

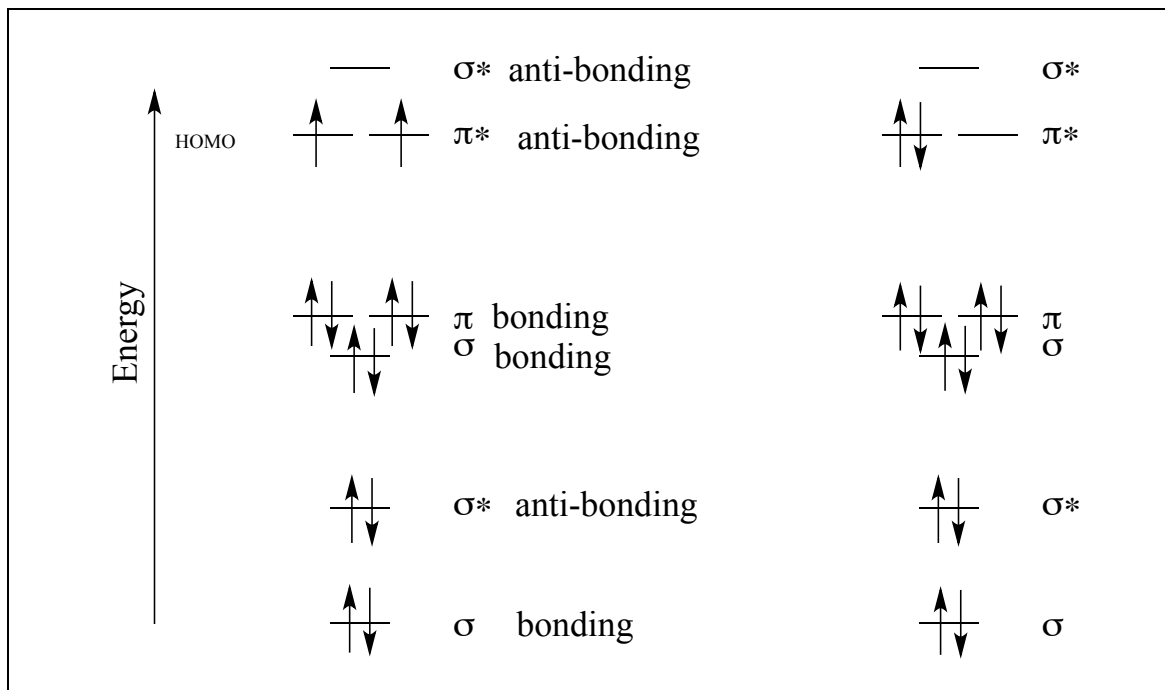
Marks
8

- Oxygen exists in the troposphere as a diatomic molecule.

How many valence electrons in the O₂ molecule?

12

The molecular orbital energy levels for O₂ are shown below. On the left-hand diagram, fill in the **valence** electrons for oxygen, O₂, in the ground state.



- (a) What is the bond order for O₂?

$$\frac{1}{2} (8 - 4) = 2$$

- (b) Clearly label a bonding orbital and an anti-bonding orbital on the left-hand diagram.
- (c) Clearly label the HOMO of O₂ on the left-hand diagram.
- (d) On the right-hand diagram, indicate the lowest energy electronic configuration for O₂ which has no unpaired electrons.

The blue colour of liquid O₂ arises from an electronic transition whereby one 635 nm photon excites two molecules to the state indicated by the configuration in (d) *at the same time*. What wavelength photon would be emitted by one molecule returning from this state to the ground state?

If one 635 nm photon excites two molecules, then half as much energy is will be emitted when one molecule returns to the ground state.

As $E = hc / \lambda$, if the energy is halved, the wavelength doubles: $\lambda = 1270$ nm.

Answer: **1270 nm**

Suggest a heteronuclear diatomic species, isoelectronic with O₂, that might be expected to have similar spectroscopic behaviour.

NO⁺, NF