education

Department:
Education
PROVINCE OF KWAZULU-NATAL

NATIONAL
SENIOR CERTIFICATE

GRADE 12

PHYSICAL SCIENCES P2 (CHEMISTRY)

PREPARATORY EXAMINATION

SEPTEMBER 2019

MARKS : 150

TIME : 3 Hours

This question paper consists of 14 pages, a special answer sheet and 4 data sheets.

INSTRUCTIONS AND INFORMATION

1.   Write your centre number and examination number in the appropriate spaces 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.   Number the answers correctly according to the numbering system used in this question paper.

5.   Leave ONE line between two subquestions, for example between QUESTION 2.1 and QUESTION 2.2.

6.   You may use a non-programmable calculator.

7.   You may use appropriate mathematical instruments.

8.   You are advised to use the attached DATA SHEETS.

9.   Show ALL formulae and substitutions in ALL calculations.

10.   Round off your final numerical answers to a minimum of TWO decimal places.

11.   Give brief motivations, discussions et cetera where required.

12.   Write neatly and legibly.

QUESTION 1: MULTIPLE-CHOICE QUESTIONS

Various options are provided as possible answers to the following questions. Choose the answer and write only the letter (A-D) next to the question number (1.1-1.10) in the ANSWER BOOK, for example 1.11 D.

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

A   Halogenation.

B   Dehydropolymerisation.

C   Addition polymerisation.

D   Condensation polymerisation.   (2)

1.2   A compound with the molecular formula $C_5H_{10}O$ could be . . .

(I) an ester.
(II) a ketone.
(III) an aldehyde.

A   (I) only.

B   (I) and (II) only

C   (II) and (III) only

D   (I), (II) and (III)   (2)

1.3   A catalyst will change the . . .

A   time required to reach equilibrium.

B   amount of products present at equilibrium.

C   amount of reactants present at equilibrium.

D   length time for a reaction remains at equilibrium.   (2)

1.4   The difference between the potential energy of the products and the potential energy of the reactants in a chemical reaction is equal to the . . .

A   rate of the reaction.

B   enthalpy of the reaction.

C   enthalpy change of the reaction.

D   total potential energy of the particles.   (2)

1.5   Which ONE of the following represents the products formed during the hydrolysis of sodium ethanoate, $NaCH_3COO$?

    A $Na^+(aq)$ and $OH^-(aq)$

    B $Na^+(aq)$ and $CH_3COO^-(aq)$

    C $H_3O^+(aq)$ and $CH_3COO^-(aq)$

    D $CH_3COOH(aq)$ and $OH^-(aq)$ (2)

1.6   The reaction, $H_2(g) + I_2(g) \rightleftharpoons 2HI(g)$, $\Delta H < 0$, reaches equilibrium at a temperature of 445 °C in a sealed container.
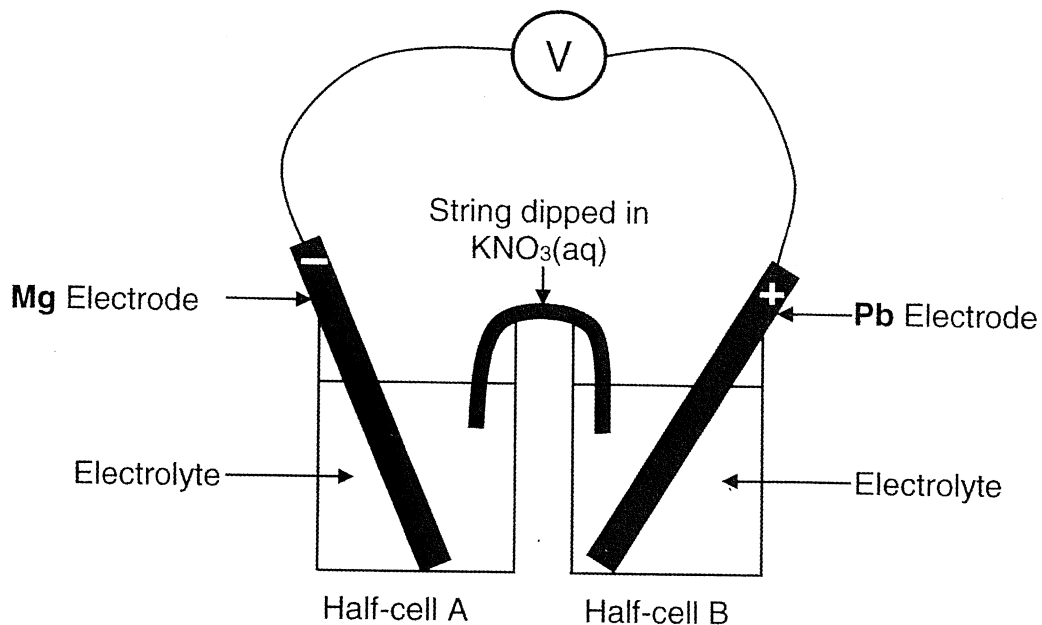
    Which ONE of the following change/s will INCREASE the CONCENTRATION of $HI(g)$?

    I adding a catalyst
    II decreasing the temperature
    III increasing the pressure by reducing the volume of the reaction container

    A   only II

    B   only III

    C   I and II only

    D   II and III only   (2)

1.7   Learners set up an electrochemical cell, shown in the simplified diagram below, using magnesium and lead electrodes.


Which of the following changes will INCREASE the reading on the voltmeter?

(i)   Decreasing the initial concentration of the electrolyte in half-cell A.

(ii)   Decreasing the initial concentration of the electrolyte in half-cell B.

(iii) Increasing the initial concentration of the electrolyte in half-cell A.

(iv)   Increasing the initial concentration of the electrolyte in half-cell B.

A   (i) Only

B   (ii) only

C   (ii) and (iii) only

D   (i) and (iv) only

(2)

1.8   The balanced equation for the net(overall) cell reaction that occurs during the electrolysis of a concentrated sodium chloride solution is :

$$2 H_2O(\ell) + 2 C\ell^- \rightarrow C\ell_2(g) + H_2(g) + 2OH^-(aq)$$
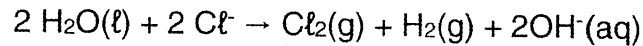
Which ONE of the following statements concerning the above electrolysis is TRUE?

A   The reaction is exothermic.

B   The reaction is spontaneous.

C   chlorine gas is formed at the anode.

D   hydrogen gas is formed at the anode.   (2)

1.9   Which ONE of the following reactions DOES NOT occur during the Contact Process?

A $S + O_2 \rightarrow SO_2$

B $2 SO_2 + O_2 \rightarrow 2 SO_3$

C $SO_3 + H_2O \rightarrow H_2SO_4$

D $SO_3 + H_2SO_4 \rightarrow H_2S_2O_7$ (2)

1.10   Phosphorous rich fertiliser . . .

A   improves the quality of fruit and flowers.

B   is used to stimulate root growth in plants.

C   is produced industrially by the Ostwald process.

D   is essential for growing plants with strong stems and healthy green leaves.

(2)
[20]

QUESTION 2 (Start on a new page.)

The letters A to G in the table below represent seven organic compounds.

A	propanoic acid	B	$CH_3CH_2CH_2COCH_2CH_3$
C		**D**	
E	$CH_3CCCH(CH_3)CH_3$	**F**	ethene
G	$CH_3(CH_2)_3CH_3$		

2.1   Using the information in the table, write down the:

     2.1.1   IUPAC name of compound **B**.   (2)

     2.1.2   Name of the FUNCTIONAL GROUP of the homologous series to which compound **A** belongs.   (1)

     2.1.3   Structural formula of compound **E**.   (2)

     2.1.4   The type of polymerisation where F is the monomer.   (1)

     2.1.5   IUPAC name and structural formula of the polymer formed from compound **F**.   (3)

     2.1.6   Letter that represents a compound that is a chain isomer of 2,2 – dimethylpropane.   (1)

2.2   Compound **C**, in the table is the product of the reaction between an alcohol and a carboxylic acid in the presence of concentrated sulphuric acid.

     Write down the:

     2.2.1   Homologous series to which compound **C** belongs.   (1)

     2.2.2   IUPAC name of compound **C**.   (2)

     2.2.3   Structural formula of the carboxylic acid required to prepare compound **C**.   (2)

     2.2.4   Function of concentrated sulphuric acid in the above reaction.   (1)

2.3   Compound C, in the table, has isomers.

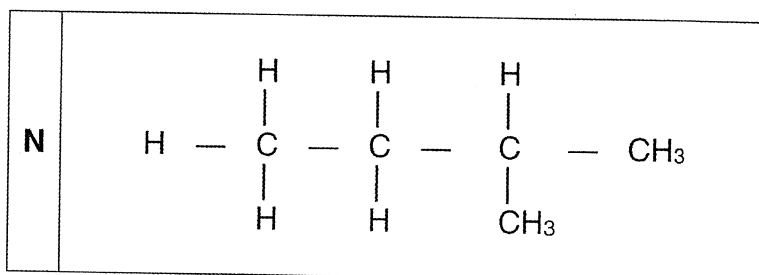   2.3.1   Define the term *functional isomer*.   (2)

    2.3.2   Write down the IUPAC name of the straight chain functional isomer of compound **C**.   (2)

[20]

QUESTION 3 (Start on a new page.)

Consider the organic compounds represented by the letters **M** and **N** below:
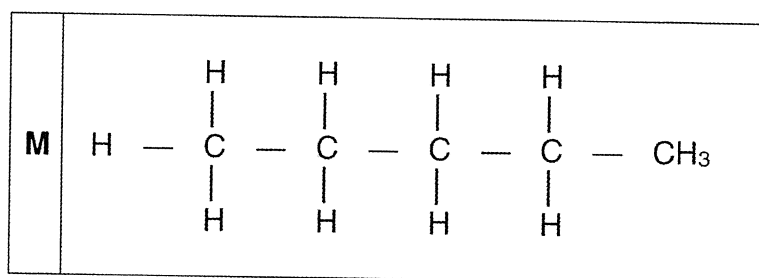
An investigation is performed to determine which compound; **M** or **N** has a higher vapour pressure.

3.1   Define *vapour pressure*.   (2)

3.2   For this investigation write down:

    3.2.1   The independent variable.   (1)

    3.2.2   A controlled variable.   (1)

3.3   This investigation is carried out at an atmospheric pressure of 100 kPa.

The temperature at which the vapour pressure of compound N equals 100 kPa is 27,80 °C.

   3.3.1   At a temperature, **T**, the vapour pressure of compound **M** equals
             100 kPa. Is **T**, GREATER THAN, EQUAL TO or LESS THAN 27,80 °C?   (1)

    3.3.2   Refer to structure, intermolecular forces and energy to explain the
             answer to QUESTION 3.3.1.   (3)

3.4   Which compound **M** or **N** has the HIGHER vapour pressure?   (1)
                                                                                    [9]

QUESTION 4 (Start on a new page.)

REACTION I and **REACTION II** below are organic reactions in which 2–bromobutane
is reacted with solutions of KOH.
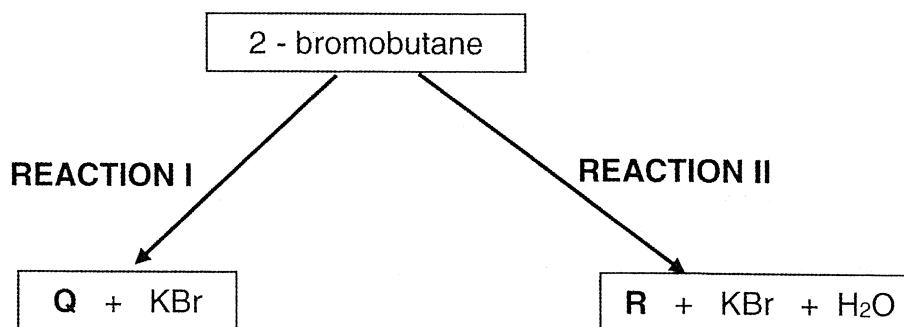
Q and **R** are the <u>major organic products</u> formed in **REACTION I** and **REACTION II**
respectively.
Q and **R** represent different organic compounds.

4.1   State TWO reaction conditions for:

    4.1.1   **REACTION I.**   (2)

    4.1.2   **REACTION II.**   (2)

4.2   What type of reaction (SUBSTITUTION, ADDITION or ELIMINATION), takes
       place in **REACTION I**?   (1)

4.3   Use structural formulae to write down a balanced equation for the reaction that
       takes place in **REACTION II**.   (4)

4.4   Is **R** saturated or unsaturated? Give a reason for the answer.   (3)

4.5   In a third reaction, **R** is converted to **Q**. Name the type of addition reaction that
       takes place during this conversion.   (2)
                                                                                    [14]

QUESTION 5 (Start on a new page)

Powdered calcium carbonate reacts with hydrochloric acid according to the following balanced equation.

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

The mass of the $CaCO_3$ after every 10 s from the start of the reaction is indicated in the table below:

Time in seconds	0	10	20	30	40	50	60	70	80
Mass of CaCO₃ in grams	X	74	63	54	46	42	40	40	40

The initial mass of the $CaCO_3$ is **X** g.

5.1 According to the data in the table above, which substance, calcium carbonate or hydrochloric acid is in excess? Give a reason for the answer. (2)

5.2 The average rate of the reaction in the first 30 s is 1,07 g·s⁻¹.

    5.2.1 Define *reaction rate*, in words. (2)

    5.2.2 Calculate the initial mass, **X**, of calcium carbonate. (5)

5.3 What volume of CO_2 is produced between 60 and 80 seconds? (1)

5.4 Use the collision theory to explain why the average rate of reaction between powdered calcium carbonate and the given hydrochloric acid solution decreases with time. (3)

5.5 How will the rate of the above reaction be affected if the initial mass of carbonate was doubled? (Only write down, INCREASES, DECREASES or REMAINS THE SAME) (1)
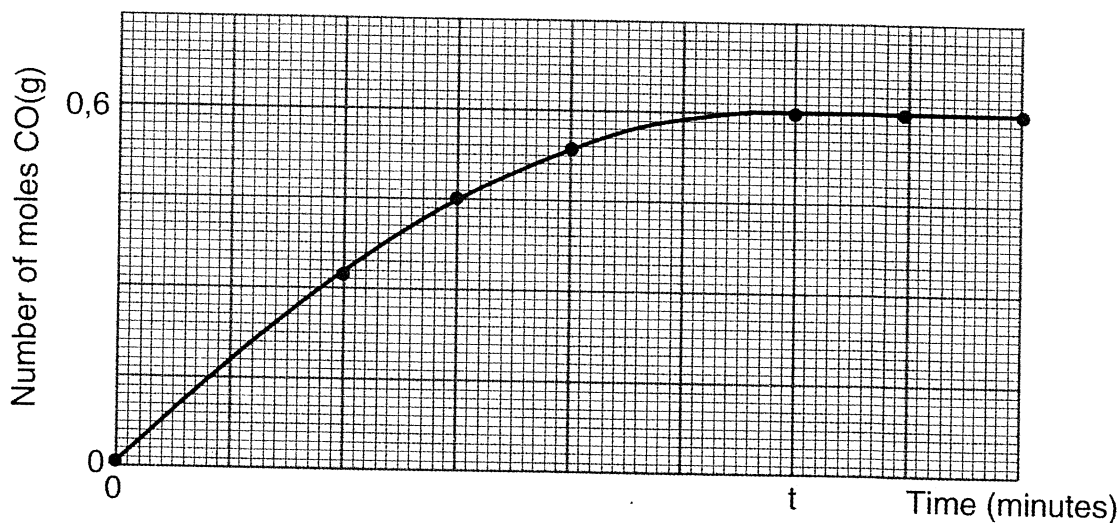
[14]

QUESTION 6 (Start on a new page)

Study the reversible reaction represented by the balanced equation at a fixed temperature below:

$$CH_4(g) + H_2O(g) \rightleftharpoons CO(g) + 3H_2(g) \quad \Delta H = +226 \text{ kJ}$$
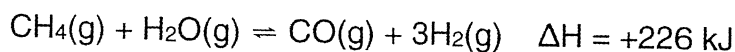
Initially, 2,2 moles of $CH_4(g)$ and 1,8 moles of $H_2O(g)$ were mixed in a sealed 2 dm³ container.

The graph below shows the relationship between the number of moles of $CO(g)$ and time in minutes.

6.1   State Le Chatelier's Principle.   (2)

6.2   What information about the reaction can be deduced from the graph after **t** minutes?   (2)

6.3   Calculate the value of the equilibrium constant, Kc, at the fixed temperature used in the reaction.   (7)

6.4   Draw a graph (not to scale), on the special answer sheet provided showing the changes in the number of moles of $CH_4(g)$ as the reaction proceeds. Indicate the initial number of moles of $CH_4(g)$ and the number of moles of $CH_4(g)$ at equilibrium, on the graph.   (4)

6.5   The initial number of moles of $CH_4(g)$ is now doubled in the same 2 dm³ container.
        How will this change affect the following? (Choose from INCREASES, DECREASES or REMAINS THE SAME)?

        6.5.1   The amount of $H_2(g)$ at equilibrium.   (1)

        6.5.2   Value of the equilibrium constant(Kc).   (1)

6.6   Explain the answer to QUESTION 6.5.1 by referring to Le Chatelier's Principle.   (3)
                                                                                       [20]

QUESTION 7 (Start on a new page.)

7.1   A *dilute solution of sulphuric acid* has a concentration 0,012 mol.dm^{-3}

        7.1.1   Define an acid according to Arrhenius theory.   (2)

        7.1.2   Is the above solution of sulphuric acid a strong or weak acid?
                  Explain the answer.   (3)

7.2   A learner adds 24 cm^3 of a solution of sulphuric acid of concentration 0,25 mol.dm^{-3} to an unknown volume, X cm^3, of a solution of sodium hydroxide of concentration 0,15 mol.dm^{-3}. The balanced equation for the reaction is:

$$H_2SO_4 + 2NaOH \longrightarrow Na_2SO_4 + 2H_2O$$
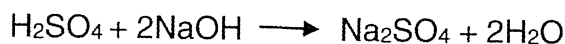
The pH of the resulting solution is 0,65.

        7.2.1   Calculate the concentration of the sulphuric acid solution after it has
                  reacted with the sodium hydroxide solution.   (4)

        7.2.2   Calculate the initial volume(X) of the sodium hydroxide solution. Assume
                  that the volume of the solution after the reaction is (X + 24) cm^3.   (7)

                                                                                  [16]

QUESTION 8 (Start on a new page.)

A standard galvanic cell is set up using a zinc and an unknown metal, **X**. The graph below shows the change in mass of the metal, **X** whilst the cell is in operation.
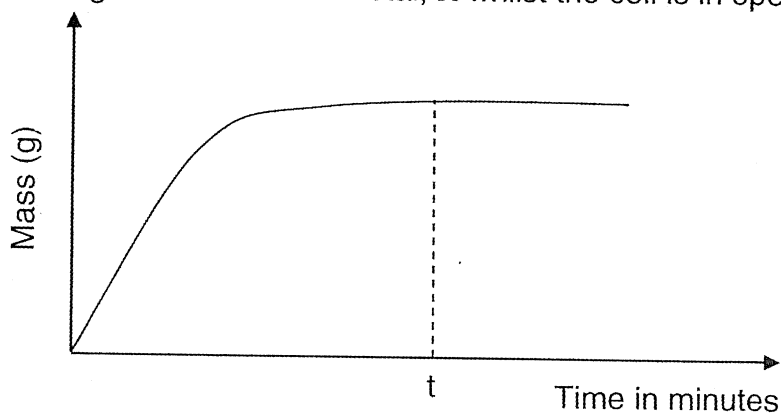
8.1   Define an electrolyte.   (2)

8.2   Write down the half reaction that takes place at the anode of this cell.   (2)

8.3   The initial emf of this cell under standard conditions is 0,63 V.

        8.3.1   Write down TWO standard conditions required for the initial emf to be
                  0,63 V   (2)

        8.3.2   Identify the metal **X**, by calculating the standard reduction potential of **X**.   (5)

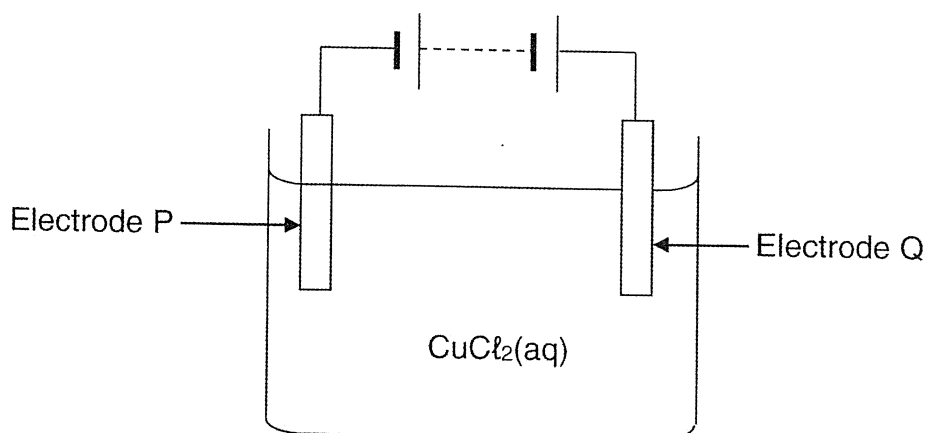8.4   Write down the cell notation for this cell.   (3)

8.5   Write down the value of the emf at time **t**, shown on the graph.   (1)

                                                                                         [15]

QUESTION 9 (Start on a new page.)

An electrolytic cell is set up using two carbon rods, P and Q and a concentrated copper(II) chloride solution as an electrolyte.
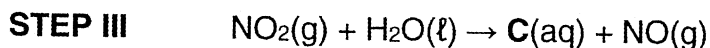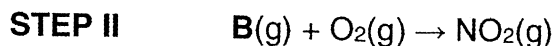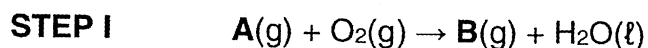

When the cell is functioning ONE of the carbon electrodes is coated with a reddish brown layer.

9.1   Write down the energy conversion that takes place in this cell.   (1)

9.2   Which electrode, **P** or **Q** is coated with the reddish brown layer?   (1)

9.3   Write down a half reaction that takes place at the electrode that is coated with the reddish brown layer.   (2)

9.4   The carbon rods in the above cell are **NOW** replaced with copper rods.

    9.4.1   Describe the observation that will be made at electrode **Q**.   (2)

    9.4.2   Refer to relative strengths of reducing agents to explain the observation made at electrode **Q**.   (3)

The cell can be used to electroplate a tin medal with a thin layer of copper.

    9.4.3   Which electrode, **P** or **Q** must be replaced with the tin medal?   (1)
                                                                                        [10]

QUESTION 10 (Start on a new page.)

10.1 The unbalanced equations below represent various steps in the Ostwald process.

STEP I $A(g) + O_2(g) \rightarrow B(g) + H_2O(\ell)$

STEP II $B(g) + O_2(g) \rightarrow NO_2(g)$

STEP III $NO_2(g) + H_2O(\ell) \rightarrow C(aq) + NO(g)$

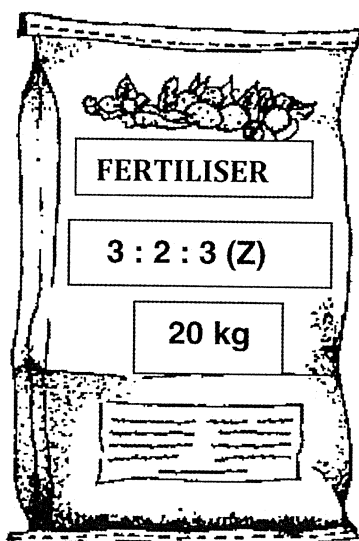10.1.1 Write down the name of the industrial process that produces gas **A**.   (1)

10.1.2 Write down the name or formula of gas **B**.   (1)

10.1.3 Name the catalyst that is used in **STEP I**.   (1)

The product, **C**, from **STEP III** mixes with reactant A from **STEP I** to produce a fertiliser.

10.1.4 Write a balanced equation to illustrate this reaction.   (3)

10.2 Consider the fertiliser in the bag illustrated below:

The only phosphorous containing compound used in the production of this fertiliser is $(NH_4)_3PO_4$

11,95 kg of $(NH_4)_3PO_4$ was used in preparing the fertiliser illustrated above.

Calculate the value represented by the letter **Z**, in the above illustration.   (6)

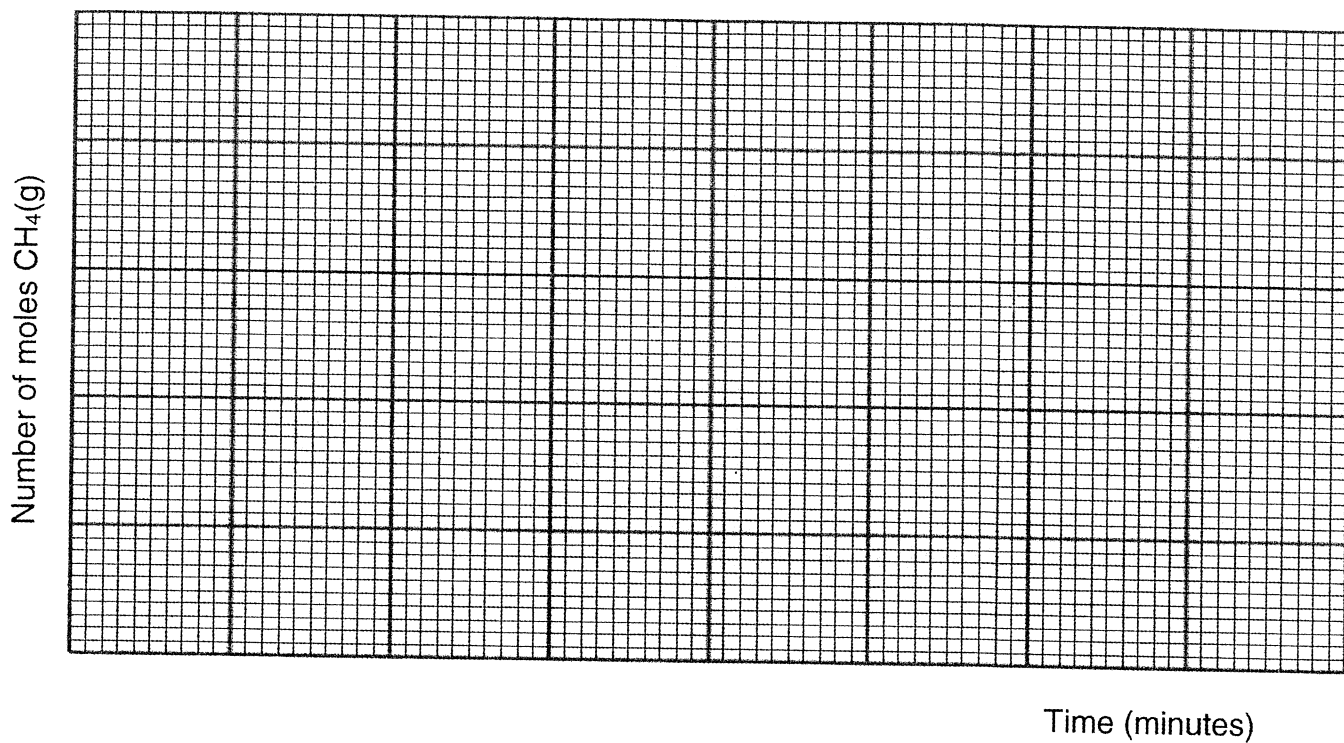   **[12]**

TOTAL MARKS: **150**

SPECIAL ANSWER SHEET FOR QUESTION 6.4

NAME: _____ GRADE: _____

DETACH THIS ANSWER SHEET AND SUBMIT WITH YOUR ANSWER BOOKLET

Number of moles $CH_4(g)$

Time (minutes)

DATA FOR PHYSICAL SCIENCES GRADE 12
PAPER 2 (CHEMISTRY)

GEGEWENS VIR FISIESE WETENSKAPPE GRAAD 12
VRAESTEL 2 (CHEMIE)

TABLE 1: PHYSICAL CONSTANTS/*TABEL 1: FISIESE KONSTANTES*

NAME/*NAAM*	SYMBOL/*SIMBOOL*	VALUE/*WAARDE*
Standard pressure *Standaarddruk*	p^{θ}	$1{,}013 \times 10^5$ Pa
Molar gas volume at STP *Molêre gasvolume by STD*	V_m	$22{,}4$ dm³·mol⁻¹
Standard temperature *Standaardtemperatuur*	T^{θ}	273 K
Charge on electron *Lading op elektron*	e	$-1{,}6 \times 10^{-19}$ C
Avogadro's constant *Avogadro-konstante*	N_A	$6{,}02 \times 10^{23}$ mol⁻¹

TABLE 2: FORMULAE/*TABEL 2: FORMULES*

$n = \dfrac{m}{M}$	$n = \dfrac{N}{N_A}$
$c = \dfrac{n}{V}$ or/*of* $c = \dfrac{m}{MV}$	$n = \dfrac{V}{V_m}$
$\dfrac{c_a V_a}{c_b V_b} = \dfrac{n_a}{n_b}$	$pH = -\log[H_3O^+]$

$$K_w = [H_3O^+][OH^-] = 1 \times 10^{-14} \text{ at/}by \text{ 298 K}$$

$$E^{\theta}_{cell} = E^{\theta}_{cathode} - E^{\theta}_{anode} \ / \ E^{\theta}_{sel} = E^{\theta}_{katode} - E^{\theta}_{anode}$$

or/*of*

$$E^{\theta}_{cell} = E^{\theta}_{reduction} - E^{\theta}_{oxidation} / E^{\theta}_{sel} = E^{\theta}_{reduksie} - E^{\theta}_{oksidasie}$$

or/*of*

$$E^{\theta}_{cell} = E^{\theta}_{oxidising\,agent} - E^{\theta}_{reducing\,agent} \ / \ E^{\theta}_{sel} = E^{\theta}_{oksideermiddel} - E^{\theta}_{reduseermiddel}$$

TABLE 3: THE PERIODIC TABLE OF ELEMENTS

1 (I)	2 (II)	3	4	5	6	7	8	9	10	11	12	13 (III)	14 (IV)	15 (V)	16 (VI)	17 (VII)	18 (VIII)
2,1 **H** 1 / 1																	2 **He** 4
1,0 **Li** 3 / 7	1,5 **Be** 4 / 9											2,0 **B** 5 / 11	2,5 **C** 6 / 12	3,0 **N** 7 / 14	3,5 **O** 8 / 16	4,0 **F** 9 / 19	10 **Ne** 20
0,9 **Na** 11 / 23	1,2 **Mg** 12 / 24											1,5 **Aℓ** 13 / 27	1,8 **Si** 14 / 28	2,1 **P** 15 / 31	2,5 **S** 16 / 32	3,0 **Cℓ** 17 / 35,5	18 **Ar** 40
0,8 **K** 19 / 39	1,0 **Ca** 20 / 40	1,3 **Sc** 21 / 45	1,5 **Ti** 22 / 48	1,6 **V** 23 / 51	1,6 **Cr** 24 / 52	1,5 **Mn** 25 / 55	1,8 **Fe** 26 / 56	1,8 **Co** 27 / 59	1,8 **Ni** 28 / 59	1,9 **Cu** 29 / 63,5	1,6 **Zn** 30 / 65	1,6 **Ga** 31 / 70	1,8 **Ge** 32 / 73	2,0 **As** 33 / 75	2,4 **Se** 34 / 79	2,8 **Br** 35 / 80	36 **Kr** 84
0,8 **Rb** 37 / 86	1,0 **Sr** 38 / 88	1,2 **Y** 39 / 89	1,4 **Zr** 40 / 91	**Nb** 41 / 92	1,8 **Mo** 42 / 96	1,9 **Tc** 43	2,2 **Ru** 44 / 101	2,2 **Rh** 45 / 103	2,2 **Pd** 46 / 106	1,9 **Ag** 47 / 108	1,7 **Cd** 48 / 112	1,7 **In** 49 / 115	1,8 **Sn** 50 / 119	1,9 **Sb** 51 / 122	2,1 **Te** 52 / 128	2,5 **I** 53 / 127	54 **Xe** 131
0,7 **Cs** 55 / 133	0,9 **Ba** 56 / 137	1,6 **La** 57 / 139	1,6 **Hf** 72 / 179	**Ta** 73 / 181	**W** 74 / 184	1,9 **Re** 75 / 186	**Os** 76 / 190	**Ir** 77 / 192	**Pt** 78 / 195	1,9 **Au** 79 / 197	1,7 **Hg** 80 / 201	1,8 **Tℓ** 81 / 204	1,8 **Pb** 82 / 207	1,9 **Bi** 83 / 209	2,0 **Po** 84	2,5 **At** 85	86 **Rn**
0,7 **Fr** 87	0,9 **Ra** 88 / 226	**Ac** 89															

58 **Ce** 140	59 **Pr** 141	60 **Nd** 144	61 **Pm**	62 **Sm** 150	63 **Eu** 152	64 **Gd** 157	65 **Tb** 159	66 **Dy** 163	67 **Ho** 165	68 **Er** 167	69 **Tm** 169	70 **Yb** 173	71 **Lu** 175
90 **Th** 232	91 **Pa**	92 **U** 238	93 **Np**	94 **Pu**	95 **Am**	96 **Cm**	97 **Bk**	98 **Cf**	99 **Es**	100 **Fm**	101 **Md**	102 **No**	103 **Lr**

KEY/SLEUTEL: Atomic number / Atoomgetal; Symbol / Simbool; Electronegativity / Elektronegatiwiteit; Approximate relative atomic mass / Benaderde relatiewe atoommassa — 29 **Cu** 1,9 / 63,5

TABLE 4A: STANDARD REDUCTION POTENTIALS
TABEL 4A: STANDAARD-REDUKSIEPOTENSIALE

Half-reactions/*Halfreaksies*	E^{θ} (V)
$F_2(g) + 2e^- \rightleftharpoons 2F^-$	+ 2,87
$Co^{3+} + e^- \rightleftharpoons Co^{2+}$	+ 1,81
$H_2O_2 + 2H^+ + 2e^- \rightleftharpoons 2H_2O$	+1,77
$MnO_4^- + 8H^+ + 5e^- \rightleftharpoons Mn^{2+} + 4H_2O$	+ 1,51
$C\ell_2(g) + 2e^- \rightleftharpoons 2C\ell^-$	+ 1,36
$Cr_2O_7^{2-} + 14H^+ + 6e^- \rightleftharpoons 2Cr^{3+} + 7H_2O$	+ 1,33
$O_2(g) + 4H^+ + 4e^- \rightleftharpoons 2H_2O$	+ 1,23
$MnO_2 + 4H^+ + 2e^- \rightleftharpoons Mn^{2+} + 2H_2O$	+ 1,23
$Pt^{2+} + 2e^- \rightleftharpoons Pt$	+ 1,20
$Br_2(\ell) + 2e^- \rightleftharpoons 2Br^-$	+ 1,07
$NO_3^- + 4H^+ + 3e^- \rightleftharpoons NO(g) + 2H_2O$	+ 0,96
$Hg^{2+} + 2e^- \rightleftharpoons Hg(\ell)$	+ 0,85
$Ag^+ + e^- \rightleftharpoons Ag$	+ 0,80
$NO_3^- + 2H^+ + e^- \rightleftharpoons NO_2(g) + H_2O$	+ 0,80
$Fe^{3+} + e^- \rightleftharpoons Fe^{2+}$	+ 0,77
$O_2(g) + 2H^+ + 2e^- \rightleftharpoons H_2O_2$	+ 0,68
$I_2 + 2e^- \rightleftharpoons 2I^-$	+ 0,54
$Cu^+ + e^- \rightleftharpoons Cu$	+ 0,52
$SO_2 + 4H^+ + 4e^- \rightleftharpoons S + 2H_2O$	+ 0,45
$2H_2O + O_2 + 4e^- \rightleftharpoons 4OH^-$	+ 0,40
$Cu^{2+} + 2e^- \rightleftharpoons Cu$	+ 0,34
$SO_4^{2-} + 4H^+ + 2e^- \rightleftharpoons SO_2(g) + 2H_2O$	+ 0,17
$Cu^{2+} + e^- \rightleftharpoons Cu^+$	+ 0,16
$Sn^{4+} + 2e^- \rightleftharpoons Sn^{2+}$	+ 0,15
$S + 2H^+ + 2e^- \rightleftharpoons H_2S(g)$	+ 0,14
$2H^+ + 2e^- \rightleftharpoons H_2(g)$	**0,00**
$Fe^{3+} + 3e^- \rightleftharpoons Fe$	− 0,06
$Pb^{2+} + 2e^- \rightleftharpoons Pb$	− 0,13
$Sn^{2+} + 2e^- \rightleftharpoons Sn$	− 0,14
$Ni^{2+} + 2e^- \rightleftharpoons Ni$	− 0,27
$Co^{2+} + 2e^- \rightleftharpoons Co$	− 0,28
$Cd^{2+} + 2e^- \rightleftharpoons Cd$	− 0,40
$Cr^{3+} + e^- \rightleftharpoons Cr^{2+}$	− 0,41
$Fe^{2+} + 2e^- \rightleftharpoons Fe$	− 0,44
$Cr^{3+} + 3e^- \rightleftharpoons Cr$	− 0,74
$Zn^{2+} + 2e^- \rightleftharpoons Zn$	− 0,76
$2H_2O + 2e^- \rightleftharpoons H_2(g) + 2OH^-$	− 0,83
$Cr^{2+} + 2e^- \rightleftharpoons Cr$	− 0,91
$Mn^{2+} + 2e^- \rightleftharpoons Mn$	− 1,18
$A\ell^{3+} + 3e^- \rightleftharpoons A\ell$	− 1,66
$Mg^{2+} + 2e^- \rightleftharpoons Mg$	− 2,36
$Na^+ + e^- \rightleftharpoons Na$	− 2,71
$Ca^{2+} + 2e^- \rightleftharpoons Ca$	− 2,87
$Sr^{2+} + 2e^- \rightleftharpoons Sr$	− 2,89
$Ba^{2+} + 2e^- \rightleftharpoons Ba$	− 2,90
$Cs^+ + e^- \rightleftharpoons Cs$	- 2,92
$K^+ + e^- \rightleftharpoons K$	− 2,93
$Li^+ + e^- \rightleftharpoons Li$	− 3,05

Increasing oxidising ability/*Toenemende oksiderende vermoë*

Increasing reducing ability/*Toenemende reduserende vermoë*

TABLE 4B: STANDARD REDUCTION POTENTIALS
TABEL 4B: STANDAARD-REDUKSIEPOTENSIALE

Increasing oxidising ability/Toenemende oksiderende vermoë

Increasing reducing ability/Toenemende reduserende vermoë

Half-reactions/Halfreaksies	E^θ (V)
$Li^+ + e^- \rightleftharpoons Li$	$-3,05$
$K^+ + e^- \rightleftharpoons K$	$-2,93$
$Cs^+ + e^- \rightleftharpoons Cs$	$-2,92$
$Ba^{2+} + 2e^- \rightleftharpoons Ba$	$-2,90$
$Sr^{2+} + 2e^- \rightleftharpoons Sr$	$-2,89$
$Ca^{2+} + 2e^- \rightleftharpoons Ca$	$-2,87$
$Na^+ + e^- \rightleftharpoons Na$	$-2,71$
$Mg^{2+} + 2e^- \rightleftharpoons Mg$	$-2,36$
$A\ell^{3+} + 3e^- \rightleftharpoons A\ell$	$-1,66$
$Mn^{2+} + 2e^- \rightleftharpoons Mn$	$-1,18$
$Cr^{2+} + 2e^- \rightleftharpoons Cr$	$-0,91$
$2H_2O + 2e^- \rightleftharpoons H_2(g) + 2OH^-$	$-0,83$
$Zn^{2+} + 2e^- \rightleftharpoons Zn$	$-0,76$
$Cr^{3+} + 3e^- \rightleftharpoons Cr.$	$-0,74$
$Fe^{2+} + 2e^- \rightleftharpoons Fe$	$-0,44$
$Cr^{3+} + e^- \rightleftharpoons Cr^{2+}$	$-0,41$
$Cd^{2+} + 2e^- \rightleftharpoons Cd$	$-0,40$
$Co^{2+} + 2e^- \rightleftharpoons Co$	$-0,28$
$Ni^{2+} + 2e^- \rightleftharpoons Ni$	$-0,27$
$Sn^{2+} + 2e^- \rightleftharpoons Sn$	$-0,14$
$Pb^{2+} + 2e^- \rightleftharpoons Pb$	$-0,13$
$Fe^{3+} + 3e^- \rightleftharpoons Fe$	$-0,06$
$\mathbf{2H^+ + 2e^- \rightleftharpoons H_2(g)}$	$\mathbf{0,00}$
$S + 2H^+ + 2e^- \rightleftharpoons H_2S(g)$	$+0,14$
$Sn^{4+} + 2e^- \rightleftharpoons Sn^{2+}$	$+0,15$
$Cu^{2+} + e^- \rightleftharpoons Cu^+$	$+0,16$
$SO_4^{2-} + 4H^+ + 2e^- \rightleftharpoons SO_2(g) + 2H_2O$	$+0,17$
$Cu^{2+} + 2e^- \rightleftharpoons Cu$	$+0,34$
$2H_2O + O_2 + 4e^- \rightleftharpoons 4OH^-$	$+0,40$
$SO_2 + 4H^+ + 4e^- \rightleftharpoons S + 2H_2O$	$+0,45$
$Cu^+ + e^- \rightleftharpoons Cu$	$+0,52$
$I_2 + 2e^- \rightleftharpoons 2I^-$	$+0,54$
$O_2(g) + 2H^+ + 2e^- \rightleftharpoons H_2O_2$	$+0,68$
$Fe^{3+} + e^- \rightleftharpoons Fe^{2+}$	$+0,77$
$NO_3^- + 2H^+ + e^- \rightleftharpoons NO_2(g) + H_2O$	$+0,80$
$Ag^+ + e^- \rightleftharpoons Ag$	$+0,80$
$Hg^{2+} + 2e^- \rightleftharpoons Hg(\ell)$	$+0,85$
$NO_3^- + 4H^+ + 3e^- \rightleftharpoons NO(g) + 2H_2O$	$+0,96$
$Br_2(\ell) + 2e^- \rightleftharpoons 2Br^-$	$+1,07$
$Pt^{2+} + 2e^- \rightleftharpoons Pt$	$+1,20$
$MnO_2 + 4H^+ + 2e^- \rightleftharpoons Mn^{2+} + 2H_2O$	$+1,23$
$O_2(g) + 4H^+ + 4e^- \rightleftharpoons 2H_2O$	$+1,23$
$Cr_2O_7^{2-} + 14H^+ + 6e^- \rightleftharpoons 2Cr^{3+} + 7H_2O$	$+1,33$
$C\ell_2(g) + 2e^- \rightleftharpoons 2C\ell^-$	$+1,36$
$MnO_4^- + 8H^+ + 5e^- \rightleftharpoons Mn^{2+} + 4H_2O$	$+1,51$
$H_2O_2 + 2H^+ + 2e^- \rightleftharpoons 2H_2O$	$+1,77$
$Co^{3+} + e^- \rightleftharpoons Co^{2+}$	$+1,81$
$F_2(g) + 2e^- \rightleftharpoons 2F^-$	$+2,87$