(v) During electroplating, it is necessary to add more chromium(III) sulfate but during copper plating using a copper anode, it is not necessary to add more copper(II) sulfate.
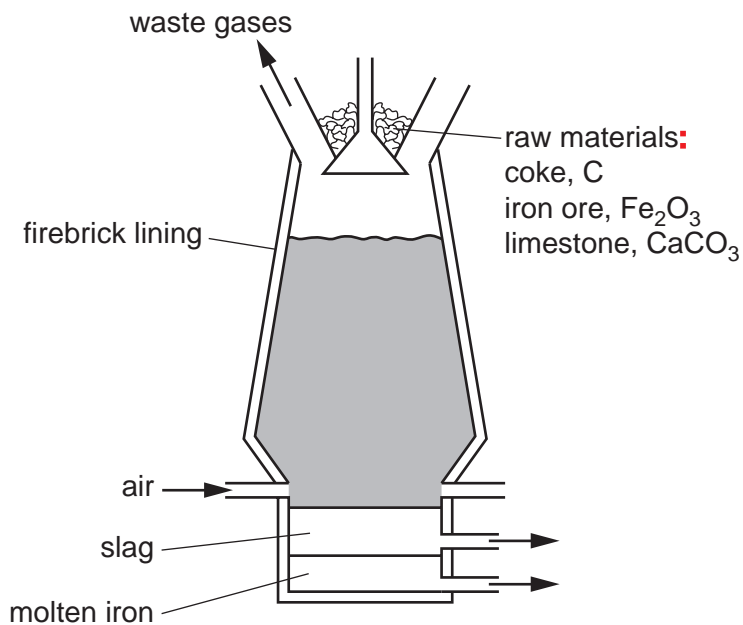
Explain this difference.

....

....

.... [2]

[Total: 12]

2   Iron is extracted from its ore, hematite, in the blast furnace.

Describe the reactions involved in this extraction.

Include one equation for a redox reaction and one for an acid/base reaction.

....

....

....

....

....

....

....

....

....

.... [5]

[Total: 5]

3 Gallium is a metallic element in Group III. It has similar properties to aluminium.

(a) (i) Describe the structure and bonding in a metallic element.
You should include a labelled diagram in your answer.

....

.... [3]

(ii) Explain why metallic elements such as gallium are good conductors of electricity.

.... [1]

(b) Give the formula of

gallium(III) chloride, ...

gallium(III) sulfate. ....
[2]

(c) Gallium(III) oxide, Ga_2O_3, is amphoteric.

(i) Write the chemical equation for the reaction between gallium(III) oxide and dilute nitric acid to form a salt and water only.

.... [2]

(ii) The reaction between gallium(III) oxide and sodium hydroxide solution forms only water and a salt containing the negative ion $Ga_2O_4^{2-}$.

Write the chemical equation for this reaction.

.... [2]

(d) Alloys of gallium and other elements are often more useful than the metallic element itself.

Suggest **two** reasons why alloys of gallium are more useful than the metallic element.

....

.... [2]

[Total: 12]

4 Zinc is extracted from an ore called zinc blende, which consists mainly of zinc sulfide, ZnS.

(a) (i) The zinc sulfide in the ore is first converted into zinc oxide.

Describe how zinc oxide is made from zinc sulfide.

....

.... [1]

(ii) Write a chemical equation for the reaction in **(a)(i)**.

.... [2]

(b) Zinc oxide is converted into zinc. Zinc oxide and coke are fed into a furnace. Hot air is blown into the bottom of the furnace.

Zinc has a melting point of $420\,°C$ and a boiling point of $907\,°C$. The temperature inside the furnace is over $1000\,°C$.

(i) Explain how zinc oxide is converted into zinc. Your answer should include details of how the heat is produced and equations for all the reactions you describe.

....

....

....

....

.... [3]

(ii) Explain why the zinc produced inside the furnace is a gas.

.... [1]

(iii) State the name of the physical change for conversion of gaseous zinc into molten zinc.

.... [1]

(c) Rusting of steel can be prevented by coating the steel with a layer of zinc.

Explain, in terms of electron transfer, why steel does **not** rust even if the layer of zinc is scratched so that the steel is exposed to air and water.

....

....

....

....

.... [4]

(d) When a sample of steel is added to dilute hydrochloric acid, an aqueous solution of iron(II) chloride, $FeCl_2$, is formed.

When a sample of rust is added to dilute hydrochloric acid, an aqueous solution of iron(III) chloride, $FeCl_3$, is formed.

(i) Aqueous sodium hydroxide is added to the solutions of iron(II) chloride and iron(III) chloride.

Complete the table below, showing the observations you would expect to make.

	iron(II) chloride solution	iron(III) chloride solution
aqueous sodium hydroxide		

[2]

Solutions of iron(II) chloride and iron(III) chloride were added to solutions of potassium iodide and acidified potassium manganate(VII). The results are shown in the table.

	iron(II) chloride solution	iron(III) chloride solution
potassium iodide solution	no change	solution turns from colourless to brown
acidified potassium manganate(VII) solution	solution turns from purple to colourless	no change

(ii) What **types** of substance cause potassium iodide solution to turn from colourless to brown?

.... [1]

(iii) What **types** of substance cause acidified potassium manganate(VII) solution to turn from purple to colourless?

.... [1]

(iv) Which **ion** in iron(III) chloride solution causes potassium iodide solution to turn from colourless to brown?

.... [1]
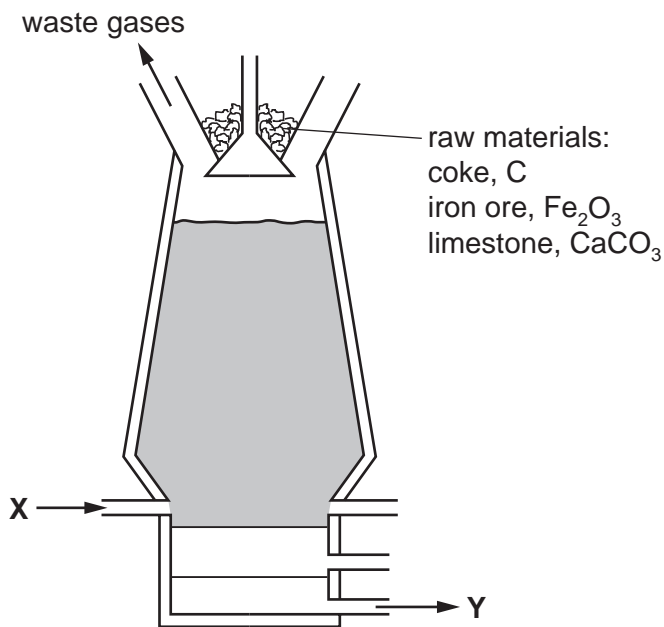
(v) Which **ion** in iron(II) chloride solution causes acidified potassium manganate(VII) solution to turn from purple to colourless?

.... [1]

[Total: 18]

5 The diagram shows a blast furnace.

(a) The following equations represent reactions which take place in the blast furnace.

A $C + O_2 \rightarrow CO_2$

B $CaCO_3 \rightarrow CaO + CO_2$

C $CaO + SiO_2 \rightarrow CaSiO_3$

D $CO_2 + C \rightarrow 2CO$

E $Fe_2O_3 + 3CO \rightarrow 2Fe + 3CO_2$

(i) Which reaction is used to increase the temperature inside the blast furnace? .... [1]

(ii) Which reaction is an example of thermal decomposition? .... [1]

(iii) In which reaction is carbon both oxidised and reduced? .... [1]

(iv) Which equation shows the removal of an impurity from the iron? .... [1]

(v) Which equation shows the reaction of an acidic substance with a basic substance?

.... [1]

(b) Use the diagram of the blast furnace to help you answer these questions.

(i) What enters the blast furnace at **X**?

.... [1]

(ii) What leaves the blast furnace at **Y**?

.... [1]

(iii) Name **two** waste gases that leave the blast furnace.

1. ....

2. ....

[2]

(c) The graph shows how the malleability of iron changes as the percentage of carbon in the iron changes.
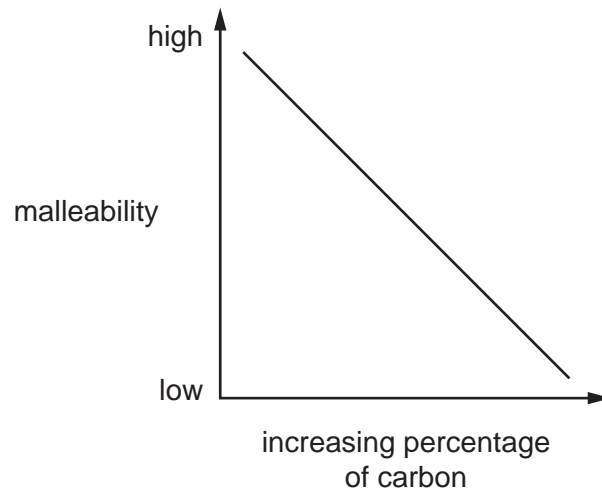
(i) Describe how the malleability of iron changes as the percentage of carbon changes.

....

.... [1]

(ii) Iron obtained from the blast furnace contains high levels of carbon.

Explain how the amount of carbon in the iron can be decreased.

....

....

.... [2]

[Total: 12]