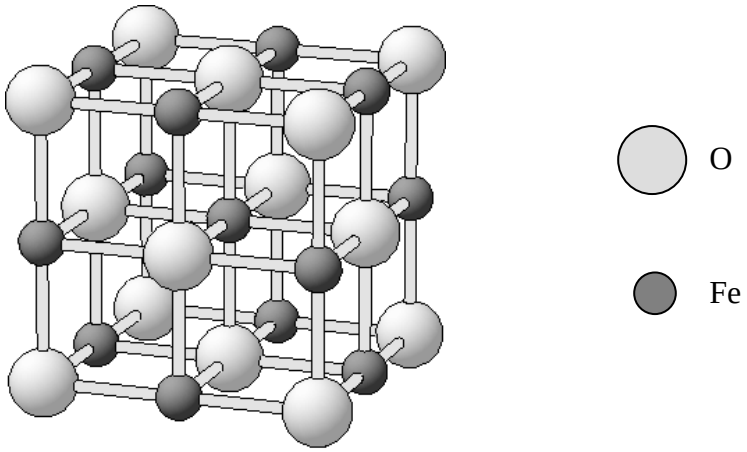
Marks 8

- Iron forms three common oxides, FeO, Fe_3O_4 and Fe_2O_3. The unit cell for one of these oxides is shown below.



Explain which oxide the structure represents and describe the nature of the packing of the ions and their coordination numbers.

The structure contains 1 Fe atom at the centre and 12 Fe atoms on the edges. The atoms on the edges are shared between 4 cells and so contribute 1/4 to each:

number of Fe atoms = 1 (centre) + 12 × 1/4 (edges) = 4

The structure contains 8 O atoms on the corners and 6 O atoms on the faces. The atoms on the corners are shared between 8 cells and so contribute 1/8 to each and the atoms on the faces are shared between 2 cells and so contribute 1/2 to each:

number of O atoms = 8 × 1/8 (corners) + 6 × 1/2 = 4

There are 4 Fe atoms and 4 O atoms in the unit cell: the stoichimetry is Fe_4O_4 or FeO.

The coordination number is 6 for both Fe and O. The structure can be described as the cubic close packed arrangement of O atoms, with Fe in all of the octahedral holes.

The mineral magnetite, Fe_3O_4, is found in the beaks of homing pigeons. It contains a mixture of Fe^{2+} and Fe^{3+} ions. What is the ratio of Fe^{2+} to Fe^{3+} in Fe_3O_4?

As each O has an oxidation number of -2 and there are 4 of them in the formula, the 3 Fe atoms must together have a charge of +8. This is consistent with their being two Fe^{3+} ions and one Fe^{2+} per formula unit.

The ratio of Fe^{3+} to Fe^{2+} is 2 to 1.

ANSWER CONTINUES ON THE NEXT PAGE

How many unpaired electrons are there in an Fe^{2+} ion and in an Fe^{3+} ion? Explain your answer using the box notation.

Fe is in Group 8 so Fe^{2+} has a d^6 configuration and Fe^{3+} has a d^5 configuration. These electrons arrange in the five *d*-orbitals to minimise the repulsion between them by maximising the number of unpaired electrons:

Fe^{2+} 

Fe^{3+} 

Fe^{2+} has 4 unpaired electrons and Fe^{3+} has 5 unpaired electrons.

Fe^{2+}: **4**	Fe^{3+}: **5**