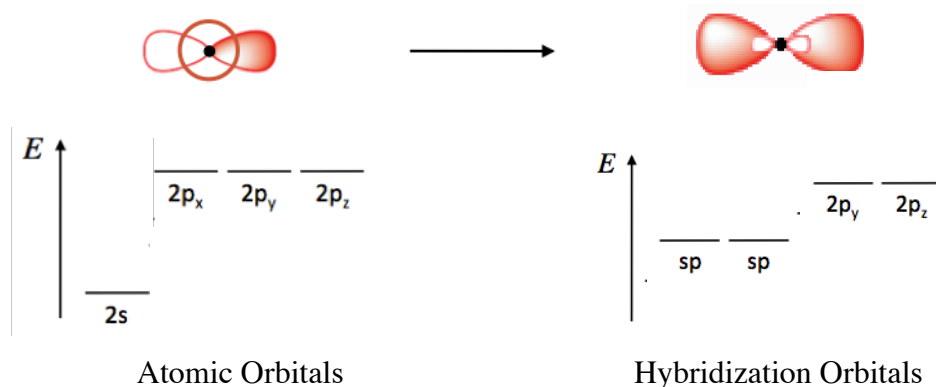


28. Hybridization

Atoms mix their own orbitals when creating polyatomic molecules to minimize the molecule's energy. This hybridization changes the shapes of orbitals to create the maximum separation of electrons within the resulting molecule. The resulting shapes of these orbitals determine the shapes of the molecules. Unlike interference of different electron orbitals between two atoms, hybridization occurs inside a single atom, around a single nucleus.

sp orbital

The first type of hybridization is called the sp hybridization orbital, and is created by combining a 1s and a 2p orbital. Much like the rules of interference, the number of orbitals used in creating the hybrid is equal to the number of hybrid orbitals that are created. For example, the images below show a single 1s orbital and a single 2p_x orbital. These two orbitals combine to form two sp orbitals with different energy. The resulting decrease in overall energy of the electron waves results in a more stable state for bonding.



Due to the orientation of these orbitals, we can see that the two hybrid sp orbitals are also aligned along the x-axis, with an angle of 180° between them. In addition, the overall energy of the atom is lowered because of hybridization.

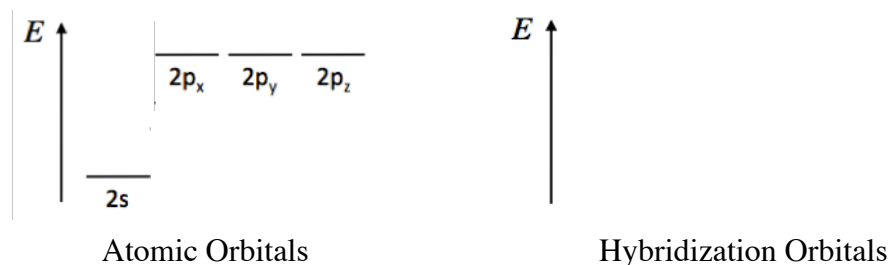
sp² orbital

When molecules need to arrange three pairs of electrons (lone pairs or bonding pairs) around a central atom, another form of hybridization takes place. The second hybridized orbital is called the sp² and is a combination of the 1s, 2p_x and 2p_y orbitals. Because three orbitals contribute to this hybridization, three sp² orbitals are created.



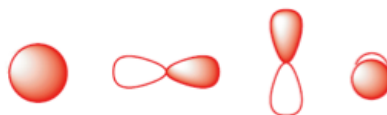
1) What should be the angle between each of these orbitals on this plane?

2) Draw the resulting energy diagram after sp^2 hybridization. Remember, each sp^2 orbital is 33% s-character and 67% p-character.



sp^3 orbitals

The last hybridized orbitals to be investigated are the sp^3 orbitals. This includes the 1s, 2p_x, 2p_y, and 2p_z orbitals. The orientation of these hybrid orbitals will be in three dimensions because they include all three 2p orbitals (the one farthest right is the 2p_z orbital and is drawn as if coming out of the page to show its axial orientation). Each one will be at an angle of 109° from each other in a tetrahedral shape.



3) Draw the four orbitals around a single nucleus before hybridization.

4) How many hybridized orbitals will be created from this combination?

5) Using the information above, see if you can determine the shape of the sp^3 orbitals within the atom, and sketch below. You may find it helpful to describe your drawing as well.

6) Draw the resulting energy diagram after the hybridization of these hybridized orbitals.

