CWED/MNED COMMON PAPER

PHYSICAL SCIENCES - PAPER 2

GRADE 12 **AUGUST 2019**

EXAMINER: CW PLC **TIME: 3 HOURS**

MODERATORS: S HENEKE AND Z MOERAT **TOTAL: 150**

INSTRUCTIONS AND INFORMATION

1. Write your name in the space below and submit the Examination Paper with your Answer Book.

   GRADE: ……

   NAME: ……..

2. This question paper consists of 10 questions. Answer ALL the questions in the ANSWER BOOK.
3. Number the answers correctly according to the numbering system used in this question paper
4. Leave ONE line between two sub questions, for example between QUESTION 2.1 and QUESTION 2.2.
5. You may use a non-programmable calculator.
6. You may use appropriate mathematical instruments.
7. You are advised to use the attached DATA SHEETS.
8. Show ALL formulae and substitutions in ALL calculations.
9. Round off your final numerical answers to a minimum of TWO decimal places.
10. Give brief motivations, discussions etc where required.

QUESTION 1 (Multiple-choice)

Four options are provided as possible answers to the following questions. Each question has only ONE correct answer. Write only the letter (A – D) next to the question number (1.1 – 1.10) on your ANSWER BOOK.

1.1 Which ONE of the following compounds CANNOT be an alkene?

A C_2H_4

B C_3H_6

C C_3H_8

D C_4H_8 (2)

1.2 The reaction below takes place in the presence of a catalyst and at high temperatures. The equation for the reaction is:

$$C_{12}H_{26}\,(\ell) \rightarrow C_2H_4\,(g) + C_3H_6\,(g) + C_7H_{16}\,(\ell)$$

This reaction is an example of …

A Substitution

B Addition

C Polymerisation

D Cracking (2)

1.3 Study the following combustion reaction:

$$C_8H_{18} + O_2 \rightarrow \_\_\_\_\_ + \_\_\_\_\_$$

Which ONE of the following pairs of compounds (with balancing numbers) correctly represents the products formed during the COMPLETE combustion of octane?

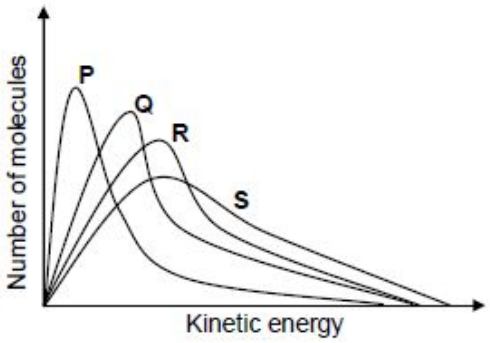
A 18CO and $16H_2O$

B 6CO and $18H_2$

C $18CO_2$ and $6H_2$

D $16CO_2$ and $18H_2O$ (2)

1.4 The graphs below represent the molecular distribution for a reaction at different temperatures.



Which ONE of the graphs above represents the reaction at the highest temperature?

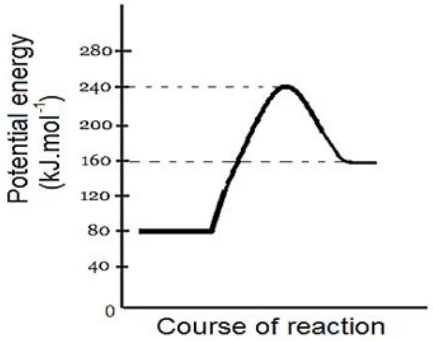
A P

B Q

C R

D S (2)

1.5 Consider the following potential energy diagram for a chemical reaction:



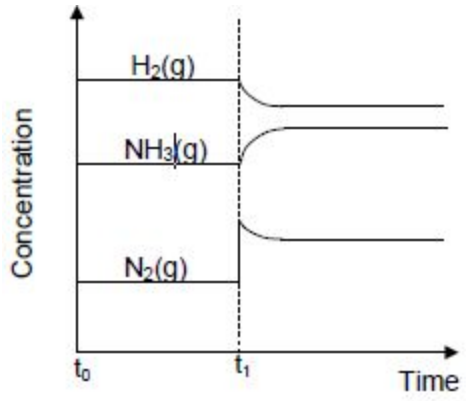
Which ONE of the following shows the values of the change in enthalpy and the activation energy for this reaction?

	Enthalpy change ($kJ.mol^{-1}$)	**Activation energy ($kJ.mol^{-1}$)**
A	200	40
B	160	240
C	80	160
D	160	80

(2)

1.6 The graph below shows a change made to a chemical equilibrium in a closed container at time t_1. The equation for the reaction is:

$$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g) \qquad \Delta H < 0$$



Which ONE of the following is the change made at time t_1?

A Addition of a catalyst

B Increase in temperature

C Increase in the concentration of $N_2(g)$

D Increase in pressure by decreasing the volume (2)

1.7 Which ONE of the following represents the products formed during the hydrolysis of ammonium chloride?

A NH_3 (aq) and H_3O^+ (aq)

B NH_4^+ (aq) and $C\ell^-$ (aq)

C $HC\ell$ (aq) and OH^- (aq)

D $C\ell^-$ (aq) and H_3O^+ (aq) (2)

1.8 Which indicator will be most suitable to use for the titration of sodium hydroxide (NaOH) with ethanoic acid (CH_3COOH)?

A Methyl red

B Phenolphthalein

C Bromothymol blue

D Universal indicator (2)

1.9 Which ONE of the following statements regarding an electrolytic cell is CORRECT?

A It could be used to refine metals..

B Reduction occurs at the anode.

C A spontaneous chemical reaction produces an electric current.

D Electrons flow to the electrode where oxidation occurs. (2)

1.10 Consider a galvanic cell based on the following reaction:

$$Sn^{4+}(aq) + Sn(s) \rightarrow 2Sn^{2+}(aq)$$

Which ONE of the following statements regarding this cell is CORRECT?

A Sn is the anode of the cell.

B Sn is the cathode of the cell.

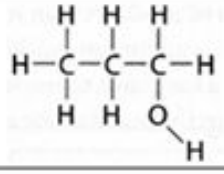
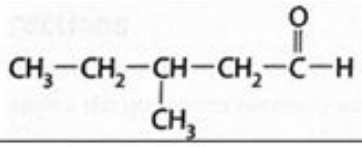
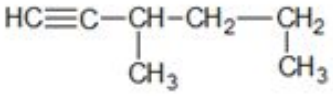
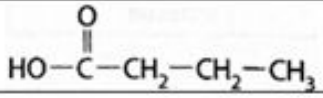
C $Sn^{4+}(aq)$ is the reducing agent.

D Sn is the oxidising agent. (2)

[20]

QUESTION 2 (Start on a new page.)

The letters A to F in the table represent six organic compounds.

A	$CH_2=CH-CH_2-CH_2-CH_2-CH_2-CH_3$	B	
C		D	
E	**hexan-2-one**	F	

2.1 Write down the letter that represents the following:
(You can use a compound more than once.)

2.1.1 A substance belonging to the homologous series with general formula $C_nH_{2n.}$ (1)

2.1.2 An alkyne (1)

2.1.3 An aldehyde (1)

2.1.4 A substance which has a carbonyl group as its functional group. (1)

2.2 Write down the:

2.2.1 IUPAC name of compound D (2)

2.2.2 STRUCTURAL FORMULA of compound E. (2)

2.2.3 IUPAC name of compound A. (2)

2.2.4 definition of a STRUCTURAL ISOMER. (2)

2.2.5 STRUCTURAL FORMULA of a FUNCTIONAL isomer of compound F. (2)

2.3.6 IUPAC name of a POSITIONAL isomer of compound B. (2)

[16]

QUESTION 3 (Start on a new page.)

An experiment is conducted to determine the boiling point of organic compounds with similar molecular mass from three different homologous series, indicated with letters **A to C**, determined under the same conditions. The results are given in the table below:

ORGANIC COMPOUND	MOLECULAR FORMULA	BOILING POINT (°C)
A	$CH_3CH_2CH_2OH$	+ 97
B	$CH_3CH_2CH_2CH_3$	- 1
C	CH_3CH_2CHO	+ 48

3.1 Write the NAME of the homologous series to which **A** belong. (1)

3.2 Formulate an investigative question for this practical investigation. (2)

3.3 Identify the:

3.3.1 DEPENDENT variable for this investigation. (1)

3.3.2 INDEPENDENT variable for this investigation. (1)

3.4 Write down the IUPAC name for compound **C**. (1)

3.5 Fully explain the difference between the boiling points of compound **A** and **B**. (4)

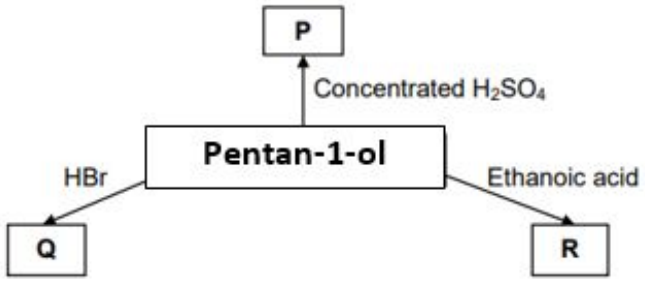
3.6 Which one of the above mentioned compounds will have the highest VAPOUR PRESSURE? Explain your answer. (2)

3.7 Explain why this investigation can be regarded as a fair test. (1)

[13]

QUESTION 4 (Start on a new page.)

Some of the reactions of **Pentan-1-ol** are represented in the flow diagram below. **P, Q** and **R** represent the organic products formed.



4.1 Is pentan-1-ol a PRIMARY, SECONDARY or TERTIARY alcohol? (1)

4.2 Product **P** is formed when pentan-1-ol is heated in the presence of **concentrated** sulphuric acid.

Write down the:

4.2.1 Name of the type of reaction that takes place. (1)

4.2.2 Balanced equation for the reaction that takes place using STRUCTURAL FORMULAE. (5)

4.3 Product **R** is formed when pentan-1-ol reacts with **ethanoic acid** in the presence of an **acid catalyst**.

Write down the:

4.3.1 Name of the type of reaction that takes place. (1)

4.3.2 Structural formula of the organic product formed. (2)

4.4 When **HBr** reacts with pentan-1-ol, compound **Q**, a haloalkane, is formed.

Write down the:

4.4.1 Name of the type of reaction that takes place. (1)

4.4.2 IUPAC name of the haloalkane formed. (2)

[13]

QUESTION 5 (Start on a new page.)

A group of learners uses the reaction of clean magnesium ribbon with dilute hydrochloric acid to investigate factors that influence reaction rate. The balanced equation for the reaction is:

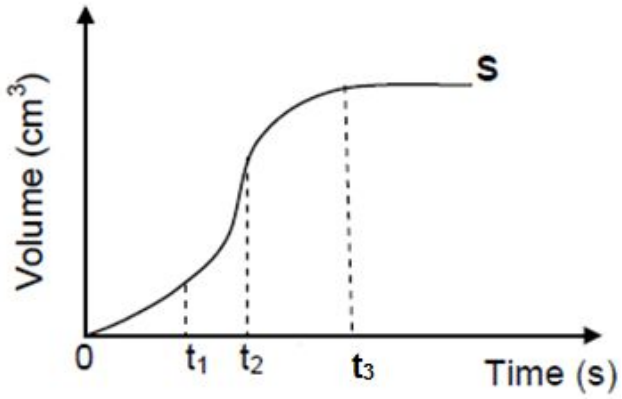
$$Mg(s) + 2HC\ell(aq) \rightarrow MgC\ell_2(aq) + H_2(g) \qquad \Delta H < 0$$

5.1 Is the above reaction EXOTHERMIC or ENDOTHERMIC? Give a reason for the answer. (2)

5.2 In one of the experiments 5 g magnesium ribbon was added to the hydrochloric acid solution.

5.2.1 If 30 cm^3 dilute hydrochloric acid solution of concentration 1,5 $mol \cdot dm^{-3}$ is USED UP in 1 minute, calculate the average reaction rate in $mol \cdot s^{-1}$. (5)

The volume of hydrogen gas produced as a function of time in this experiment is represented by graph **S** below. (The graph is NOT drawn to scale.)

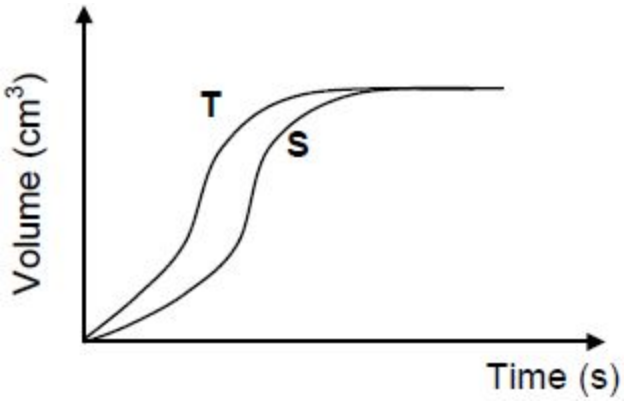


5.2.2 How does the reaction rate change between:
(Write down INCREASES, DECREASES or NO CHANGE.)

(a) t_1 and t_2
Use the COLLISION THEORY to explain the answer. (4)

(b) t_2 and t_3
Give a reason for the answer WITHOUT referring to the graph. (2)

5.3 In another experiment they add 5 g of magnesium to 30 cm^3 of dilute hydrochloric acid of concentration 1,5 $mol \cdot dm^{-3}$. They obtained graph **T** below. (The graph is NOT drawn to scale.)



Give TWO possible reasons why graph **T** differs from graph **S**. (2)

[15]

QUESTION 6 (Start on a new page.)

Methanol (CH_3OH) is manufactured by compressing a mixture of carbon monoxide (CO) and hydrogen (H_2) to 300 times atmospheric pressure. The mixture is passed over zinc oxide, that acts as a catalyst, at 300°C. The chemical equation is as follows:

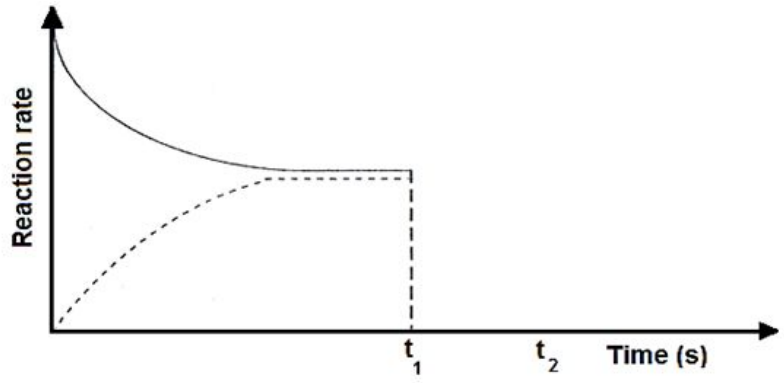
$$CO(g) + 2H_2(g) \rightleftharpoons CH_3OH(g) \qquad \Delta H > 0$$

6.1 Initially **x** mol of CO and 8 mol of H_2 are placed in a container with a volume of 10 dm^3. It is heated to 300°C to produce methanol. When equilibrium is established, the concentration of hydrogen in the container is 0,225 $mol.dm^{-3}$ and the value of the equilibrium constant is 6,22.

6.1.1 Define the term *chemical equilibrium*. (2)

6.1.2 Determine the initial amount (**x**) of CO that was placed in the container. (9)

The *Reaction rate versus Time* graph below shows how the equilibrium is reached. The dotted line indicates the reverse reaction.



6.2 State *Le Chatelier's principle* in words. (2)

6.3 REDRAW the graph and show ON THE SAME graph how the following changes will affect the equilibrium.

6.3.1 A catalyst is added at t_1. (1)

6.3.2 Temperature is increased at t_2. (1)

[15]

QUESTION 7 (Start on a new page.)

7.1 The **hydrogen sulphate ion** *can act as both an acid and a base*. It reacts with water according to the following balanced equation:

$$HSO_4^- (aq) + H_2O(\ell) \rightleftharpoons H_2SO_4(aq) + OH^- (aq)$$

7.1.1 Write down ONE word for a substance that *can act as both an acid and a base*. (1)

7.1.2 HSO_4^- (aq) acts as a base in the above reaction. Write down the formula of the conjugate acid of HSO_4^-(aq). (1)

7.2 Hydrochloric acid is a monoprotic acid. A learner neutralises some of a standard solution of hydrochloric acid of concentration 5 mol·dm^{-3} with sodium hydrogen carbonate powder in a flask. The reaction that takes place is: (Assume that the HCℓ ionises completely.)

$$HC\ell(aq) + NaHCO_3(s) \rightarrow NaC\ell(aq) + H_2O(\ell) + CO_2(g)$$

The effervescence (fizzing), due to the formation of carbon dioxide, stops after the learner has added 25 g sodium hydrogen carbonate to the acid.

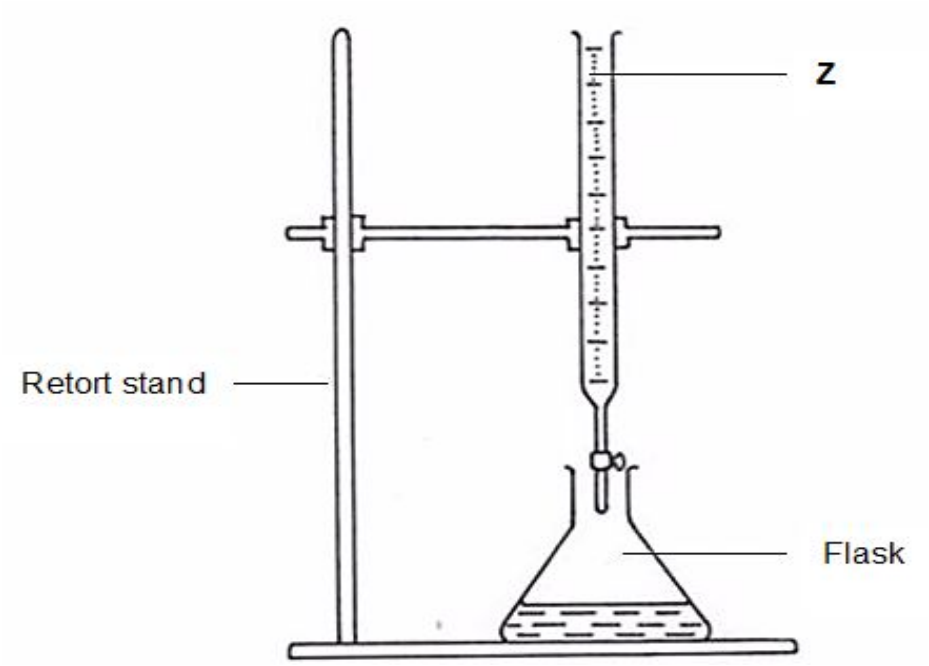
7.2.1 Give a reason why hydrochloric acid is referred to as a *monoprotic acid*. (1)

7.2.2 Calculate the volume of hydrochloric acid that was used. Assume that all the sodium hydrogen carbonate reacts with all the acid. (6)

The learner now dilutes some of the 5 mol·dm^{-3} hydrochloric acid solution in the flask to 0,3 mol·dm^{-3}.

7.2.3 Define the term *dilute acid*. (2)

7.3 During a titration, 25 cm^3 of the 0,3 $mol \cdot dm^{-3}$ hydrochloric acid (HCℓ) solution is added to an Erlenmeyer flask and titrated with a 0,2 $mol \cdot dm^{-3}$ sodium hydroxide solution (NaOH). The following apparatus was used:



The balanced equation for the reaction is:

$$HCl(aq) + NaOH(aq) \rightarrow NaCl(s) + H_2O(\ell)$$

7.3.1 Write down the NAME of the apparatus labelled **Z**. (1)

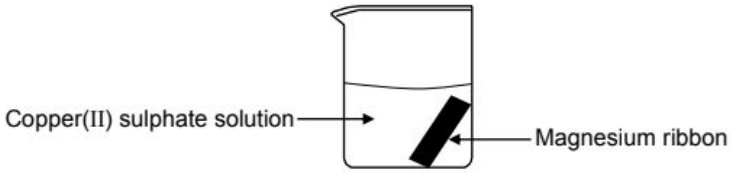
7.3.2 Calculate the pH of the solution in the flask after the addition of 30 cm^3 of sodium hydroxide. The endpoint of the titration is not yet reached at this point. (8)

7.3.3 Will the pH at the end of this titration be EQUAL TO 7, GREATER THAN 7 or SMALLER THAN 7? Explain your answer. (2)

[22]

QUESTION 8 (Start on a new page.)

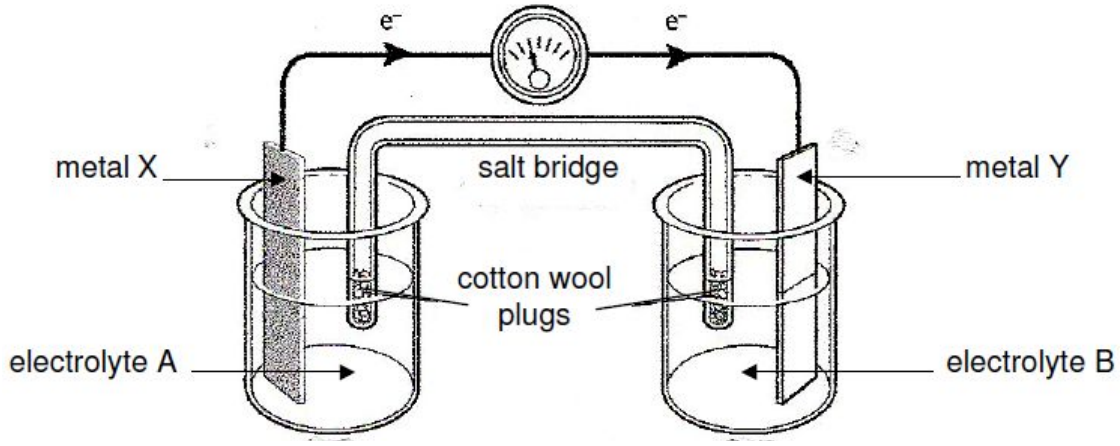
8.1 In an experiment, the learners place magnesium ribbon in a beaker containing a blue solution of copper(II) sulphate. After a while the solution becomes colourless.



8.1.1 State ONE observable change in the beaker, besides a colour change of the solution, that the learners can make. (1)

8.1.2 Refer to the relative strengths of oxidising agents or reducing agents to explain why the solution becomes colourless. (2)

8.2 The diagram below shows an electrochemical cell set up under standard conditions using aluminium (Aℓ) and nickel (Ni) electrodes. $A\ell C\ell_3(aq)$ and $NiC\ell_2(aq)$ are used as electrolytes, and a solution of sodium nitrate ($NaNO_3(aq)$) is used in the salt bridge.



Answer each of the following questions on this electrochemical cell:

8.2.1 The diagram indicates that electrons flow **from metal X to metal Y**. Identify:

(a) Metal **X** (1)

(b) Electrolyte **B** (1)

8.2.2 What is the initial concentration of electrolyte **B** under standard conditions? (1)

8.2.3 Write down the FORMULA of the ions that moves from the salt bridge towards the half cell that contains metal **Y** in the cell. (1)

8.2.4 Write down the half reaction that occurs at the cathode half cell. (2)

8.2.5 Calculate the initial reading on the voltmeter. (4)

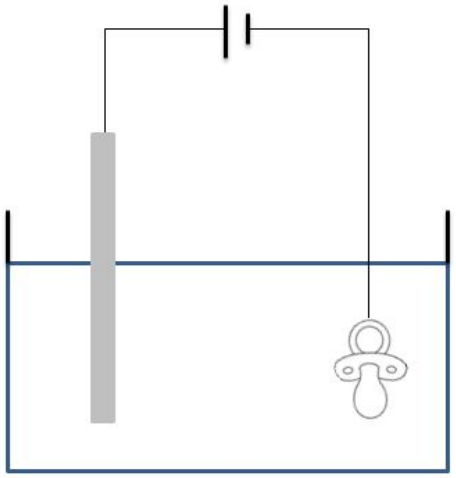
8.2.6 State what happens to the concentration of metal ions in the solution containing electrolyte A as the cell is in operation?
Write only INCREASE, DECREASE or REMAINS THE SAME. (1)

8.2.7 State the effect that your answer to question 8.2.6 has on the voltmeter reading?
Write only INCREASE, DECREASE or REMAINS THE SAME.
Briefly motivate your answer. (3)

[17]

QUESTION 9 (Start on a new page.)

A grandmother wants to preserve her first grandson`s baby dummy by electroplating it with silver. The dummy is made of plastic and at first coated with a layer of graphite before being dipped into an electrolyte.



9.1 What energy conversion takes place in the cell above? (2)

9.2 Will the dummy be the ANODE or CATHODE of the cell?
Explain your answer. (3)

9.3 What does the other electrode consist of? (1)

9.4 Write down the half-reaction that is responsible for the change on the dummy`s surface. (2)

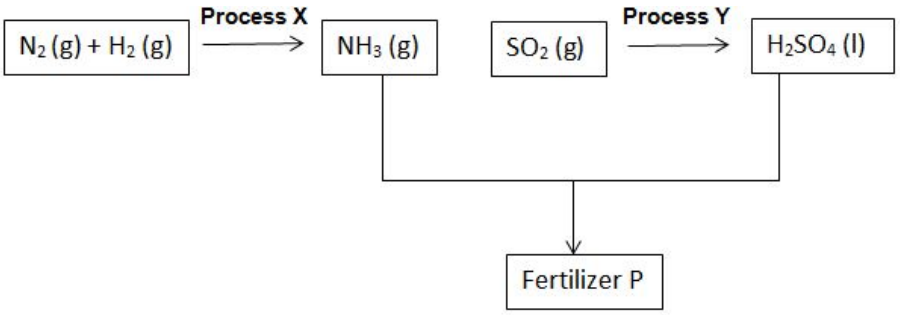
9.5 Write down a complete chemical formula for a possible electrolyte. (1)

9.6 Explain why the dummy should be covered with graphite before the plating process. (1)

[10]

QUESTION 10 (Start on a new page.)

10.1 The flow diagram below illustrates the processes involved in the preparation of fertiliser **P.**

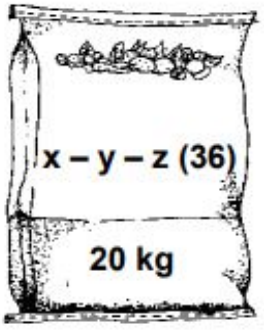


Write down the:

10.1.1 Names of processes X and Y. (2)

10.1.2 Balanced equation for the formation of fertiliser P. (3)

10.2 The diagram below shows a bag of NPK fertiliser of which the NPK ratio is unknown.



It is found that the mass of nitrogen in the bag is 4,11 kg and the mass of phosphorus is 0,51 kg.

Calculate the NPK ratio of the fertiliser. (4)

[9]

TOTAL: 150