Paper 3

Questions are applicable for both core and extended candidates

1 A list of substances is shown.

brass
calcium oxide
carbon monoxide
diamond
glucose
hydrogen
litmus
magnesium bromide
methyl orange
sodium chloride
stainless steel
thymolphthalein
water
zinc oxide

Answer the following questions about these substances.
Each substance may be used once, more than once or not at all.

State which substance:

(a) is formed by the thermal decomposition of calcium carbonate in the blast furnace

..... [1]

(f) is a compound that reduces iron(III) oxide in the blast furnace.

..... [1]

2 A list of symbols and formulae is shown.

Br_2
CH_4
C_2H_4
Cl^-
CO_2
Cr^{3+}
Cu^{2+}
H_2
K^+
N_2
N^{3-}
O_2
SO_4^{2-}

Answer the following questions about these symbols and formulae.
Each symbol or formula may be used once, more than once or not at all.

State which symbol or formula represents:

(e) a compound produced by the thermal decomposition of calcium carbonate

..... [1]

3 This question is about iron.

(a) Iron is extracted from iron ore in a blast furnace.

(i) Name the main ore of iron.

..... [1]

(ii) The main ore of iron contains iron(III) oxide.

Describe the extraction of iron from iron ore in the blast furnace.

In your answer, describe:

- the production of carbon monoxide

.....

.....

.....

- the role of carbon monoxide

.....

- the role of calcium carbonate, added to the blast furnace.

.....

.....

.....

[4]

(iii) Iron collects at the base of the blast furnace as a liquid.

Describe the arrangement and motion of the particles in a liquid.

arrangement .....

.....

motion .....

.....

[2]

4 This question is about metals.

(b) Carbon is used to extract iron from iron ore in a blast furnace.

State **two** uses of carbon in the extraction process.

1 .....

2 .....

[2]

5 This question is about metals and metal compounds.

(b) Iron is extracted in a blast furnace by reduction of iron(III) oxide, Fe_2O_3, with carbon monoxide.

Carbon monoxide is produced by the reaction of carbon with carbon dioxide.

$$C + CO_2 \rightarrow 2CO$$

(i) Explain how this equation shows that carbon dioxide is reduced.

.....

..... [1]

(ii) Name the type of chemical reaction where oxidation and reduction take place simultaneously.

..... [1]

(iii) Calcium carbonate is added to the blast furnace.

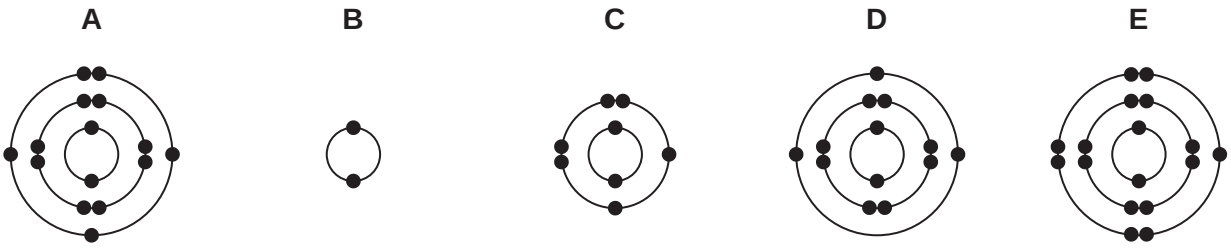
The calcium carbonate undergoes thermal decomposition.

State the meaning of the term thermal decomposition.

.....

..... [2]

6 **(a)** The electronic structures of five atoms, **A**, **B**, **C**, **D** and **E**, are shown.



Answer the following questions about these electronic structures.
Each electronic structure may be used once, more than once or not at all.

State which electronic structure, **A**, **B**, **C**, **D** or **E**, represents:

(v) an atom of the metal that is extracted from bauxite.

..... [1]

7 **(a)** A list of symbols and formulae is shown.

CaO
CH_4
C_2H_4
C_2H_6
Cl^-
Cu^{2+}
H_2
He
K^+
N_2
Na^+
SO_2

Answer the following questions using these symbols or formulae.
Each symbol or formula may be used once, more than once or not at all.

State which symbol or formula represents:

(i) a compound produced by the thermal decomposition of calcium carbonate

..... [1]

8 This question is about acids and bases.

(c) Calcium oxide is lime.

Give **one** use of lime.

..... [1]

9 **(c)** Iron is extracted from iron ore.

(i) Name an ore of iron.

..... [1]

(ii) Iron ore contains iron(III) oxide.
Iron(III) oxide is reduced by carbon monoxide in a blast furnace.

Complete the chemical equation for this reaction.

$$Fe_2O_3 + 3CO \rightarrow .....Fe + ...CO_2$$ [2]

(iii) Calcium carbonate is added to the blast furnace, where it undergoes thermal decomposition.
Calcium oxide is formed.

State the meaning of the term *thermal decomposition*.

.....

..... [2]

(iv) Choose the correct statement about the reaction of calcium oxide in the blast furnace.

Tick (✓) **one** box.

It reacts with carbon monoxide to form slag.	☐
It reacts with carbon to form carbon dioxide and calcium.	☐
It reacts with impurities in the iron ore to form slag.	☐
It catalyses the removal of oxygen from iron(III) oxide.	☐

[1]

(v) State **one** advantage of recycling iron.

..... [1]

Paper 4

Questions are applicable for both core and extended candidates unless indicated in the question

10 Iron ore contains iron(III) oxide, Fe_2O_3. A blast furnace is used to extract iron from Fe_2O_3.

Equations for some of the reactions in the blast furnace are shown.

equation 1 $C + O_2 \rightarrow CO_2$

equation 2 $CaCO_3 \rightarrow CaO + CO_2$

equation 3 $CaO + SiO_2 \rightarrow CaSiO_3$

(a) **Equation 1** shows the combustion of carbon in the blast furnace.

(i) Name the substance which provides the carbon for this reaction.

..... [1]

(ii) State the purpose of the combustion of carbon in the blast furnace.

..... [1]

(b) Iron(III) oxide, Fe_2O_3, in iron ore is converted to iron when it reacts with carbon monoxide, CO, in the blast furnace.

(i) Calculate the percentage by mass of iron in iron(III) oxide, Fe_2O_3.

percentage = ...% [2]

(ii) State the name of the iron ore which consists mainly of iron(III) oxide.

..... [1]

(iii) Describe how carbon monoxide is formed in the blast furnace.

..... [1]

(iv) Write the symbol equation to show the reaction that occurs when iron(III) oxide is converted to iron in the blast furnace. **(extended only)**

..... [2]

(v) Name the chemical process which happens to iron when iron(III) oxide is converted to iron in the blast furnace.

..... [1]

(c) State the type of reaction shown by **equation 2**.

..... [1]

(d) **(i)** Explain why the reaction in **equation 3** can be described as an acid–base reaction.

.....

.....

..... [2]

(ii) State:

- the chemical name of SiO_2 **(extended only)**

.....

- the common name given to $CaSiO_3$ when it is formed in the blast furnace. **(extended only)**

.....

[2]

(e) Aluminium **cannot** be extracted from its ore using a blast furnace.

(i) State why aluminium is **not** extracted from its ore using a blast furnace. **(extended only)**

..... [1]

(ii) Name the process used to extract aluminium from its ore. **(extended only)**

..... [1]

(f) Both iron(III) oxide and aluminium oxide contain metal ions with a 3+ charge.

(i) Write the electronic configuration of an Al^{3+} ion.

..... [1]

(ii) Deduce the number of protons and electrons in an Fe^{3+} ion.

protons	electrons

[2]

[Total: 19]

11 This question is about the first 30 elements in the Periodic Table.

Name the element which:

(c) is extracted from hematite ..... [1]

12 A list of substances is shown.

aluminium oxide	**carbon dioxide**	**chlorine**	**diamond**	**ethanol**
glucose	**iron(III) oxide**	**limestone**	**nitrogen**	**oxygen**

Answer the questions using the list of substances.

Each substance may be used once, more than once or not at all.

State which of the substances:

(b) is the main constituent of bauxite **(extended only)**

..... [1]

13 Boron and aluminium are Group III elements.

(c) Aluminium is extracted from its purified ore as shown in Fig. 2.1.

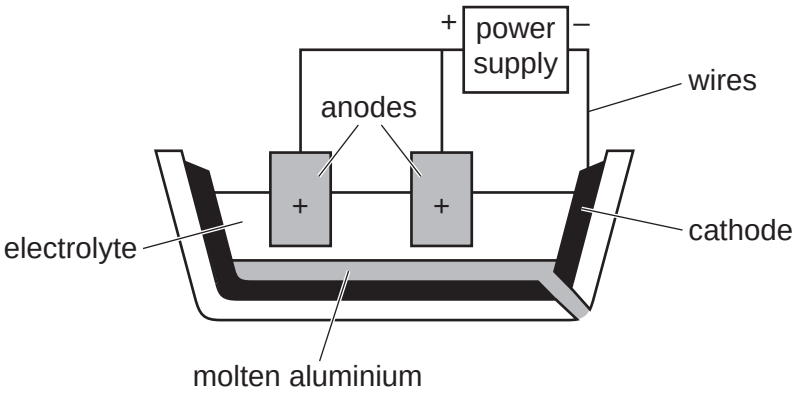


Fig. 2.1

(i) Name the ore of aluminium. **(extended only)**

..... [1]

(ii) The electrolyte contains aluminium oxide and one other substance.

Name the other substance and explain why it is used. **(extended only)**

name .....

explanation .....

.....

[2]

(iii) Write the ionic half-equation for the reaction at the cathode. **(extended only)**

..... [2]

(iv) Explain why the anodes need frequent replacement. **(extended only)**

.....

..... [2]

14 This question is about electricity and chemical reactions.

(b) Bauxite is an ore containing aluminium.
Aluminium is extracted by electrolysis of purified bauxite in molten cryolite using carbon electrodes.

(i) Name the aluminium compound in purified bauxite. **(extended only)**

..... [1]

(ii) State **two** reasons why cryolite is used in this electrolysis. **(extended only)**

1 .....

2 .....
[2]

(iii) The anode is made from carbon.

Explain why the carbon anode has to be replaced regularly. **(extended only)**

.....

..... [1]