BONDING IN ETHYNE

1. Carbon has the electronic structure $1s^22s^22p_x^12p_y^1$. Hydrogen is $1s^1$. One of the $2s$ electrons is promoted by moving it into the slightly higher energy $2p_z$ orbital to give the structure $1s^22s^12p_x^12p_y^12p_z^1$.

Each carbon atom in ethyne has to join to two other things (a hydrogen atom and another carbon atom). It reorganises 2 of its s and p electrons into 2 orbitals with the same shape and energy. These are called sp$^1$ hybrids. The other two p orbitals are left unchanged.

The sp$^1$ hybrids arrange themselves as far apart as possible with the remaining p orbitals at right angles to them.

The hybrid orbitals overlap in space with the $1s^1$ orbital on a hydrogen atom and with one of the sp$^1$ orbitals on the other carbon atom to form molecular orbitals containing both electrons.

Lined up just before overlap:
The end-to-end overlap gives sigma bonds.

The remaining p orbitals overlap sideways to give two pi bonds.

Giving:

- One pi bond above and below the molecule
- Another pi bond in front of and behind the molecule