Hybridization

Elements in the second period have one s and three p orbitals in their valence shell. Before they combine with other atoms to make molecules, these atomic orbitals hybridize in one of the three following patterns.

sp\(^3\) - all atomic orbitals are hybridized:

\[
\text{s + p + p + p} \rightarrow \text{sp}^3 + \text{sp}^3 + \text{sp}^3 + \text{sp}^3
\]

Atoms which have sp\(^3\) hybridization:
- atoms with 4 single bonds
- atoms with 3 single bonds and one electron pair
- atoms with 2 single bonds and two electrons pairs

sp\(^2\) - one s and two p orbitals are hybridized, leaving one p orbital unhybridized:

\[
\text{s + p + p + p} \rightarrow \text{sp}^2 + \text{sp}^2 + \text{sp}^2 + \text{p}
\]

Atoms which have sp\(^2\) hybridization:
- atoms with two single bonds and one double bond
- atoms with two lone pairs and one double bond
- atoms with one single bond, one lone pair, and one double bond
- atoms with three single bonds and an empty orbital

sp: one s and one p orbital are hybridized, leaving two p orbitals unhybridized

\[
\text{s + p + p + p} \rightarrow \text{sp} + \text{sp} + \text{p} + \text{p}
\]

Atoms which have sp hybridization:
- atoms with one single bond and one triple bond
- atoms with two double bonds
- atoms with one lone pair and one triple bond

Things that go into hybridized orbitals:
- single bonds,
- 1st bond in a double bond
- 1st bond in a triple bond
- unpaired electrons (unless are delocalized by resonance)

Things that go into unhybridized p orbitals:
- 2nd bond of a double bond
- 2nd and 3rd bonds of a triple bond
- empty orbitals
- unpaired electrons if delocalized by resonance

Note that "sp\(^3\)" refers both to a single sp\(^3\) orbital and to the entire sp\(^3\) hybridization pattern.