LIMPOPO
PROVINCIAL GOVERNMENT
REPUBLIC OF SOUTH AFRICA

DEPARTMENT OF EDUCATION

NATIONAL SENIOR CERTIFICATE

GRADE 12

PHYSICAL SCIENCES P2: CHEMISTRY

SEPTEMBER 2018

MARKS: 150

TIME: 3 hours

This question paper consists of 14 pages and 4-paged 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 Which ONE of the following pairs of compounds contain members of the same homologous series?

A C_2H_4 and C_3H_6
B C_3H_6 and C_4H_6
C CH_4O and $C_2H_4O_2$
D $C_2H_4O_2$ and $C_3H_5O_2$ (2)

1.2 The following equation represents the cracking of a hydrocarbon at high temperature and pressure:

$$C_{11}H_{24} \rightarrow 2C_2H_4 + Y + C_4H_{10}$$

Which ONE of the following can be the IUPAC name of product Y?

A Pent-1-ene
B Pentane
C Prop-1-ene
D Propane (2)

1.3 2-chloro butane is strongly heated in the presence of concentrated sodium hydroxide. The major product that forms is:

A But-1-ene
B But-2-ene
C Butan-1-ol
D Butan-2-ol (2)

1.4 Consider the chemical reaction represented by the balanced equation below:

$$CaCO_3(s) + 2HC\ell(aq) \rightleftharpoons CaC\ell_2(s) + CO_2(g) + H_2O(\ell)$$

Which ONE of the following changes will increase the rate of $CO_2(g)$ production?

A Increase in pressure.
B Increase in the mass of $CaCO_3$.
C Increase in the volume of $HC\ell(aq)$.
D Increase in the concentration of $HC\ell(aq)$. (2)

1.5 The equilibrium in a closed container is represented by the following equation:

$$2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g) \quad \Delta H<0$$

Which ONE of the following actions will increase both the K_c-value and the concentration of SO_3 present at equilibrium?

A Increasing the concentration of oxygen.
B Decreasing the temperature.
C Increasing the temperature.
D Increasing the pressure at constant temperature. (2)

1.6 Consider the following equation:

$$CaO(s) + SO_2(g) \rightleftharpoons CaSO_4(s)$$

If the equilibrium concentration of $SO_2(g)$ at 25 °C is equal to x $mol{\cdot}dm^{-3}$, then the value of the equilibrium constant at this temperature will be equal to:

A x
B x^2
C $\frac{1}{x^2}$
D $\frac{1}{x}$ (2)

1.7 A solution has a pH of 1. This solution:

A Is always a strong acid
B Is always a weak base
C Contains a higher concentration of H_3O^+ -ions than OH^- -ions
D Contains a higher concentration of OH^- -ions than H_3O^+-ions (2)

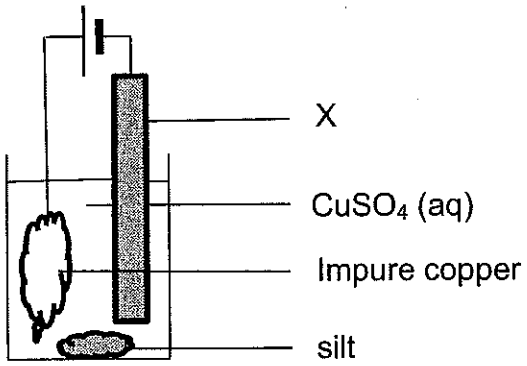
1.8 $MnO_4^-(aq)$ –ions are reduced by hydrogen sulphide (H_2S) gas. The equation representing the oxidation half reaction is:

A $H_2S \rightarrow 2H^+ + S + 2e^-$
B $2H^+ + S + 2e^- \rightarrow H_2S$
C $Mn^{2+} + 4H_2O \rightarrow MnO_4^- + 8H^+ + 5e^-$
D $MnO_4^- + 8H^+ + 5e^- \rightarrow Mn^{2+} + 4H_2O$ (2)

1.9 Which ONE of the following pairs of metals will have the highest emf if they are used as electrodes in a standard electrochemical cell? (Use the redox table)

A Zn and Cu
B Pb and Hg
C Zn and Ag
D Fe and Pb (2)

1.10 The diagram below represents a cell which is used to refine copper. The impure copper contains silver and zinc .



Which ONE of the following half reactions will occur at electrode X?

A $SO_4^{2-} + 4H^+ + 2e^- \rightarrow SO_2 + H_2O$
B $Cu \rightarrow Cu^{2+} + 2\ e^-$
C $Cu^{2+} + 2e^- \rightarrow Cu$
D $Zn^{2+} + 2e^- \rightarrow Zn$ (2)

[20]

QUESTION 2 (Start on a new page)

2.1 Consider the following two organic compounds:

A. $CH_3 - CH_2 - CH_2 - CH_2 - O - H$

B. $CH_3 - CH_2 - C - O - O - H$

2.1.1 To which homologous series does compound **B** belong? (1)

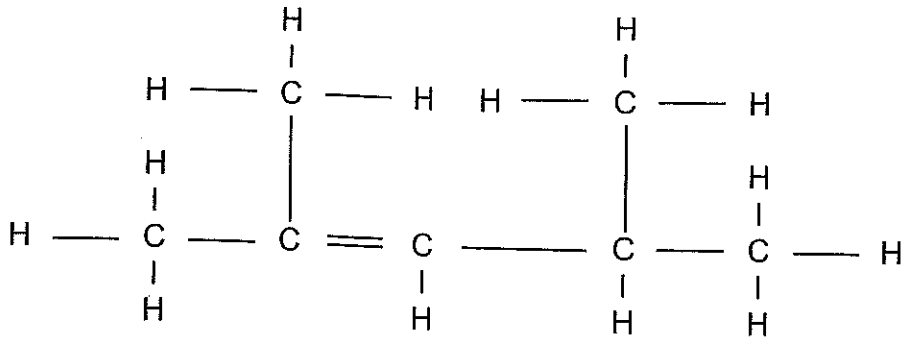
2.1.2 Define the term *isomers*. (2)

2.1.3 Use STRUCTURAL FORMULAE and write down a functional isomer of compound **B.** (2)

2.1.4 Use STRUCTURAL FORMULAE and write a balanced equation for the reaction which occurs when **A** and **B** react. (4)

2.1.5 Give the IUPAC name of the organic product that forms in the reaction mentioned in 2.1.4. (2)

2.2 Write the IUPAC name of the compound represented by the structural formula below.



(2)
[13]

QUESTION 3 (Start on a new page)

The table below shows the results obtained during an experiment to determine the boiling points of some alkanes and alcohols with comparable molecular masses.

	Compound	Relative molecular mass	Boiling point (°C)
A	CH_3CH_3	30	-89
B	CH_3OH	32	65
C	$CH_3CH_2CH_3$	44	-42
D	CH_3CH_3OH	46	78
E	$CH_3CH_2CH_2CH_3$	58	0
F	$CH_3CH_2CH_2OH$	60	97
G	$CH_3CH_2CH_2CH_2CH_3$	72	36
H	$CH_3CH_2CH_2CH_2OH$	74	117

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

3.2 Consider the boiling points of the four alkanes (A,C,E and G) in the above table.

3.2.1 What is the phase of G at room temperature? (1)

3.2.2 Describe the tendency in boiling points of the alkanes from A to G. (1)

3.2.3 How will the boiling point of a chain isomer of E compare with the boiling point of compound E? (Choose from HIGHER THAN, LOWER THAN or THE SAME.)
Explain your answer. (2)

3.3 The boiling point of alcohol F is much higher than that of alkane E. Explain this observation by referring to the type and strength of intermolecular forces in alkanes and alcohols as well as the energy involved. (3)

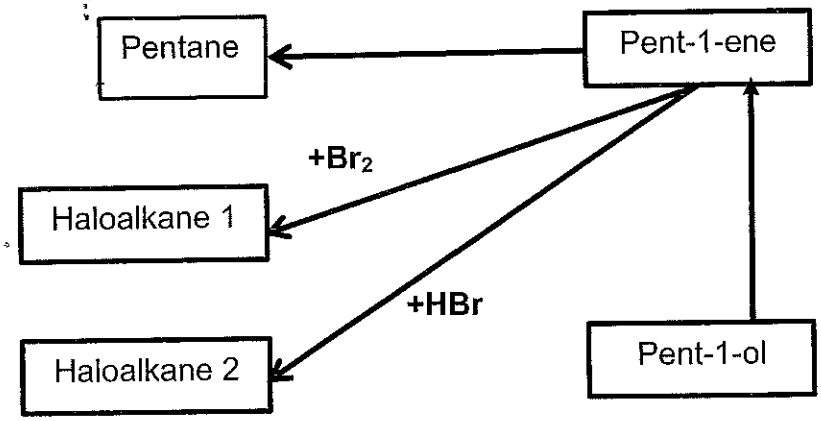
3.4 3.4.1 Define the term *vapour pressure.* (2)

3.4.2 How will the vapour pressure of compound H compare with the vapour pressure of compound B? (Choose from HIGHER THAN, LOWER THAN or THE SAME.) (1)

3.5 Use structural formulae to draw a structural isomer of compound H which is also a tertiary alcohol. (2)
[14]

QUESTION 4 (Start on a new page)

A learner decides to investigate certain reactions of pent-1-ene. He draws the following flow diagram to assist him:



4.1 Pent-1-ene reacts with bromine water (Br_2) at room temperature.

4.1.1 What is observed during the reaction? (1)

4.1.2 Name the type of addition reaction which occurs. (1)

4.2 Pent-1-ene reacts with HBr.

4.2.1 Use structural formulae to represent this reaction. (3)

4.2.2 Give the name of the major product in the above reaction. (2)

4.2.3 The learner wants to change this major product back to an alkene. Name a reactant as well as two reaction conditions which are needed in order to achieve this. (3)

4.3 The learner wants to change pent-1-ol into pent-1-ene. Give the formula of the catalyst needed for this reaction. (1)

4.4 Pent-1-ene reacts with a compound and forms pentane.

4.4.1 Give the NAME of the compound with which pent-1-ene reacted. (1)

4.4.2 Pentane reacts with oxygen. Write a balanced equation for this reaction by using molecular formulae. (3)

4.4.3 Is the reaction in 4.4.2 an exothermic or endothermic reaction? ' (1)
[16]

QUESTION 5 (Start on a new page)

The Haber process for the industrial preparation of ammonia can be represented by the following chemical reaction:

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

5.1 5.1.1 Is the reaction a homogeneous or a heterogeneous reaction? (1)

5.1.2 What is indicated by ΔH? (1)

5.1.3 Give the NAME of the catalyst which can be used in this reaction. (1)

5.2 One of the ways in which the reaction rate can be increased is by increasing the concentration of N_2. Explain in terms of the collision theory why the reaction rate will increase. (3)

5.3 Other methods to increase the reaction rate of this reaction are listed below:

A: Addition of a suitable catalyst
B: Increasing temperature
C: Increasing pressure by decreasing the volume of the container

Use the letter A, B or C to indicate which of these methods will:

5.3.1 Decrease the amount of $NH_3(g)$ which is produced at equilibrium Explain. (4)

5.3.2 Have no effect on the amount of $NH_3(g)$ which is produced at equilibrium (2)

5.2.3 increase the amount of $NH_3(g)$ which is produced at equilibrium (2)
[14]

QUESTION 6 (Start on a new page)

6.1 The first step in the Ostwald process for the manufacture of nitric acid is the catalytic oxidation of ammonia. A platinum alloy gauze is used as catalyst. The gauze is heated at the start of the process.
The equation for the reaction is:

$$4NH_3(g) + 5O_2(g) \rightleftharpoons 4NO(g) + 6H_2O(g) \quad \Delta H = -905\ kJ{\cdot}mol^{-1}$$

6.1.1 Define the term *catalyst.* (2)

6.1.2 Why does the platinum alloy gauze remain warm during this process? (2)

The second step in the Ostwald process takes place in a closed container and is represented by the following equation:

$$2NO(g) + O_2(g) \rightleftharpoons 2NO_2(g) \quad \Delta H = -113\ kJ{\cdot}mol^{-1}$$

6.1.3 Use Le Chatelier's principle to explain what effect the increase of pressure will have on the yield NO_2. (3)

6.2 The equation below represents an equilibrium reaction in a sealed 1 dm^{-3} container:

$$NO_2(g) + NO(g) \rightleftharpoons N_2O(g) + O_2(g) \qquad \Delta H > 0$$

Equilibrium is reached at a certain temperature. The K_c value at this temperature is 3,93 and the concentrations for each reactant and product in the container at equilibrium was:

$[NO_2] = 0,06\ mol{\cdot}dm^{-3}$
$[NO] = 0,29\ mol{\cdot}dm^{-3}$
$[N_2O] = 0,18\ mol{\cdot}dm^{-3}$
$[O_2] = 0,38\ mol{\cdot}dm^{-3}$

One of the conditions which influence equilibrium is changed and a new equilibrium is reached. The concentration NO_2 at this new equilibrium is $0,12\ mol{\cdot}dm^{-3}$.

6.2.1 Calculate the K_c value at the new equilibrium. (8)

6.2.2 Name the condition which was changed and explain how it was changed. (2)
[18]

QUESTION 7 (Start on a new page)

7.1 The concentrations of hydronium ions i (H_3O^+) and hydroxide (OH^-) in a sample of sea water are 10^{-8} mol·dm^{-3} and 10^{-6} mol·dm^{-3} respectively.

7.1.1 Is the sea water acidic or basic? (1)

7.1.2 Calculate the pH of the sea water. (2)

7.1.3 Shells which consist mainly of $CaCO_3$, are possibly responsible for the pH of the sea water.
Write down a balanced equation to confirm this statement. (2)

7.2 A solution is prepared by adding 25,0 cm^3 of a 0,20 mol·dm^{-3} NaOH solution to 40,0 cm^3 of a 0,15 mol·dm^{-3} HCl solution.
The balanced equation for this reaction is:

$$NaOH + HCl \rightarrow NaCl + H_2O$$

7.2.1 One of the reactants is in excess. Calculate the number of moles of this reactant which will be left at the end of the reaction. (7)

7.2.2 Calculate the pH of the final solution. (5)
[17]

QUESTION 8 (Start on a new page)

8.1 Two half cells, Fe (s)/Fe^{2+} (aq) and O_2 (g)/H_2O (ℓ) in an acidic solution are used to set up an electrochemical cell. The cell works under standard conditions.

8.1.1 Write down the standard conditions which are applicable to this cell (3)

8.1.2 Which half- cell represents the anode? (2)

8.1.3 Write down the balanced equation for the oxidation half reaction. (2)

8.1.4 Write down the balanced equation for the reduction half reaction. (2)

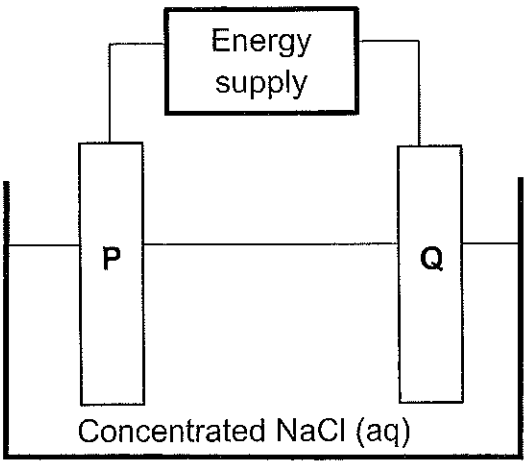
8.1.5 Write down the cell notation for this cell. (3)

8.1.6 Calculate the emf of this cell. (4)

8.2 A magnesium rod is attached to underground iron pipes in order to prevent the pipes from rusting. Explain in terms of relative strengths of reducing agents how this is possible. (3)
[19]

QUESTION 9 (Start on a new page)

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



Chlorine gas is given off at electrode **Q**.
Write down the:

9.1 Electrode where reduction takes place (**P** or **Q**) (1)

9.2 Half reaction which occurs at electrode **P** (2)

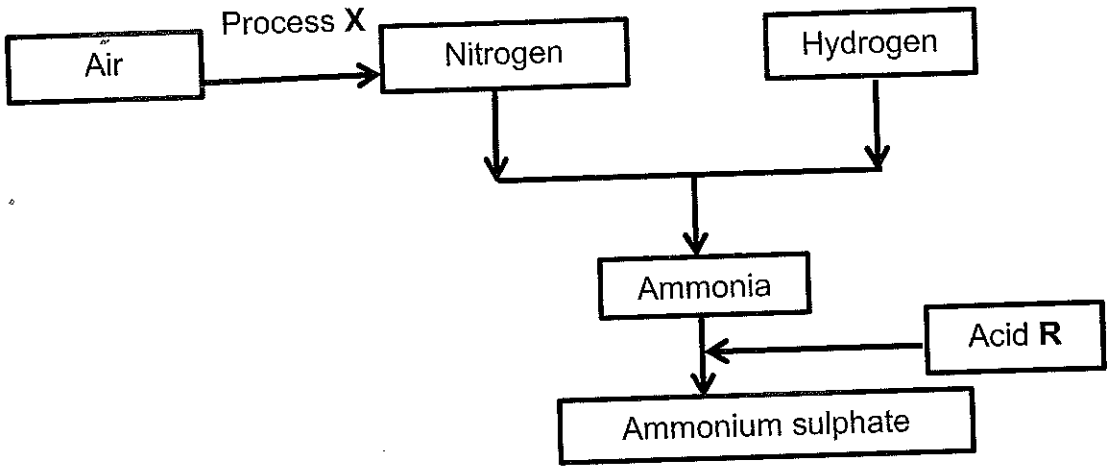
9.3 Direction in which electrons flow in the external circuit (**P** to **Q** or **Q** to **P**) (1)

9.4 NAME of the reducing agent in this reaction (1)

9.5 This process is used in the chloro-alkaline industry. Write down the FORMULAE of two products which are manufactured during this process. (2)
[7]

QUESTION 10 (Start on a new page)

The flow diagram below represents processes which are used in the fertilizer industry.



10.1 Write down:

10.1.1 The name of the industrial process **X** (1)

10.1.2 The name of the process used to manufacture acid **R** which is used to manufacture ammonium sulphate (1)

10.1.3 A balanced equation for the preparation of ammonium sulphate (3)

10.2 The following information appears on a 50 kg bag of fertilizer. -

N : P : K
3 : 1 : 5 (30)

10.2.1 What does the N:P:K on the bag represent? (2)

10.2.2 Calculate the mass of nitrogen in the bag. (3)

10.2.3 Calculate the mass of filler in the bag. (2)
[12]

TOTAAL: 150