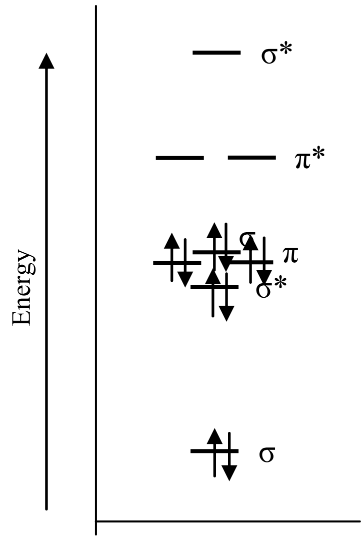
Marks
6

- Carbon and oxygen can combine to form carbon monoxide, the second most abundant molecule in the universe.

The molecular orbital energy level diagram provided shows the energies of the orbitals for the valence electrons in CO. Indicate on this diagram the ground state electronic configuration of CO using the arrow notation for electron spins.



What homonuclear diatomic molecule has the same electronic structure as CO? Comment on the bond orders of these two species.

N_2. This is has the same number of valence electrons – it is *isoelectronic*. N has 5 valence electrons so N_2 has 2 × 5 = 10 valence electrons. C has 4 and O has 6 valence electrons so CO has 4 + 6 = 10 valence electrons. They both have a triple bond: i.e. they both a bond order of 3:

bond order = ½ (no. of bonding electrons – no. of antibonding electrons)
= ½ (8 - 2) = 3

How would adding an electron to CO to form CO^- affect the strength of the bond between the two atoms? Explain your answer.

The extra electron would go into the π* antibonding orbital. The bond order would consequently drop from 3 to 2.5: bond order = ½ (8 - 3) = 2.5

Hence the bond would be weaker.

Are the atomic orbital energies of oxygen lower or higher than carbon? Explain your answer and comment on how this may affect the electron density in bonding orbitals of the CO molecule.

Oxygen is more electronegative: the energies of its orbitals are lower than those of carbon. This is because oxygen is the smaller atom with a higher nuclear charge. The bond would therefore be polarised with a greater amount of the shared electron density on the oxygen end of the bond.