

CAIE Chemistry IGCSE

9.6 Extraction of metals

Flashcards

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Where are most metals extracted from?



Where are most metals extracted from?

From ores found in the Earth's crust.



What is an ore?



What is an ore?

A rock which contains metals, often chemically combined with other substances.



Which metals are found in the Earth's crust as uncombined elements?



Which metals are found in the Earth's crust as uncombined elements?

Unreactive metals such as gold



Most ores contain metals chemically combined with oxygen. What process must be carried out to extract the metal?



Most ores contain metals chemically combined with oxygen. What process must be carried out to extract the metal?

Reduction



Which two methods could be used to extract metals from their ores?



How can metals be extracted from their ores?

Reduction with carbon: Can only be done if the metal is less reactive than carbon in the reactivity series

Electrolysis: Can be done with all metals, but requires a large amount of energy (high cost).



How can iron be extracted from its oxide,
hematite?



How can iron be extracted from its oxide, hematite?

Iron is less reactive than carbon so can be extracted by reduction with carbon.



What is used to extract iron from its oxide, hematite?



What is used to extract iron from its oxide, hematite?

Hematite, coke, limestone and air, in a blast furnace

Hematite: made up of iron (III) oxide Fe_2O_3

Coke: Coal based fuel with a high carbon content

Limestone: Calcium carbonate CaCO_3 used to remove any acidic impurities from the iron



What is the purpose of burning coke (carbon) in the extraction of iron?



What is the purpose of burning coke (carbon) in the extraction of iron?

- Hot air enters through the bottom of the furnace and moves to the top.
- At the bottom of the furnace, the coke burns in the hot air producing carbon dioxide, an exothermic reaction that releases heat to keep the furnace hot.
- Carbon + Oxygen \rightarrow Carbon dioxide



How is carbon monoxide produced in the extraction of iron?



How is carbon monoxide produced in the extraction of iron?

- The carbon dioxide produced from the burning of coke reacts further with the coke to form carbon monoxide
- Carbon dioxide + Carbon \rightarrow Carbon monoxide



How is iron produced using carbon monoxide in the extraction of iron?



How is iron produced using carbon monoxide in the extraction of iron?

- The carbon monoxide reduces iron (III) oxide (hematite) to iron in a redox reaction
- Iron (III) oxide + Carbon monoxide \rightarrow Iron + Carbon dioxide
- The pure iron flows to the bottom of the blast furnace to be removed.



What is the purpose of limestone in the extraction of iron?



What is the purpose of limestone in the extraction of iron?

- The hematite contains other impurities like sand (silicon (IV) oxide), so limestone (calcium carbonate CaCO_3) is added to help remove these impurities
- CaCO_3 thermal decomposes from the heat in the blast furnace into calcium oxide
- Calcium carbonate \rightarrow Calcium oxide + Carbon dioxide
- The calcium oxide reacts with the silicon (IV) oxide to form a 'slag' :calcium silicate.
- Calcium oxide + Silicon (IV) oxide \rightarrow Calcium silicate



What is the main ore that aluminium is extracted from called?



What is the main ore that aluminium is extracted from called?

Bauxite



How can aluminium be extracted from its ore?



How can aluminium be extracted from its ore?

Aluminium is more reactive than carbon so electrolysis must be used.

When the molten ore undergoes electrolysis, the pure metal forms at the cathode.

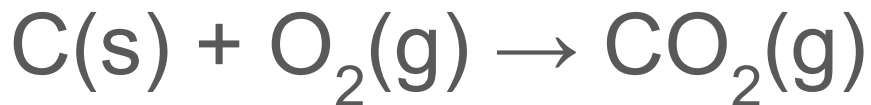


Give the symbol equation for the burning
of carbon (coke) in the extraction of iron
(extended only)



Give the symbol equation for the burning of carbon (coke) in the extraction of iron (**extended only**)

Carbon + Oxygen → Carbon dioxide



Give the symbol equation for the
reduction of carbon dioxide to carbon
monoxide in the extraction of iron
(extended only)



Give the symbol equation for the reduction of carbon dioxide to carbon monoxide in the extraction of iron
(extended only)

Carbon dioxide + Carbon \rightarrow Carbon monoxide
 $\text{CO}_2(\text{g}) + \text{C}(\text{s}) \rightarrow 2\text{CO}(\text{g})$

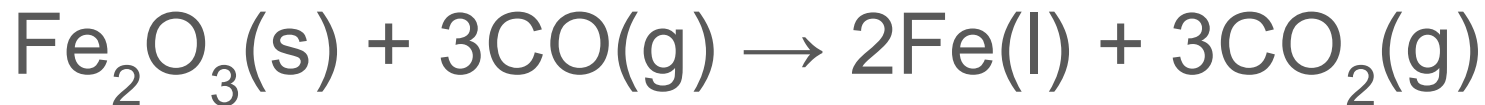


Give the symbol equation for the
reduction of iron (III) oxide by carbon
monoxide in the extraction of iron
(extended only)



Give the symbol equation for the reduction of iron (III) oxide by carbon monoxide in the extraction of iron (**extended only**)

Iron (III) oxide + Carbon monoxide \rightarrow Iron + Carbon dioxide



Give the symbol equation for the thermal decomposition of limestone in the extraction of iron
(extended only)



Give the symbol equation for the thermal decomposition of limestone in the extraction of iron
(extended only)

Limestone is calcium carbonate CaCO_3

Calcium carbonate \rightarrow Calcium oxide + Carbon dioxide

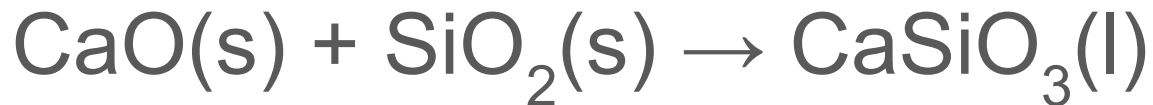


Give the symbol equation for the
formation of slag in the extraction of iron
(extended only)



Give the symbol equation for the formation of slag in the extraction of iron (**extended only**)

Calcium oxide + Silicon (IV) oxide \rightarrow Calcium silicate (slag)



When aluminium is extracted from aluminium oxide, why is it first dissolved in molten cryolite?
(extended only)



When aluminium is extracted from aluminium oxide, why is it first dissolved in molten cryolite?

(extended only)

Aluminium oxide has a very high melting point. It is dissolved in molten cryolite to reduce the melting point of the electrolyte, reducing energy usage and cost.



What are the electrodes for the
electrolysis of aluminium oxide made
from?
(extended only)



What are the electrodes for the electrolysis of aluminium oxide made from? (extended only)

The electrodes are made from graphite (carbon)



Why does the anode for the electrolysis
of aluminium oxide need to be regularly
replaced?
(extended only)



Why does the anode for the electrolysis of aluminium oxide need to be regularly replaced? (extended only)

- During electrolysis oxide ions lose electrons at the anode, become oxidised and form oxygen molecules
- The carbon the anodes are made from reacts with the oxygen to form carbon dioxide which bubbles away, so the anodes have to be replaced regularly.



What occurs at the cathode during the electrolysis of aluminium oxide? Include the ionic half equation (extended only)



What occurs at the cathode during the electrolysis of aluminium oxide? Include the ionic half equation
(extended only)

Cathode - Al^{3+} ions gain electrons to form aluminium atoms, becoming reduced.

The half equation is $\text{Al}^{3+} + 3\text{e}^{-} \rightarrow \text{Al}$.



What occurs at the cathode during the electrolysis of aluminium oxide? Include the ionic half equation (extended only)



What occurs at the anode during the electrolysis of aluminium oxide? Include the ionic half equation
(extended only)

Anode - O^{2-} ions loses electrons to form oxygen, becoming oxidised.

The half equation is $2\text{O}^{2-} - 4\text{e}^{-} \rightarrow \text{O}_2$

