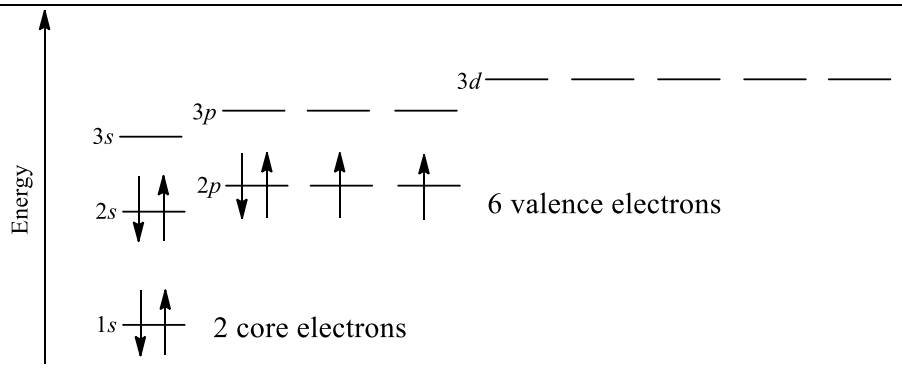
Marks 8

- What is the ground state electron configuration of oxygen?

$1s^2\ 2s^2\ 2p^4$

The following diagram represents the relative energies of the atomic orbitals in the first three shells. Using arrows to represent electrons, show the most stable electron arrangement of the oxygen atom. Label the core electrons and the valence electrons.



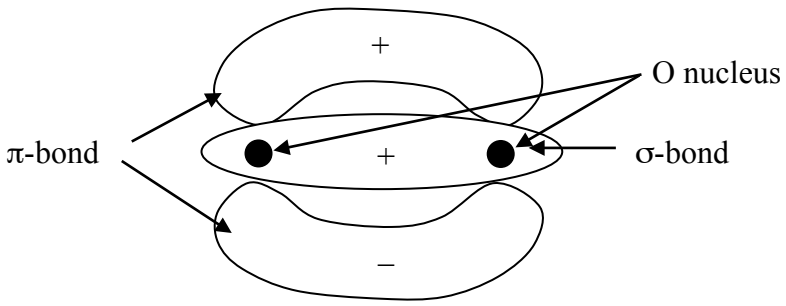
Briefly explain how your diagram illustrates the Pauli exclusion principle, Aufbau principle and Hund's rule.

Pauli exclusion principle: there's a maximum of 2 electrons in each orbital with opposite spins, ensuring that no two electrons have the same set of quantum numbers.

Aufbau principle: lowest energy orbitals fill first.

Hund's rule: electrons in degenerate orbitals (*i.e.* orbitals with same energy) have the maximum number of parallel spins to minimise electron / electron repulsion.

Draw an oxygen molecule showing the shapes of the σ-orbital and the π-orbital present.



Oxygen and sulfur are both Group 16 elements with a valence of two. Oxygen is a diatomic molecule at room temperature, whilst the bonding in solid sulfur consists only of σ-bonds. Suggest reasons why, at room temperature, the O=O molecule is stable and the S=S molecule is not.

Sulfur would use 3*p* orbitals to form a π-bond. These orbitals are diffuse and overlap is poor and so it is more stable to use σ-bonds to 2 other atoms. Good overlap of the 2*p* orbitals in oxygen means that the π-bond is stable.