LIMPOPO
PROVINCIAL GOVERNMENT
REPUBLIC OF SOUTH AFRICA

DEPARTMENT OF
EDUCATION

NATIONAL SENIOR CERTIFICATE

GRADE 12

PHYSICAL SCIENCES P2: CHEMISTRY

SEPTEMBER 2017

MARKS: 150

TIME: 3 hours

This question paper consists of 16 pages and 4 data sheets.

INSTRUCTIONS AND INFORMATION

1. Write your NAME in the appropriate space on the ANSWER BOOK.
2. This question paper consists of TEN questions. Answer ALL the questions in the ANSWER BOOK.
3. Start EACH question on a NEW page in the ANSWER BOOK.
4. You may use a non-programmable calculator.
5. You may use appropriate mathematical instruments.
6. YOU ARE ADVISED TO USE THE ATTACHED DATA SHEETS.
7. Number the answers correctly according to the numbering system used in this question paper.
8. Give brief motivations, discussions, et cetera where required.
9. Show ALL formulae and substitutions in ALL calculations.
10. Round off your final numerical answers to a minimum of TWO decimal places.
11. Write neatly and legibly

QUESTION 1: MULTIPLE- CHOICE QUESTIONS

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) in the ANSWER BOOK.

1.1 How many moles of water will be formed when one mole of ethane (C_2H_6) burns in an excess of oxygen?

$$2\ C_2H_6 + 5\ O_2 \rightarrow 2\ CO_2 + 6\ H_2O$$

A 6
B 4
C 3
D 1 (2)

1.2 An example of how useful products are obtained by the cracking of long chain hydrocarbons is represented by the equation below.

$$C_8H_{18} \rightarrow C_6H_{12} + Y$$

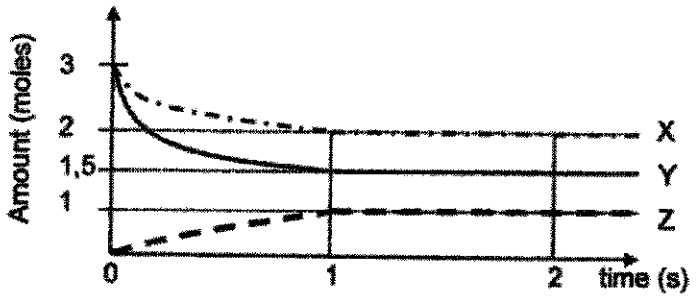
In this reaction, compound Y is:

A Propanol
B Propyne
C Propene
D Propane (2)

1.3 The monomer of polyethene is:

A Ethane
B Ethene
C Ethyne
D Propene (2)

1.4 The graph below shows the changes in the amounts of X, Y and Z versus time during a reaction.



The equation for the reaction can be represented as follows:

A $X + Y \rightarrow Z$

B $5X + 3y \rightarrow 2Z$

C $3X + 3Y \rightarrow Z$

D $2X + 3Y \rightarrow 2Z$ (2)

1.5 A chemical equilibrium is established when...

A No further reactions take place.

B None of the original chemicals are left.

C The concentrations of all chemicals are equal.

D The rates of the forward and reverse reactions are equal. (2)

1.6 In which ONE of the following reactions will the yield of the products be favoured by an increase in the pressure on the reaction mixture?

A $2\ NO(g) + Cl_2(g) \rightleftharpoons 2\ NOCl(g)$

B $CO(g) + H_2O(g) \rightleftharpoons CO_2(g) + H_2(g)$

C $2\ SO_3(g) \rightleftharpoons 2\ SO_2(g) + O_2(g)$

D $PCl_5(g) \rightleftharpoons PCl_3(g) + Cl_2(g)$ (2)

1.7 Which one of the following is CORRECT for a solution with pH = 4?

A $[H^+(aq)] = 10^{-10}$ mol·dm^{-3}

B $[OH^-(aq)] = 10^{-10}$ mol·dm^{-3}

C $[H^+(aq)] = 10^{4}$ mol·dm^{-3}

D $[OH^-(aq)] = 10^{-4}$ mol·dm^{-3} (2)

1.8 A beaker contains a 0,01 mol·dm^{-3} NaOH-solution. A spoonful of a soluble compound, X, is added to the solution and the pH of the solution decreases. Which ONE of the following can be compound X?

A Ammonium carbonate

B Ammonium chloride

C Potassium nitrate

D Sodium chloride (2)

1.9 A reaction is represented by the following equation:

$$MnO_2 + 4HCl \rightarrow MnCl_2 + 2H_2O + Cl_2$$

In this reaction MnO_2 acts as:

A An alkali

B A catalyst

C An oxidising agent

D A reducing agent (2)

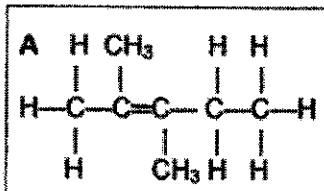
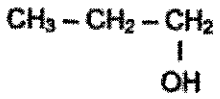
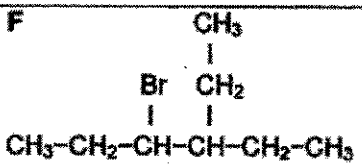
1.10 The main products formed by the Haber and Ostwald processes respectively are:

	Haber process	**Ostwald process**
A	Nitrogen	Nitric acid
B	Nitrogen	Ammonia
C	Ammonia	Sulphuric acid
D	Ammonia	Nitric acid

(2)
[20]

QUESTION 2 (Start on a new page)

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

A 	**B** Hexanoic acid
C $CH_3CH_2CH_2CHO$	**D** $CHCCH_3$
E 	**F** 

Use the information in the table (where applicable) to answer the following questions:

2.1 Write down the:

2.1.1 IUPAC name of compound **A** (2)

2.1.2 IUPAC name of compound **F** (2)

2.1.3 Structural formula of compound **D** (1)

2.2 What is a *structural isomer*? (2)

2.3 Which compound in the above table is a functional isomer of ethyl butanoate? (1)

2.4 Compound **E** reacts with compound **B**. Give the IUPAC name of the organic product that is formed. (2)
[10]

QUESTION 3 (Start on a new page)

Learners investigate factors that influence boiling point. The results obtained are shown in the table below.

	COMPOUND	MOLECULAR MASS	BOILING POINT (°C)
A	$CH_3(CH_2)_2COOH$	88	164
B	$CH_3(CH_2)_4OH$	88	138
C	$CH_3COOC_2H_5$	88	77

3.1 Define the term *boiling point.* (2)

3.2 From the table write down:

3.2.1 The independent variable (1)

3.2.2 The dependent variable (1)

3.2.3 A control variable (1)

3.3 What type of intermolecular force is found between molecules of compound **A**, which is not found in compound **C**? (1)

3.4 Compound **B** has a much higher boiling point than compound **C**. Fully explain this observation by referring to the type of intermolecular forces in each. (4)

3.5 2,2-dimethylpropan-1-ol is a structural isomer of compound **B.**

3.5.1 What is this type of an isomer called? (1)

3.5.2 Will the vapour pressure of 2,2-dimethylpropan-1-ol be HIGHER THAN, LOWER THAN or THE SAME as that of compound **B**? (1)
[12]

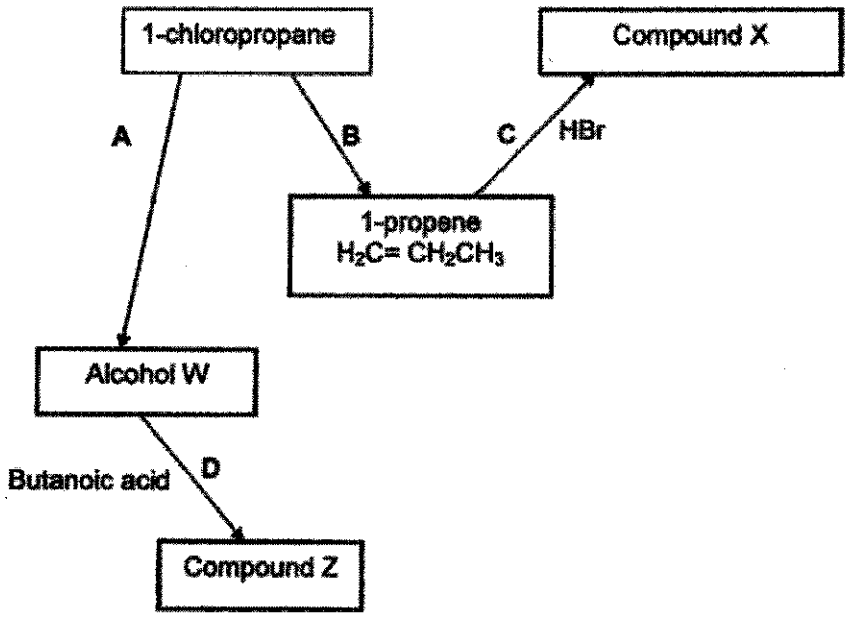
QUESTION 4 (Start on a new page)

4.1 Different organic compounds have different properties due to different functional groups.

4.1.1 Define the term *functional group*. (2)

4.1.2 Carboxylic acids, ketones and aldehydes all contain a carbonyl group. Give the structural formula of a carbonyl group. (1)

4.2 Study the flow diagram below and answer the questions that follow.



For reaction **B** write down the:

4.2.1 Balanced equation using structural formulae for the organic reactants and products (5)

4.2.2 Type of reaction that occurs (1)

4.2.3 Reaction conditions needed (2)

Alcohol W is produced in reaction **A**.

4.2.4 Write down the IUPAC name of alcohol W. (1)

4.2.5 Is alcohol W a primary or a secondary alcohol? (1)

For reaction **C** write down the:

4.2.6 Balanced equation using structural formulae for the organic reactants and products (2)

4.2.7 Type of reaction that occurs (1)

Consider reaction **D**.

4.2.8 How will you know that compound Z has formed? (1)

4.2.9 To which homologous series does compound Z belong? (1)

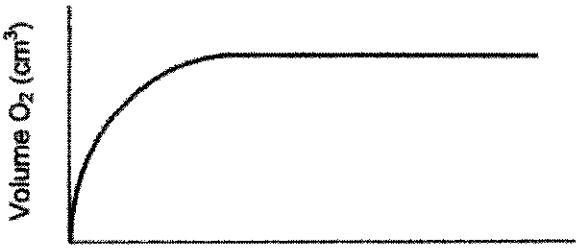
4.2.10 Write down the structural formula of the functional group of compound Z. (1)
[19]

QUESTION 5 (Start on a new page)

Manganese dioxide (MnO_2) acts as a CATALYST in the decomposition of hydrogen peroxide to produce water and oxygen. The equation for the reaction is as follows:

$$2H_2O_2(aq) \xrightarrow{MnO_2} 2H_2O(l) + O_2(g)$$

One gram (1 g) of MnO_2 powder is added to a hydrogen peroxide solution with a concentration of 2 mol·dm^{-3} at 25 °C and the volume $O_2(g)$ which is formed is measured with a gas syringe. The sketch graph below shows the results which were obtained.



5.1 Define the term *catalyst*. (2)

5.2 Redraw the graph in your answer book.

5.2.1 On THE SAME system of axes, sketch the graph that would be obtained if no catalyst is used. Label this graph **A**. (1)

5.2.2 On THE SAME system of axes, sketch the graph that would be obtained if more hydrogen peroxide, at a higher temperature, also with 1 g MnO_2 powder as catalyst, decomposes. Label this graph **B**. (2)

5.3 What mass of MnO_2 will be left at the end of the experiment? (1)

5.4 Define the term *reaction rate*. (2)

5.5 Use the collision theory and explain how a catalyst increases the rate of a reaction. (2)
[10]

QUESTION 6 (Start on a new page)

6.1 Study the reaction below:

$$\underset{\text{(colourless)}}{N_2O_4(g)} \rightleftharpoons \underset{\text{(brown)}}{2NO_2(g)} \quad \Delta H = +58\ kJ{\cdot}mol^{-1}$$

The initial potential energy of the reactants is 20 $kJ{\cdot}mol^{-1}$ and the activation energy for the forward reaction is 90 $kJ{\cdot}mol^{-1}$.

6.1.1 Draw a potential energy diagram for the course of this reaction. Indicate the following on your diagram:

- Energy of the reactants
- Energy of activated complex
- Activation energy of forward reaction (3)

6.1.2 On the same diagram, use a dotted line to indicate the effect of a catalyst on this reaction. (1)

6.1.3 Which reaction will be favoured if the temperature of the reaction mixture is increased? (Write only FORWARD or REVERSE.) (1)

6.1.4 Use Le Chatelier's Principle to explain the answer to QUESTION 6.1.3. (3)

6.2 The hypothetical reaction shown below takes place in a sealed container.

$$A_2(g) + B_2(g) \rightleftharpoons 2AB(g)$$

The change in the equilibrium constant, K_c, at different temperatures, is shown in the table below.

Temperature (°C)	K_c
1000	5,0
750	2,0
500	0,5

Use the information in the table and indicate whether the REVERSE REACTION is exothermic or endothermic. Briefly explain your answer. (3)

6.3 Study the reversible reaction represented by the balanced equation below:

$$H_2(g) + CO_2(g) \rightleftharpoons H_2O(g) + CO(g)$$

Initially x moles $H_2(g)$ are mixed with 0,3 moles $CO_2(g)$ in a sealed 10 dm^3 container. When equilibrium is reached at a certain temperature, it is found that 0,2 moles $H_2O(g)$ are present.

The equilibrium constant (K_c) for this reaction at this temperature is 4.

6.3.1 Calculate the initial number of moles, x, of $H_2(g)$ which were in the container. (9)

6.3.2 The concentration of CO_2 gas is now increased. How does this change affect the value of the equilibrium constant (Kc)? Write only INCREASES, DECREASES or REMAINS THE SAME. (1)

[21]

QUESTION 7 (Start on a new page)

7.1 The hydrogen carbonate ion (HCO_3^-) can act as both an acid and a base.

7.1.1 Define an acid and a base in terms of the Lowry-Bronsted theory. (2)

7.1.2 What are substances, which can act as both an acid and a base, called? (1)

Consider the following equations:

A. $H_2CO_3 + H_2O \rightleftharpoons H_3O^+ + HCO_3^-$

B. $HCO_3^- + H_2O \rightleftharpoons H_3O^+ + CO_3^{2-}$

7.1.3 In which of the above reactions does HCO_3^- acts as an acid? Answer only A or B. (2)

7.1.4 Give the conjugate base of H_2CO_3. (1)

7.1.5 Why is H_2CO_3 a diprotic acid? (1)

7.2 60 cm^3 of a 0,50 $mol \cdot dm^{-3}$ solution of hydrochloric acid is added to 0,8 g of solid calcium carbonate ($CaCO_3$). The $CaCO_3$ reacts completely. The balanced equation for the reaction is as follows:

$$2HCl + CaCO_3 \rightarrow CaCl_2 + CO_2 + H_2O$$

7.2.1 Calculate the number of moles of HCl that have reacted with the $CaCO_3$. (5)

7.2.2 Calculate the pH of the solution when the reaction is completed. (9)
[21]

QUESTION 8 (Start on a new page)

A learner sets up a standard Ni-Cu electrochemical cell and connects it to a 0,5 V bulb.

8.1 Write down the cell notation for this cell. (3)

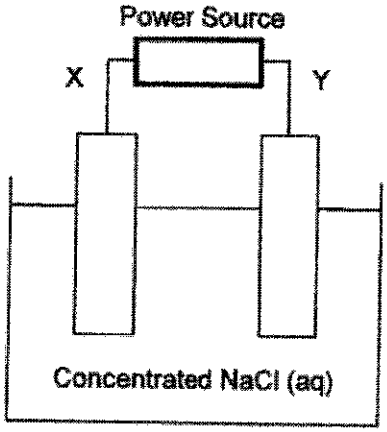
8.2 What is the polarity of the Ni electrode? (1)

8.3 Which electrode is the cathode? (1)

8.4 Use a relevant calculation to determine whether the bulb will burn or not. (6)
[11]

QUESTION 9 (Start on a new page)

The simplified diagram below represents an electrolytic cell which is used for the electrolysis of a concentrated sodium chloride solution.



Chlorine gas is released at electrode Y.

9.1 Which electrode, X or Y, is positive? (1)

9.2 What will be formed at electrode X? (1)

9.3 Write down the half reaction to explain your answer to QUESTION 9.2. (2)

9.4 Is X the cathode or the anode? (1)

9.5 In which direction do electrons flow in the external circuit? (X to Y or Y to X.) (1)

9.6 Give the NAME of the substance that acts as reducing agent. (1)

9.7 Write a balanced net equation for the reaction that takes place in this cell. (3)
[10]

QUESTION 10 (Start on a new page)

A group of learners want to start a vegetable garden at school to supply the community with vegetables. They are given three bags of fertilizer by a farmer. The three bags are marked as follows:

FERTILIZER A: 3:2:1 (28)
FERTILIZER B: 2:3:4 (22)
FERTILIZER C: Ammonium sulphate

10.1 What is represented by each of the following in fertilizer A?

10.1.1 3:2:1 (1)

10.1.2 28 (1)

10.2 Calculate the:

10.2.1 Percentage nitrogen in fertilizer A (3)

10.2.2 Mass of potassium present in a 20 kg bag of fertilizer B (3)

10.3 Write a balanced equation for the preparation of fertilizer C from ammonia and a suitable acid. (3)

10.4 Give the name of the process which is used to manufacture the acid needed for the preparation of fertilizer C. (1)

10.5 Name ONE function of phosphorous in plants. (1)

After some time a fish pond in the garden turns green and starts to smell.

10.6 Name the phenomenon which occurs in the fish pond. (1)

10.7 Give a possible cause for the phenomenon in QUESTION 10.6. (1)

10.8 Name ONE negative impact that this phenomenon may have. (1)
[16]

GRAND TOTAL: 150