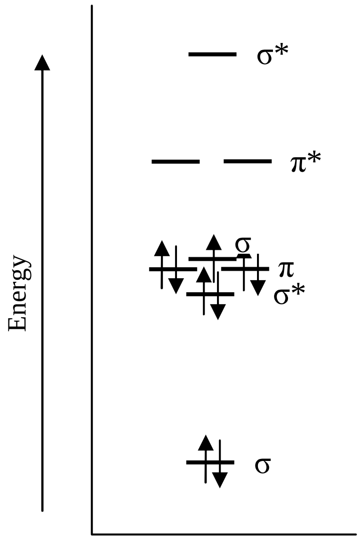
Marks
5

- The N_2^+ ion plays a role in the colourful display of the Northern Lights (the *Aurora Borealis*).

The molecular orbital energy level diagram provided shows the energies of the orbitals for the valence electrons in the N_2^+ ion. Indicate on this diagram the ground state electronic configuration of N_2^+ using the arrow notation for electron spins.



Calculate the bond order of N_2^+.

Bond order = ½ (7 – 2) = 2.5

Indicate the lowest energy electron excitation in this ion by identifying the initial and final states of the electron undergoing the excitation.

The lowest energy excitation corresponds to the electron moving from π → σ

The line at 3914 Å (391.4 nm) in the emission spectrum of the *Aurora Borealis* is due to N_2^+ returning to its ground state. Calculate the energy gap (in eV) between the molecular orbitals involved in this transition.

As $E = \frac{hc}{\lambda}$, the line corresponds to an energy of:

$$E = \frac{(6.626\times10^{-34})\times(2.998\times10^{8})}{(391.4\times10^{-9})} = 5.075\times10^{-19}\ \text{J}$$

As 1 eV = 1.602×10^{-19} J, this corresponds to:

$$E = 5.075 \times 10^{-18} =, \frac{5.075\times10^{-19}}{1.602\times10^{-19}} = 3.172\ \text{eV}$$

Answer: **3.172 eV**