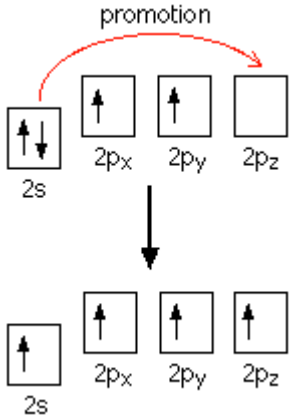
BONDING IN CARBONYL COMPOUNDS

1. a) $1s^2 2s^2 2p_x^1 2p_y^1$.

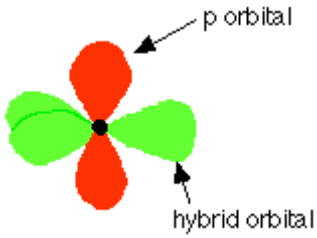
b) One of the 2s electrons is promoted by moving it into the slightly higher energy $2p_z$ orbital to give the structure $1s^2 2s^1 2p_x^1 2p_y^1 2p_z^1$.

Or with a diagram:



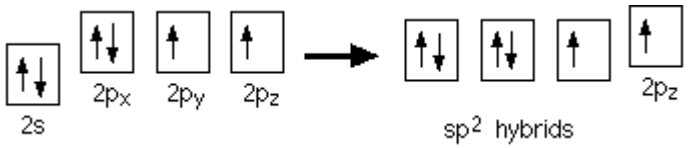
Each carbon atom has to join to three other things (two hydrogen atoms and an oxygen atom). It reorganises 3 of its s and p electrons into 3 sp^2 hybrid orbitals with the same shape and energy. The other p orbital is left unchanged.

The sp^2 hybrids arrange themselves as far apart as possible with the remaining p orbital at right angles to them.

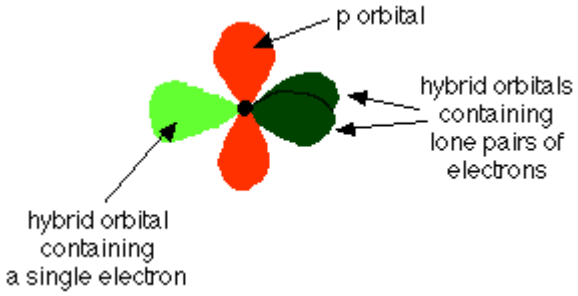


c) $1s^2 2s^2 2p_x^2 2p_y^1 2p_z^1$.

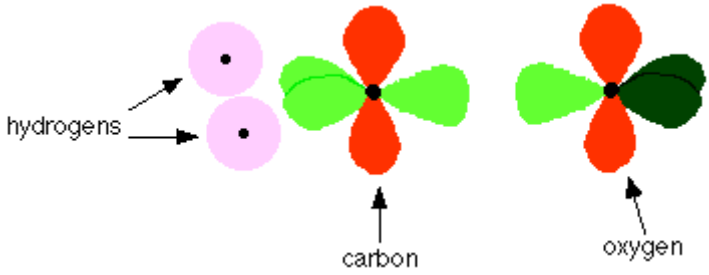
d) Hybridisation occurs to give three sp^2 hybrid orbitals and an unchanged p orbital.



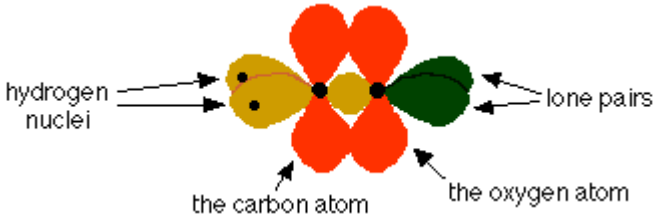
Two of the hybrid orbitals have lone pairs in them. (The arrangement in space is shown at the top of the next page.)



Just prior to bonding, you can think of the atoms arranged as follows:



Sigma bonds are formed between two of the sp^2 hybrid orbitals on the carbon and the two hydrogen atoms, and between the remaining sp^2 orbital on the carbon and the one on the oxygen:



Finally, a pi bond is made by sideways overlap between the p orbitals. Because the oxygen is more electronegative than the carbon, the electrons in the pi bond are distorted so that they spend more time at the oxygen end of the bond. That is different from the more even distribution in a carbon-carbon double bond.