step 4: Add lone pairs to fill all remaining unfilled valence shells.

Step 5: Add any formal charges as identified by the table presented during the first lecture.

*This works for all but molecules with a carbocation. Do not worry about those at this time.

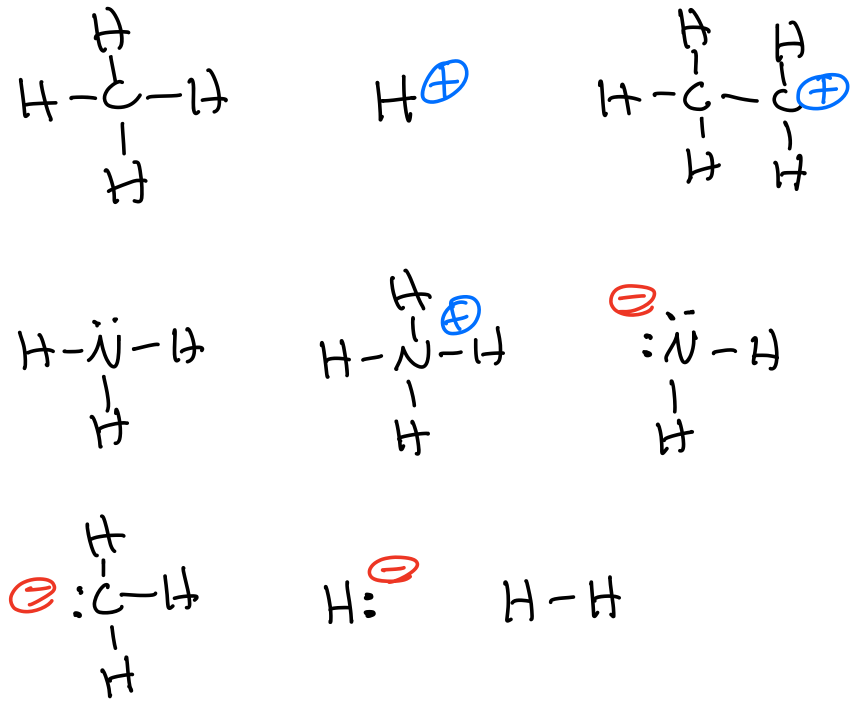
Valence Electrons in Neutral Atoms:

H	C	N	O	F,Cl,Br,I
1	4	5	6	7

Formal Charge Identification:

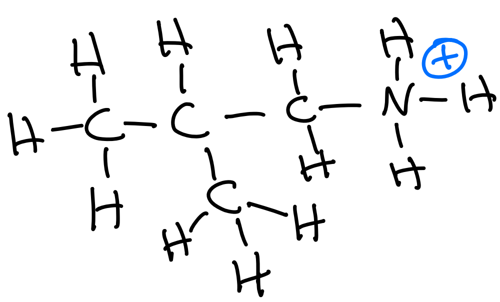
only exceptions to filled valence Golden rule

Atom	# electrons in the valence shell	Neutral Bonds	Neutral Lone Pairs	Positive Charge Bonds	Positive Charge Lone Pairs	Negative Charge Bonds	Negative Charge Lone Pairs
H	2	1	0	0	0	0	1 (rare)
C	8	4	0	3	0	3	1
N	8	3	1	4	0	2	2
O	8	2	2	3	1	1	3
F,Cl,Br,I	8	1	3	-	-	0	4



Use the stepwise approach:

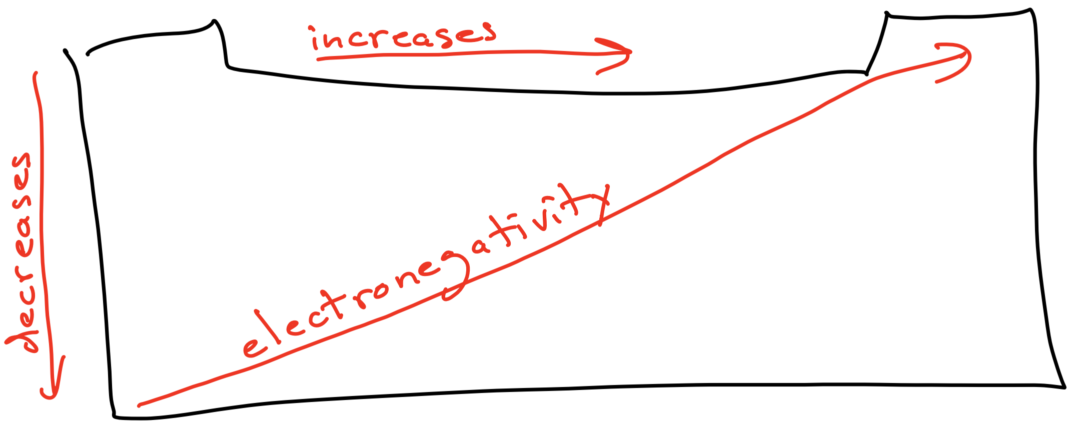
Ex. $(CH_3)_2CHCH_2NH_3$



Formal charge is not a theory →
it just keeps track of electrons
vs protons in a molecule

Theory → tells us quantitatively
where electrons are
located.

Linus Pauling → more electron
density is around
the more
electronegative
atom



Periodic Table

Electronegativity increases with increasing nuclear charge

→ Decreases with increasing number of electrons

Based on electrostatic attraction between protons in the nucleus and electrons

1A	2A	3B	4B	5B	6B	7B	8B			1B	2B	3A	4A	5A	6A	7A
								H 2.1								
Li 1.0	Be 1.5											B 2.0	C 2.5	N 3.0	O 3.5	F 4.0
Na 0.9	Mg 1.2											Al 1.5	Si 1.8	P 2.1	S 2.5	Cl 3.0
K 0.8	Ca 1.0	Sc 1.3	Ti 1.5	V 1.6	Cr 1.6	Mn 1.5	Fe 1.8	Co 1.8	Ni 1.8	Cu 1.9	Zn 1.6	Ga 1.6	Ge 1.8	As 2.0	Se 2.4	Br 2.8
Rb 0.8	Sr 1.0	Y 1.2	Zr 1.4	Nb 1.6	Mo 1.8	Tc 1.9	Ru 2.2	Rh 2.2	Pd 2.2	Ag 1.9	Cd 1.7	In 1.7	Sn 1.8	Sb 1.9	Te 2.1	I 2.5
Cs 0.7	Ba 0.9	La 1.1	Hf 1.3	Ta 1.5	W 1.7	Re 1.9	Os 2.2	Ir 2.2	Pt 2.2	Au 2.4	Hg 1.9	Tl 1.8	Pb 1.8	Bi 1.9	Po 2.0	At 2.2

- <1.0
- 1.0 – 1.4
- 1.5 – 1.9
- 2.0 – 2.4
- 2.5 – 2.9
- 3.0 – 4.0