# Models – Advantages and Disadvantages (1)

- They help us to *visualize*, *explain*, and *predict* chemical changes.
- Because a model is a *simplified* version of what we think is true, the processes it depicts are sometimes described using the phrase *as if*. When you read, "It is as if an electron were promoted from one orbital to another," the phrase is a reminder that we do not necessarily think this is what really happens. We merely find it useful to talk about the process as if this is the way it happens.

# Models – Advantages and Disadvantages (2)

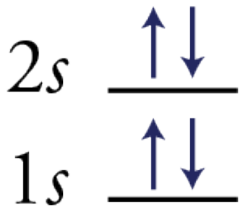
- One characteristic of models is that they ***change with time***. Because our models are simplifications of what we think is real, we are not surprised when they sometimes fail to explain experimental observations. When this happens, the model is altered to fit the new observations.

# Assumptions of the Valence-Bond Model

- Only the highest energy electrons participate in bonding.
- Covalent bonds usually form to pair unpaired electrons.

# Fluorine

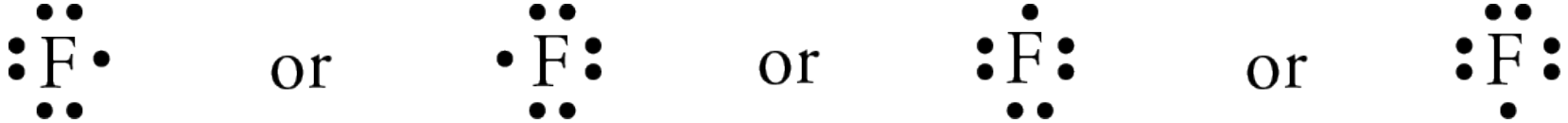
F $1s^2\ 2s^2\ 2p^5$

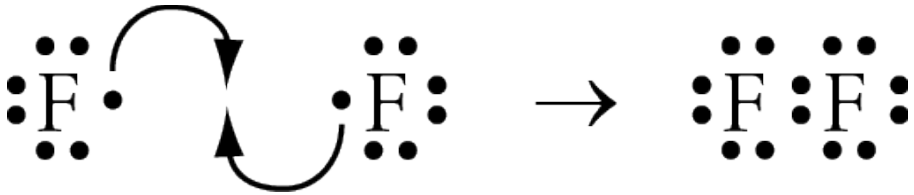




Valence electrons

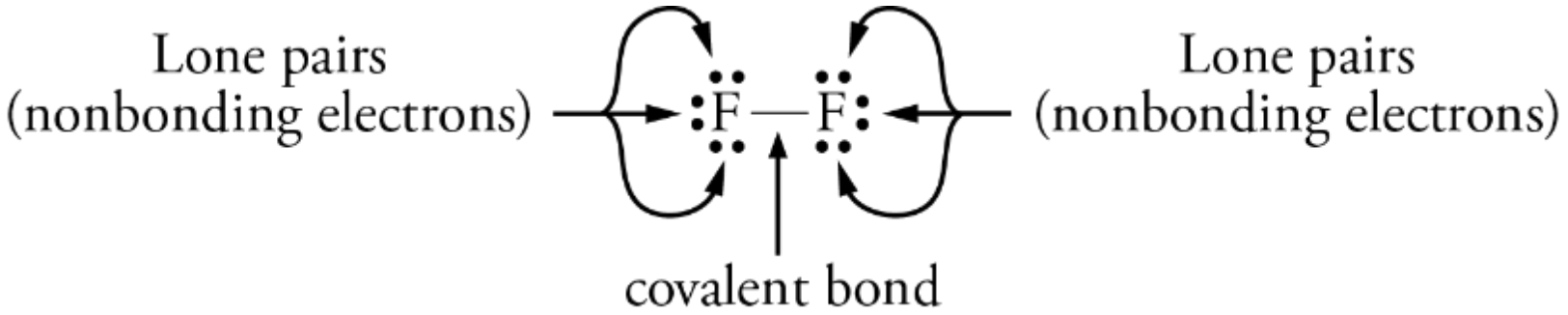




# Lewis Structures

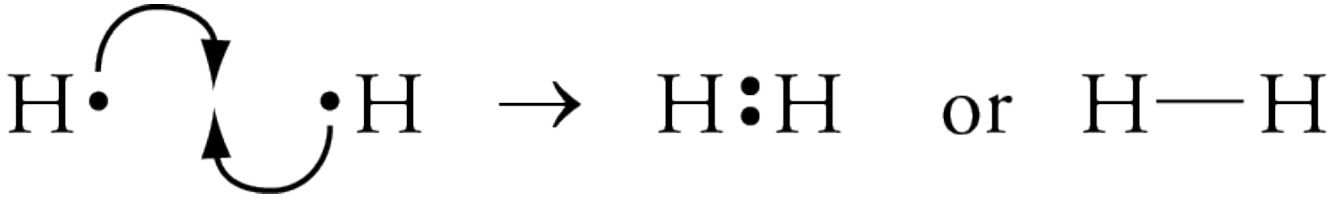
- ***Lewis structures*** represent molecules using element symbols, lines for bonds, and dots for lone pairs.



# $H_2$ Formation

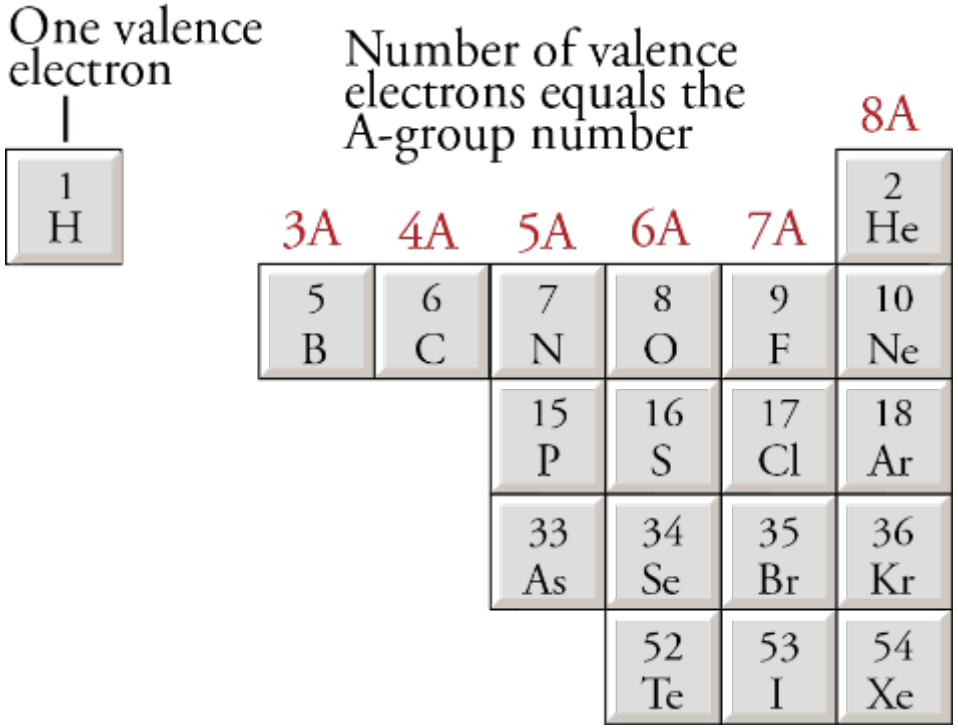
- The unpaired electron on a hydrogen atom makes the atom unstable.


- Two hydrogen atoms combine to form one hydrogen molecule.

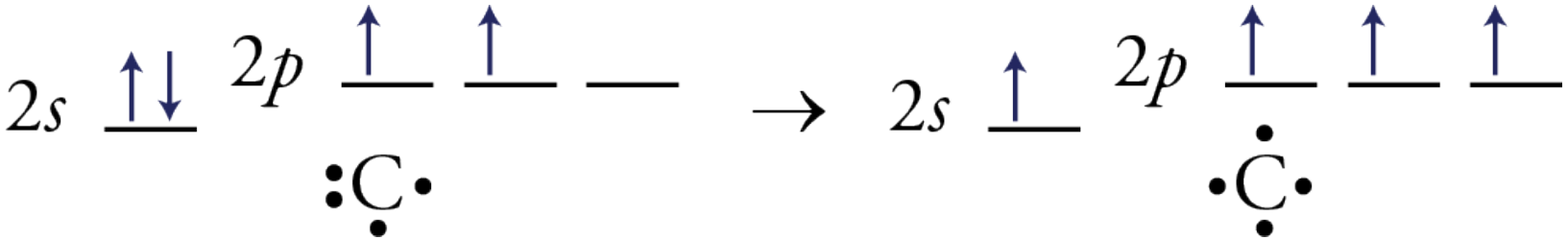


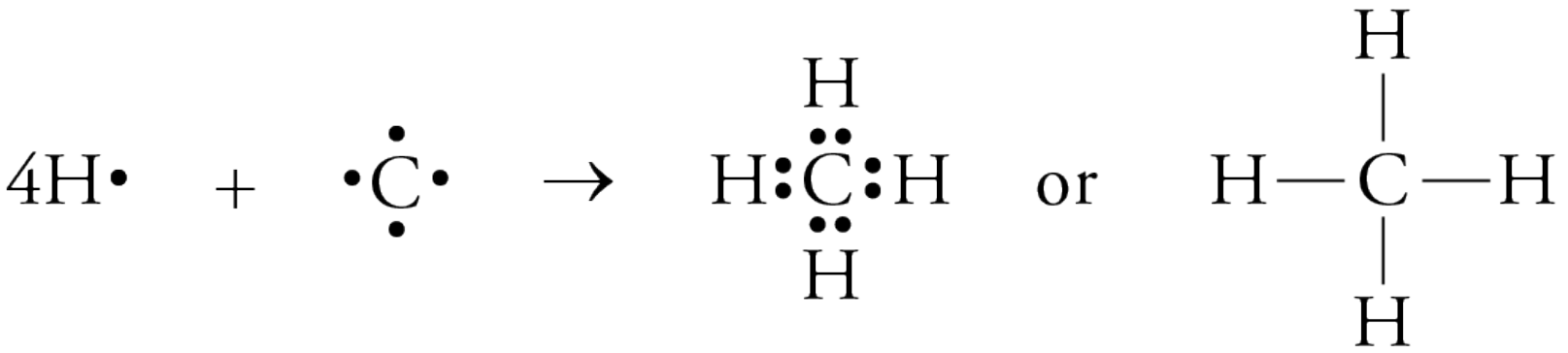
# Valence Electrons

- ***Valence electrons*** are the highest-energy *s* and *p* electrons in an atom.



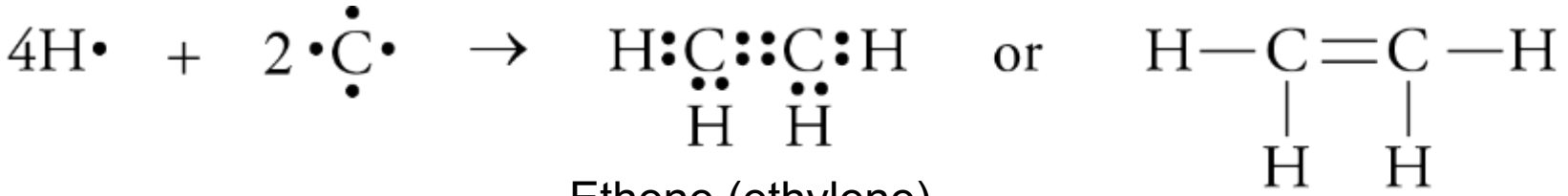
# Carbon – 4 bonds



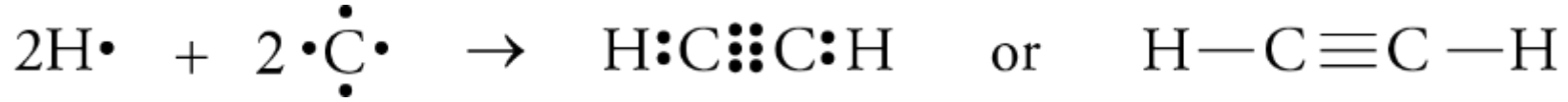




Methane, $CH_4$

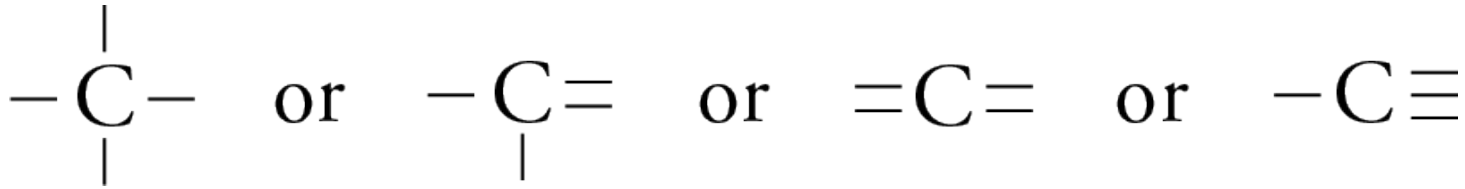
# Carbon – Multiple Bonds



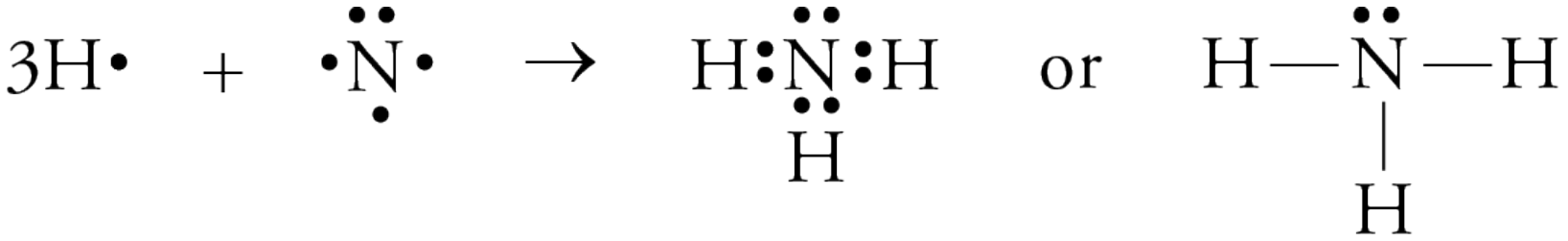

Ethene (ethylene)



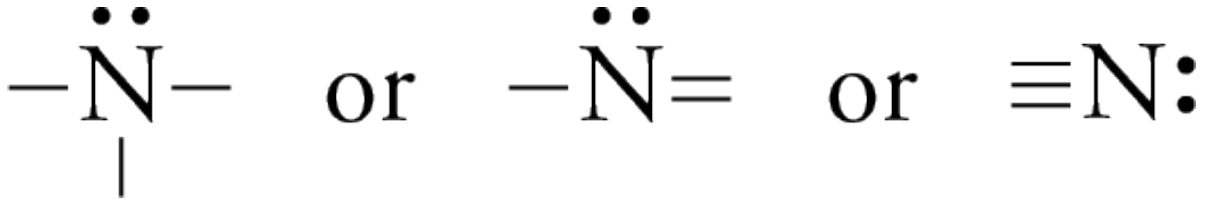

Ethyne (acetylene)



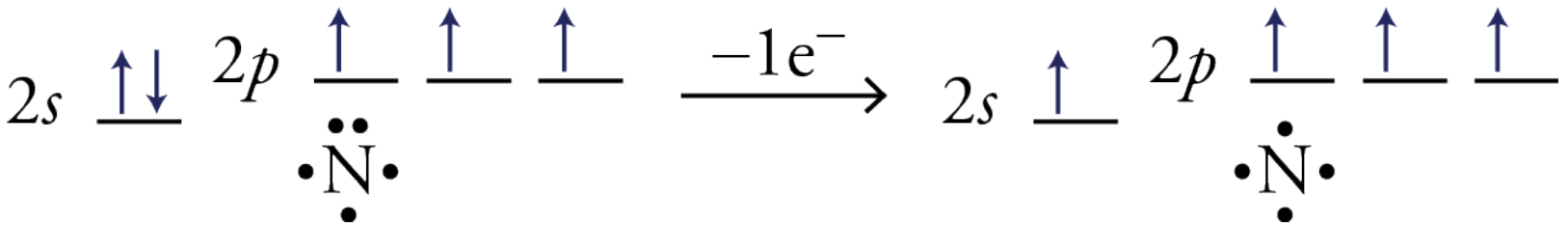
# Nitrogen – 3 bonds & 1 lone pair

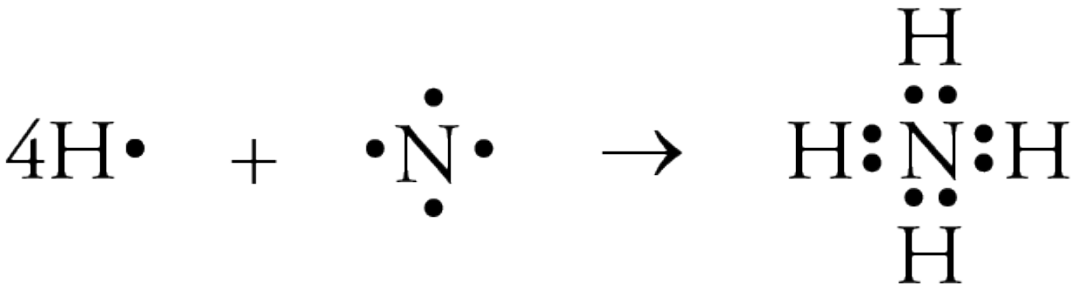




Ammonia, $NH_3$



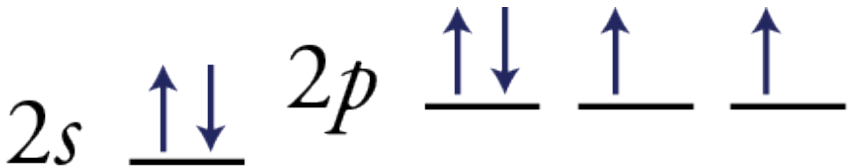
# Nitrogen – 4 bonds

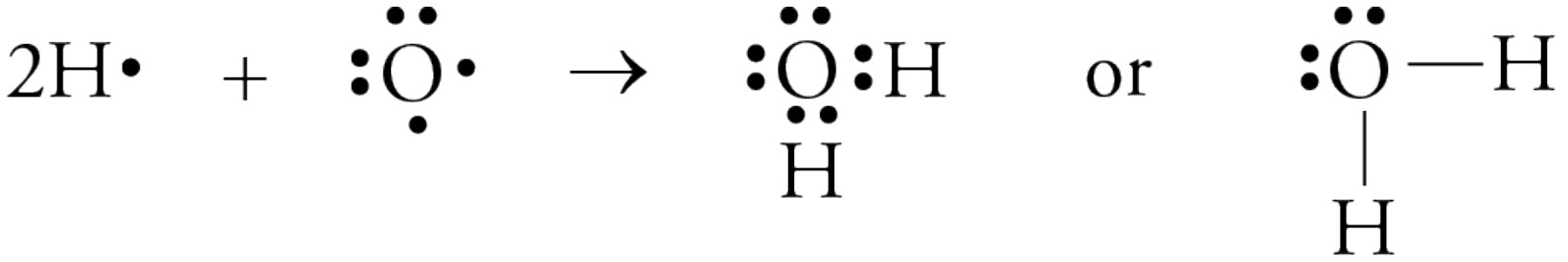


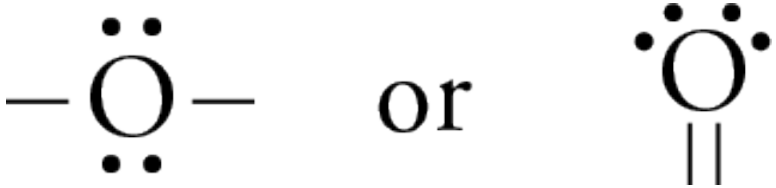

Ammonium, $NH_4^+$

# Oxygen – 2 bonds & 2 lone pairs

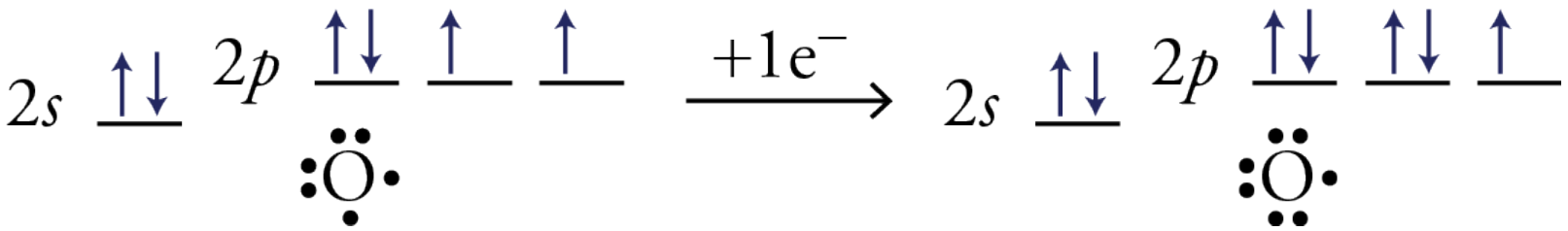


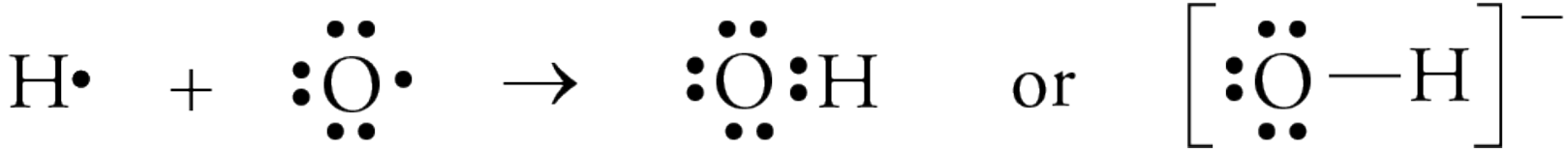




Water, $H_2O$



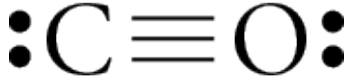
# Oxygen – 1 bond & 3 lone pairs



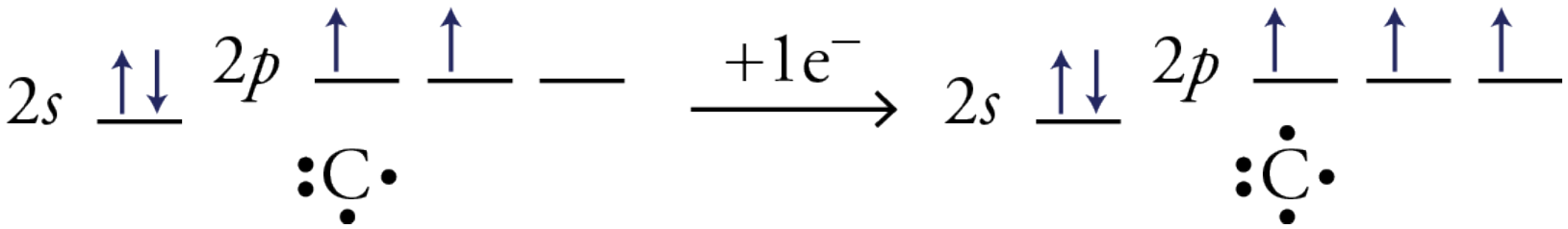



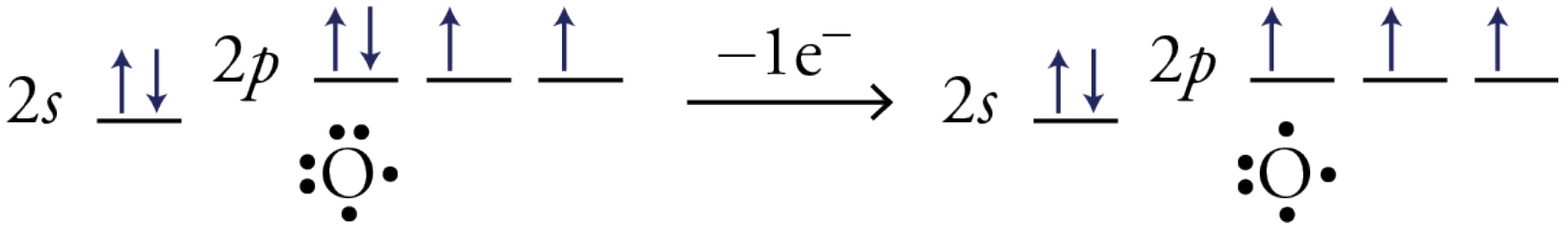

Hydroxide, $OH^-$

# Carbon – 3 bonds & 1 lone pair
# Oxygen – 3 bonds & 1 lone pair

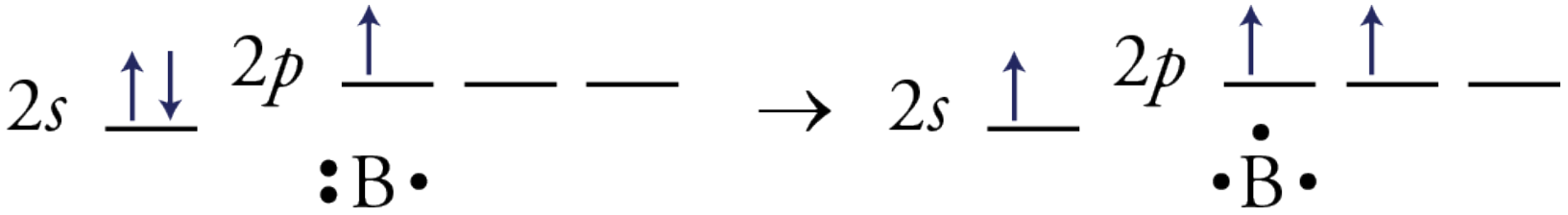


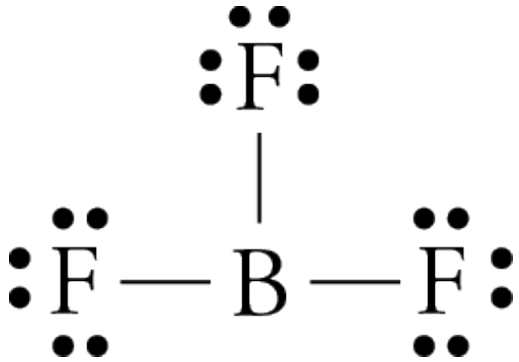
Carbon monoxide, CO



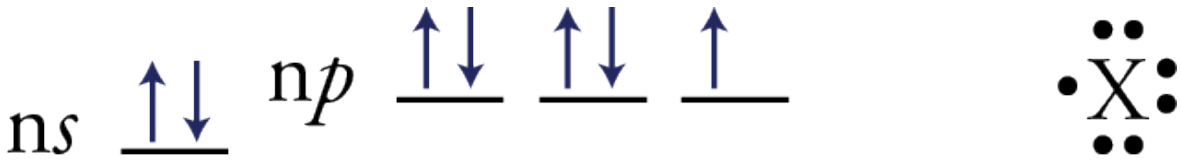
# Boron – 3 bonds

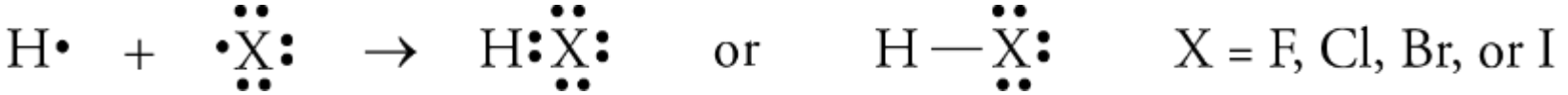



Boron trifluoride, $BF_3$

# Halogens – 1 bond & 3 lone pairs



# Most Common Bonding Patterns for Nonmetals

| Element | # Bonds | # lone pairs |
|---|---|---|
| H | 1 | 0 |
| C | 4 | 0 |
| N, P | 3 | 1 |
| O, S, Se | 2 | 2 |
| F, Cl, Br, I | 1 | 3 |