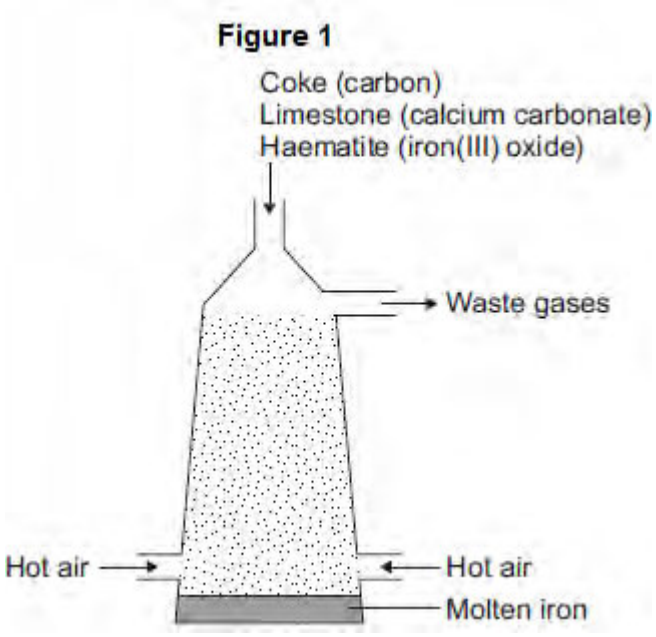
**Q1.** This question is about iron and aluminium.

(a) Iron is extracted in a blast furnace. **Figure 1** is a diagram of a blast furnace.

**Figure 1**




(i) Calcium carbonate decomposes at high temperatures.

Complete the word equation for the decomposition of calcium carbonate.

calcium carbonate $\longrightarrow$ ..... +

.....

**(2)**

(ii) Carbon burns to produce carbon dioxide.

The carbon dioxide produced reacts with more carbon to produce carbon monoxide.

Balance the equation.

$$C(s) + CO_2(g) \longrightarrow \text{.....} CO(g)$$

**(1)**

(iii) Carbon monoxide reduces iron(III) oxide:

$$Fe_2O_3(s) + 3\,CO(g) \longrightarrow 2\,Fe(s) + 3\,CO_2(g)$$

Calculate the maximum mass of iron that can be produced from 300 tonnes of iron(III) oxide.

Relative atomic masses ($A_r$): O = 16; Fe = 56

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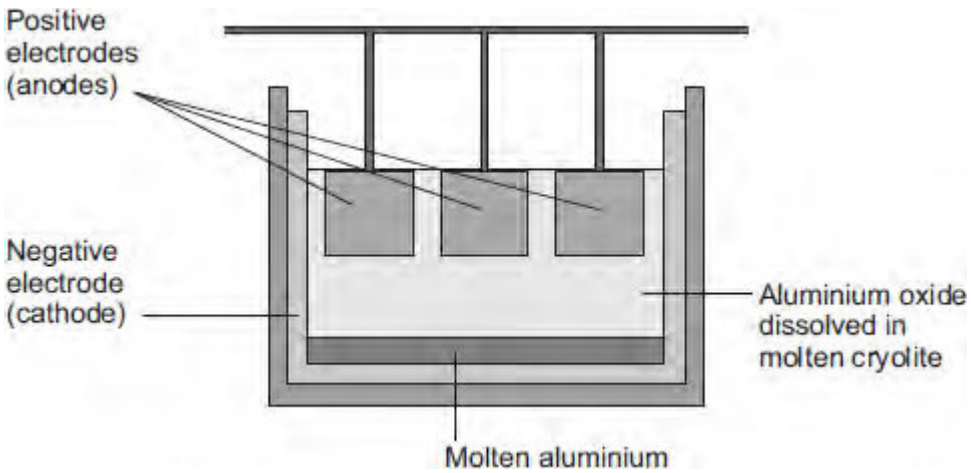
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Maximum mass = ..... tonnes

**(3)**

(b) Aluminium is extracted by electrolysis, as shown in **Figure 2**.

**Figure 2**




(i) Why can aluminium **not** be extracted by heating aluminium oxide with carbon?

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**(1)**

(ii) Explain why aluminium forms at the negative electrode during electrolysis.

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**(3)**

(iii) Explain how carbon dioxide forms at the positive electrodes during electrolysis.

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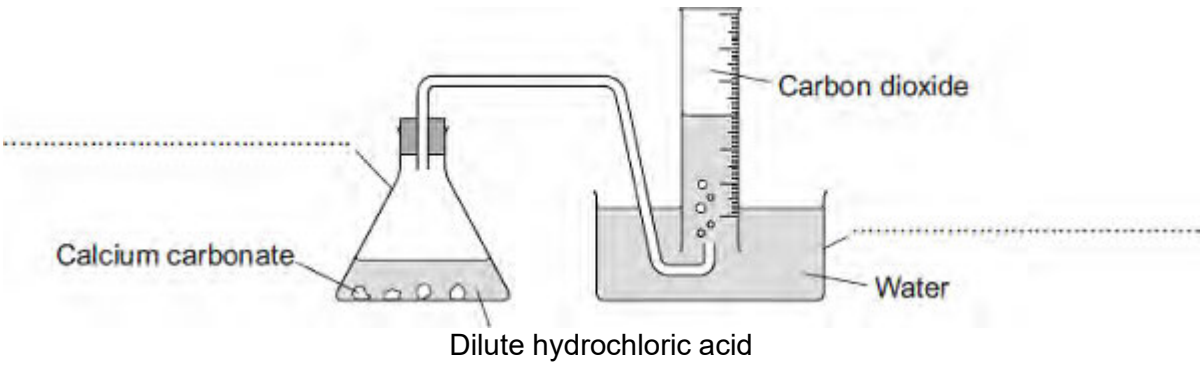
**(3)**
**(Total 13 marks)**

**Q2.** Some students were investigating the rate at which carbon dioxide gas is produced when metal carbonates react with an acid.

One student reacted 1.00 g of calcium carbonate with 50 $cm^3$, an excess, of dilute hydrochloric acid.

The apparatus used is shown in **Diagram 1**.

**Diagram 1**




(a) Complete the **two** labels for the apparatus on the diagram.

**(2)**

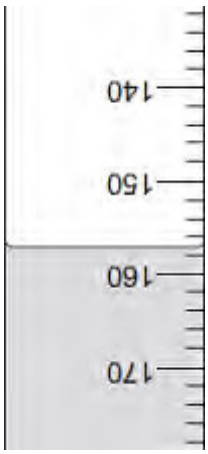
(b) The student measured the volume of gas collected every 30 seconds.

The table shows the student's results.

| **Time in seconds** | **Volume of carbon dioxide collected in $cm^3$** |
|---|---|
| 30 | 104 |
| 60 | |
| 90 | 198 |
| 120 | 221 |
| 150 | 232 |
| 180 | 238 |
| 210 | 240 |
| 240 | 240 |

(i) **Diagram 2** shows what the student saw at 60 seconds.

**Diagram 2**




What is the volume of gas collected?

Volume of gas = ..... $cm^3$

**(1)**

(ii) Why did the volume of gas stop changing after 210 seconds?

.....

.....

**(1)**

(c) Another student placed a conical flask containing 1.00 g of a Group 1 carbonate ($M_2CO_3$) on a balance.

He then added 50 $cm^3$, an excess, of dilute hydrochloric acid to the flask and measured the mass of carbon dioxide given off.

The equation for the reaction is:

$$M_2CO_3 + 2HCl \longrightarrow 2MCl + H_2O + CO_2$$

The final mass of carbon dioxide given off was 0.32 g.

(i) Calculate the amount, in moles, of carbon dioxide in 0.32 g carbon dioxide.

Relative atomic masses ($A_r$): C = 12; O = 16

.....

.....

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Moles of carbon dioxide = ..... moles

**(2)**

(ii) How many moles of the metal carbonate are needed to make this number of moles of carbon dioxide?

.....

.....

Moles of metal carbonate = ..... moles

**(1)**

(iii) The mass of metal carbonate used was 1.00 g.

Use this information, and your answer to part **(c) (ii)**, to calculate the relative formula mass ($M_r$) of the metal carbonate.

If you could not answer part **(c) (ii)**, use 0.00943 as the number of moles of metal carbonate. This is **not** the answer to part **(c) (ii)**.

.....

.....

Relative formula mass ($M_r$) of metal carbonate = .....

**(1)**

(iv) Use your answer to part **(c) (iii)** to calculate the relative atomic mass ($A_r$) of the metal in the metal carbonate ($M_2CO_3$) and so identify the Group 1 metal in the metal carbonate.

If you could not answer part **(c) (iii)**, use 230 as the relative formula mass of the metal carbonate. This is **not** the answer to part **(c) (iii)**.

To gain full marks, you must show your working.

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Relative atomic mass of metal is .....

Identity of metal .....

**(3)**

(d) Two other students repeated the experiment in part **(c)**.

(i) When the first student did the experiment some acid sprayed out of the flask as the metal carbonate reacted.

Explain the effect this mistake would have on the calculated relative atomic mass of the metal.

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**(3)**

(ii) The second student used 100 $cm^3$ of dilute hydrochloric acid instead of 50 $cm^3$.

Explain the effect, if any, this mistake would have on the calculated relative atomic mass of the metal.

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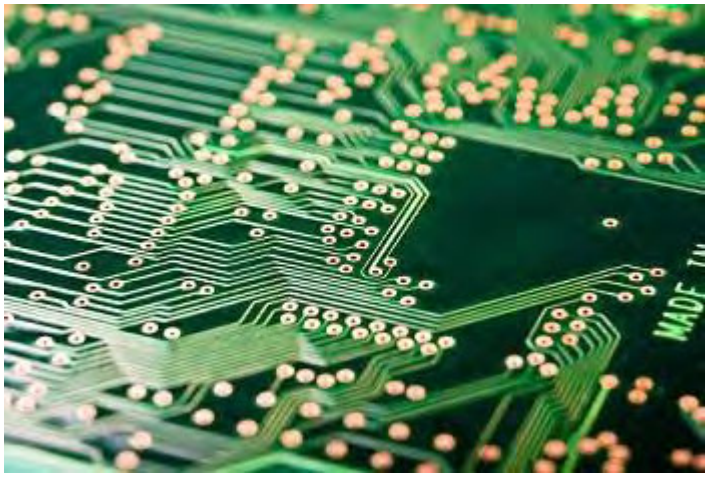
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**(3)**
**(Total 17 marks)**

**Q3.**Etching is a way of making printed circuit boards for computers.



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Printed circuit boards are made when copper sheets are etched using iron(III) chloride solution. Where the copper has been etched, only plastic remains.

(a) Copper is a good conductor of electricity.

Explain why.

.....

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.....

**(2)**

(b) Iron(III) chloride can be produced by the reaction shown in the equation:

$2\ Fe + 3\ Cl_2 \rightarrow 2\ FeCl_3$

(i) Calculate the maximum mass of iron(III) chloride ($FeCl_3$) that can be produced from 11.20 g of iron.

Relative atomic masses ($A_r$): Cl = 35.5; Fe = 56.

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Maximum mass of iron(III) chloride = ..... g

**(3)**

(ii) The actual mass of iron(III) chloride ($FeCl_3$) produced was 24.3 g.

Calculate the percentage yield.

(If you did not answer part (b)(i) assume that the maximum theoretical mass of iron(III) chloride ($FeCl_3$) is 28.0 g. This is **not** the correct answer to part (b)(i).)

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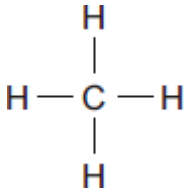
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Percentage yield = .....%

**(1)**
**(Total 6 marks)**

**Q4.** Saturated hydrocarbons, for example methane and octane, are often used as fuels.

(a) Methane can be represented as:




(i) The formula of methane is ..... .

**(1)**

(ii) Draw a ring around the correct answer to complete the sentence.

In a saturated hydrocarbon molecule all of the bonds are

| |
|---|
| double. |
| ionic. |
| single. |

**(1)**

(iii) Draw a ring around the correct answer to complete the sentence.

The homologous series that contains methane and octane is called the

alcohols.

alkanes.

alkenes.

**(1)**

(b) (i) The complete combustion of petrol produces carbon dioxide, water vapour and sulfur dioxide.

Name **three** elements petrol must contain.

1 .....

2 .....

3 .....

**(3)**

(ii) The exhaust gases from cars can contain oxides of nitrogen.

Complete the sentence.

Nitrogen in the oxides of nitrogen comes from ..... .

**(1)**

(iii) The sulfur dioxide and oxides of nitrogen from cars cause an environmental problem.

Name the problem and describe **one** effect of the problem.

Name of problem .....

Effect of problem .....

.....

**(2)**

(c) When a fuel burns without enough oxygen, there is incomplete combustion.

One gaseous product of incomplete combustion is carbon monoxide.

Name **one** solid product of incomplete combustion.

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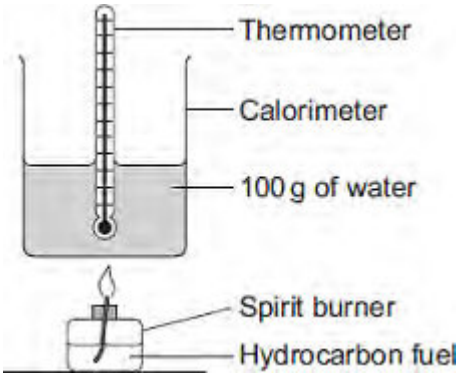
**(1)**

(d) A student investigated how well different hydrocarbon fuels would heat up 100 g of water.

Her hypothesis was:

| |
|---|
| **The more carbon atoms there are in a molecule of any fuel, the better the fuel is.** |

The apparatus the student used is shown in the diagram.




She burned each hydrocarbon fuel for 2 minutes.

Her results are shown in the table.

| Name of hydrocarbon fuel | Number of carbon atoms in a molecule of hydrocarbon fuel | Temperature change of water in °C after 2 minutes | Temperature change per g of fuel burned | Observations |
|---|---|---|---|---|
| | | | | |

| | | | | |
|---|---|---|---|---|
| Pentane | 5 | 30 | 60 | no smoke |
| Hexane | 6 | 40 | 57 | very small amount of smoke |
| Octane | 8 | 55 | 55 | small amount of smoke |
| Decane | 10 | 57 | 52 | large amount of smoke |
| Dodecane | 12 | 60 | 43 | very large amount of smoke |

The student investigated only hydrocarbons.

Look carefully at her results.

How well do the student's results support her hypothesis?

**The more carbon atoms there are in a molecule of any fuel, the better the fuel is.**

Give reasons for your answer.

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**(4)**

(e) A 0.050 mol sample of a hydrocarbon was burned in excess oxygen.

The products were 3.60 g of water and 6.60 g of carbon dioxide.

(i) Calculate the number of moles of carbon dioxide produced.

Relative atomic masses: C = 12; O = 16.

.....

.....

Moles of carbon dioxide = .....

**(2)**

(ii) When the hydrocarbon was burned 0.20 mol of water were produced.

How many moles of hydrogen atoms are there in 0.20 mol of water?

.....

Moles of hydrogen atoms = .....

**(1)**

(iii) The amount of hydrocarbon burned was 0.050 mol.

Use this information and your answers to parts **(e) (i)** and **(e) (ii)** to calculate the molecular formula of the hydrocarbon.

If you could not answer parts **(e) (i)** or **(e) (ii)** use the values of 0.20 moles carbon dioxide and 0.50 moles hydrogen. These are **not** the answers to parts **(e) (i)** and **(e) (ii)**.

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Formula = .....

**(2)**

**(Total 19 marks)**