1 An ore of copper is the mineral, chalcopyrite. This is a mixed sulphide of iron and copper.

(a) Analysis of a sample of this ore shows that 13.80 g of the ore contained 4.80 g of copper, 4.20 g of iron and the rest sulphur.
Complete the table and calculate the empirical formula of chalcopyrite.

	copper	iron	sulphur
composition by mass / g	4.80	4.20	
number of moles of atoms			
simplest mole ratio of atoms			

[3]

The empirical formula is

..... [1]

(b) Impure copper is extracted from the ore. This copper is refined by electrolysis.

(i) Name;
the material used for the positive electrode (anode),

.....

the material used for the negative electrode (cathode),

.....

a suitable electrolyte.

..... [3]

(ii) Write an ionic equation for the reaction at the negative electrode.

..... [1]

(iii) One use of this pure copper is electrical conductors, another is to make alloys. Name the metal that is alloyed with copper to make brass.

..... [1]

(c) Two of the elements in chalcopyrite are the metal, copper, and the non-metal, sulphur. These have different properties. Copper is an excellent conductor of electricity and is malleable. Sulphur is a poor conductor and is not malleable, it is brittle. Explain, in terms of their structures, why this is so.

difference in electrical conductivity

.....

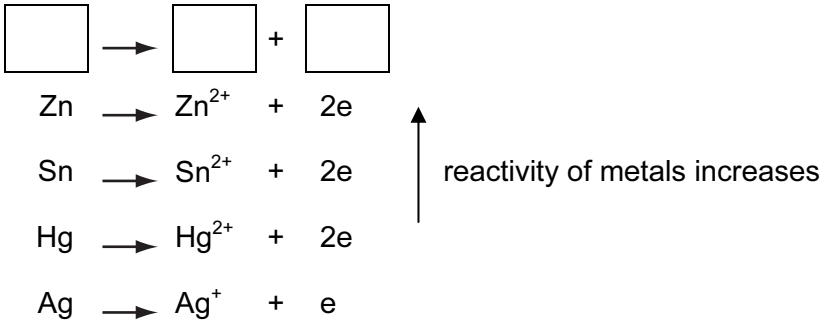
..... [2]

difference in malleability

.....

..... [2]

2 In the following list of ionic equations, the metals are in order of reactivity.



(a) (In the space at the top of the series, write an ionic equation that includes a more reactive metal. [1]

(ii) Define *oxidation* in terms of electron transfer.

.....

[1]

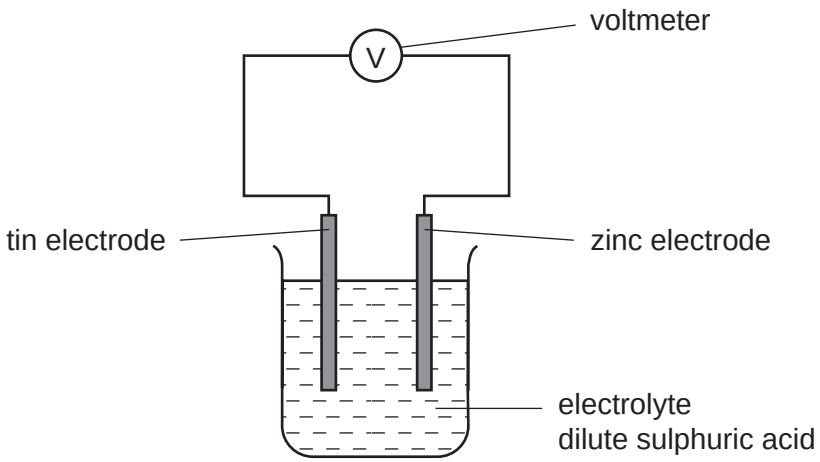
(iii) Explain why the positive ions are likely to be oxidising agents.

[1]

(iv) Which positive ion(s) can oxidise mercury metal (Hg)?

[1]

(b) The following diagram shows a simple cell.



(i) Predict how the voltage of the cell would change if the tin electrode was replaced with a silver one.

[1]

(ii) Which electrode would go into the solution as positive ions? Give a reason for your choice.

[1]

(iii) State how you can predict the direction of the electron flow in cells of this type.

[1]

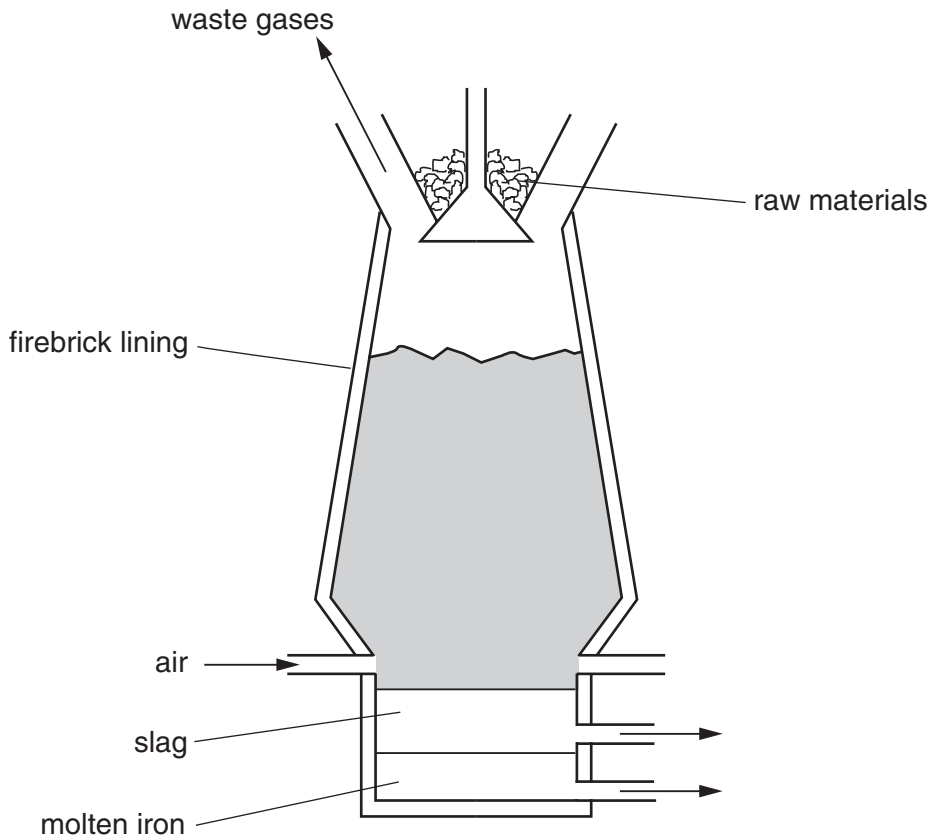
3 No one knows where iron was first isolated. It appeared in China, the Middle East and in Africa. It was obtained by reducing iron ore with charcoal.

(a) Complete the following equation.

$$\underset{\text{iron ore}}{Fe_2O_3} + \underset{\text{charcoal}}{\quad} \rightarrow \text{.....} + \text{.....}$$

[2]

(b) In 1705 Abraham Darby showed that iron ore could be reduced using coke in a blast furnace.



(i) The temperature in the furnace rises to 2000 °C. Write an equation for the exothermic reaction that causes this high temperature.

.....

(ii) In the furnace, the ore is reduced by carbon monoxide. Explain how this is formed.

.....

.....[3]

(c) The formation of slag removes an impurity in the ore. Write a word equation for the formation of the slag.

.....[2]

(d) Stainless steel is an alloy of iron. It contains iron, other metals and about 0.5% of carbon.

(i) State a use of stainless steel.

.....

(ii) Name a metal, other than iron, in stainless steel.

.....

(iii) The iron from the blast furnace is impure. It contains about 5% of carbon and other impurities, such as silicon and phosphorus. Describe how the percentage of carbon is reduced and the other impurities are removed.

.....

.....

.....[6]

(e) One of the methods used to prevent iron or steel from rusting is to electroplate it with another metal, such as tin. Complete the following.

The anode is made of ..... .

The cathode is made of ..... .

The electrolyte is a solution of ..... .

[3]

4 Zinc blende is the common ore of zinc. It is usually found mixed with an ore of lead and traces of silver.

(a) (i) Describe how zinc blende is changed into zinc oxide.

.....

.....[2]

(ii) Write an equation for the reduction of zinc oxide by carbon.

.....[2]

(iii) The boiling point of lead is 1740 °C and that of zinc is 907 °C. Explain why, when both oxides are reduced by heating with carbon at 1400 °C, only lead remains in the furnace.

.....

.....[2]

(b) A major use of zinc is to make diecasting alloys. These contain about 4% of aluminium and they are stronger and less malleable than pure zinc.

(i) Give one other large scale use of zinc.

.....[1]

(ii) Describe the structure of a typical metal, such as zinc, and explain why it is malleable.

.....

.....

.....[3]

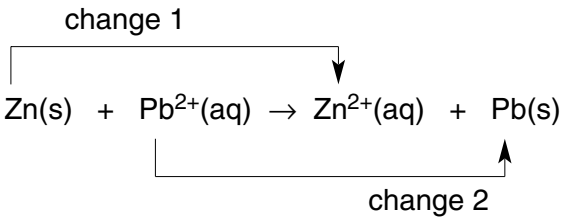
(iii) Suggest why the introduction of a different metallic atom into the structure makes the alloy stronger than the pure metal.

.....

.....[2]

(c) A solution of an impure zinc ore contained zinc, lead and silver(I) ions. The addition of zinc dust will displace both lead and silver.

(i) The ionic equation for the displacement of lead is as follows.



Which change is reduction? Explain your answer.

.....

.....[2]

(ii) Write an ionic equation for the reaction between zinc atoms and silver(I) ions.

.....[2]

5 For over 5000 years copper has been obtained by the reduction of its ores. More recently the metal has been purified by electrolysis.

(a) Copper is used to make alloys.

(i) Give **two** other uses of copper.

.....[2]

(ii) Alloys have similar structures to pure metals. Give a labelled diagram that shows the structure of a typical alloy, such as brass.

[3]

(b) Copper is refined by the electrolysis of aqueous copper(II) sulphate using copper electrodes. Describe the change that occurs at the electrodes.

(i) cathode (pure copper) .....

.....[1]

(ii) anode (impure copper) .....

.....[1]

(iii) Write an ionic equation for the reaction at the cathode.

.....[1]

(iv) If carbon electrodes are used, a colourless gas is given off at the anode and the electrolyte changes from a blue to a colourless solution.

The colourless gas is ..... .

The solution changes into ..... . [2]

(c) Electrolysis and cells both involve chemical reactions and electricity.

What is the essential difference between them?

.....

.....[2]

(d) Copper is an unreactive metal. Its compounds are easily reduced to the metal or decomposed to simpler compounds. Complete the following equations.

(i) ...CuO + ... $\rightarrow$ ...Cu + ...

(ii) Copper(II) hydroxide $\xrightarrow[\text{(heat)}]{}$ ..... + ...

.....

(iii) $Cu(NO_3)_2 \xrightarrow[\text{(heat)}]{}$ ..... + ... + ...

[4]