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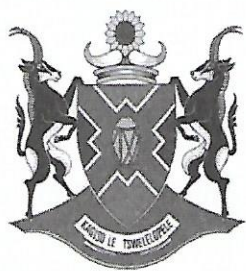
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## **education**

Lefapha la Thuto la Bokone Bophirima  
Noordwes Departement van Onderwys  
North West Department of Education  
**NORTH WEST PROVINCE**

### **NATIONAL SENIOR CERTIFICATE**

**GRADE 12**

**PHYSICAL SCIENCES: CHEMISTRY (P2)**

**SEPTEMBER 2020**

**MARKS: 150**

**DURATION: 3 hours**



EPHSCP2

**This question paper consists of 17 pages and 4 data sheets.**

**QUESTION 1: MULTIPLE-CHOICE QUESTIONS**

Four options are provided as possible answers to the following questions. Each question has only ONE correct answer. Choose the answer and write only the letter (A–D) next to the question number (1.1 to 1.10) in the ANSWER BOOK, e.g. 1.11 D.

1.1 The group of atoms which determine the chemical properties of carboxylic acids is called the ...

- A carboxyl group.
- B carbonyl group.
- C hydroxyl group.
- D formyl group. (2)

1.2. Which ONE of the following pairs of compounds contains members of the same homologous series.

- A  $C_2H_4$  and  $C_3H_8$
- B  $C_3H_6$  and  $C_4H_6$
- C  $CH_4O$  and  $C_2H_4O_2$
- D  $C_2H_4O$  and  $C_3H_6O$  (2)

1.3. The organic compounds shown in the table below have the same molar mass ( $60 \text{ g.mol}^{-1}$ )

| Compound | Molecular Formula | Boiling point ( $^{\circ}\text{C}$ ) |
|----------|-------------------|--------------------------------------|
| P        | $C_6H_{14}$       | 69                                   |
| Q        | $C_3H_6O_2$       | ?                                    |
| R        | $C_4H_{10}O$      | 118                                  |

Which ONE of the following is most likely to be the boiling point in ( $^{\circ}\text{C}$ ) of compound R.

- A 121
- B 141
- C 98
- D 36 (2)

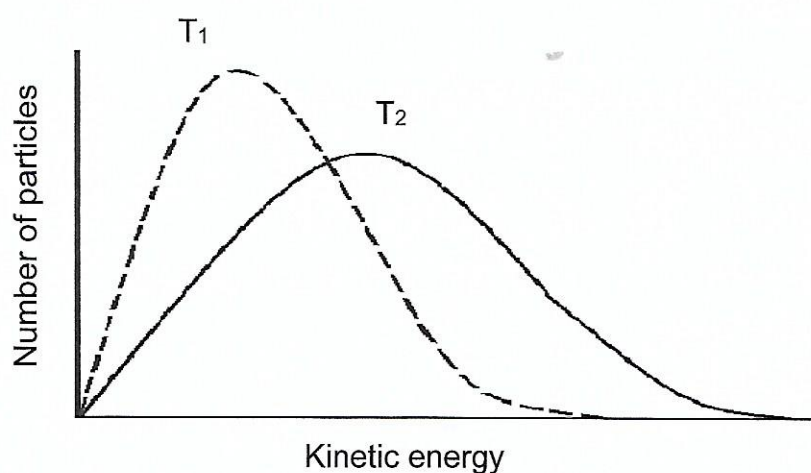


1.4. Which ONE of the following organic reactions below involves the bonding of monomers by a dehydration process?

- A Halogenation
- B Dehydrohalogenation
- C Addition polymerisation
- D Condensation polymerisation

(2)

1.5. The energy distribution curves for particles in a fixed mass of gas at two different temperatures,  $T_1$  and  $T_2$  are shown below.

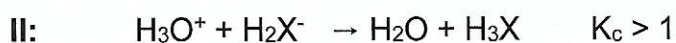


Which ONE of the following is the correct interpretation of the curves as the temperature of the gas changes from  $T_1$  to  $T_2$ ?

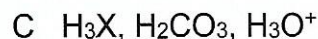
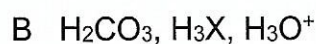
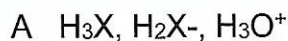
|   | Activation energy ( $E_a$ ) | Number of effective collisions |
|---|-----------------------------|--------------------------------|
| A | Remains the same            | Increases                      |
| B | Decrease                    | Decreases                      |
| C | Decrease                    | Increases                      |
| D | Remains the same            | Decreases                      |

(2)

1.6 Reactions I and II below have equilibrium constants ( $K_c$ ) greater than 1.



Based on the reactions above, the ACIDS in order of INCREASING STRENGTH (weakest to strongest) are ...



1.7 A solution that is formed by combining 200 cm<sup>3</sup> of 0,15 mol·dm<sup>-3</sup> HCl with 300 cm<sup>3</sup> of 0,9 mol·dm<sup>-3</sup> NaOH has a [OH<sup>-</sup>] of :

A 0,24 mol·dm<sup>-3</sup>

B 0,27 mol·dm<sup>-3</sup>

C 0,8 mol·dm<sup>-3</sup>

D 0,48 mol·dm<sup>-3</sup> (2)

1.8 Which ONE of the following correctly describes the electrode in an electrolytic cell and its polarity the best?

|   | ELECTRODE | POLARITY | TYPE OF HALF-REACTION |
|---|-----------|----------|-----------------------|
| A | Anode     | Positive | Reduction             |
| B | Anode     | Negative | Oxidation             |
| C | Cathode   | Negative | Reduction             |
| D | Cathode   | Positive | Oxidation             |

(2)

- 1.9 You are supplied with the following half-cell:  $\text{Fe(s)}/\text{Fe}^{3+}$  ( $1 \text{ mol} \cdot \text{dm}^{-3}$ ). This half-cell should be used to produce a highest possible potential difference. The most suitable half-cell combination for this purpose is:

- A  $\text{Pt}, \text{SO}_2(\text{g})/\text{SO}_4^{2-}$  ( $1 \text{ mol} \cdot \text{dm}^{-3}$ )  
 B  $\text{Mg(s)}/\text{Mg}^{2+}$  ( $\text{mol} \cdot \text{dm}^{-3}$ )  
 C  $\text{Pt}, \text{Br}_2(\text{g})/\text{Br}^-$  ( $1 \text{ mol} \cdot \text{dm}^{-3}$ )  
 D  $\text{Co(s)}/\text{Co}^{2+}$  ( $1 \text{ mol} \cdot \text{dm}^{-3}$ ) (2)

- 1.10 Choose the correct combination of plant nutrients according to the headings in the table:

|   | Non-mineral nutrients | Primary mineral nutrients |
|---|-----------------------|---------------------------|
| A | C, H, O               | N, P, K                   |
| B | C, H, N               | Ca, P, K                  |
| C | N, H, O               | S, P, Ca                  |
| D | N, P, K               | C, H, O                   |

(2)  
[20]

**QUESTION 2 (Start on a new page.)**Study the organic compounds represented by the letters **A** to **F** below:

|          |   |          |                        |
|----------|---|----------|------------------------|
| <b>A</b> | $  \begin{array}{c}  \text{H} \qquad \qquad \text{H} \\    \qquad \qquad   \\  \text{H}-\text{C}-\text{C}=\text{C}-\text{C}-\text{H} \\    \quad   \qquad   \\  \text{H} \quad \text{H} \quad \text{H}  \end{array}  $  | <b>B</b> | 2-chlorohex-3-ene      |
| <b>C</b> | $  \begin{array}{c}  \text{Cl} \qquad \qquad \text{H} \\    \qquad \qquad   \\  \text{H}-\text{C}-\text{C}-\text{C}-\text{H} \\    \quad   \quad   \\  \text{H} \quad \text{C}=\text{H} \quad \text{H} \\    \\  \text{H}-\text{C}-\text{H} \\    \\  \text{H}  \end{array}  $      | <b>D</b> | Pentanoic acid         |
| <b>E</b> | $  \begin{array}{c}  \text{H} \quad \text{H} \quad \text{H} \quad \text{H} \\    \quad   \quad   \quad   \\  \text{H}-\text{C}-\text{C}-\text{C}-\text{C}-\text{O}-\text{H} \\    \quad   \quad   \quad   \\  \text{H} \quad \text{H} \quad \text{H} \quad \text{H}  \end{array}  $ | <b>F</b> | PVC(Polyvinylchloride) |

- 2.1 Define the term *isomer*. (2)
- 2.2 Write down THE LETTER(s), (A–F) that represent the following:
- 2.2.1 An unsaturated hydrocarbon. (1)
- 2.2.2 A compound with a carbonyl group. (1)
- 2.2.3 Structural isomer of compound **C**. (2)
- 2.3 Compounds **D** and **E** are heated in the presence of concentrated sulphuric acid to form an ester.
- Write down:
- 2.3.1 The type of the reaction above. (1)
- 2.3.2 The function of sulphuric acid in this reaction. (1)
- 2.3.3 Structural formula of a tertiary alcohol that is a structural isomer of compound **E**. (2)
- 2.4 Structural formula of a repeat unit of compound **F** polymer. (2)

**[12]**



**QUESTION 3 (Start on a new page.)**

Learners investigate factors which influences the boiling points of various organic compounds.

The results obtained are shown in the table below:

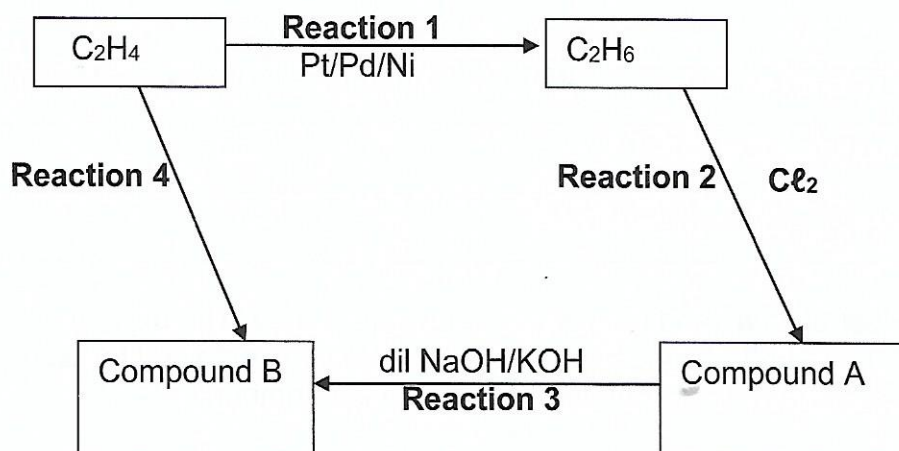
|   | COMPOUND      | BOILING POINTS (°C) |
|---|---------------|---------------------|
| A | Ethane        | - 89                |
| B | Chloroethane  | 12                  |
| C | Ethanol       | 78                  |
| D | Ethanoic acid | 118                 |

- 3.1 Define the term *boiling point*. (2)
- 3.2 Which ONE of the compounds, **A** or **C** or **D** has the highest vapour pressure? Refer to the data in the table to give a reason for the answer. (2)
- 3.3 Write down the:
- 3.3.1 NAME of the ester that will be formed when compound **C** and **D** reacts together. (2)
- 3.3.2 Structural formula of the ester formed in QUESTION 3.3.1 above. (2)
- 3.4 Fully explain the difference between the boiling points of ethanol and ethanoic acid by referring to the types of intermolecular force present in each of these compounds. (4)
- [12]**



**QUESTION 4 (Start on a new page.)**

In the flow diagram below, ethane ( $C_2H_4$ ) is used as a starting material in the preparation of compound **B**.



- 4.1 During **Reaction 1**, compound  $C_2H_4$  undergoes polymerization to form compound  $C_2H_6$ .

For this reaction, write down the:

- 4.1.1 Type of polymerization (1)
- 4.1.2 Balanced equation for complete combustion of  $C_2H_6$  using molecular formulae. (3)
- 4.2 Compound **A** is the major product formed in **Reaction 2**. Write down the:
- 4.2.1 IUPAC name of compound **A** (2)
- 4.2.2 Type of substitution reaction (1)
- 4.3 For **Reaction 3**, write down
- 4.3.1 Type of reaction (1)
- 4.3.2 A balanced structural chemical equation for the reaction. (4)
- 4.4 For **Reaction 4**, write down:
- 4.4.1 The type of addition reaction. (1)
- 4.4.2 ONE reaction condition. (1)

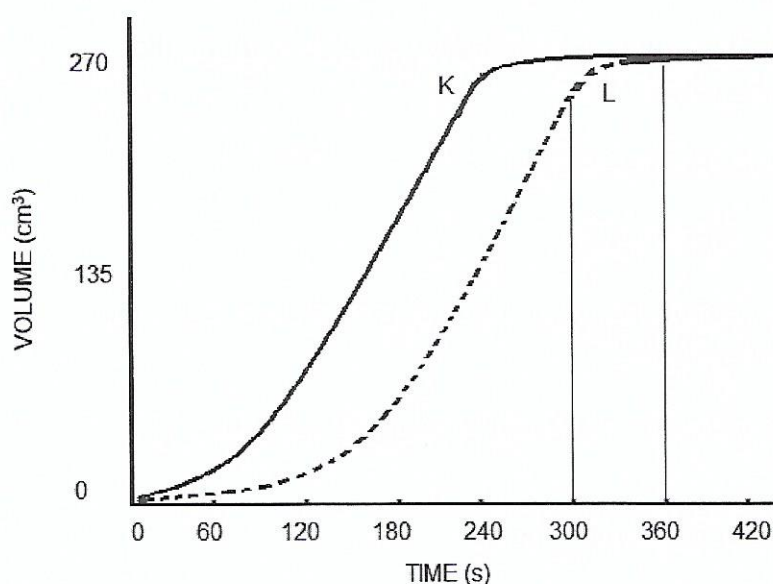
**[14]**

**QUESTION 5 (Start on a new page.)**

Learners investigate one of the factors that influence the rate of a chemical reaction. The investigation is conducted as indicated below.

| TEST TUBE | CONTENTS OF TEST TUBE  |
|-----------|--|
| <b>A</b>  | 1 g potassium chlorate( $\text{KClO}_3$ ) + 5 g manganese(IV) oxide ( $\text{MnO}_2$ ) |
| <b>B</b>  | potassium chlorate( $\text{KClO}_3$ )  |
| <b>C</b>  | manganese(IV) oxide ( $\text{MnO}_2$ )   |

The test tubes were set up in a sand bath and then evenly heated. The oxygen produced was measured at 60-second intervals. No reading was obtained for test tube **C**. The graph shows the results obtained during the experiment.

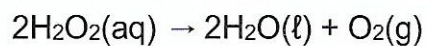


The equation for production of oxygen using potassium chlorate:



- 5.1 Which factor is being investigated? (1)
- 5.2 Which graph, line K or L was obtained for the reaction in test tube **B**? (1)
- 5.3 Give a reason for your answer to QUESTION 5.2. (2)

In another experiment, the learners obtain the following results for the decomposition of hydrogen peroxide:



| TIME | H <sub>2</sub> O <sub>2</sub> CONCENTRATION (mol·dm <sup>-3</sup> ) |
|------|---|
| 0    | 0,0200  |
| 200  | 0,0160  |
| 400  | 0,0131  |
| 600  | 0,0106  |
| 800  | 0,0086  |

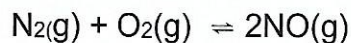
5.4 Define reaction rate. (2)

5.5 Calculate the AVERAGE rate of decomposition (in mol·dm<sup>-3</sup>·s<sup>-1</sup>) of H<sub>2</sub>O<sub>2</sub>(aq) in the first 400 s. (3)

5.6 Calculate the mass of oxygen produced at the first 600 s if 50 cm<sup>3</sup> of hydrogen peroxide decomposes in this time interval. (5)  
[14]

**QUESTION 6 (Start on a new page.)**

The following chemical equilibrium is established when Nitrogen(N<sub>2</sub>) and Oxygen (O<sub>2</sub>) are placed in a sealed container.



6.1 Define the term chemical equilibrium. (2)

6.2 How will an increase in pressure on the system affect the yield of NO(g)? (Choose from INCREASE, DECREASE or STAYS THE SAME.)

Explain your answer (3)

6.3 In a similar reaction 7 moles of Nitrogen gas (N<sub>2</sub>) and 2 moles of Oxygen gas(O<sub>2</sub>) are sealed in an empty container with a volume of 2 dm<sup>3</sup>. The container is sealed and equilibrium is established according to the above equation.

The K<sub>c</sub> value of this reaction at 25 °C is 4,8 x10<sup>-31</sup>.

6.3 1 What does this value of K<sub>c</sub> indicates with regards to the amount of NO(g) in the equilibrium mixture at 25 °C? (2)

The container is now heated and the system reaches a new equilibrium at 2500 C. At this temperature it is found that there are 0,4 moles of NO(g) present.

6.3.2 Determine the K<sub>c</sub> value at this temperature. (8)

6.3.3 Use Le Chatelier's principle to explain why the forward reaction is endothermic. (4)

**[19]**



**QUESTION 7 (Start on a new page.)**

- 7.1 Hydrochloric acid (HCl), with a concentration of  $0,01 \text{ mol} \cdot \text{dm}^{-3}$ , is a strong monoprotic acid. Another monoprotic acid HX has a pH of 3.

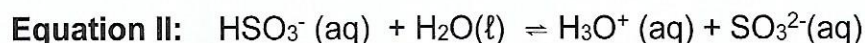
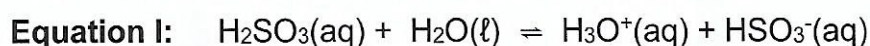
7.1.1. Define the term *strong acid*. (2)

7.1.2 Calculate the concentration of the hydrogen ions in the HX solution. (3)

7.1.3 Is the acid similar in strength to HCl? (Answer YES or NO). (1)

7.1.4 Give a reason to QUESTION 7.1.3 above. (2)

- 7.2 Sulphurous acid reacts with water in two steps as represented by the equations below.



7.2.1 Define the term *ampholyte*. (2)

7.2.2 Write down the FORMULA of a species that acts as an ampholyte in the above reactions. (1)

7.2.3 Write down the NAME of the conjugate base of hydrogen sulphite ion. (1)

- 7.3 Five grams (5 g) of an impure sample of sodium carbonate is added to 100 ml of a  $0,2 \text{ mol} \cdot \text{dm}^{-3}$  solution of sulphuric acid. The acid is in excess. The equation for the reaction is given as follows:



7.3.1 Calculate the number of moles of sulphuric acid. (3)

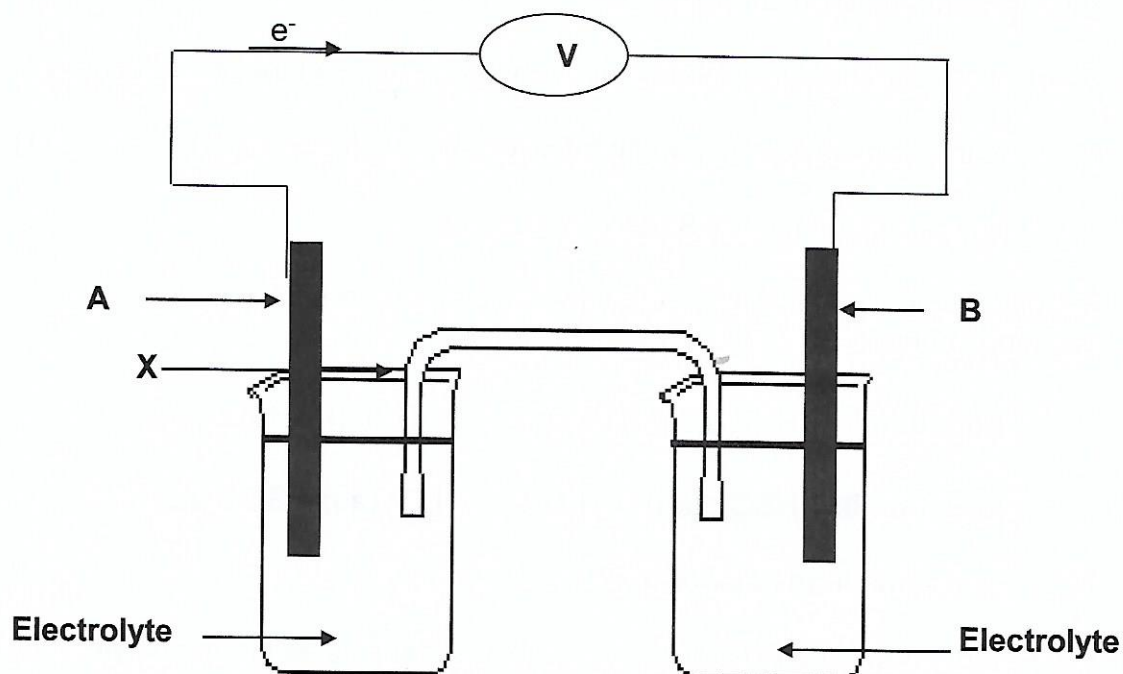
The excess acid neutralizes  $20 \text{ cm}^3$  of a solution of  $0,2 \text{ mol} \cdot \text{dm}^{-3}$  of magnesium hydroxide according to the following equation:



7.3.2 Calculate the mass of the impurity in the sodium carbonate sample. (7)  
[22]

**QUESTION 8 (Start on a new page.)**

A standard electrochemical cell of Silver and Cobalt is constructed by a group of learners and is connected to a 1,5 V bulb as shown in the diagram below.



- 8.1 Define *oxidising agent* in terms of electron transfer. (2)
- 8.2 Which electrode is Silver, **A** or **B**? Refer to the relative oxidising ability to explain your answer. (3)
- 8.3 Write down the Net (overall) balanced chemical reaction that takes place in this cell. (3)
- 8.4 Use a relevant calculation to determine if the bulb will glow or not when the above electrochemical cell is in operation. (5)
- [13]**

**QUESTION 7 (Start on a new page.)**

- 7.1 Hydrochloric acid (HCl), with a concentration of  $0,01 \text{ mol} \cdot \text{dm}^{-3}$ , is a strong monoprotic acid. Another monoprotic acid HX has a pH of 3.

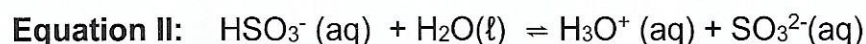
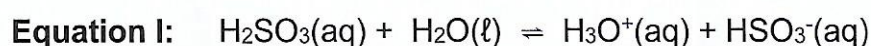
7.1.1. Define the term *strong acid*. (2)

7.1.2 Calculate the concentration of the hydrogen ions in the HX solution. (3)

7.1.3 Is the acid similar in strength to HCl? (Answer YES or NO). (1)

7.1.4 Give a reason to QUESTION 7.1.3 above. (2)

- 7.2 Sulphurous acid reacts with water in two steps as represented by the equations below.



7.2.1 Define the term *ampholyte*. (2)

7.2.2 Write down the FORMULA of a species that acts as an ampholyte in the above reactions. (1)

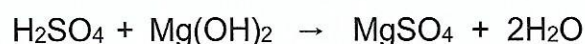
7.2.3 Write down the NAME of the conjugate base of hydrogen sulphite ion. (1)

- 7.3 Five grams (5 g) of an impure sample of sodium carbonate is added to 100 ml of a  $0,2 \text{ mol} \cdot \text{dm}^{-3}$  solution of sulphuric acid. The acid is in excess. The equation for the reaction is given as follows:



7.3.1 Calculate the number of moles of sulphuric acid. (3)

The excess acid neutralizes  $20 \text{ cm}^3$  of a solution of  $0,2 \text{ mol} \cdot \text{dm}^{-3}$  of magnesium hydroxide according to the following equation:

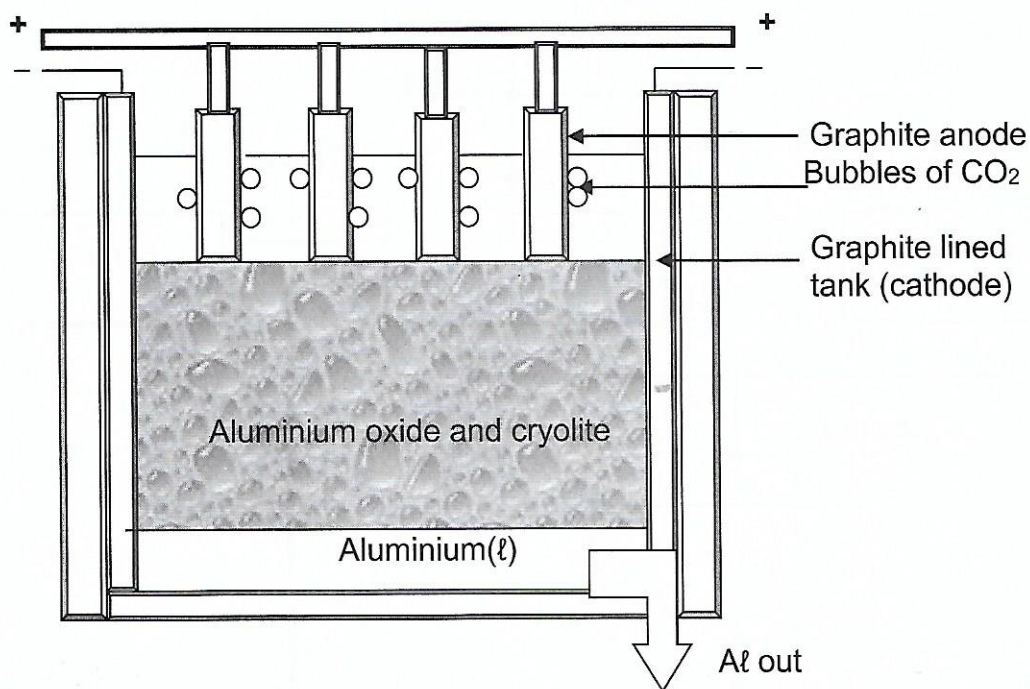


7.3.2 Calculate the mass of the impurity in the sodium carbonate sample. (7)  
**[22]**



**QUESTION 9 (Start on a new page.)**

The diagram below represents an electrolytic cell that is used for the extraction of aluminium from the ore, bauxite, known as hydrated aluminium oxide.



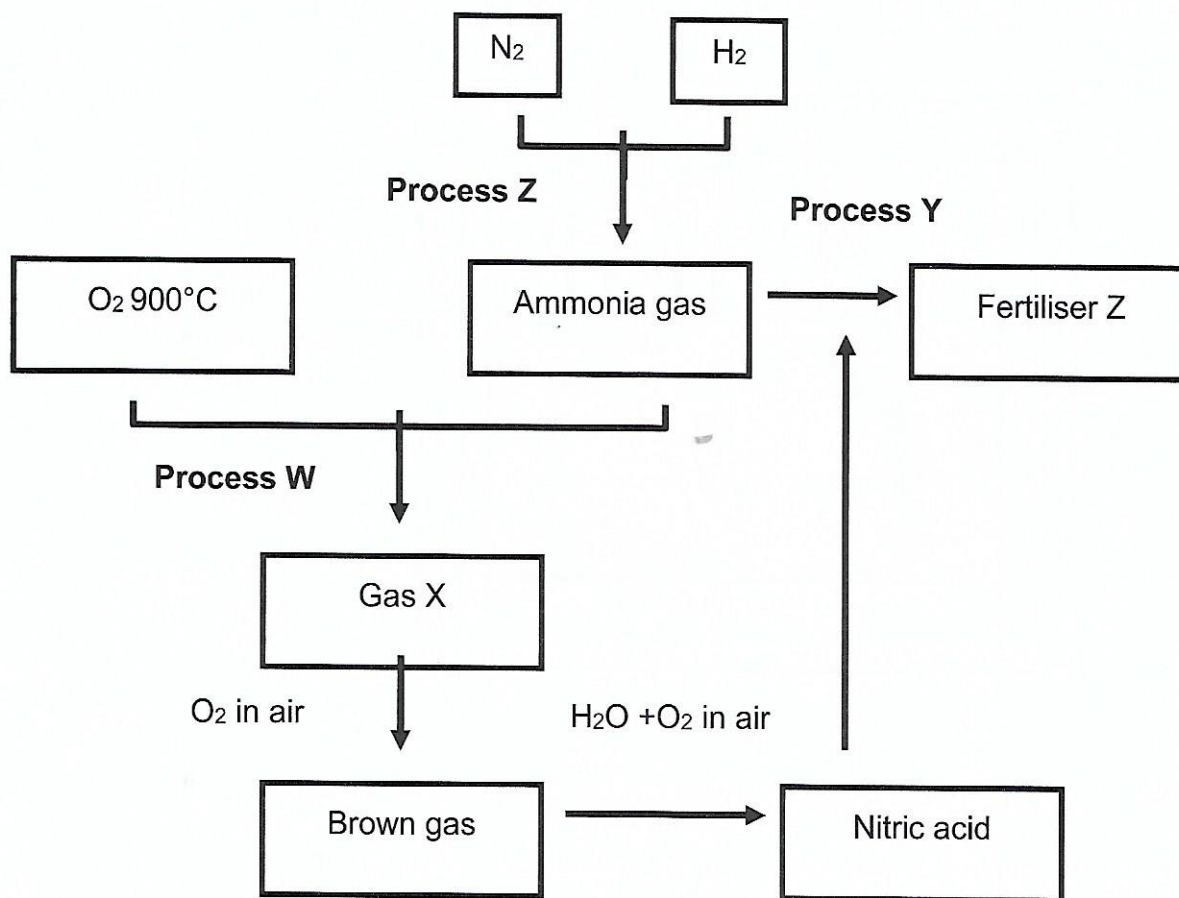
- 9.1 Which energy conversion takes place in this electrochemical cell. (2)
- 9.2 Identify the electrode at which the reduction reaction occurs. (1)
- 9.3 Write down the:
- 9.3.1 NAME and FORMULA of the substance that is used as a solvent for aluminium oxide. (2)
- 9.3.2 Chemical formula for bauxite. (2)
- 9.4 Why must the carbon electrodes in this cell be replaced regularly. (2)

**[9]**



**QUESTION 10 (Start on a new page.)**

In the flow diagram below ammonia gas is converted into nitrate salts.



10.1 In process **W** ammonia gas reacts with oxygen gas.  
Write down the:

10.1.1 NAME of the industrial process. (1)

10.1.2 Balanced chemical equation for process **W**. (3)

10.2 Ammonia reacts with nitric acid to produce fertilizer **Z**.  
Write down the:

10.2.1 NAME of the process **Y**. (1)

10.2.2 Balanced chemical equation for the preparation of  
fertilizer **Z**. (3)

10.3 For process **Z**, write down the:

10.3.1 Name of the industrial process (1)

10.3.2 Catalyst used in this process (1)

10.4 The information on a 10kg bag of fertilizer with an NPK ratio of 3:1:2 (23) states that this NPK ratio will result in sturdy plants with strong stems.

10.4.1 What does the term *NPK ratio* means? (2)

10.4.2 Calculate the Mass of the pure fertilizer in the bag. (3)  
[15]

**TOTAL: 150**