

Candidate forename						Candidate surname					
Centre number						Candidate number					

**OXFORD CAMBRIDGE AND RSA EXAMINATIONS**  
**GCSE**

**A171/02**

**TWENTY FIRST CENTURY SCIENCE**  
**CHEMISTRY A**

**Modules C1 C2 C3 (Higher Tier)**

**FRIDAY 15 JUNE 2012: Afternoon**

**DURATION: 1 hour**  
**plus your additional time allowance**

**MODIFIED ENLARGED**

**Candidates answer on the Question Paper.**  
**A calculator may be used for this paper.**

**OCR SUPPLIED MATERIALS:**

**Insert provided for question 2**  
**Insert provided for question 3**

**OTHER MATERIALS REQUIRED:**


**Pencil**  
**Ruler (cm/mm)**

**READ INSTRUCTIONS OVERLEAF**

## **INSTRUCTIONS TO CANDIDATES**

- **Write your name, centre number and candidate number in the boxes on the first page. Please write clearly and in capital letters.**
- **Use black ink. HB pencil may be used for graphs and diagrams only.**
- **Answer ALL the questions.**
- **Read each question carefully. Make sure you know what you have to do before starting your answer.**
- **Write your answer to each question in the space provided. Additional paper may be used if necessary but you must clearly show your candidate number, centre number and question number(s).**

## **INFORMATION FOR CANDIDATES**

- **Your quality of written communication is assessed in questions marked with a pencil (.**
- **The number of marks is given in brackets [ ] at the end of each question or part question.**
- **The total number of marks for this paper is 60.**

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**Answer ALL the questions.**

- 1 The Earth's early atmosphere was probably formed by volcanic activity.  
It consisted mainly of carbon dioxide and water vapour.  
The table shows the most important changes that have taken place in the Earth's atmosphere from early times to the present day.**

<b>gas</b>	<b>approximate percentage (%) in early atmosphere</b>	<b>percentage (%) in atmosphere 500 years ago</b>	<b>percentage (%) in today's atmosphere</b>
<b>nitrogen</b>	<b>very small</b>	<b>78</b>	<b>78</b>
<b>oxygen</b>	<b>0</b>	<b>21</b>	<b>21</b>
<b>carbon dioxide</b>	<b>85</b>	<b>0.03</b>	<b>0.04</b>
<b>water vapour</b>	<b>10</b>	<b>between 1 and 5</b>	<b>between 1 and 5</b>

- (a) Explain how the changes in the percentages of carbon dioxide and oxygen shown in the table took place.



The quality of written communication will be assessed in your answer.

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[6]

- (b) The atmosphere today may contain pollutant gases. Steps are being taken to reduce the amount of pollutant gases released into the air.**

**The flue gases from power stations contain the acidic gas, sulfur dioxide.**

**Sulfur dioxide can be removed by reacting it with calcium hydroxide.**

- (i) This makes a solid product and water.**

**Name the solid product.**

\_\_\_\_\_ **[1]**

- (ii) Complete this sentence about the reaction.**

**The reaction between calcium hydroxide and sulfur dioxide happens because calcium hydroxide is**

\_\_\_\_\_ **[1]**

- (iii) Another process uses limestone (calcium carbonate) to remove sulfur dioxide.**

**This reaction makes a solid product and carbon dioxide.**

**Suggest a disadvantage of using calcium carbonate rather than calcium hydroxide.**

\_\_\_\_\_  
\_\_\_\_\_ **[1]**

**[Total: 9]**

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- 2 Scientists investigated the nitrogen dioxide concentration in the air next to a city road over a 24 hour period on DAY 1.**

**Their results are shown in the graph on the insert provided for question 2.**

- (a) The World Health Organisation (WHO) has suggested limits for nitrogen dioxide concentrations.**

**These are  $200\text{ }\mu\text{g}/\text{m}^3$  for a one-hour average exposure and  $40\text{ }\mu\text{g}/\text{m}^3$  for an annual average exposure.**

**Some students are discussing these limits as they look at the graph.**

**ALI says “The concentration is lower than  $40\text{ }\mu\text{g}/\text{m}^3$  for several hours on this day.”**

**BETH says “The concentration is higher than  $200\text{ }\mu\text{g}/\text{m}^3$  for only part of the day.”**

**CAL says “The concentration stayed higher than  $200\text{ }\mu\text{g}/\text{m}^3$  for more than one hour.”**

**DAN says “People only stay near the city road for a short time during the time of highest concentration.”**

**ED says “The graph only shows measurements for one day.”**



- (i) Whose comment shows that one of the WHO limits has been exceeded?**

**answer\_\_\_\_\_ [1]**

- (ii) Whose comment shows that no conclusion can be made about the other WHO limit from the evidence in this graph?**

**answer\_\_\_\_\_ [1]**

- (b) The scientists also counted the number of vehicles travelling along the road on DAY 1.**

**These results are shown in the tables opposite.**

**Use information from the tables to explain the shape of the graph.**

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[3]

<b>HOUR OF THE DAY</b>	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>	<b>6</b>	<b>7</b>	<b>8</b>	<b>9</b>	<b>10</b>	<b>11</b>	<b>12</b>
<b>NUMBER OF CARS</b>	<b>2</b>	<b>3</b>	<b>5</b>	<b>9</b>	<b>31</b>	<b>54</b>	<b>242</b>	<b>461</b>	<b>584</b>	<b>472</b>	<b>287</b>	<b>277</b>

<b>HOUR OF THE DAY</b>	<b>13</b>	<b>14</b>	<b>15</b>	<b>16</b>	<b>17</b>	<b>18</b>	<b>19</b>	<b>20</b>	<b>21</b>	<b>22</b>	<b>23</b>	<b>24</b>
<b>NUMBER OF CARS</b>	<b>275</b>	<b>285</b>	<b>363</b>	<b>458</b>	<b>566</b>	<b>449</b>	<b>372</b>	<b>163</b>	<b>64</b>	<b>36</b>	<b>22</b>	<b>12</b>

- (c) The scientists repeated this investigation on DAY 2.**

**The table opposite shows the measurements they took at 9 am.**

- (i) The measurement for SAMPLE 2 is much higher than the other measurements.**

**What should the scientists consider when deciding whether or not to include this value in their calculation of the best estimate?**

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[2]

- (ii) The scientists use these results to work out the best estimate of the nitrogen dioxide concentration at 9 am on DAY 2. They calculate a concentration of  $284 \mu\text{g}/\text{m}^3$ .**

**Look at the nitrogen dioxide concentration at 9 am on the graph for DAY 1.**

**Suggest reasons for the difference between the two values.**

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[1]

<b>SAMPLE NUMBER</b>	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>	<b>6</b>	<b>7</b>	<b>8</b>	<b>9</b>	<b>10</b>
<b>NITROGEN DIOXIDE CONCENTRATION IN <math>\mu\text{g}/\text{m}^3</math></b>	<b>281</b>	<b>308</b>	<b>285</b>	<b>282</b>	<b>284</b>	<b>286</b>	<b>283</b>	<b>285</b>	<b>284</b>	<b>285</b>

**(d) Electrically-powered cars are already used in many cities.**

**These cars may NOT be the ideal solution to air pollution problems.**

**Put ticks (✓) in the boxes next to the THREE statements that, when taken together, give the best explanation for this.**

- ☐ **Fossil fuels are burned to generate mains electricity.**
- ☐ **Fossil fuels are non-renewable and will one day run out.**
- ☐ **As fossil fuels are burned, pollutant gases are given off.**
- ☐ **Electric cars give out pollutant gases as they are used.**
- ☐ **Electric cars have batteries that are charged from the mains electricity supply.**
- ☐ **The batteries in electric cars have to be replaced every few years.**

**[3]**

**[Total: 11]**

**3 A company plans to make a new rope for sailing boats.**

**The new rope must be strong and quite stretchy.**

**Scientists working for the company test ropes made from five polymers, A, B, C, D and E.**

**They want to know which is the best polymer to use.**

**They measure how much each rope stretches as a load is applied to it.**

**They do this until the rope breaks.**

**Each rope has the same thickness and the same length.**

**Their results are shown in the graph on the insert provided for question 3. Each line ends when the rope breaks.**

**(a) The scientists make sure that all factors except the type of polymer are identical for each test.**

**Explain why.**

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**[2]**

**(b) Look at the graph.**

**Is there a link between the stretchiness of the ropes and their strength?**

**Explain your answer.**

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**[2]**

**(c) A and E are different forms of the SAME polymer.**

**What differences in the structure of the polymers could have caused these differences in their properties?**

**Put ticks (✓) in the boxes next to the TWO correct statements.**

☐

**Polymer E has less plasticizer than polymer A.**

☐

**Polymer E has cross-linked chains but polymer A does not.**

☐

**Polymer E is less crystalline than polymer A.**

☐

**Polymer E has shorter chains than polymer A.**

☐

**Polymer E has fewer cross-links than polymer A.**

**[2]**



- (d) Ropes made of DIFFERENT polymer molecules have different breaking strengths.**

**Use ideas about forces and molecules to explain why.**

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**[2]**

- (e) The company chooses to make the new rope from polymer C.**

**Suggest why they use this polymer rather than any of the others.**

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**[3]**

**[Total: 11]**

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#### 4 Crude oil is a mixture of hydrocarbons.

(a) Which elements are present in a hydrocarbon?

\_\_\_\_\_ [1]

(b) The hydrocarbons in crude oil are used to make fuels, lubricants and raw materials for chemical synthesis.

Some of the following statements about the hydrocarbons in crude oil are true and some are false.

Put a tick (✓) in the correct box next to each statement to show whether it is TRUE or FALSE.

	TRUE	FALSE
There are hydrocarbon molecules of many different sizes.		
Most of the hydrocarbon molecules are used for chemical synthesis.		
All of the hydrocarbon molecules can be burned as fuels.		
All of the hydrocarbon molecules can be polymerised.		

[2]

**(c) The hydrocarbon molecules in crude oil boil at different temperatures.**

**In a refinery the hydrocarbons in crude oil are separated into fractions.**

<b>FRACTIONS</b>	<b>APPROXIMATE NUMBER OF CARBON ATOMS PER MOLECULE IN THE FRACTION</b>	<b>APPROXIMATE BOILING TEMPERATURE IN °C</b>
<b>fuel gas</b>	<b>1 – 4</b>	<b>below room temperature</b>
<b>petrol</b>	<b>7</b>	<b>50</b>
<b>paraffin</b>	<b>10</b>	<b>150</b>
<b>diesel</b>	<b>15</b>	<b>250</b>
<b>heavy oil</b>	<b>more than 20</b>	<b>400</b>
<b>bitumen</b>	<b>over 70</b>	<b>over 600</b>

**Use the information opposite to describe the link between the size of the molecules in each fraction and the temperature at which the fraction boils.**

**Explain this pattern using ideas about forces, molecular size and the way in which molecules are arranged in liquids and gases.**



**The quality of written communication will be assessed in your answer.**

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**[6]**

**[Total: 9]**

- 5 Plasticizers are added to the polymer PVC to make it more flexible.**

**Some plasticizer may leach out of the polymer and contaminate the environment.**

**People disagree about the size of the risks involved in the use of plasticizers.**

**A spokesman for a plastic manufacturer says “I think that there is almost no risk in using plasticizers. There is no evidence that they have caused any person to become ill.”**

**A member of a public pressure group says “We have called for the use of plasticizers to be banned. They have been shown to harm rats and they build up in people’s bodies.”**

- (a) Discuss the risks of using PVC which contains plasticizers and why people may view these risks differently.**



**The quality of written communication will be assessed in your answer.**

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[6]

**(b) The life cycle of a plasticized PVC product that is used in people's homes includes these four stages.**

**A making the plasticized polymer**

**B packaging the product**

**C using the product**

**D disposing of the product**

**(i) At which stage, A, B, C or D, would MEMBERS OF THE PUBLIC be most at risk from plasticizers?**

**answer** \_\_\_\_\_ **[1]**

**(ii) At which stage, A, B, C or D, would WORKERS be most at risk from plasticizers?**

**answer** \_\_\_\_\_ **[1]**

**(c) To make a personal decision about whether or not the risks involved in the use of plasticizers are acceptable, what information would you need?**

**Put ticks (✓) in the boxes next to the TWO best answers.**

- ☐ **The probability that you may suffer harmful effects from the use of plasticizers.**
- ☐ **The benefit of using plasticizers in PVC.**
- ☐ **How much PVC is manufactured in the UK each year.**
- ☐ **What harmful effects plasticizers can cause at the concentrations involved.**
- ☐ **The chemical formulae of the plasticizers that are used.**
- ☐ **Which manufacturers make plasticized PVC.**

**[2]**

**[Total: 10]**



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**6 Sodium chloride (common salt) has many uses.**

**It is used in the food industry and to treat icy roads in winter.**

**(a) Salt mined from underground contains rock fragments and grit.**

**Most of this salt is used to treat icy roads in winter.**

**(i) Suggest why this salt is particularly useful to treat icy roads**

\_\_\_\_\_  
\_\_\_\_\_ [1]

**(ii) Suggest why this salt is NOT used in the food industry.**

\_\_\_\_\_  
\_\_\_\_\_ [1]

**(b) Salt for the chemical industry can be obtained by solution mining.**

**(i) Describe how salt is obtained by solution mining.**

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_ [2]

- (ii) Describe and explain an environmental problem that can occur as a result of solution mining.**

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**[2]**

- (iii) By passing electricity through salt solution, three useful products can be made.

The diagram opposite shows the electrolysis cell used for this process.

The labels A, B and C represent three chemicals involved in this process.

Complete the table below to show the names of each of these three chemicals.

Choose words from this list.

**SODIUM CARBONATE**

**SODIUM CHLORIDE**

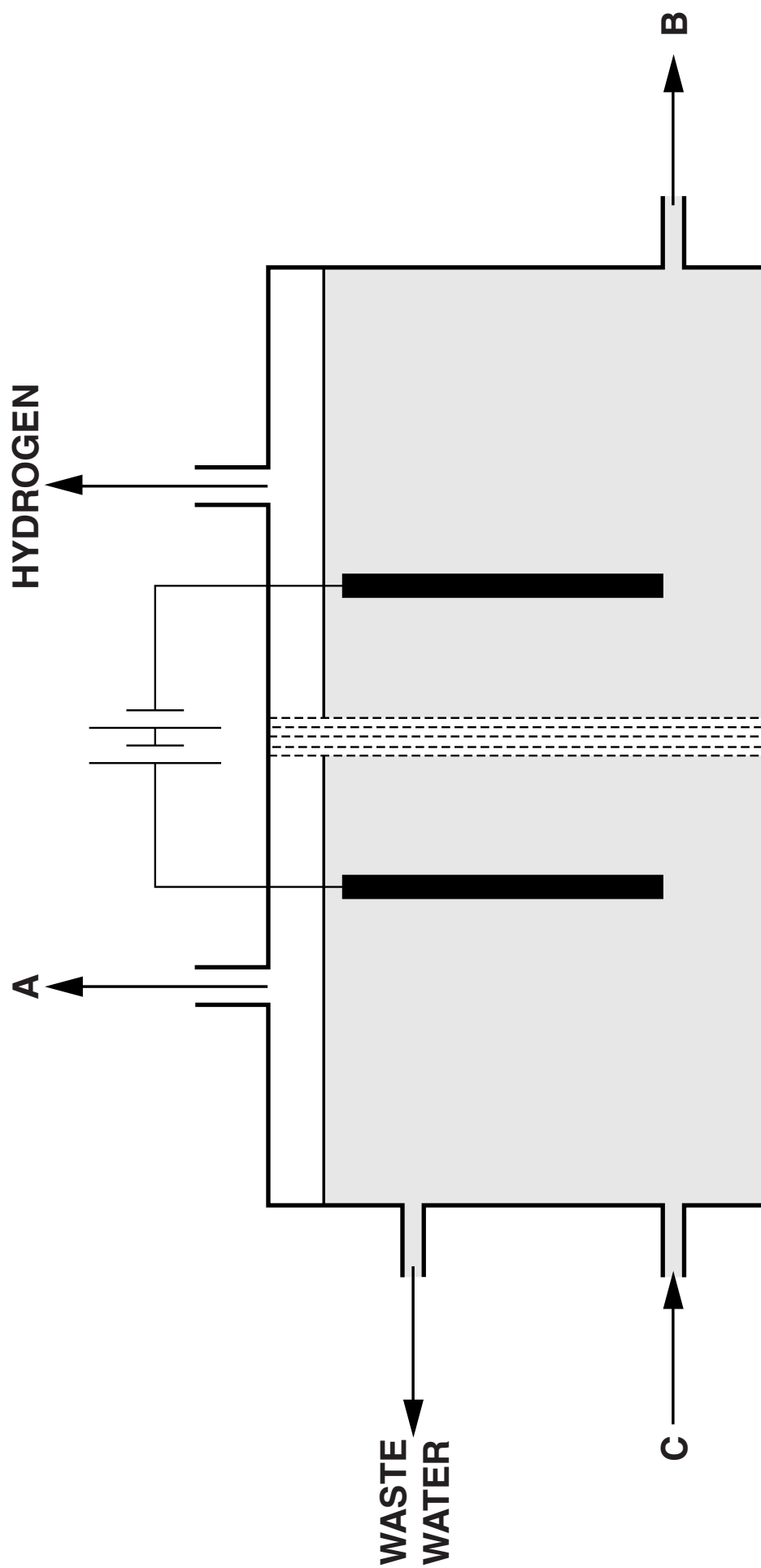
**CHLORINE**

**NITROGEN**

**SODIUM HYDROXIDE**

<b>LABEL</b>	<b>CHEMICAL</b>
<b>A</b>	
<b>B</b>	
<b>C</b>	

[2]



- (c) One industrial use of salt is to make the alkali, sodium carbonate.**

**There are large underground deposits of salt in the North West of England.**

**This resulted in the development of an industry to make sodium carbonate.**

**The diagram opposite shows the process used to produce sodium carbonate.**

**Use the diagram to suggest TWO other reasons why the alkali industry developed in the North West of England.**

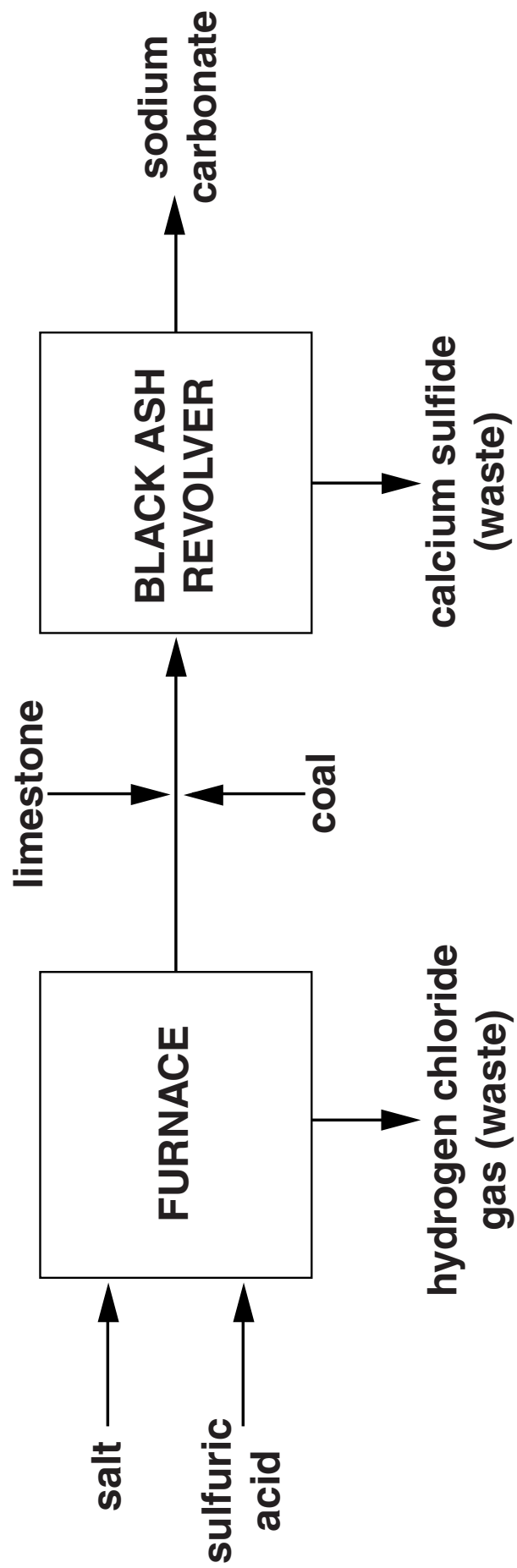
**1** \_\_\_\_\_

\_\_\_\_\_

**2** \_\_\_\_\_

\_\_\_\_\_ **[2]**

**[Total: 10]**



**END OF QUESTION PAPER**

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