SO FAR, we've seen that ...

1. Atoms may share one, two, or three pairs of electrons with each other.

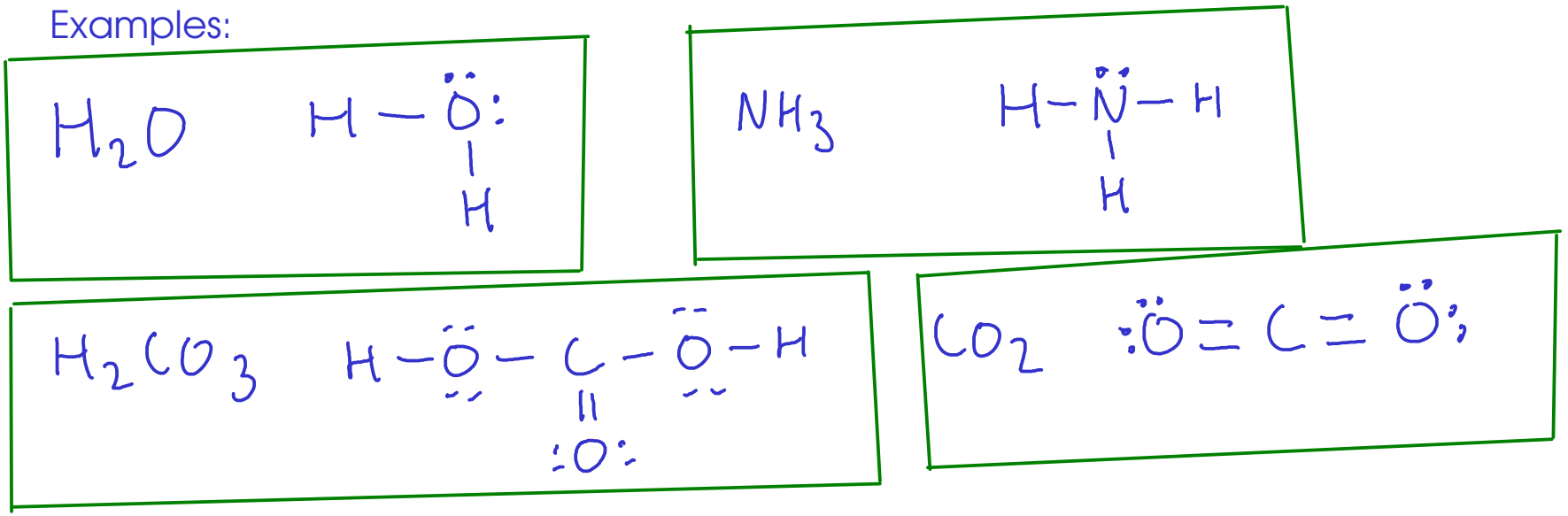
2. Atoms will usually share enough electrons so that each atom ends up with a share in EIGHT electrons - the "octet rule"

   - HYDROGEN will only end up with two electrons!

   - Some other atoms may end up with more or less than eight electrons. Exceptions to the octet rule are covered in Chapter 9.

NOW, how could we come up with dot structures for some more complicated (and therefore, more interesting) molecules?

Examples:



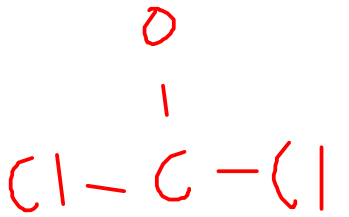
DRAWING DOT STRUCTURES FOR SIMPLE MOLECULES

$COCl_2$

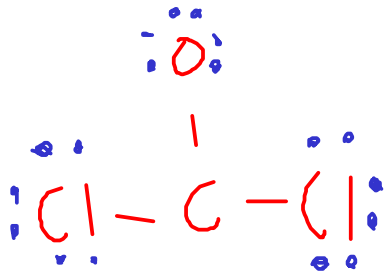
C: 1 x 4
O: 1 x 6
Cl: 2 x 7
24 e⁻

1. Count valence electrons

2. Pick central atom and draw skeletal structure
   - central atom is usually the one that needs to gain the most electrons!
   - skeletal structure has all atoms connected to center with single bonds



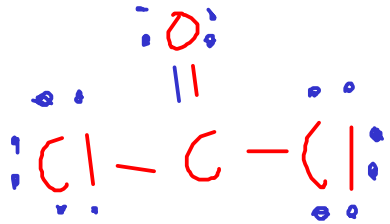
Pick CARBON as central atom, since it needs to gain more electrons (4) than either oxygen (2) or a chlorine (1) ...



Distribute remailing electrons. Stop when you get to the total number of valence electrons (24)...

3. Distribute remaining valence electrons around structure, outer atoms first. Follow octet rule until you run out of electrons.

... but carbon has a share in only SIX valence electrons, and we're out! How to fix? FORM MORE BONDS. Change a "lone pair" into a bond. But which? Pick OXYGEN, since it needs more electrons (and is more likely to form more bonds...)



Making a double bond between C and O gives each atom its share in eight electrons...

4. Check octet rule - each atom should have a share in 8 electrons (H gets 2). if not, make double or triple bonds.

1. Count valence electrons

2. Pick central atom and draw skeletal structure
   - central atom is usually the one that needs to gain the most electrons!
   - skeletal structure has all atoms connected to center with single bonds

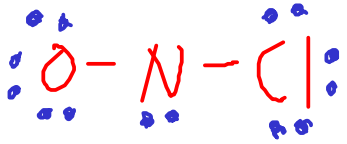
3. Distribute remaining valence electrons around structure, outer atoms first. Follow octet rule until you run out of electrons.

4. Check octet rule - each atom should have a share in 8 electrons (H gets 2). if not, make double or triple bonds.

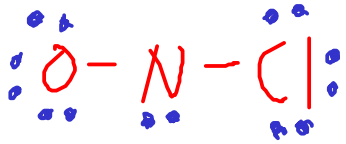
NOCl

N : 1 x 5
O : 1 x 6
Cl : 1 x 7
18 e⁻

Pick N as central atom (needs to gain more electrons than either O or Cl)



Distribute remaining electrons. We ran out of space on the outside, so the last pair of electrons goes on central N...



... but we still don't have enough electrons for N. We'll create a double bond between O and N (same reasoning as the last example)

Making the double bond gives each atom a share in eight valence electrons!

1. Count valence electrons

2. Pick central atom and draw skeletal structure
   - central atom is usually the one that needs to gain the most electrons!
   - skeletal structure has all atoms connected to center with single bonds

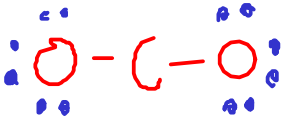
3. Distribute remaining valence electrons around structure, outer atoms first. Follow octet rule until you run out of electrons.

4. Check octet rule - each atom should have a share in 8 electrons (H gets 2). if not, make double or triple bonds.

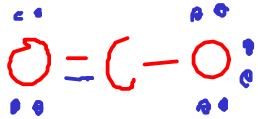
CO_2

C: 1 x 4
O: 2 x 6
16 e^-

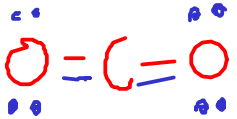
Pick C as central atom ...



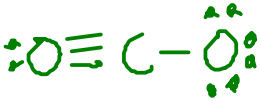
... but C only has a share in 4 valence electrons.



... now 6



... now 8.



This structure is incorrect. Why? It suggests that two oxygen atoms in identical environments (both bonded to a carbon and nothing else) will actually bond differently. Since they are the same element, they should not.

Also, experimental data shows that there are not bonds of two different lengths in carbon dioxide ...

1. Count valence electrons

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   - central atom is usually the one that needs to gain the most electrons!
   - skeletal structure has all atoms connected to center with single bonds

3. Distribute remaining valence electrons around structure, outer atoms first. Follow octet rule until you run out of electrons.

4. Check octet rule - each atom should have a share in 8 electrons (H gets 2). if not, make double or triple bonds.

HNO_2 "nitrous acid"

In oxyacids, the acidic hydrogen atoms are attached to OXYGEN atoms in the structure!

H: 1 x 1
N: 1 x 5
O: 2 x 6
18 e⁻

This is an OXYACID, so we know that oxygen must be bonded directly to at least one hydrogen.

Distribute ...

... but not enough on N. Create a double bond.

... now all atoms have a share in 8 except hydrogen, which only gets 2 anyway.

A DOT STRUCTURE FOR A LARGER MOLECULE

CH_3CH_2OH ETHANOL!

C : 4 x 2 = 8
H : 1 x 6 = 6
O : 6 x 1 = 6
| 20

1. Count valence electrons

2. Pick central atom and draw skeletal structure
   - central atom is usually the one that needs to gain the most electrons!
   - skeletal structure has all atoms connected to center with single bonds

3. Distribute remaining valence electrons around structure, outer atoms first. Follow octet rule until you run out of electrons.

4. Check octet rule - each atom should have a share in 8 electrons (H gets 2). if not, make double or triple bonds.

This formula gives us a hint to the structure of ethanol. Ethanol has THREE central atoms chained together.

CH_3 CH_2 OH