1 Most metals are extracted in a blast furnace or by electrolysis.

(a) (i) The chemical equations for two reactions that occur during the extraction of aluminium are

A $\underline{Al^{3+}} + 3e^- \rightarrow Al$

B $\underline{C} + O_2 \rightarrow CO_2$

For each of these reactions, complete the table to show whether the underlined species is being oxidised or reduced. In each case, explain your choice.

(3)

Reaction	Species oxidised or reduced	Explanation of choice
A		
B		

(ii) Reaction **A** takes place at the negative electrode during the extraction of aluminium.

Write an ionic half-equation for the reaction at the positive electrode.

(2)

.....

(iii) Reaction **B** gives a waste product during the extraction of aluminium.

What effect does this reaction have on the positive electrodes?

(1)

.....

.....

(iv) Reaction **B** is also important in the extraction of iron in a blast furnace.

Name the raw material that reacts with oxygen and state why the reaction is important.

(2)

Raw material .....

Importance of reaction .....

.....

(b) Galena (PbS) and cerussite ($PbCO_3$) are two ores of lead. A mining company is considering which of these two ores to use for the extraction of lead.

The equations for the reactions occurring are

Process using galena:

$$2PbS + 3O_2 \rightarrow 2PbO + 2SO_2$$

$$2PbO + C \rightarrow 2Pb + CO_2$$

Process using cerussite:

$$PbCO_3 \rightarrow PbO + CO_2$$

$$2PbO + C \rightarrow 2Pb + CO_2$$

(i) Both processes form carbon dioxide, which the mining company hopes to sell.

Complete the table to show **two** uses of carbon dioxide and a property on which each use depends.

(4)

Use	Property

(ii) One disadvantage of using galena is that the sulfur dioxide produced can cause acid rain.

Write a chemical equation to show the formation of an acidic solution from sulfur dioxide and state one effect of acid rain.

(2)

Equation .....

Effect .....

.....

(c) The company uses a sample of cerussite containing 500 g of $PbCO_3$

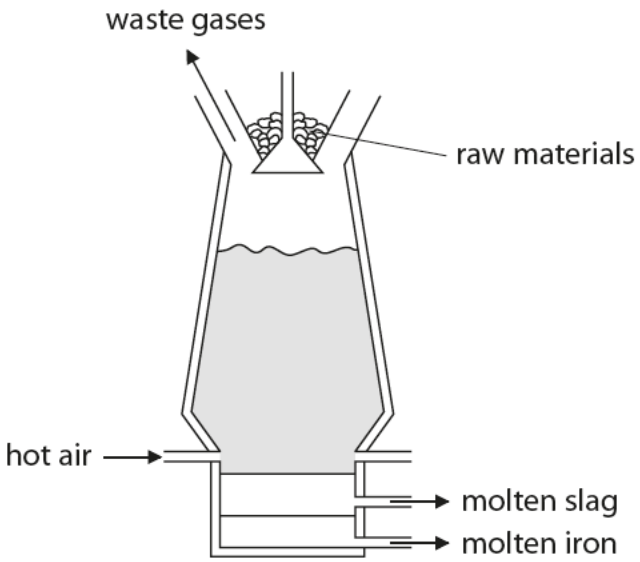
Calculate the maximum mass of lead that can be obtained from this sample of cerussite.

(3)

Mass of lead = ... g

(Total for Question 1 = 17 marks)

2 Iron is extracted from its ore using a blast furnace.



(a) The iron ore is mixed with two other raw materials and put into the top of the furnace.

Give the names of the two other raw materials.

(2)

1 .....

2 .....

(b) The most common ore used is haematite, which contains iron(III) oxide, Fe_2O_3

The oxide is converted into iron by reaction with carbon monoxide, CO

(i) Write a chemical equation for the reaction between iron(III) oxide and carbon monoxide.

(2)

.....

(ii) Explain which element is reduced in this reaction.

(2)

.....

.....

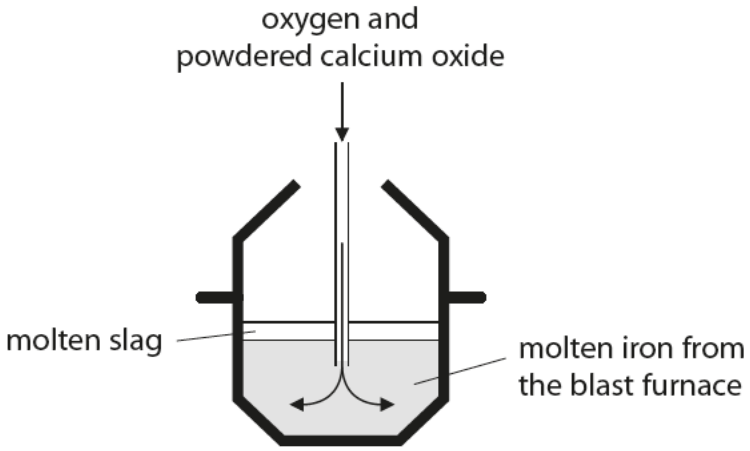
.....

.....

(c) The iron from the blast furnace contains about 10% by mass of impurities.

Two of the impurities are carbon and silicon.

The diagram shows a method of decreasing the amounts of carbon and silicon in the iron.



The oxygen converts carbon and silicon into their oxides.

The carbon dioxide escapes as a gas. Silicon dioxide reacts with the calcium oxide to form molten slag.

(i) Write a chemical equation for the reaction between carbon and oxygen to form carbon dioxide.

(1)

.....

(ii) The equation for the reaction between silicon dioxide and calcium oxide to form slag is

$$SiO_2(s) + CaO(s) \rightarrow CaSiO_3(l)$$

What type of reaction is this?

(1)

☒ **A** combustion

☒ **B** decomposition

☒ **C** neutralisation

☒ **D** redox

(d) One problem with using iron is rusting.

(i) Name the two substances that must be present for iron to rust.

(2)

1 .....

2 .....

(ii) One method of preventing iron from rusting is to paint it.

State how this method of rust prevention works.

(1)

.....

.....

(e) Iron can also be protected from rusting by coating it with zinc.

(i) Give the name of this type of protection.

(1)

.....

(ii) Explain how this method of protection works, even when the surface of the zinc is scratched to expose the iron underneath.

(2)

.....

.....

.....

.....

(f) Aluminium is extracted from its oxide using electrolysis.

(i) Why is aluminium **not** extracted by heating its oxide with carbon monoxide?

(1)

.....

.....

(ii) Why is iron **not** extracted from its oxide using electrolysis?

(1)

.....

.....

(Total for Question 2 = 16 marks)

3 This question is about the insoluble salt lead(II) bromide.

(a) A student uses the precipitation method to prepare lead(II) bromide.

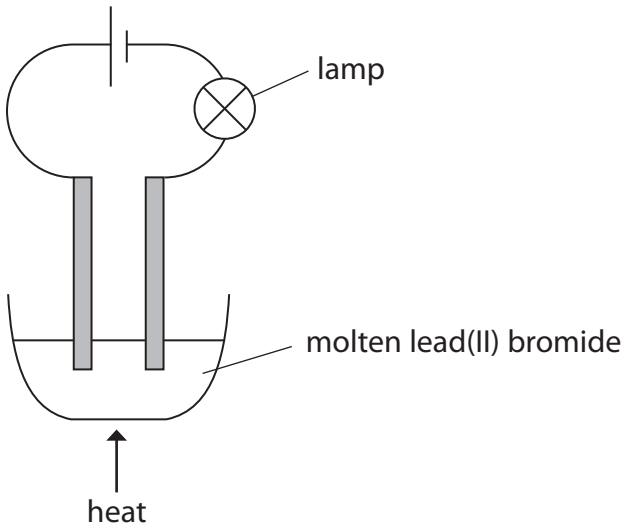
The equation for the reaction she uses is

$$Pb(NO_3)_2(aq) + 2NaBr(aq) \rightarrow PbBr_2(s) + 2NaNO_3(aq)$$

Describe how she could use solutions of lead(II) nitrate and sodium bromide to obtain a pure, dry sample of lead(II) bromide.

(5)

(b) The student's teacher uses this apparatus to electrolyse a pure sample of molten lead(II) bromide.



The student records these observations.

a small blob of a silvery liquid appears at one electrode

a brown substance forms at the other electrode

the lamp stops working soon after the teacher stops heating the lead(II) bromide

(i) Which is the correct statement about this electrolysis?

(1)

☒ **A** the brown substance is bromide

☒ **B** the products are both elements

☒ **C** the silvery liquid forms at the positive electrode

☒ **D** the silvery liquid is molten lead(II) bromide

(ii) The student writes this half-equation to show the reaction in which the brown substance forms.

$$2Br^- + 2e^- \rightarrow 2Br$$

Identify the two mistakes in her half-equation.

(2)

1 .....

.....

2 .....

.....

(iii) Explain why the lamp stops working after the teacher stops heating the lead(II) bromide.

(1)

.....

.....

.....

(Total for Question 3 = 9 marks)