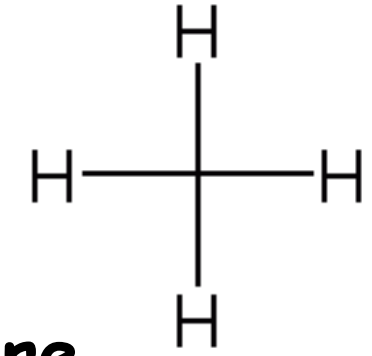
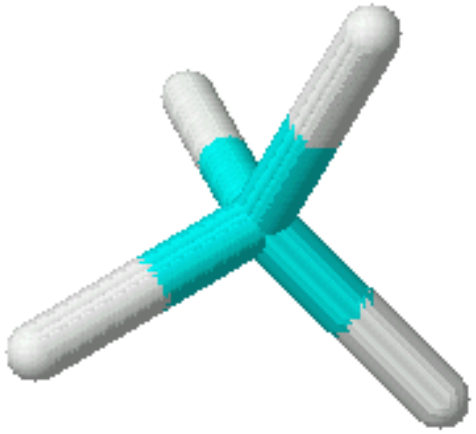
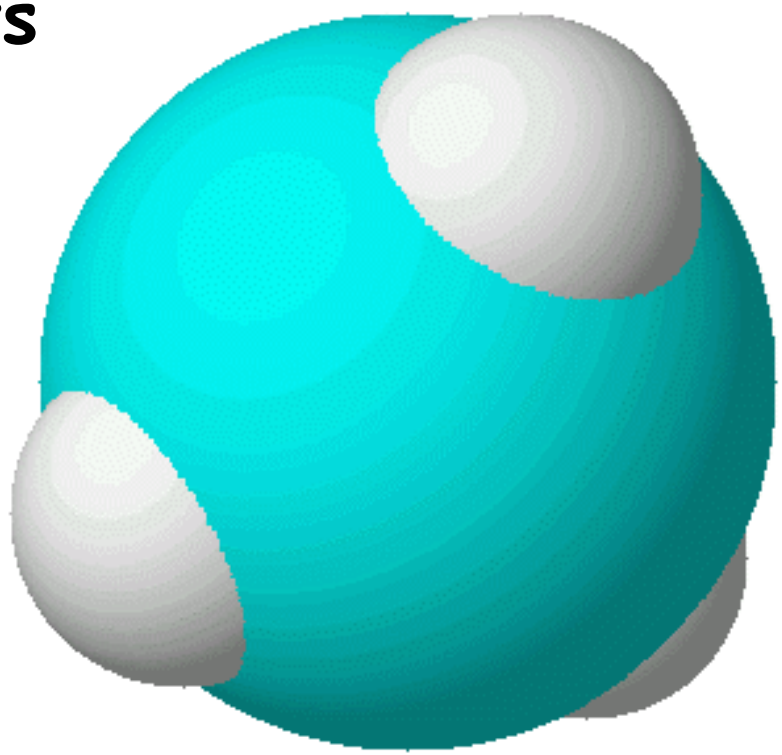
Covalent Bonding

Bonding models for methane, CH_4. Models are NOT reality. Each has its own strengths and limitations.







CA Standards

- *Students know* atoms combine to form molecules by sharing electrons to form covalent or metallic bonds or by exchanging electrons to form ionic bonds.

- *Students know* chemical bonds between atoms in *molecules* such as H_2, CH_4, NH_3, H_2CCH_2, N_2, Cl_2, and many large biological molecules are covalent.

- *Students know* how to draw Lewis dot structures.

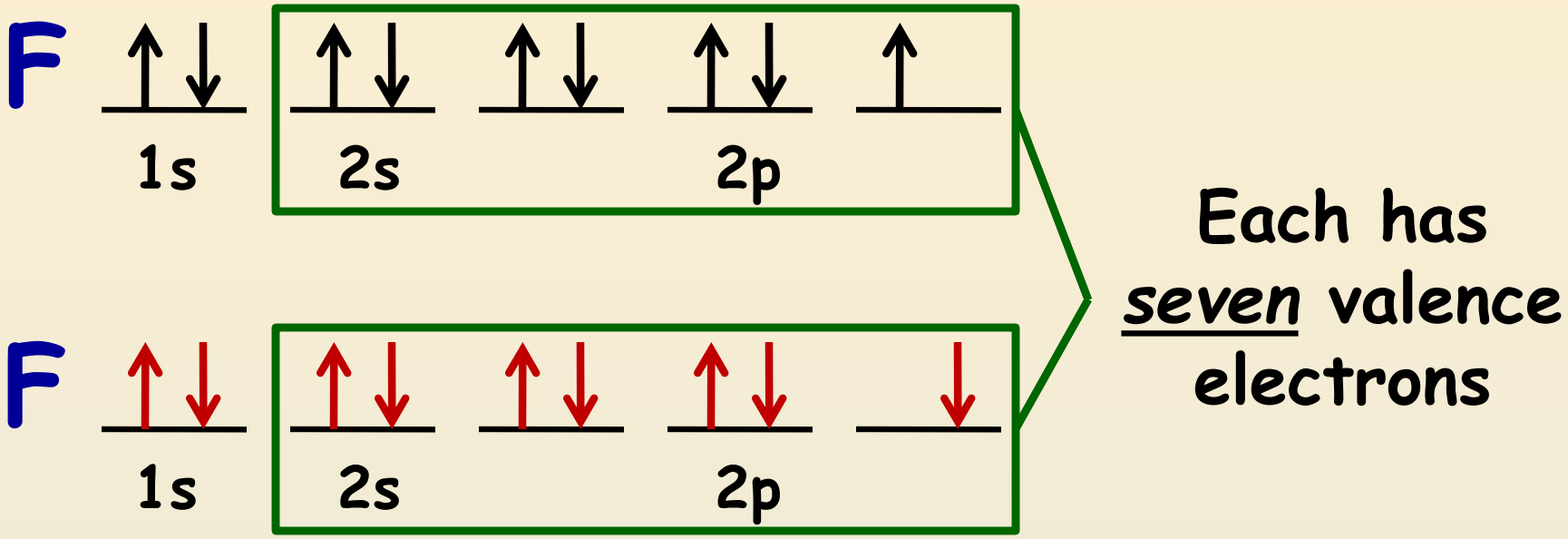
The Octet Rule and Covalent Compounds

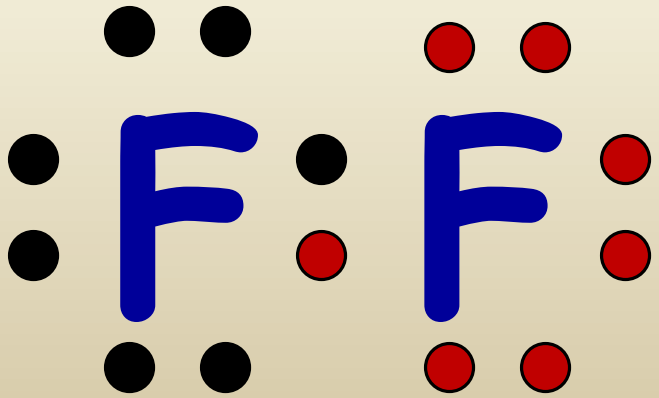
- Covalent compounds tend to form so that each atom, by sharing electrons, has an octet of electrons in its highest occupied energy level.

- Covalent compounds involve atoms of *nonmetals only*.

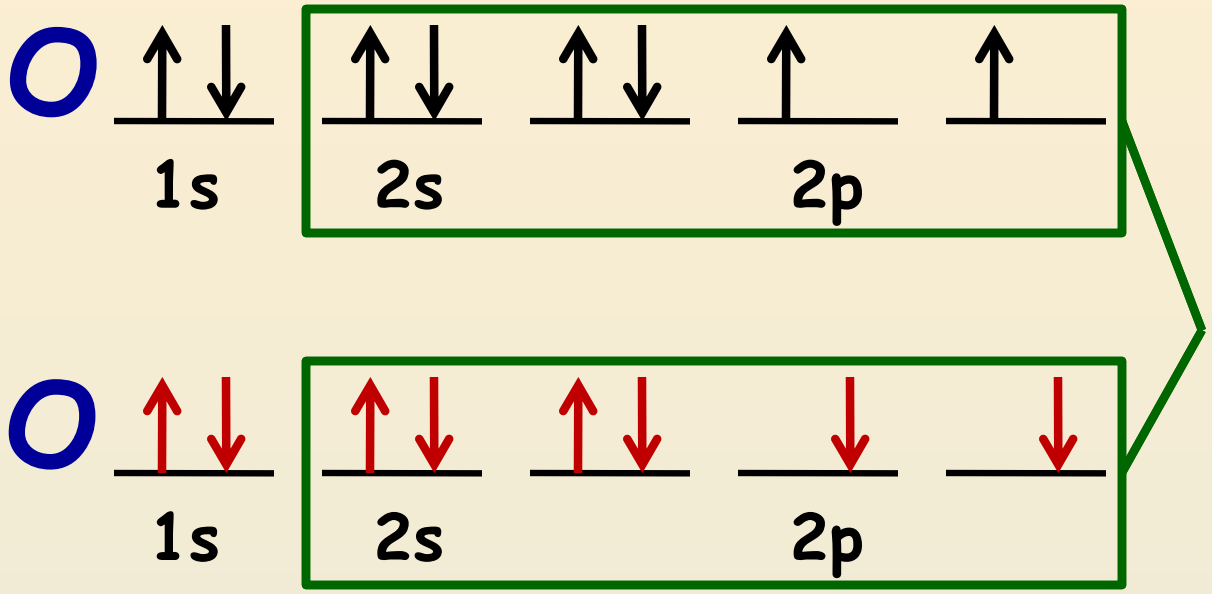
- The term "*molecule*" is used exclusively for covalent bonding

The Octet Rule:
The Diatomic Fluorine Molecule

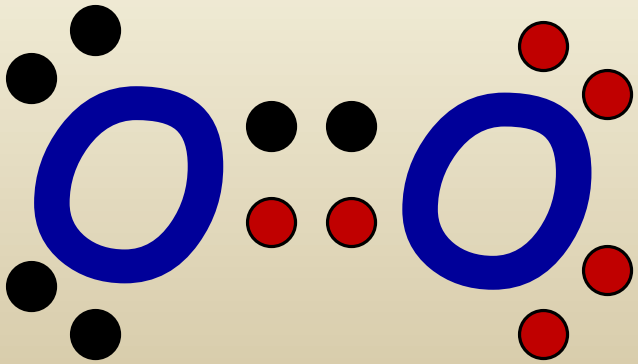




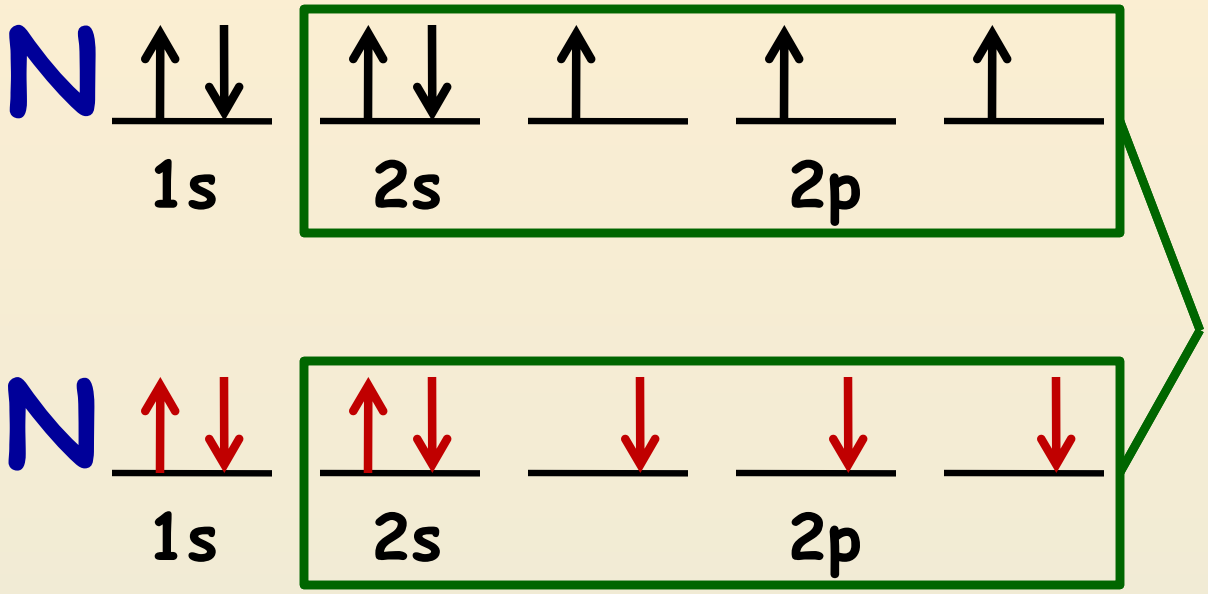
The Octet Rule:
The Diatomic Oxygen Molecule



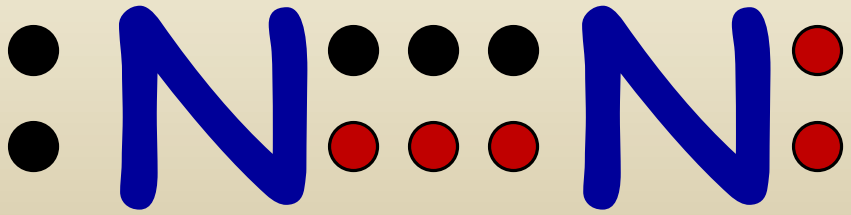
Each has *six* valence electrons



The Octet Rule:
The Diatomic Nitrogen Molecule



Each has *five* valence electrons



Lewis Structures

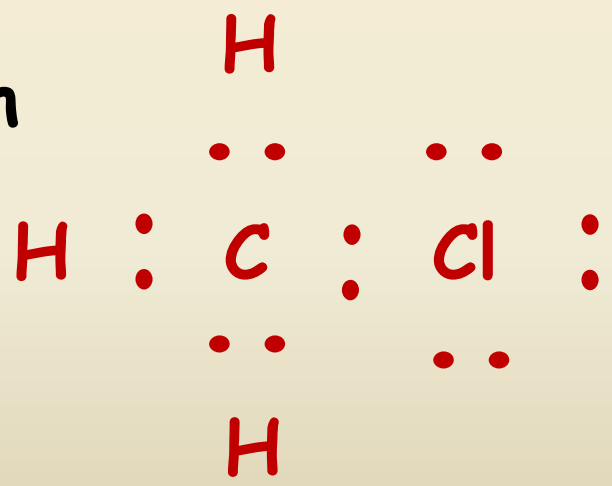
- Lewis structures show how valence electrons are arranged among atoms in a molecule.
- Lewis structures Reflect the central idea that stability of a compound relates to noble gas electron configuration.
- Shared electrons pairs are covalent bonds and can be represented by two dots (:) or by a single line (-)

The HONC Rule

- Hydrogen (and Halogens) form one covalent bond
- Oxygen (and sulfur) form two covalent bonds
  - One double bond, or two single bonds
- Nitrogen (and phosphorus) form three covalent bonds
  - One triple bond, or three single bonds, or one double bond and a single bond
- Carbon (and silicon) form four covalent bonds.
  - Two double bonds, or four single bonds, or a triple and a single, or a double and two singles

Completing a Lewis Structure - CH_3Cl

- Make carbon the central atom (it wants the most bonds, 4)
- Add up available valence electrons:
  - C = 4, H = (3)(1), Cl = 7 Total = 14
- Join peripheral atoms to the central atom with electron pairs.
- Complete octets on atoms other than hydrogen with remaining electrons

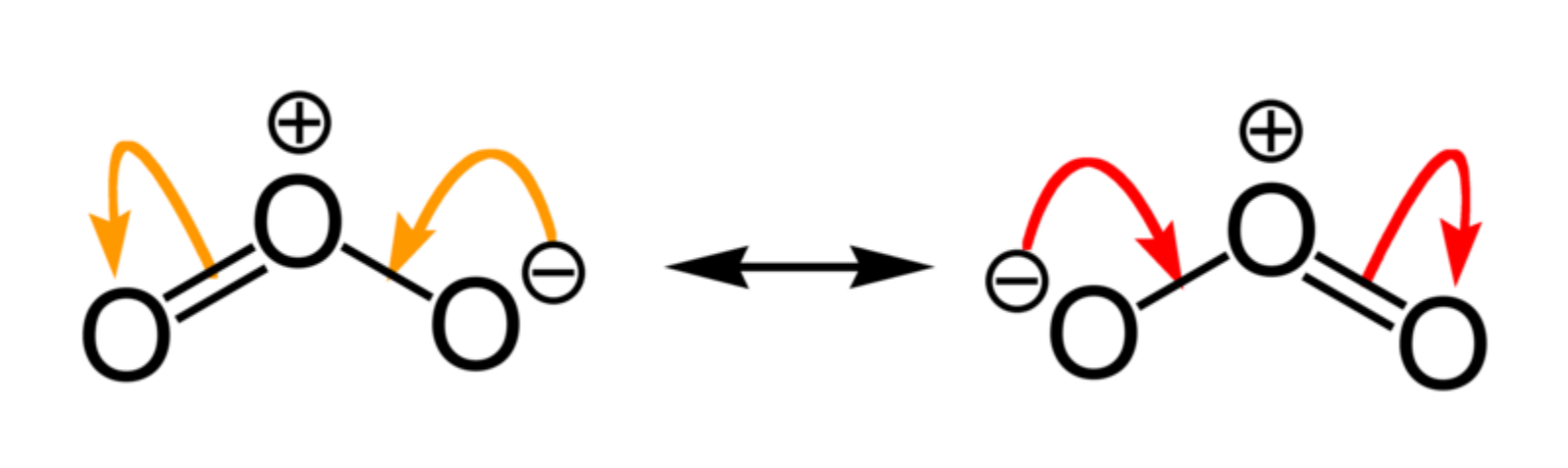


Bond Length and Bond Energy

Bond	Length (pm)	Energy (kJ/mol)
C - C	154	346
C=C	134	612
C≡C	120	835
C - N	147	305
C=N	132	615
C≡N	116	887
C - O	143	358
C=O	120	799
C≡O	113	1072
N - N	145	180
N=N	125	418
N≡N	110	942

Resonance

- Occurs when more than one valid Lewis structure can be written for a particular molecule.



- These are resonance structures.
  The actual structure is an average of the resonance structures.

Resonance in Benzene, C_6H_6