

1 Iron is a transition element.

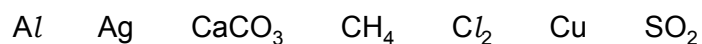
Describe how iron is converted to steel.  
In your answer, refer to basic oxides and oxygen.

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

[3]

[Total: 3]

2 The following formulae represent different substances.



State which of these substances is added to a blast furnace to remove impurities during the production of iron.

.....

[1]

[Total: 1]

3 This question is about the elements in Period 3 of the Periodic Table.

Na	Mg	Al	Si	P	S	Cl	Ar
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State which Period 3 element is extracted from the ore bauxite.

.....

[1]

[Total: 1]

- 4 Iron is extracted from hematite in the blast furnace.

The hematite contains silicon(IV) oxide (sand) as an impurity.

What reacts with this impurity to remove it?

- A calcium oxide
- B carbon
- C carbon dioxide
- D slag

[1]

[Total: 1]

- 5 Iron can be extracted from iron ore by reduction with carbon in a blast furnace.

Explain why iron is extracted by reduction with carbon and **not** by electrolysis. Refer to the position of iron in the reactivity series in your answer.

.....

.....

[1]

[Total: 1]

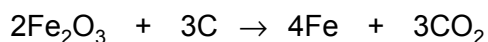
- 6 Iron can be extracted from iron ore by reduction with carbon in a blast furnace.

- (a) Which **one** of these substances is an ore of iron?  
Draw a circle around the correct answer.

**bauxite      graphite      hematite      limestone**

[1]

- (b) The equation shows one of the reactions occurring in the blast furnace.



How does this equation show that  $\text{Fe}_2\text{O}_3$  is reduced?

.....

.....

[1]

[Total: 2]

- 7 Aluminium oxide is a compound present in aluminium ore.

(a) Name an ore which contains aluminium oxide.

..... [1]

(b) Predict the products of the electrolysis of molten aluminium oxide at:

the positive electrode .....

the negative electrode ..... [2]

(c) Suggest why aluminium is extracted by electrolysis and **not** by reduction with carbon.

..... [1]

[Total: 4]

8 The names of eight substances are given.

aluminium oxide      calcium oxide      ethanol      nitrogen

iron(III) oxide      methane      oxygen      silicon(IV) oxide

State which substance is the main constituent of bauxite.

..... [1]

[Total: 1]

9 Period 3 of the Periodic Table is shown.

sodium	magnesium	aluminium	silicon	phosphorus	sulfur	chlorine	argon
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Answer the following questions using only these elements.

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

State which element:

(a) is a gas at room temperature and pressure

..... [1]

(b) forms a basic oxide with a formula of the form  $X_2O$

..... [1]

(c) is made of atoms which have a full outer shell of electrons

..... [1]

(d) forms an oxide which causes acid rain

..... [1]

(e) is extracted from bauxite

..... [1]

(f) forms an oxide which has a macromolecular structure

..... [1]

(g) consists of diatomic molecules.

..... [1]

[Total: 7]

10 The iron extracted from hematite using a blast furnace is impure.

Identify the main impurity in this iron and explain how it is removed in the steel-making process.

main impurity.....

how it is removed.....

.....

..... [3]

[Total: 3]

11 Three of the raw materials added to a blast furnace used to extract iron from hematite are coke, hematite and limestone.

Name **one** other raw material added to the blast furnace.

..... [1]

[Total: 1]

12 A series of reactions occurs in a blast furnace during the extraction of iron from hematite.

Describe these reactions.

Include:

- **one** chemical equation for the reduction of hematite
- **one** chemical equation for the formation of slag.

.....

.....

.....

.....

.....

.....

.....

.....

.....

[5]

[Total: 5]

13 Siderite is an ore of iron.

(a) State the name of **one** other ore of iron.

..... [1]

(b) Siderite contains mainly iron(II) carbonate.

Describe how to show that siderite contains a carbonate.

.....

.....

..... [3]

[Total: 4]

- 14** Iron from a blast furnace is treated with oxygen and with calcium oxide to make steel.

Which substances in the iron are removed?

	oxygen removes	calcium oxide removes
<b>A</b>	carbon	acidic oxides
<b>B</b>	carbon	basic oxides
<b>C</b>	iron	acidic oxides
<b>D</b>	iron	basic oxides

[1]

[Total: 1]

- 15** One source of sulfur dioxide is burning sulfur in air.  
Describe how sulfur dioxide can be made from the ore zinc sulfide.

.....

..... [2]

[Total: 2]

- 16** Iron from a blast furnace contains carbon, sulfur, silicon and phosphorus as impurities.

Phosphorus is converted to phosphorus(V) oxide.  
Phosphorus(V) oxide is a solid.  
Explain how this oxide is removed from the molten iron.

.....

.....

..... [3]

[Total: 3]

17 Two industrial processes that involve heating are

- extracting iron from its ore using a blast furnace,
- making lime.

In which of these processes is calcium carbonate used?

	extracting iron	making lime
<b>A</b>	✓	✓
<b>B</b>	✓	x
<b>C</b>	x	✓
<b>D</b>	x	x

[1]

[Total: 1]

18 Titanium is extracted from an ore called rutile. Rutile is an impure form of titanium(IV) oxide,  $\text{TiO}_2$ .

Rutile is mixed with coke and heated in a furnace through which chlorine gas is passed. The product is gaseous titanium(IV) chloride,  $\text{TiCl}_4$ .

Titanium(IV) chloride,  $\text{TiCl}_4$ , is heated with an excess of magnesium, in an atmosphere of argon.

After titanium(IV) chloride is heated with magnesium, the unreacted magnesium is removed by adding an excess of dilute hydrochloric acid to the mixture.

The dilute hydrochloric acid also dissolves the magnesium chloride.

The dilute hydrochloric acid does **not** react with the titanium or dissolve it.

(a) Give **two** observations and write a chemical equation for the reaction that occurs when dilute hydrochloric acid reacts with magnesium.

1 .....

2 .....

chemical equation ..... [3]

(b) Name the process that is used to separate the titanium from the mixture after all the magnesium has been removed.

..... [1]

- (c) Titanium does not react with the dilute hydrochloric acid or dissolve in it.

Suggest why titanium does **not** react with dilute hydrochloric acid.

..... [1]

[Total: 5]

- 19 Titanium is extracted from an ore called rutile. Rutile is an impure form of titanium(IV) oxide,  $\text{TiO}_2$ .

Rutile is mixed with coke and heated in a furnace through which chlorine gas is passed. The product is gaseous titanium(IV) chloride,  $\text{TiCl}_4$ .

Titanium(IV) chloride is heated with an excess of magnesium, in an atmosphere of argon.

- (a) Balance the chemical equation for the reaction.



- (b) Titanium(IV) chloride can be reacted with sodium instead of magnesium.

The reaction between titanium(IV) chloride and sodium is similar to the reaction between titanium(IV) chloride and magnesium.

Write a chemical equation for the reaction between titanium(IV) chloride and sodium.

..... [1]

- (c) Suggest why the reaction between titanium(IV) chloride and magnesium is done in an atmosphere of argon and **not** in air.

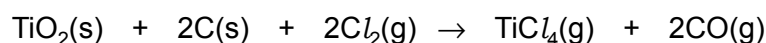
.....

..... [1]

[Total: 3]

- 20 Titanium is extracted from an ore called rutile. Rutile is an impure form of titanium(IV) oxide,  $\text{TiO}_2$ .

Rutile is mixed with coke and heated in a furnace through which chlorine gas is passed. The product is gaseous titanium(IV) chloride,  $\text{TiCl}_4$ .



The gaseous titanium(IV) chloride produced is condensed into the liquid state. The titanium(IV) chloride is then separated from liquid impurities.

- (a) Suggest the name of the process by which liquid titanium(IV) chloride could be separated from the liquid impurities.

..... [1]



(b) Carbon monoxide, CO(g), is also produced in the reaction.

Why should carbon monoxide **not** be released into the atmosphere?

..... [1]

[Total: 2]

21 Tin is a metallic element in Group IV. Its main ore is cassiterite which is an impure form of tin(IV) oxide, SnO<sub>2</sub>.  
Tin also occurs in stannite, Cu<sub>2</sub>FeSnS<sub>4</sub>.

(a) Calculate the relative formula mass,  $M_r$ , of Cu<sub>2</sub>FeSnS<sub>4</sub>.

$M_r$  of Cu<sub>2</sub>FeSnS<sub>4</sub>..... [1]

(b) The  $M_r$  of SnO<sub>2</sub> is 151.

Calculate the percentage of tin by mass in SnO<sub>2</sub>.

percentage of tin by mass in SnO<sub>2</sub>..... [1]

(c) The percentage of tin by mass in Cu<sub>2</sub>FeSnS<sub>4</sub> is 27.6 %.

Use this information and your answer to (b) to suggest whether it would be better to extract tin from SnO<sub>2</sub> or Cu<sub>2</sub>FeSnS<sub>4</sub>.  
Explain your answer.

.....  
..... [1]

[Total: 3]

22 Aluminium is extracted from its ore by electrolysis.

(a) Name the main ore of aluminium.

..... [1]

(b) Why is aluminium **not** extracted from its ore by reduction with carbon?

..... [1]

(c) The main ore of aluminium contains aluminium oxide. Aluminium oxide is dissolved in molten cryolite before it is electrolysed.

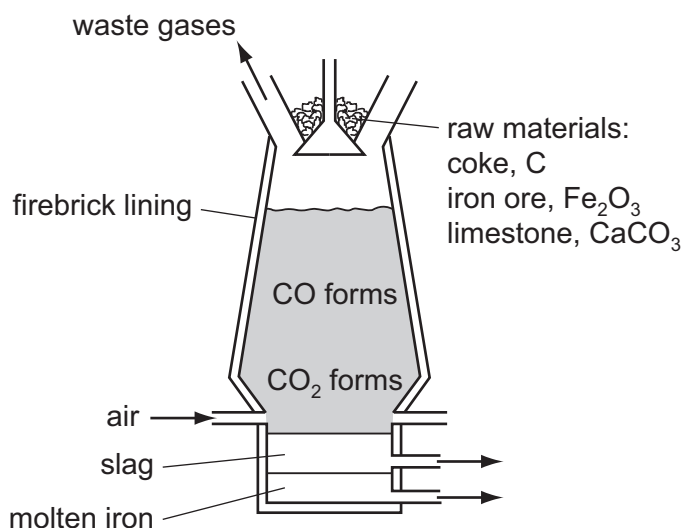
Give **two** reasons, other than cost, why cryolite is used.

1.....

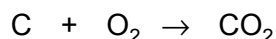
2..... [2]

[Total: 4]

**23** Iron is extracted from the ore hematite in the Blast Furnace.



The coke reacts with the oxygen in the air to form carbon dioxide.



(a) Explain why carbon monoxide is formed higher in the Blast Furnace.

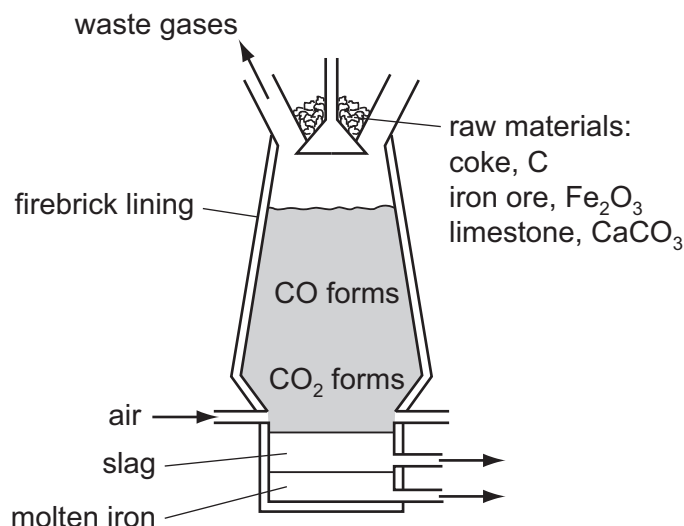
..... [2]

(b) Write an equation for the reduction of hematite, Fe<sub>2</sub>O<sub>3</sub>, by carbon monoxide.

..... [2]

[Total: 4]

**24** Iron is extracted from the ore hematite in the Blast Furnace.



- (a) Limestone decomposes to form two products, one of which is calcium oxide. Name the other product.

..... [1]

- (b) Calcium oxide reacts with silicon(IV) oxide, an acidic impurity in the iron ore, to form slag. Write an equation for this reaction.

..... [2]

- (c) Explain why the molten iron and the molten slag form two layers and why molten iron is the lower layer.

.....  
 ..... [2]

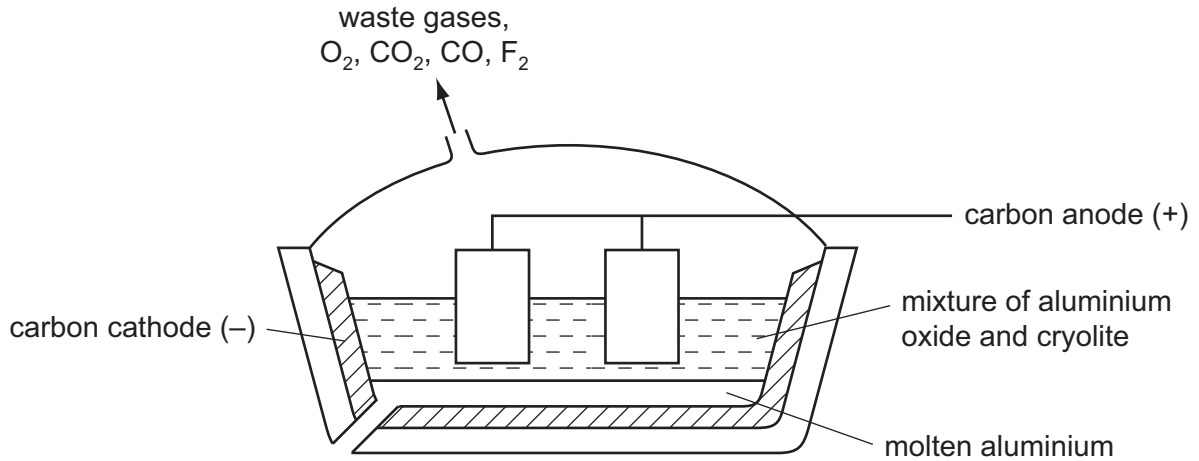
- (d) Suggest why the molten iron does **not** react with the air.

..... [1]

[Total: 6]

- 25 Aluminium is obtained by the reduction of aluminium ions to aluminium atoms.

In the modern method of extraction, aluminium is obtained by the electrolysis of aluminium oxide (alumina) dissolved in molten cryolite,  $\text{Na}_3\text{AlF}_6$ .



(a) The major ore of aluminium is impure aluminium oxide.  
What is the name of this ore?

..... [1]

(b) This ore is a mixture of aluminium oxide, which is amphoteric, and iron(III) oxide which is basic.

Explain how these two oxides can be separated by the addition of aqueous sodium hydroxide.

.....  
 .....  
 ..... [2]

(c) Give **two** reasons why the electrolyte contains cryolite.

.....  
 .....  
 ..... [2]

[Total: 5]

26 Zinc is obtained from the ore, zinc blende, ZnS.

Describe the extraction of zinc from its ore, zinc blende. Include at least one balanced equation in your description.

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

[5]

[Total: 5]