

Q1. This question is about the structure of atoms.

(a) Choose words from the list to complete the sentences below.

electrons ions neutrons protons

In an atom, the particles with a negative charge are called

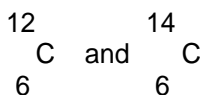
Particles in the nucleus with no charge are called

An atom has no overall charge because it has the same number of electrons and

.....

(3)

(b) Two isotopes of the element carbon are:



Complete the table of information for these two isotopes.

| | ATOMIC NUMBER | MASS NUMBER | NUMBER OF PROTONS | NUMBER OF NEUTRONS |
|---|---------------|-------------|-------------------|--------------------|
| $\begin{array}{c} ^{12} \\ \text{Isotope C} \\ 6 \end{array}$ | 6 | 12 | 6 | 6 |
| $\begin{array}{c} ^{14} \\ \text{Isotope C} \\ 6 \end{array}$ | 6 | | 6 | |

(2)

(Total 5 marks)

Q2. The formula for the chemical compound magnesium sulphate is MgSO_4 .

Calculate the relative formula mass (M_r) of this compound. (Show your working.)

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.....
.....

(Total 2 marks)

Q3. Calculate the formula mass (M_r), of the compound

calcium hydroxide, $\text{Ca}(\text{OH})_2$.

(Show your working)

.....

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.....

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.....

(Total 3 marks)

##

Atoms of calcium, phosphorus and fluorine are represented below, each with its mass number and proton number.

| | | | | |
|----|----|----|---|----------------|
| 40 | 31 | 19 | ← | mass numbers |
| Ca | P | F | | |
| 20 | 15 | 9 | ← | proton numbers |

(a) Use this information to complete the table.

| | CALCIUM | PHOSPHOROUS | FLUORINE |
|-----------------------------------|---------|-------------|----------|
| Number of protons in the nucleus | 20 | | 9 |
| Number of neutrons in the nucleus | 20 | 16 | |
| Number of electrons | | 15 | 9 |

(3)

(b) Calcium and fluorine atoms can combine to form the compound calcium fluoride, CaF_2 .

The fluoride ion is represented by F^- .

(i) Explain how the fluorine atom forms a fluoride ion.

.....

.....

(2)

(ii) How is the calcium ion represented?

.....

(2)

- (c) Phosphorus and fluorine form a covalent compound, phosphorus trifluoride.

Complete the sentences below which are about this compound.

Phosphorus trifluoride is made up of phosphorus and fluorine

These are joined together by sharing pairs of to form phosphorus trifluoride

(3)

- (d) (i) Sodium chloride, an ionic compound, has a high melting point whereas paraffin wax, a molecular compound, melts easily.

Explain why.

.....
.....
.....
.....

(2)

- (ii) Molten ionic compounds conduct electricity but molecular compounds are non-conductors, even when liquid.

Explain why.

.....
.....
.....

(2)

(Total 14 marks)

Q5. The information on the Data Sheet will be helpful in answering this question.

- (a) Calculate the formula mass (M_r) of the compound iron (III) oxide, Fe_2O_3 .

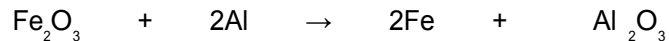
(Show your working.)

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(3)

- (b) Calculate the mass of iron produced when 32g of iron (III) oxide is completely reduced by aluminium.

The reaction is shown in the symbol equation:



(Show your working.)

.....
.....
.....
.....

Answer = grams

(3)
(Total 6 marks)

Q6. You will find it helpful to use the information on the Data Sheet when answering this question.

In the nucleus of an aluminium atom are:

13 protons
and 14 neutrons.

(a) Complete these sentences.

- (i) The mass number of the aluminium atom is
- (ii) In an atom of aluminium there are electrons.

(2)

(b) Why is an aluminium atom electrically neutral?

.....
.....
.....

(2)

(c) Complete the table for the element fluorine.

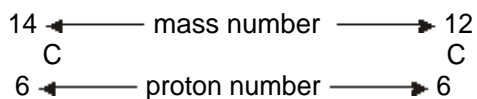
| PARTICLE | NUMBER OF PROTONS | NUMBER OF NEUTRONS | NUMBER OF ELECTRONS |
|---------------|-------------------|--------------------|---------------------|
| Fluorine atom | 9 | | 9 |
| Fluoride atom | | 10 | |

(3)
(Total 7 marks)

Q7. The two carbon atoms represented below are isotopes.

ISOTOPE 1

ISOTOPE 2



(a) Describe **two** ways in which the isotopes are similar.

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.....

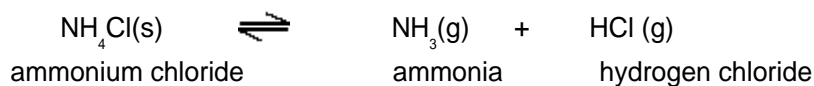
(2)

(b) Describe as fully as you can **one** way in which they are different.

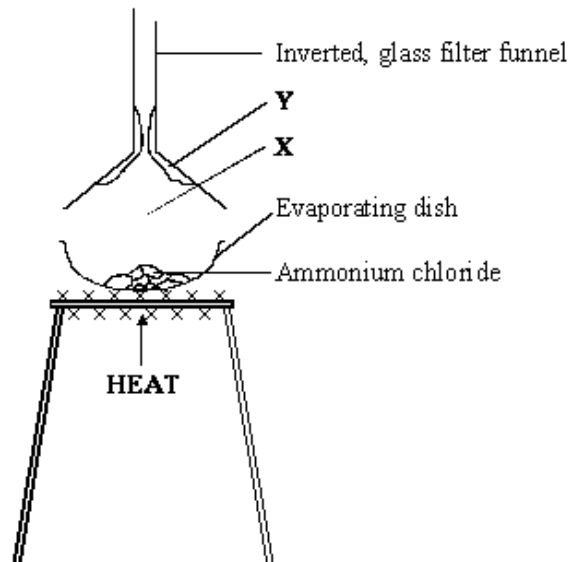
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(2)
(Total 4 marks)

Q8. (a) The equation for the reaction that takes place when ammonium chloride is heated is:



The diagram shows how a teacher demonstrated this reaction. The demonstration was carried out in a fume cupboard.



(i) Apart from the gases normally in the atmosphere, which two gases would be at **X**?

..... and

(1)

(ii) Name the white solid that has formed at **Y**.

.....

(1)

(iii) Why was the demonstration carried out in a fume cupboard?

.....

(1)

(iv) Complete the **four** spaces in the passage.

The chemical formula of ammonia is NH_3 . This shows that there is one atom of and three atoms of in each of ammonia. These atoms are joined by bonds that are formed by sharing pairs of electrons. This type of bond is called a bond.

(4)

(b) Electrons, neutrons and protons are sub-atomic particles.

(i) Complete the **three** spaces in the table.

| Name of sub-atomic particle | Relative mass | Relative charge |
|-----------------------------|------------------|-----------------|
| ..... | 1 | +1 |
| ..... | 1 | 0 |
| ..... | $\frac{1}{1840}$ | -1 |

(2)

(ii) Which **two** sub-atomic particles are in the nucleus of an atom?

..... and

(1)

(Total 10 marks)

Q9. (a) Atoms are made of sub-atomic particles. Complete the **six** spaces in the table.

| Name of sub-atomic particle | Relative mass | Relative charge |
|-----------------------------|------------------|-----------------|
| ..... | $\frac{1}{1840}$ | ..... |
| Neutron | ..... | ..... |
| ..... | 1 | ..... |

(3)

(b) Complete the spaces in the sentences.

(i) The atomic number of an atom is the number of in its nucleus and is equal to the number of if the atom is not charged.

(1)

(ii) The mass number of an atom is the total number of and in its nucleus.

(1)

(c) The table gives information about the atoms of three elements.

| Name of element | Chemical symbol | Number of electrons in: | | |
|-----------------|-----------------|-------------------------|-----------------------|-----------------------|
| | | 1 st shell | 2 nd shell | 3 rd shell |
| Fluorine | F | 2 | 7 | 0 |
| Neon | Ne | 2 | 8 | 0 |
| Sodium | Na | 2 | 8 | 1 |

Two of these elements can react together to form a chemical compound.

(i) What is the name and the formula of this compound?

Name Formula

(2)

(ii) What type of bonding holds this compound together?

.....

(1)

(iii) Explain, in terms of electron transfer, how the bonding occurs in this compound.

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(2)

(Total 10 marks)

Q10. Electrons, neutrons and protons are sub-atomic particles.

(a) Complete the **six** spaces in the following table.

| Name of sub-atomic particle | Relative mass | Relative charge |
|-----------------------------|------------------|-----------------|
| ..... | 1 | ..... |
| ..... | ..... | 0 |
| ..... | $\frac{1}{1840}$ | ..... |

(3)

(b) An aluminium atom has 13 electrons. How are these arranged in shells around the nucleus?

.....

(1)

(c) Chromium atoms have 24 protons and 28 neutrons.

(i) How many electrons does each neutral chromium atom have?

.....

(1)

(ii) What is the mass number of chromium?

.....

(1)

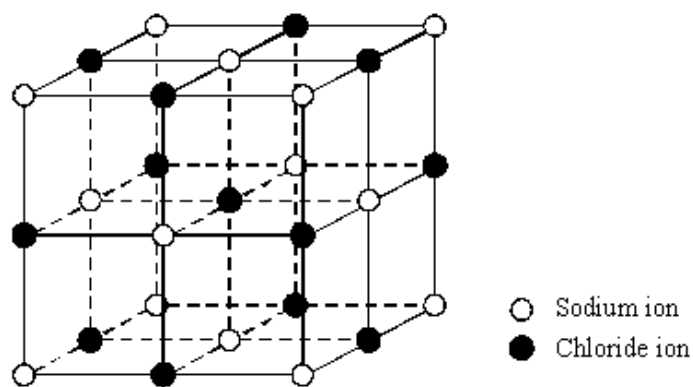
(d) What change occurs to an atom which undergoes the process of *reduction* in a chemical reaction?

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(1)

(e) The diagram shows part of the ionic lattice of a sodium chloride crystal.



Explain why the ions in this lattice stay in place.

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(3)
(Total 10 marks)

Q11. Ammonium chloride, NH_4Cl , is made up of nitrogen, hydrogen and chlorine atoms.

(i) Complete the table to show the number of atoms of each element present in NH_4Cl .

| Element | Number of atoms in NH_4Cl |
|----------|---|
| nitrogen | 1 |
| hydrogen | |
| chlorine | |

(1)

(ii) Calculate the relative formula mass of ammonium chloride, NH_4Cl .

(Relative atomic masses: H = 1, N = 14, Cl = 35.5)

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.....
.....
.....

Relative formula mass =

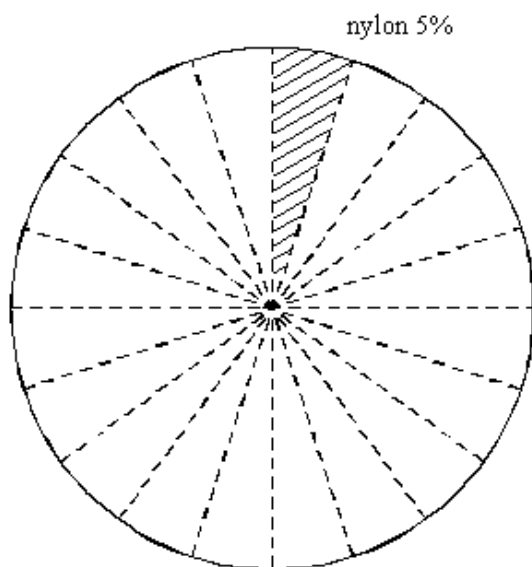
(2)
(Total 3 marks)

Q12. Ammonia is a very important chemical.

(a) The table shows the percentage of ammonia used to make different substances.

| SUBSTANCES MADE FROM AMMONIA | PERCENTAGE (%) OF AMMONIA USED |
|------------------------------|--------------------------------|
| fertilisers | 75 |
| nitric acid | 10 |
| nylon | 5 |
| others | 10 |

Shade on the pie chart the percentage of ammonia used to make nitric acid.



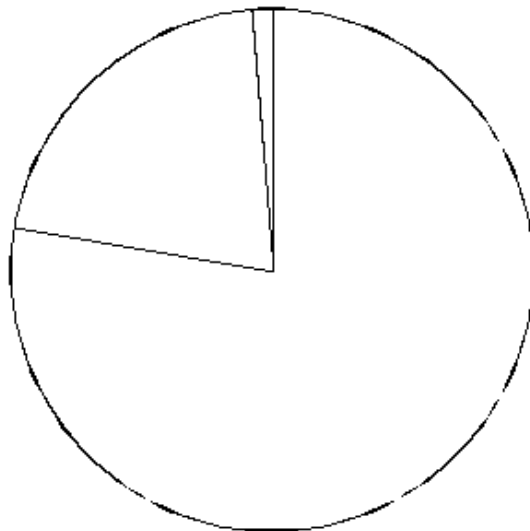
(1)

- (b) Ammonia gas is made by the reaction between nitrogen gas and hydrogen gas. Write a word equation to represent this reaction.

..... + \rightleftharpoons

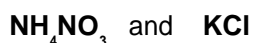
(1)

- (c) Nitrogen is one of the raw materials used to make ammonia. Nitrogen is obtained from air. This pie chart shows the proportion of nitrogen, oxygen and other gases in air. Label the area which represents the proportion of nitrogen in air.



(1)

- (d) An artificial fertiliser contains compounds with the formulae:



- (i) Use the Data Sheet to help you answer this question. Name the elements in the compound NH_4NO_3 .

1

2

3

(2)

- (ii) Use the Data Sheet to help you answer this question. Name the compound KCl.

.....

(1)

- (e) (i) Ammonium nitrate is one type of artificial fertiliser. Calculate the relative formula mass of ammonium nitrate NH_4NO_3 . (Relative atomic masses: H = 1, N = 14, O = 16.)

.....

.....

(1)

- (ii) Use your answer to part (f)(i) to help you calculate the percentage by mass of nitrogen present in ammonium nitrate NH_4NO_3 .

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.....
.....

(2)
(Total 9 marks)

Q13. Follow the steps to find the percentage of iron in iron oxide.

Relative atomic masses: O 16; Fe 56.

- (i) Step 1

Calculate the relative formula mass of iron oxide, Fe_2O_3 .

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.....

(1)

- (ii) Step 2

Calculate the total relative mass of just the iron atoms in the formula, Fe_2O_3 .

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(1)

- (iii) Step 3

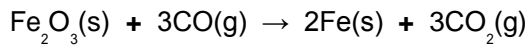
Calculate the percentage (%) of iron in the iron oxide, Fe_2O_3 .

.....
.....

Percentage of iron %

(1)
(Total 3 marks)

Q14. The chemical equation for the formation of iron is:



Calculate the relative formula mass of iron oxide, Fe_2O_3 .

Relative atomic masses: O 16; Fe 56.

.....
.....
.....

Relative formula mass $\text{Fe}_2\text{O}_3 = \dots\dots\dots$

(Total 2 marks)

Q15. There is molten rock below the Earth's solid outer crust. The rock remains molten because the radioactive decay of isotopes such as uranium, thorium and potassium releases heat energy.

(i) Explain how this released heat energy is thought to cause the recycling of rocks.

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(4)

(ii) Two *isotopes* of potassium are shown.



Explain what is meant by *isotopes*. You must include numbers of electrons, neutrons and protons in your explanation.

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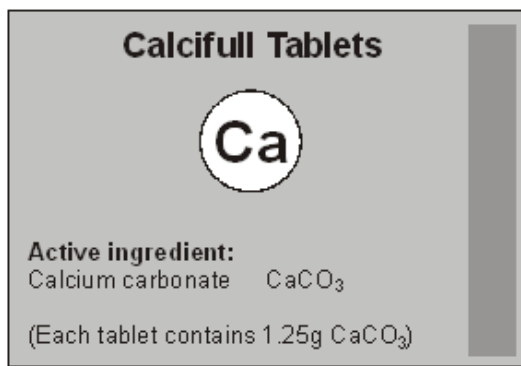
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(4)
(Total 8 marks)

Q16. Calcium carbonate tablets are used to treat people with calcium deficiency.



(a) Calculate the relative formula mass (M_r) of calcium carbonate.

Relative atomic masses: C = 12; O = 16; Ca = 40.

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.....

Relative formula mass =

(2)

- (b) Calculate the percentage of calcium in calcium carbonate, CaCO_3 .

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Percentage of calcium = %

(2)

- (c) Calculate the mass of calcium in each tablet.

.....

.....

Mass of calcium = g

(2)

- (d) An unwanted side effect of this medicine is that it can cause the patient to have 'wind' (too much gas in the intestine).

The equation below represents the reaction between calcium carbonate and hydrochloric acid (the acid present in the stomach).



Suggest why the patient may suffer from 'wind'.

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.....

(1)

(Total 7 marks)

Q17. Iron ore contains iron oxide.

- (i) Calculate the relative formula mass of iron oxide, Fe_2O_3 .

Relative atomic masses: O = 16; Fe = 56.

.....

.....

Answer =

(2)

- (ii) Calculate the percentage by mass of iron in iron oxide.

.....

Percentage of iron = %

(2)

(iii) Calculate the mass of iron that could be extracted from 1000 kg of iron oxide.

Use your answer to part (c) (ii) to help you with this calculation.

.....

Mass of iron = kg

(1)
(Total 5 marks)

Q18. Toothpastes often contain fluoride ions to help protect teeth from attack by bacteria.



Some toothpastes contain tin(II) fluoride.

This compound has the formula SnF_2 .

(a) Calculate the relative formula mass (M_r) of SnF_2 .

Relative atomic masses: F = 19; Sn = 119

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.....
.....
.....

Relative formula mass (M_r) =

(2)

(b) Calculate the percentage by mass of fluorine in SnF_2 .

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.....
.....
.....

Percentage by mass of fluorine = %

(2)

- (c) A tube of toothpaste contains 1.2 g of SnF_2 .

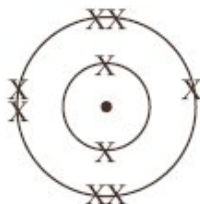
Calculate the mass of fluorine in this tube of toothpaste.

.....
.....
.....
.....

Mass of fluorine = g

(1)

- (d) The diagram represents the electron arrangement of a fluorine atom.



Explain how a fluorine atom can change into a fluoride ion, F^- .

.....
.....
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(2)

(Total 7 marks)

- Q19.** (a) A chemist was asked to identify a nitrogen compound. The chemist carried out an experiment to find the relative formula mass (M_r) of the compound.

The M_r of the compound was 44.

Relative atomic masses: N = 14, O = 16

Draw a ring around the formula of the compound.

NO

NO₂

N₂O₄

N₂O

(1)

- (b) Potassium nitrate is another nitrogen compound. It is used in fertilisers. It has the formula **KNO₃**.

The **M_r** of potassium nitrate is **101**.

Calculate the percentage of **nitrogen** by mass in potassium nitrate.

Relative atomic mass: N = 14.

.....
.....

Percentage of nitrogen = %

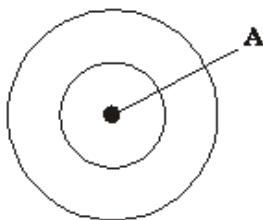
(2)

(Total 3 marks)

Q20. This question is about oxygen atoms. The periodic table on the Data Sheet may help you to answer this question.

- (a) (i) Oxygen atoms have 8 electrons.

Complete the diagram to represent the arrangement of electrons in an oxygen atom.
Use crosses (x) to represent the electrons.



(1)

- (ii) Name the part of the oxygen atom that is labelled **A** on the diagram.

.....

(1)

- (b) Two isotopes of oxygen are oxygen-16 and oxygen-18.



oxygen-16



oxygen-18

Explain, in terms of particles, how the nucleus of an oxygen-18 atom is different from the nucleus of an oxygen-16 atom.

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(2)
(Total 4 marks)

Q21. Iron is an essential part of the human diet. Iron(II) sulfate is sometimes added to white bread flour to provide some of the iron in a person's diet.



(a) The formula of iron(II) sulfate is FeSO_4

Calculate the relative formula mass (M_r) of FeSO_4

Relative atomic masses: O = 16; S = 32; Fe = 56.

.....
.....

The relative formula mass (M_r) =

(2)

(b) What is the mass of one mole of iron(II) sulfate? Remember to give the unit.

.....

(1)

(c) What mass of iron(II) sulfate would be needed to provide 28 grams of iron?

Remember to give the unit.

.....

(1)
(Total 4 marks)

Q22. (a) The table gives information about two isotopes of hydrogen, hydrogen-1 and hydrogen-2.

| | Hydrogen-1 | Hydrogen-2 |
|---------------|------------|------------|
| Atomic number | 1 | 1 |
| Mass number | 1 | 2 |

An atom of hydrogen-1 is represented as: ${}^1_1\text{H}$

Show how an atom of hydrogen-2 is represented.

(1)

(b) (i) Calculate the relative formula mass (M_r) of water, H_2O

Relative atomic masses: H = 1; O = 16.

.....
.....

Relative formula mass (M_r) =

(1)

(ii) Simple molecules like water have low boiling points.

Explain why, in terms of molecules.

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.....
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(2)

- (c) Molecules of heavy water contain two atoms of hydrogen-2 instead of two atoms of hydrogen-1.

Explain why a molecule of heavy water has more mass than a normal water molecule. You should refer to the particles in the nucleus of the two different hydrogen atoms in your answer.

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(2)
(Total 6 marks)

- Q23.** Calamine lotion is used to treat itching. The main ingredients are two metal oxides.



- (a) One of the metal oxides has a relative formula mass (M_r) of 81.

The formula of this metal oxide is MO.
(M is **not** the correct symbol for the metal.)

The relative atomic mass (A_r) of oxygen is 16.

- (i) Calculate the relative atomic mass (A_r) of metal M.

.....
.....
.....

Relative atomic mass (A_r) =

(2)

- (ii) Use your answer to part (a)(i) and the periodic table on the Data Sheet to name metal M.

The name of metal M is

(1)

- (b) The other metal oxide is iron(III) oxide.

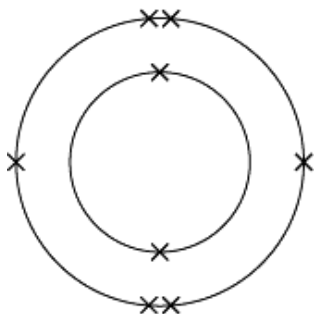
This contains iron(III) ions (Fe^{3+}) and oxide ions (O^{2-}).

- (i) Explain in terms of electrons how an iron atom (Fe) can change into an iron(III) ion (Fe^{3+}).

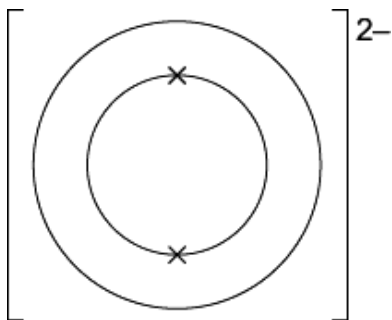
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(2)

- (ii) The diagram below represents the electronic structure of an oxygen atom (O).



Complete the diagram below to show the electronic structure of an oxide ion (O^{2-}).



(1)

(Total 6 marks)

