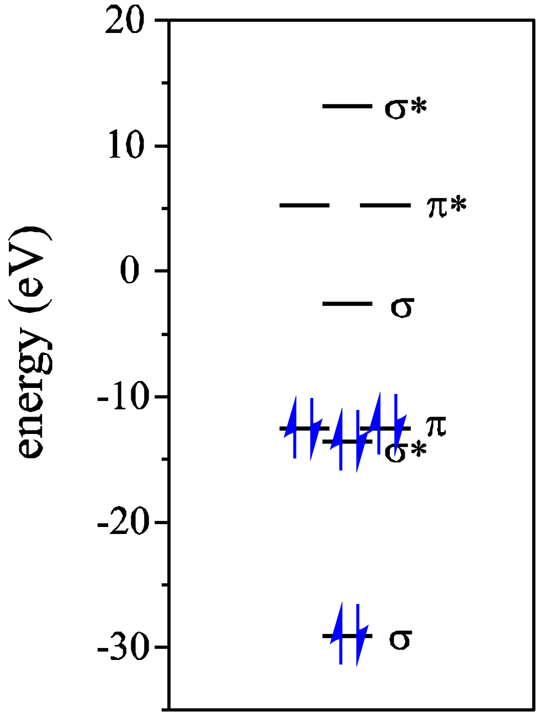
Marks 5

- C_2 is a reaction intermediate observed in flames, comets and circumstellar shells.

How many valence electrons are there in C_2?

4 from each C hence 8 overall

Complete the calculated MO diagram for the ground state of C_2 by inserting the appropriate number of valence electrons into the appropriate orbitals.



What is the bond order of C_2?

There are 6 bonding electrons (in σ and π) and 2 antibonding electrons (in σ*). Hence the bond order = ½ (6 - 2) = 2

What is the longest wavelength of light that the ground state C_2^+ ion will absorb? Show working.

The *longest* wavelength corresponds to the *lowest* energy transition that is possible. This is from the highest occupied orbital (π) to the lowest unoccupied (σ). From the diagram, the energies of these orbitals are *approximately* -12.5 eV and -2.5 eV respectively. The transition energy is therefore ~10 eV.

10 eV corresponds to 10 × (1.602 × 10^{-19} J) = 1.602 × 10^{-18} J.

From Planck's equation, the energy is related to the wavelength:

$$E = \frac{hc}{\lambda} \text{ or } \lambda = \frac{hc}{E}$$

so

$$\lambda = \frac{(6.626 \times 10^{-34}\ \text{J s})(2.998 \times 10^{8}\ \text{m s}^{-1})}{(1.602 \times 10^{-18}\ \text{J})} = 1.2 \times 10^{-7}\ \text{m or } 120\ \text{nm}$$

Answer: **1.2 × 10^{-7} m or 120 nm**