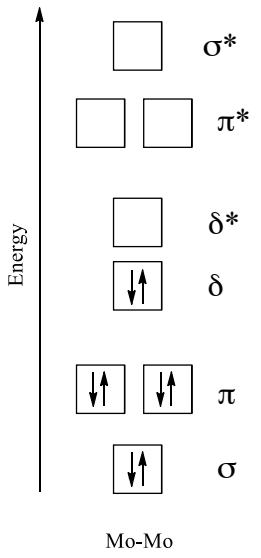
Marks 6

- The red species $K_4[Mo_2Cl_8]$ is an historically important example of a metal-metal bonded complex. Use standard nomenclature to name the complex salt.

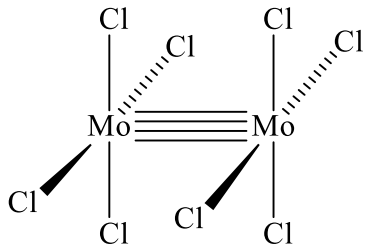
potassium octachloridodimolybdate(II)

$K_4[Mo_2Cl_8]$ possesses an extremely short Mo–Mo bond (214 pm), much shorter than the bonding distance between Mo atoms in Mo metal (273 pm)! Propose a reasonable explanation for the very short Mo–Mo bond length in the complex by adding *d*-electrons into the (partial) MO scheme shown below. Draw a structure for the complex that is consistent with the completed MO scheme and your explanation.



Mo^{2+} is d^4, so there are 8 *d* electrons which all occupy the σ, π and δ bonding orbitals as shown.

With 8 bonding electrons and no anti-bonding electrons, the complex therefore has a bond order of 4 and consequently a very short bond length.



Oxidation of the complex by one electron gives rise to a paramagnetic species in which the Mo-Mo distance increases significantly. Propose a reasonable hypothesis for the bond lengthening phenomenon.

Oxidation is the loss of 1 electron which is removed from the highest occupied molecular orbital: the δ bonding orbital. As this leads to an unpaired electron in this orbital, it is paramagnetic species.

The number of bonding electrons is thus reduced to 7. This reduces the bond order from 4.0 to 3.5, thus weakening and lengthening the Mo–Mo bond.