Not all atoms obey the octet rule all the time. Some atoms have EXPANDED VALENCE, which means they end up with more than eight valence electrons.

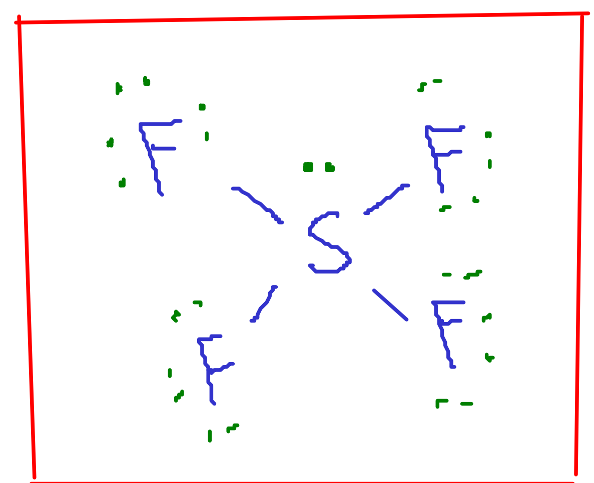
Atoms can fit more than eight electrons in their outer shells only if they have "d" subshells in their outer shell. So, to have expanded valence, an atom must be from period 3 or higher. So, sulfur can do expanded valence, but fluorine (period 2) cannot.

SF_4

S: 1 × 6
F: 4 × 7 = 28

34 electrons

Skeletal structure

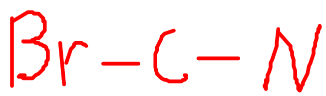


To use all 34 electrons, we put the last pair on the central sulfur atom, giving it 10. This is okay for sulfur, as it can accept the extra pair.

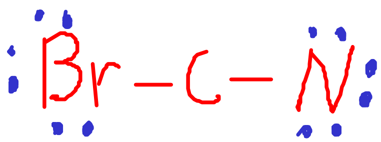
Examples:

BrCN

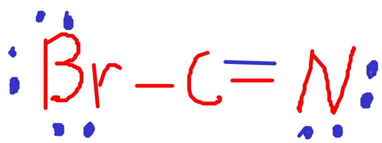
Br: 1 x 7
C: 1 x 4
N: 1 x 5
16 electrons



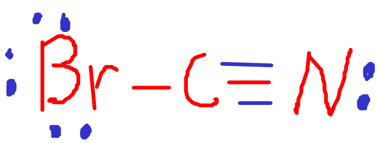
Skeletal



Add electrons, stop when we reach 16



Now carbon has a share in six electrons



Making a triple bond with nitrogen gives all atoms a share in eight valence electrons...

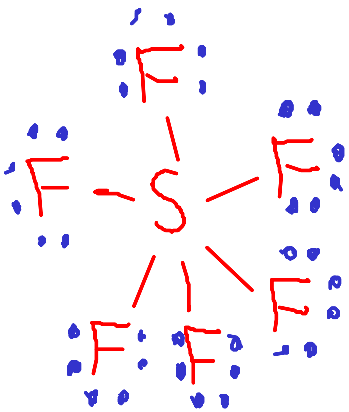
SF_6

S: 1 x 6 = 6
F: 6 x 7 = 42

48 electrons

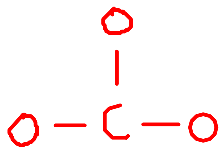
The skeletal structure has twelve electrons in sulfur's outer shell, but since sulfur is period 3, that's OK.

Sulfur hexafluoride is another example of expanded valence. Sulfur ends up with 12 outer electrons.

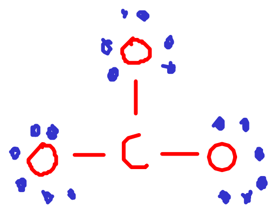


CO_3^{2-}

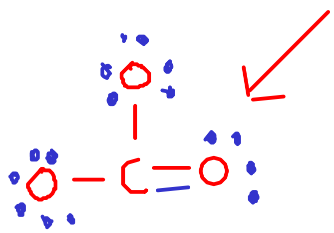
C - 1 x 4 = 4
O - 3 x 6 = 18
22 electrons
+ 2 charge
24 electrons



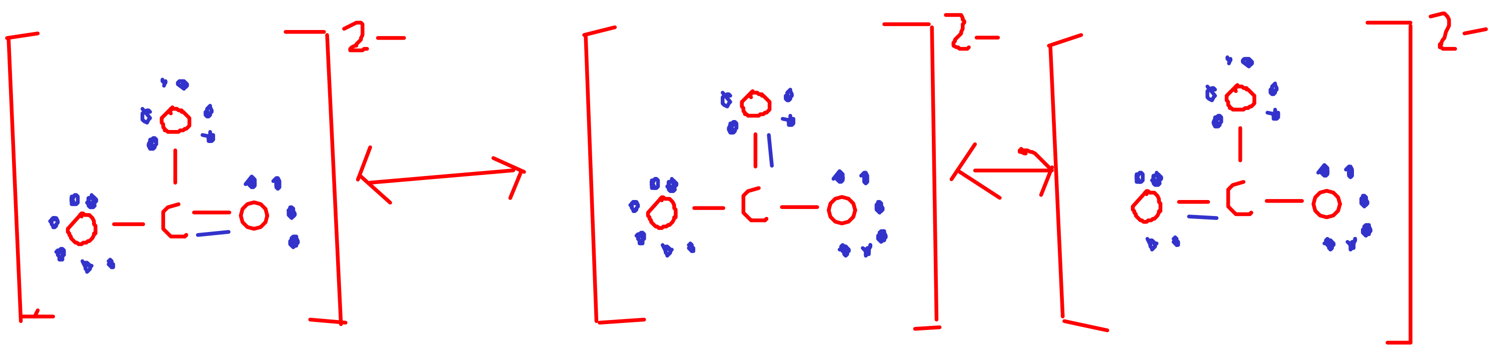
Skeleton



Distribute remaining electrons (total 24)



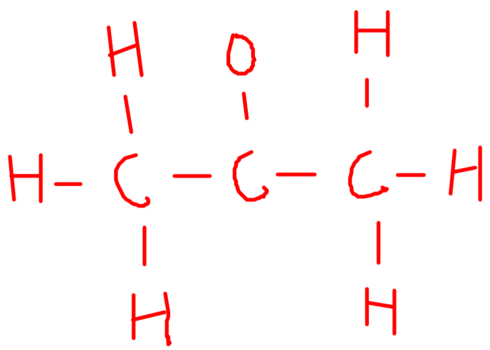
Notice that one oxygen atom is bonded differently from the others, even though all three are attached to the same carbon and to nothing else. This is a hint that the molecule has RESONANCE structures (delocalized bonds)



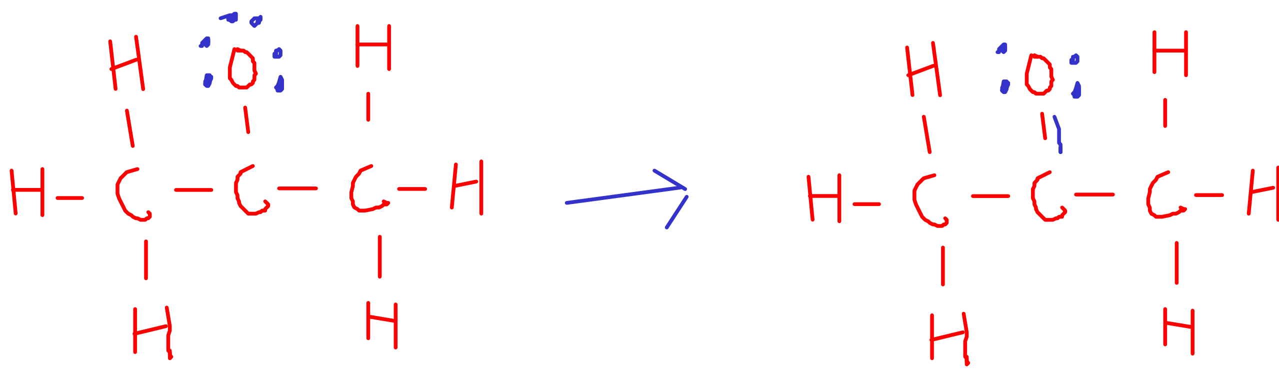
CH_3COCH_3

$C - 3 \times 4 = 12$
$H - 6 \times 1 = 6$
$O - 1 \times 6 = 6$
24 electrons

This is a large molecule. The formula hints that this molecule has three small-molecule pieces...



The skeletal structure has three "central" atoms linked together...



Making a double bond gives carbon enough (eight) outer electrons...

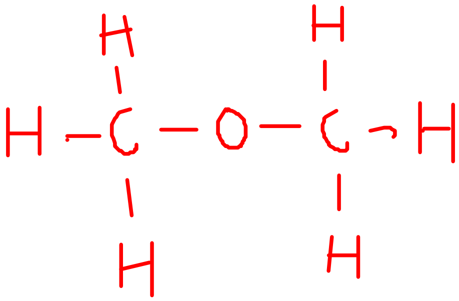
Carbon needs more electrons!

$(CH_3)_2O$

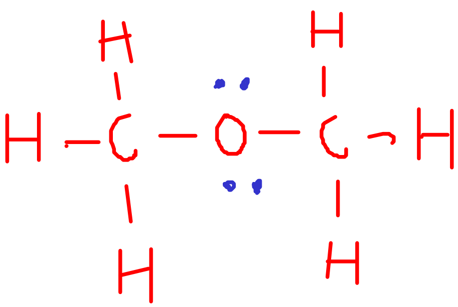
$C - 2 \times 4 = 8$
$H - 6 \times 1 = 6$
$O - 1 \times 6 = 6$

20 electrons

This molecule is called "dimethyl ether", and is an isomer of ethanol, a molecule we used earlier as an example.



The formula hints at this skeleton.



The last four electrons must go onto oxygen, as all the other atoms are "full".

ISOMERS are molecules that have the same molecular formula as each other, but have different arrangements of atoms. Depending on how different the arrangement of atoms is, some isomers may have very different properties - like dimethy ether and ethanol.