basic education

Department:
Basic Education
REPUBLIC OF SOUTH AFRICA

NATIONAL SENIOR CERTIFICATE

GRADE 12

PHYSICAL SCIENCES: CHEMISTRY (P2)

NOVEMBER 2019

MARKS: 150

TIME: 3 hours

This question paper consists of 14 pages 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, e.g. 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, etc. where required.
12. Write neatly and legibly.

QUESTION 1: MULTIPLE-CHOICE QUESTIONS

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

1.1 Which ONE of the following compounds has the HIGHEST vapour pressure?

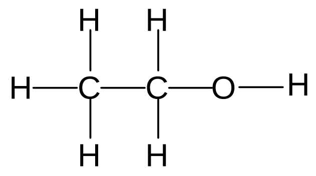
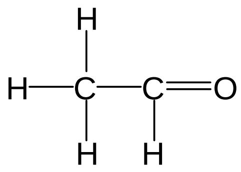
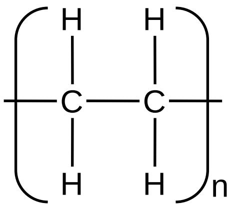
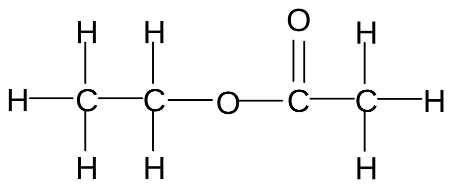
A $HCOOH$

B CH_3CHO

C CH_3CH_2OH

D $CH_3CH_2CH_3$ (2)

1.2 Which ONE of the formulae below represents the product of a POLYMERISATION reaction?

A		**B**	
C		**D**	

(2)

1.3 Which ONE of the following combinations are BOTH UNSATURATED HYDROCARBONS?

A Ethane and ethene

B Ethene and ethyne

C Ethane and ethanol

D Ethanoic acid and ethene (2)

1.4 Which ONE of the following sets of values for activation energy (**E_a**) and heat of reaction (∆**H**) is possible for a reaction?

	ACTIVATION ENERGY (E_a) ($kJ·mol^{-1}$)	**HEAT OF REACTION (∆H) ($kJ·mol^{-1}$)**
A	100	+100
B	50	+100
C	50	+50
D	100	-50

(2)

1.5 Consider the following balanced equation for a system at equilibrium:

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

How will the addition of a catalyst to the equilibrium mixture affect the YIELD and REACTION RATE?

	YIELD	**REACTION RATE**
A	Increases	Increases
B	Remains the same	Remains the same
C	Remains the same	Increases
D	Decreases	Increases

(2)

1.6 A hypothetical reaction reaches equilibrium at a certain temperature in a closed container according to the following balanced equation:

$$A(g) + 2B(g) \rightleftharpoons 3C(s) \qquad \Delta H < 0$$

Which ONE of the following changes to the equilibrium conditions will result in an INCREASE in the equilibrium constant, K_c?

A Increase in temperature

B Decrease in temperature

C Increase in pressure at constant temperature

D Decrease in pressure at constant temperature (2)

1.7 A hydrochloric acid solution, HCℓ(aq), and an acetic acid solution, CH_3COOH(aq), of EQUAL CONCENTRATIONS are compared.

How do the H_3O^+(aq) concentration of HCℓ(aq) and the pH of HCℓ(aq) compare to that of CH_3COOH(aq)?

	[H_3O^+] of HCℓ(aq)	**pH of HCℓ(aq)**
A	Higher than	Higher than
B	Higher than	Lower than
C	Equal to	Equal to
D	Higher than	Equal to

(2)

1.8 Two hypothetical half-reactions and their respective reduction potentials are shown below:

$$B^+(aq) + e^- \rightleftharpoons B(s) \qquad E^\theta = -1,5\ V$$
$$A^{2+}(aq) + 2e^- \rightleftharpoons A(s) \qquad E^\theta = 2,5\ V$$

A galvanic cell is set up using the above substances.

Which ONE of the following statements is CORRECT for this galvanic cell?

A B(s) is the reducing agent.

B A(s) is the oxidising agent.

C The mass of B(s) will increase.

D The mass of A(s) will decrease. (2)

1.9 In an electrolytic cell …

A the anode is the positive electrode.

B oxidation takes place at the cathode.

C electrons flow from the cathode to the anode.

D the mass of the anode increases. (2)

1.10 Which ONE of the following is used as a catalyst in the Ostwald process?

A Iron

B Copper

C Platinum

D Vanadium (V) oxide (2)

[20]

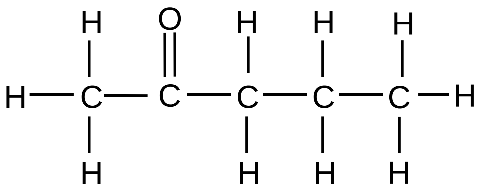
QUESTION 2 (Start on a new page.)

2.1 The IUPAC name of an organic compound is 4,4-dimethylpent-2-yne.

2.1.1 Write down the GENERAL FORMULA of the homologous series to which this compound belongs. (1)

2.1.2 Write down the STRUCTURAL formula of this compound. (3)

2.2 The organic compound below has one positional isomer and one functional isomer.



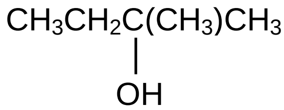
2.2.1 Define the term *positional isomer.* (2)

For this compound, write down the:

2.2.2 IUPAC name of its POSITIONAL isomer (2)

2.2.3 Structural formula of its FUNCTIONAL isomer (2)

2.3 Consider the condensed structural formula of an organic compound below.



2.3.1 Is this a PRIMARY, SECONDARY or TERTIARY alcohol?
Give a reason for the answer. (2)

2.3.2 Write down the IUPAC name of the above compound. (2)

2.3.3 Write down the IUPAC name of the MAJOR ORGANIC PRODUCT formed when this compound undergoes an elimination reaction. (2)
[16]

QUESTION 3 (Start on a new page.)

The boiling points of five organic compounds (**P**, **Q**, **R, S** and **T**) are studied.

COMPOUND	IUPAC NAME
P	Pentanal
Q	2,2-dimethylbutane
R	3-methylpentane
S	Hexane
T	Pentan-1-ol

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

The boiling points of compounds **Q**, **R** and **S** are compared.

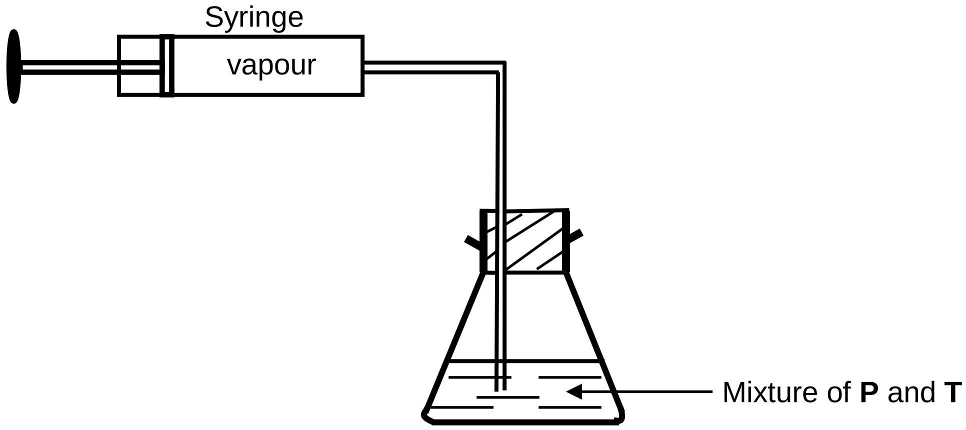
3.2 Give a reason why this is a fair comparison. (1)

The boiling points of **Q**, **R** and **S** are given below (NOT necessarily in the correct order).

55 °C	49,7 °C	68 °C

3.3 Which ONE of the three boiling points is most likely the boiling point of compound **R**? Explain the answer. (4)

3.4 A mixture of equal amounts of **P** and **T** is placed in a flask and heated to a temperature below their boiling points. Assume that no reaction or condensation takes place. The vapour produced is collected in a syringe.



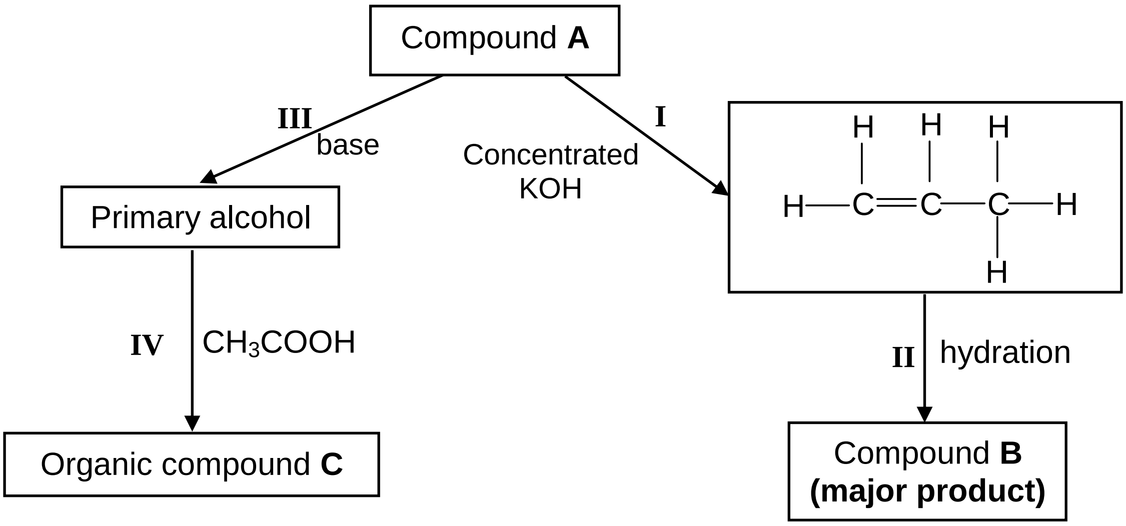
3.4.1 Which compound (**P** or **T**) will be present in a greater amount in the SYRINGE? (2)

3.4.2 Explain the answer to QUESTION 3.4.1 by referring to the TYPES and STRENGTHS of intermolecular forces. (3)

[12]

QUESTION 4 (Start on a new page.)

The flow diagram below shows how compound **A** can be used to prepare other organic compounds. The numbers **I**, **II**, **III** and **IV** represent different organic reactions.



Use the information in the flow diagram to answer the following questions.

4.1 Name the homologous series to which compound **A** belongs. (1)

4.2 Write down the TYPE of reaction represented by:

4.2.1 **I** (1)

4.2.2 **III** (1)

4.2.3 **IV** (1)

4.3 Consider **reaction III**. Write down the:

4.3.1 TWO reaction conditions for this reaction (2)

4.3.2 IUPAC name of the primary alcohol that is formed (2)

4.4 Draw the STRUCTURAL FORMULA for compound **B**. (2)

4.5 Consider **reaction IV**. Write down the:

4.5.1 Structural formula of organic compound **C** (2)

4.5.2 NAME or FORMULA of the catalyst that is used (1)
[13]

QUESTION 5 (Start on a new page.)

The calcium carbonate ($CaCO_3$) in antacid tablets reacts with dilute hydrochloric acid (HCℓ) according to the following balanced equation:

$$CaCO_3(s) + 2HC\ell(aq) \rightarrow CaC\ell_2(aq) + CO_2(g) + H_2O(\ell) \quad \Delta H < 0$$

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

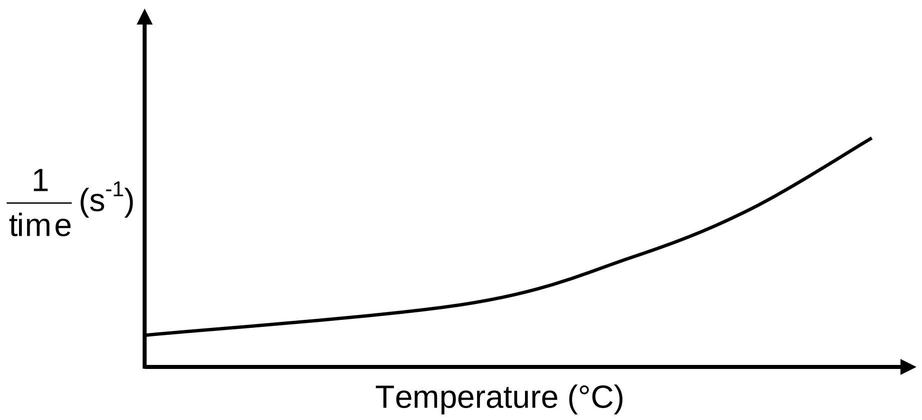
An antacid tablet of mass 2 g is placed in HCℓ(aq). After 30 s the mass of the tablet was found to be 0,25 g.

5.2 Calculate the average rate (in $g \cdot s^{-1}$) of the above reaction. (3)

The antacid tablet contains 40% calcium carbonate. Another antacid tablet of mass 2 g is allowed to react completely with HCℓ(aq).

5.3 Calculate the volume of carbon dioxide, $CO_2(g)$ that will be collected at STP. Assume that all the $CO_2(g)$ produced is from the calcium carbonate. (5)

The reaction rate of similar antacid tablets with excess HCℓ(aq) of concentration 0,1 $mol \cdot dm^{-3}$ at DIFFERENT TEMPERATURES is measured. The graph below was obtained.



Use the information in the graph to answer the following questions.

5.4 Write down ONE controlled variable for this investigation. (1)

5.5 Write down a conclusion that can be made from the graph. (2)

5.6 Use the collision theory to fully explain the answer to QUESTION 5.5 (3)

5.7 Redraw the graph above in the ANSWER BOOK. On the same set of axes, sketch the curve that will be obtained if HCℓ(aq) of concentration 0,2 $mol \cdot dm^{-3}$ is now used. Label this curve **Y**. (2)
[18]

QUESTION 6 (Start on a new page.)

Initially 60,8 g pure carbon dioxide, CO_2(g), is reacted with carbon, C(s), in a sealed container of volume 3 dm^3. The reaction reaches equilibrium at temperature **T** according to the following balanced equation:

$$C(s) + CO_2(g) \rightleftharpoons 2CO(g)$$

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

6.2 At equilibrium it is found that the concentration of the carbon dioxide is 0,054 $mol{\cdot}dm^{-3}$.

Calculate the:

6.2.1 Equilibrium constant, K_C, for this reaction at temperature **T** (7)

6.2.2 Minimum mass of C(s) that must be present in the container to obtain this equilibrium (3)

6.3 How will EACH of the following changes affect the AMOUNT of CO(g) at equilibrium?

Choose from INCREASES, DECREASES or REMAINS THE SAME.

6.3.1 More carbon is added to the container (1)

6.3.2 The pressure is increased by reducing the volume of the container at constant temperature.
Use Le Chatelier's principle to explain the answer. (3)

6.4 The table below shows the percentages of CO_2(g) and CO(g) in the container at different temperatures.

TEMPERATURE (°C)	**% CO_2(g)**	**% CO(g)**
827	6,23	93,77
950	1,32	98,68
1 050	0,37	99,63
1 200	0,06	99,94

6.4.1 Is the reaction EXOTHERMIC or ENDOTHERMIC?
Refer to the data in the table and explain the answer. (3)

6.4.2 Use the information in the table to determine temperature **T**. Show clearly how you arrived at the answer. (3)
[22]

QUESTION 7 (Start on a new page.)

A hydrogen bromide solution, HBr(aq), reacts with water according to the following balanced chemical equation:

$$HBr(aq) + H_2O(\ell) \rightleftharpoons Br^-(aq) + H_3O^+(aq)$$

The K_a value of HBr(aq) at 25 °C is 1 x 10^9.

7.1 Is hydrogen bromide a STRONG ACID or a WEAK ACID? Give a reason for the answer. (2)

7.2 Write down the FORMULAE of the TWO bases in the above reaction. (2)

7.3 HBr(aq) reacts with $Zn(OH)_2(s)$ according to the following balanced equation:

$$Zn(OH)_2(s) + 2HBr(aq) \rightarrow ZnBr_2(aq) + 2H_2O(\ell)$$

An unknown quantity of $Zn(OH)_2(s)$ is reacted with 90 cm^3 of HBr(aq) in a flask. (Assume that the volume of the solution does not change during the reaction.)

The EXCESS HBr(aq) is then neutralised by 16,5 cm^3 of NaOH(aq) of concentration 0,5 $mol{\cdot}dm^{-3}$. The balanced equation for the reaction is:

$$HBr(aq) + NaOH(aq) \rightarrow NaBr(aq) + H_2O(\ell)$$

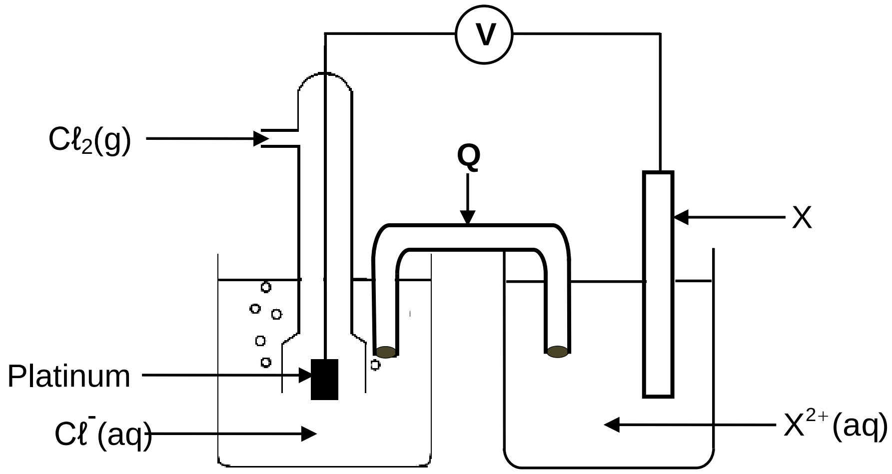
7.3.1 Calculate the pH of the HBr solution remaining in the flask AFTER the reaction with $Zn(OH)_2(s)$. (7)

7.3.2 Calculate the mass of $Zn(OH)_2(s)$ INITIALLY present in the flask if the initial concentration of HBr(aq) was 0,45 $mol{\cdot}dm^{-3}$. (6)

[17]

QUESTION 8 (Start on a new page.)

A standard electrochemical cell is set up using two standard half-cells, as shown in the diagram below.



8.1 State the energy conversion that takes place in this cell. (1)

8.2 What is the function of component **Q**? (1)

X is a metal. A voltmeter connected across the cell initially registers 1,49 V.

8.3 Use a calculation to identify metal **X**. (5)

8.4 Write down the NAME or FORMULA of the reducing agent. (1)

8.5 The reading on the voltmeter becomes ZERO after this cell operates for several hours.

8.5.1 Give a reason for this reading by referring to the rates of oxidation and reduction half-reactions taking place in the cell. (1)

A silver nitrate solution, $AgNO_3(aq)$, is NOW added to the chlorine half-cell and a precipitate forms.

8.5.2 How will the reading on the voltmeter be affected? (Choose from INCREASES, DECREASES or REMAINS the same) (1)

8.5.3 Use Le Chatelier's principle to explain the answer to QUESTION 8.5.2. (2)

[12]

QUESTION 9 (Start on a new page.)

Chlorine is produced industrially by the electrolysis of a concentrated sodium chloride solution, $NaC\ell(aq)$.

The balanced equation for the net (overall) cell reaction is as follows:

$$2NaC\ell(aq) + 2H_2O(\ell) \rightarrow H_2(g) + 2NaOH(aq) + C\ell_2(g)$$

9.1 Define the term *electrolysis*. (2)

9.2 For the above reaction, write down the:

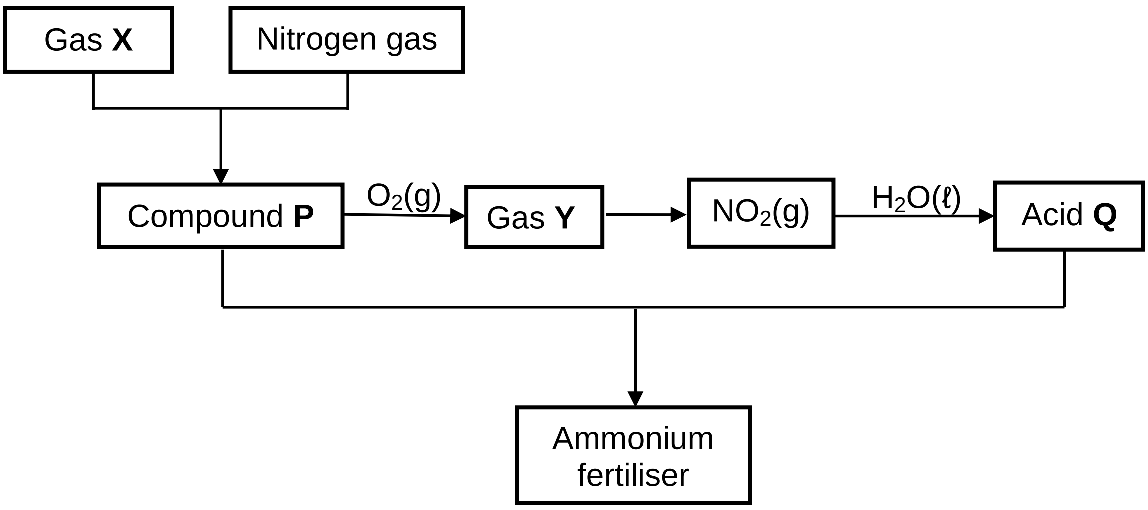
9.2.1 Half-reaction that takes place at the cathode (2)

9.2.2 NAME or FORMULA of the oxidising agent (1)

9.3 Refer to the Table of Standard Reduction Potentials to explain why sodium ions are not reduced during this process. (3)
[8]

QUESTION 10 (Start on a new page.)

The flow diagram below shows the processes involved in the industrial preparation of an ammonium fertiliser.



10.1 Write down the NAME or FORMULA of:

10.1.1 Gas **X** (1)

10.1.2 Gas **Y** (1)

10.1.3 Acid **Q** (1)

10.2 Write down the:

10.2.1 TYPE of chemical reaction that converts compound **P** into gas **Y** (1)

10.2.2 Balanced equation for the reaction between compound **P** and acid **Q** (3)

10.3 Two separate bags of fertilisers are labelled as follows:

BAG A	BAG B
1 : 3 : 4 (21)	**1 : 3 : 4 (27)**
50 kg	**40 kg**

10.3.1 What do the numbers (21) and (27) on the labels represent? (1)

10.3.2 Determine, by means of calculations, which bag (**A** or **B**) contains a greater mass of phosphorous. (4)
[12]

TOTAL: 150

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	$22,4 \text{ dm}^3\cdot\text{mol}^{-1}$
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	$6,02 \times 10^{23} \text{ mol}^{-1}$

TABLE 2: FORMULAE/*TABEL 2: FORMULES*

$n = \frac{m}{M}$	$n = \frac{N}{N_A}$
$c = \frac{n}{V}$ or/*of* $c = \frac{m}{MV}$	$n = \frac{V}{V_m}$
$\frac{c_a V_a}{c_b V_b} = \frac{n_a}{n_b}$	$pH = -\log[H_3O^+]$
$K_w = [H_3O^+][OH^-] = 1 \times 10^{-14}$ at/*by* 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
TABEL 3: DIE PERIODIEKE TABEL VAN ELEMENTE

KEY/*SLEUTEL*

29 1,9 Cu 63,5

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

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

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

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

Increasing oxidising ability/*Toenemende oksiderende vermoë* ↑

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

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

basic education

Department:
Basic Education
REPUBLIC OF SOUTH AFRICA

NATIONAL SENIOR CERTIFICATE
NASIONALE SENIOR SERTIFIKAAT

GRADE/*GRAAD* 12

PHYSICAL SCIENCES: CHEMISTRY (P2)
FISIESE WETENSKAPPE: CHEMIE (V2)

NOVEMBER 2019

MARKING GUIDELINES/*NASIENRIGLYNE*

MARKS/*PUNTE*: 150

These marking guidelines consist of 20 pages.
Hierdie nasienriglyne bestaan uit 20 bladsye.

QUESTION 1/*VRAAG 1*

1.1 D ✓✓ (2)

1.2 C ✓✓ (2)

1.3 B ✓✓ (2)

1.4 D ✓✓ (2)

1.5 C ✓✓ (2)

1.6 B ✓✓ (2)

1.7 B ✓✓ (2)

1.8 A ✓✓ (2)

1.9 A ✓✓ (2)

1.10 C ✓✓ (2)

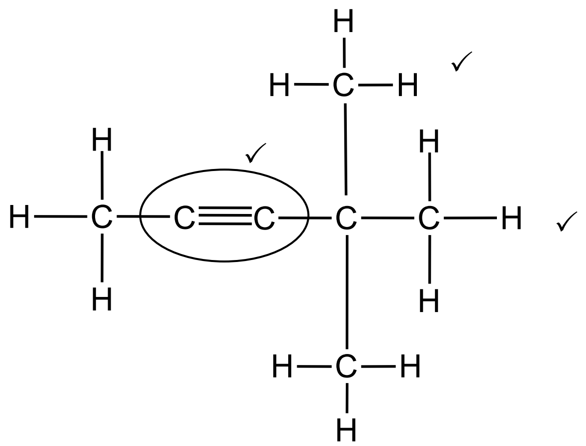
[20]

QUESTION 2/*VRAAG 2*

2.1

2.1.1 C_nH_{2n-2} ✓ (1)

2.1.2



Marking criteria/*Nasienriglyne*
- Functional group correct. ✓
  Funksionele groep korrek.
- 2 methyl substituents. ✓
  2 metielsubstituente.
- Whole structure correct:/*Hele struktuur korrek:* $\frac{3}{3}$

(3)

2.2

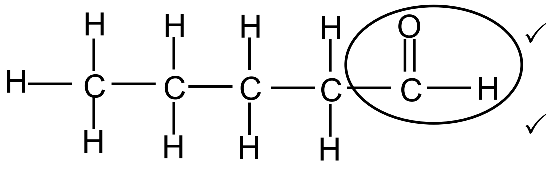
2.2.1 Compounds with the <u>same molecular formula</u>, ✓ but <u>different positions of the side chain/substituents/functional groups</u> ✓on the parent chain.
Verbindings met <u>dieselfde molekulêre formule</u>, maar <u>verskillende posisies van die syketting/substituente/funksionele groepe</u> op die stamketting. (2)

2.2.2 Pentan-3-one/3-pentanone ✓✓
Pentan-3-oon/3-pentanoon

<u>Marking criteria/*Nasienriglyne*</u>
- Functional group and correct position i.e. 3 /*Funksionele groep en korrekte posisie nl. 3.* ✓
- Whole name correct/*Hele naam korrek.* ✓

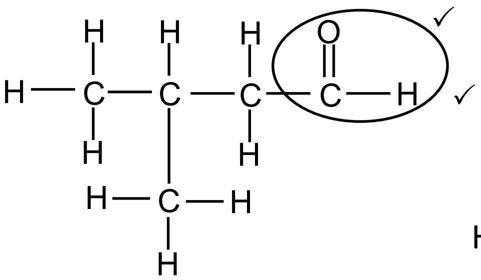
<u>Accept for ONE mark/Aanvaar vir EEN punt</u>
Pentanone with the 3 in incorrect place, e.g. penta-3-none.
Pentanoon met die 3 in foutiewe plek, bv. penta-3-noon. (2)

2.2.3

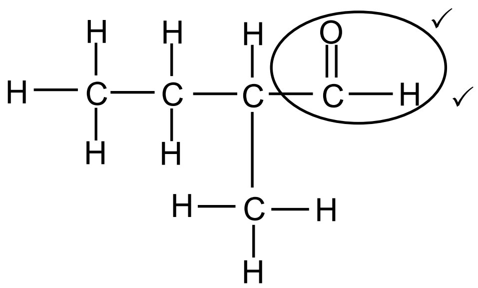


<u>Marking criteria/*Nasienriglyne*</u>
- Whole structure correct:/*Hele struktuur korrek:* $\frac{2}{2}$
- Only functional group correct/*Slegs funksionele groep korrek* Max: $\frac{1}{2}$

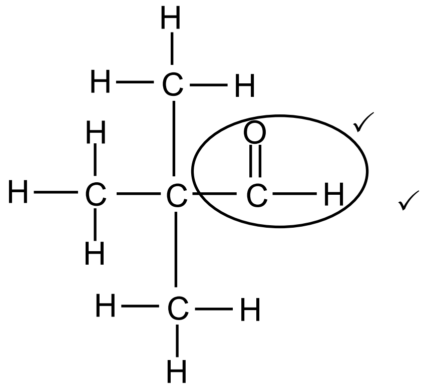
<u>OR: Any correct structure of an aldehyde with five carbon atoms.</u>
<u>OF:Enige korrekte struktuur van 'n aldehied met vyf koolstofatome.</u>



OR/*OF*



OR/*OF*



(2)

2.3

2.3.1 Tertiary (alcohol)/*Tersiêre (alkohol)* ✓

The C atom bonded to the functional group/hydroxyl (group)/-OH is bonded to three other C atoms. /The C-atom bonded to the hydroxyl (group) has no hydrogen atoms. ✓
Die C-atoom gebind aan die funksionele groep/hidroksiel(groep)/-OH is gebind aan drie ander C-atome./ Die C-atoom gebind aan die hidroksiel (groep) het geen waterstofatome nie. (2)

2.3.2 2-methylbutan-2-ol/2-methyl-2-butanol/*2-metielbutan-2-ol/2-metiel-2-butanol*

<u>Marking criteria/*Nasienriglyne*</u>
- 2-methyl/*2-metiel* ✓
- Butan-2-ol/2-butanol ✓
- Any error e.g. hyphens omitted and/or incorrect sequence:
  Enige fout, bv. koppeltekens weggelaat en/of verkeerde volgorde: Max./*Maks*: $\frac{1}{2}$

(2)

2.3.3 2-methylbut-2- ene/2-methyl-2-butene/*2-metielbut-2-een/2-metiel-2-buteen*

<u>Marking criteria/*Nasienriglyne*</u>
- 2-methyl/*2-metiel* ✓
- But-2-ene/2-butene/*But-2-een/2-buteen* ✓
- Any error e.g. hyphens omitted and/or incorrect sequence:
  Enige fout, bv. koppeltekens weggelaat en/of verkeerde volgorde: Max./*Maks*: $\frac{1}{2}$

(2)
[16]

QUESTION 3/*VRAAG 3*

3.1

<u>Marking guidelines/*Nasienriglyne*</u>
The underlined key phrases must be used in the **CORRECT CONTEXT (pressure/boiling)**. /*Die onderstreepte frases moet gebruik word in die* ***KORREKTE KONTEKS (druk/kook)***.

The <u>temperature</u> ✓ at which the <u>vapour pressure</u> of a substance <u>equals atmospheric/external pressure</u>. ✓
Die <u>temperatuur</u> waar die <u>dampdruk</u> van 'n stof <u>gelyk is aan atmosferiese/ eksterne druk</u>. (2)

3.2 (**Q**, **R** and **S**) have <u>same molecular mass/formulae/number of carbon and hydrogen atoms</u>/are (chain) isomers. ✓
*(**Q**, **R** en **S**) het <u>dieselfde molekulêre massa/formule/aantal koolstof en waterstofatome/ is (ketting)isomere</u>.*

OR/*OF*
The compounds are all <u>alkanes</u> /<u>same homologous series</u> and have the <u>same number of carbon atoms</u>.
Die verbindings is almal <u>alkane</u> /<u>dieselfde homoloë reeks</u> en het die <u>dieselfde aantal koolstofatome.</u> (1)

Marking guidelines/*Nasienriglyne*
• 55 (°C) ✓ • Compare all three compounds or Q and S in terms of branches/chain lengths / surface area. ✓ *Vergelyk al drie verbindings of Q en S in terme van vertakkings/kettinglengte/ oppervlakarea.* • Compare strengths of all three or Q and S's IMF's / *Vergelyk sterkte van al drie of Q en S se IMK'e.*✓ • Compare energy of all three /*Vergelyk energie van al drie.* ✓

3.3 55 (°C) ✓

Compare compound R with compounds Q and S:

- Compound **R** is less branched/compact/spherical/surface area than compound **Q** and more branched/compact/spherical/surface area than compound **S**. ✓
  OR
  Q is the most branched/compact /spherical/surface area and **S** is least branced/compact/spherical/surface area.
- Intermolecular forces in compound **R** are stronger than in compound **Q** and weaker than in compound **S**. ✓
- More energy needed to overcome intermolecular forces in compound **R** than in compound **Q** and less energy needed to overcome (break) intermolecular forces in compound **R** than in compound **S**. ✓

OR

- Compound **R** has a longer chain length than compound **Q** and a shorter chain length than compound **S**. ✓
  OR
  S has the longest chain length and **Q** the shortest.
- Intermolecular forces increase with increase in chain length. ✓
- More energy needed to overcome intermolecular forces as chain length increases. ✓

Vergelyk verbinding R met verbindings Q en S:.

- *Verbinding **R** is minder vertak/kompak/sferieseoppervlak as verbinding **Q** en meer vertak as verbinding **S**.*
  OF
  Q is die meeste vertak/kompak en **S** is die minste vertak/kompak/series/oppervlak.
- *Intermolekulêre kragte in verbinding **R** is sterker as in verbinding **Q** en swakker as in verbinding **S**.*
- *Meer energie word benodig om intermolekulêre kragte in verbinding **R** te oorkom as in verbinding **Q**, en minder energie word benodig om intermolekulêre kragte in verbinding **R** te oorkom / breek as in verbinding **S**.*

OF

- *Verbinding **R** het 'n langer kettinglengte as verbinding **Q** en 'n korter kettinglengte as **S**.*
  OF
  S het die langste ketting en **Q** die kortste.
- *Intermolekulêre kragte neem toe met toename in kettinglengte.*
- *Meer energie word benodig om intermolekulêre kragte te oorkom wanneer kettinglengte toeneem.* (4)

3.4
3.4.1 P ✓✓ (2)

3.4.2

Marking guidelines/*Nasienriglyne*
• Name type of IMFs in **P/pentanal**. ✓ *Noem tipe IMK'e in **P/pentanaal**.* • Name type of IMFs in/*Noem tipe IMK'e in* **T/pentan-1-ol**.✓ • Compare strength of IMFs. /*Vergelyk sterkte van IMK'e.* ✓ **OR/*OF*** Compare energy needed to overcome IMFs./*Vergelyk energie benodig om IMK'e te oorkom.*

- In **P**/ pentanal/aldehydes: <u>dipole-dipole forces</u> ✓(in addition to London forces/dispersion forces/induced dipole forces).
- In **T**/pentan-1-ol: <u>Hydrogen bonding</u>.✓ (in addition to London forces/dispersion forces/induced dipole forces).
- <u>Intermolecular forces in **P**/pentanal are weaker</u> ✓than in **T**/pentan-1-ol **OR** dipole-dipole forces are weaker than hydrogen bonds **OR** intermolecular forces in **T**/pentan-1-ol are stronger than in **P**/pentanal.
  OR
  <u>More energy needed to overcome/break intermolecular forces in **T**</u>.

- *In **P**/pentanaal/aldehiede: <u>dipool-dipoolkragte</u> (tesame met Londonkragte/ dispersiekragte/geïnduseerde dipoolkragte).*
- *In **T**/pentan-1-ol: Waterstofbinding. (tesame met Londonkragte/ dispersiekragte/geïnduseerde dipoolkragte).*
- *<u>Intermolekulêre kragte in **P** swakker</u> as in **T**/pentan-1-ol **OF** intermolekulêre kragte in **T**/pentan-1-ol sterker as in **P**/pentanaal **OF** dipool-dipoolkragte is swakker as waterstofbindings.*
  OF
  *<u>Meer energie benodig om intermolekulêre kragte te oorkom/breek in **T**</u>.* (3)

[12]

QUESTION 4/*VRAAG 4*

4.1 Haloalkane/alkyl halide ✓
Haloalkaan/alkielhalied (1)

4.2
4.2.1 Elimination/dehydrohalogenation ✓
Eliminasie/dehidrohalogenering (1)

4.2.2 Substitution/hydrolysis ✓
Substitusie/hidrolise (1)

4.2.3 Esterification/condensation ✓
Esterifikasie/kondensasie/verestering (1)

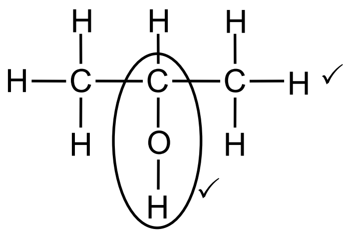
4.3
4.3.1
- (Mild) heat/Heating/*(matige) hitte/ verhitting* ✓
- Dilute (strong base)/*Verdunde (sterk basis)*/(NaOH/KOH/LiOH) ✓
  OR/*OR*
  Add water/H_2O/*Voeg water/H_2O by* (2)

4.3.2 Propan-1-ol/1-propanol ✓✓

Marking criteria/*Nasienriglyne:*
- Correct stem and functional group i.e. propanol/*Korrekte stam en funksionele groep, d.i. propanol.* ✓
- Whole name correct:/*Hele naam korrek*: propan-1-ol ✓

(2)

4.4



Marking criteria/*Nasienriglyne*
- Whole structure correct:/*Hele struktuur korrek:* $\frac{2}{2}$
- Only functional group correct/*Slegs funksionele groep korrek:* $\frac{1}{2}$

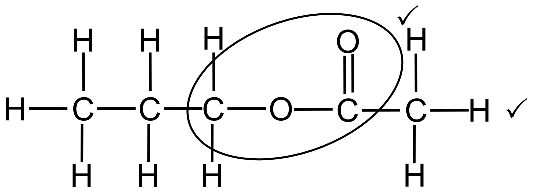
Notes/*Aantekeninge*
- Accept –OH as condensed. /*Aanvaar –OH as gekondenseerd.*
- Condensed or semi-structural formula:
  Gekondenseerde of semi-struktuurformule: Max./*Maks.* $\frac{1}{2}$
- Molecular formula/*Molekulêre formule*: $\frac{0}{2}$
- If functional group is incorrect/*Indien funksionele groep verkeerd is*: $\frac{0}{2}$
- If more than one functional group:
  Indien meer as een funksionele groep: $\frac{0}{2}$

(2)

4.5

POSITIVE MARKING FROM Q4.3.2 ONLY IF THE COMPOUND IN Q4.3.2 IS AN ALCOHOL. /*POSITIEWE NASIEN VANAF V4.3.2 SLEGS INDIEN DIE VERBINDING IN Q4.3.2 'N ALKOHOL IS.*

4.5.1



Marking criteria/*Nasienriglyne*
- Whole structure correct:/*Hele struktuur korrek:* $\frac{2}{2}$
- Only functional group correct/*Slegs funksionele groep korrek:* $\frac{1}{2}$

Notes/*Aantekeninge*
- Condensed or semi-structural formula:
  Gekondenseerde of semistruktuurformule: Max./*Maks.* $\frac{1}{2}$
- Molecular formula/*Molekulêre formule*: $\frac{0}{2}$
- If functional group is incorrect/*Indien funksionele groep verkeerd is*: $\frac{0}{2}$

(2)

4.5.2 (Concentrated) sulphuric acid/*(Gekonsentreerde) swawelsuur*/H_2SO_4 ✓ (1)

[13]

QUESTION 5/*VRAAG 5*

5.1 Exothermic/*Eksotermies* ✓

$\triangle H < 0$/Energy is released/*Energie word vrygestel* ✓ (2)

5.2

rate/*tempo* = $-\frac{\Delta m}{\Delta t}$	**OR/*OF*** rate/*tempo* = $-\frac{\Delta m}{\Delta t}$
$= -\frac{0{,}25 - 2}{30}$ ✓ ✓	$= -\frac{-1{,}75}{30}$ ✓ ✓
$= 0{,}06\ (g\cdot s^{-1})$ ✓ $(0{,}0583\ g\cdot s^{-1})$	$= 0{,}06\ (g\cdot s^{-1})$ ✓ $(0{,}0583\ g\cdot s^{-1})$

Notes/*Aantekeninge*
Accept negative answer i.e./***Aanvaar** negatiewe antwoord d.i.* $-0{,}06\ g\cdot s^{-1}$.

(3)

5.3

Marking guidelines

- Calculate/*Bereken*: m($CaCO_3$) reacted/*reageer* or / *of* V(CO_2) produced/*gevorm.* ✓
- Substitute/*Vervang*: 100 g·mol^{-1}. ✓
- USE mol ratio/*GEBRUIK molverhouding*: n(CO_2) : n($CaCO_3$) = 1 : 1 ✓
- Use of/ /*Gebruik van* 22,4 dm^{-3}·mol^{-1}.✓
- Final answer/*Finale antwoord*: 0,18 dm^3 (0,1792 dm^3) ✓

OPTION 1/*OPSIE 1*	**OPTION 2/*OPSIE 2***
m($CaCO_3$) = $\frac{40}{100}$ x 2 ✓ = 0,8 g n($CaCO_3$)$_{reacted}$ = $\frac{m}{M}$ = $\frac{0,8}{100}$ ✓ = 8 x 10^{-3} mol n(CO_2) = n($CaCO_3$) ✓ = 8 x 10^{-3} mol V(CO_2) = 8 x 10^{-3} x 22,4 ✓ = 0,18 dm^3 ✓	For 2 g antacid/*teensuurtablet*: 100 g ✓$CaCO_3$ ......22,4 dm^3 ✓ CO_2 2 g $CaCO_3$ .....0,448 dm^3 ✓ 100% CO_2 .... 0,448 dm^3 ✓ 40% CO_2 .... 0,18 dm^3 ✓ **OPTION 3/*OPSIE 3*** 100% $CaCO_3$ ....2 g 40% ....0,8 g ✓ 100 g ✓……. 1 mol 0,8 g .... 8 x 10^{-3} mol ✓ 1 mol ....22,4 dm^3 ✓ 8 x 10^{-3} mol ......0,18 dm^3 ✓

(5)

5.4 **ANY ONE/*ENIGE EEN*:**

- Concentration (of acid)/*Konsenterasie (van suur)* ✓
- Size/mass of tablet/Identical tablet /Type of tablet.
  Grootte/massa van tablet/Identiese tablet./Tipe tablet.
- State of division / Surface area / *Toestand van verdeeldheid / reaksieoppervlak.*

(1)

5.5

Criteria for conclusion/*Riglyne vir gevolgtrekking*:	
Dependent [(reaction) rate/time] and independent (temperature) variables correctly identified. *Afhanklike [(reaksie)tempo/tyd] en onafhanklike (temperatuur) veranderlikes korrek geïdentifiseer.*	✓
Relationship between the independent and dependent variables correctly stated./*Verwantskap tussen die afhanklike en onafhanklike veranderlikes korrek genoem.*	✓

Examples/*Voorbeelde*:

- Reaction rate ($\frac{1}{time}$) increases with increase in temperature.
  Reaksietempo ($\frac{1}{time}$) *neem toe met toename in temperatuur.*
- Reaction rate ($\frac{1}{time}$) decreases with decrease in temperature.
  Reaksietempo ($\frac{1}{time}$) *neem af met afname in temperatuur.*
- Time taken for reaction decreases when temperature increases.
  Tyd vir die reaksie neem af wanneer temperatuur toeneem.
- Time taken for reaction increases when temperature decreases.
  Tyd vir die reaksie neem toe as temperatuur afneem.

IF/*INDIEN*	
Reaction rate is DIRECTLY proportional to temperature:	Max. $\frac{1}{2}$
Reaksietempo is DIREK eweredig aan temperatuur:	*Maks.* $\frac{1}{2}$

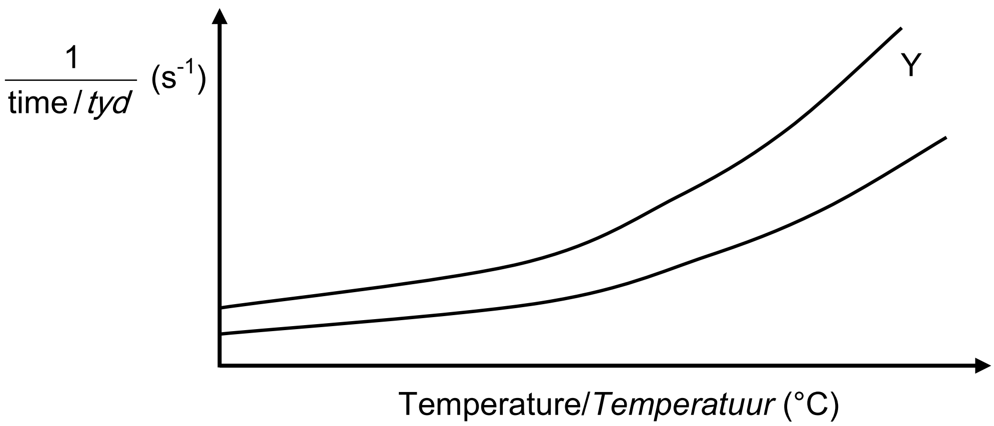
(2)

5.6
- Increase in temperature increases the average kinetic energy/molecules move faster. /*Toename in temperatuur verhoog die gemiddelde kinetiese energie/molekule beweeg vinniger.* ✓
- More molecules have enough/sufficient kinetic energy/More molecules have $E_k > E_a$. ✓
  Meer molekule het genoeg/voldoende kinetiese energie/Meer molekule het $E_k > E_a$.
- More effective collisions per unit time/second. /Frequency of effective collisions increases. ✓
  Meer effektiewe botsings per eenheidtyd/sekonde./Frekwensie van effektiewe botsings neem toe.

(3)

5.7

Marking guidelines/*Nasienriglyne*
- For each value of temperature, the CURVE Y must be above the given CURVE. / *Vir elke waarde van temperatuur, moet kurwe Y bo die gegewe kurwe wees.* ✓
- CURVE Y must have an increasing rate with an increase in temperature. / *KURWE Y moet 'n toenemende tempo het soos die temperatuur toeneem.* ✓



(2)
[18]

QUESTION 6/*VRAAG 6*

6.1 (The stage in a chemical reaction when the) rate of forward reaction equals the rate of reverse reaction. ✓✓
(Die stadium in 'n chemiese reaksie wanneer die) tempo van die voorwaartse reaksie gelyk is aan die tempo van die terugwaartse reaksie. **(2 or/*of* 0)**

OR/*OF*
(The stage in a chemical reaction when the) concentrations of reactants and products remain constant.
(Die stadium in 'n chemiese reaksie wanneer die) konsentrasies van reaktanse en produkte konstant bly. **(2 or/*of* 0)** (2)

6.2 **CALCULATIONS USING NUMBER OF MOLES**
BEREKENINGE WAT AANTAL MOL GEBRUIK

6.2.1 **Marking guidelines/*Nasienriglyne***

- Substitute/*Vervang*: 44 g·mol^{-1}. ✓
- Equilibrium concentration of CO_2 multiply by 3 dm^3
  Ewewigskonsentrasie van CO_2 *vermenigvuldig met 3 dm*^{3}
  AND/*EN* $n(CO)_{eq}$ divide by /*deel* deur 3 dm^3 ✓
- Use mole ratio/*Gebruik molverhouding:* 1:2 / n(CO) = 2n(CO_2). ✓
- $n(CO_2)_{change} = n(CO_2)_{initial} - n(CO_2)_{final}$
  $n(CO)_{eq/ewe} = n(CO)_{initial/begin} + \Delta n(CO)$ ✓
- Correct K_c expression (formulae in square brackets). ✓
  Korrekte K_c*-uitdrukking (formules in vierkanthakies).*
- Substitution of concentrations into K_c expression. ✓
  Vervanging van konsentrasies in K_c*-uitdrukking.*
- Final answer/*Finale antwoord*: 12,24 (range/*gebied*: 11,85 – 12,66) ✓

OPTION 1/*OPSIE 1*

$n(CO_2) = \frac{m}{M}$

$= \frac{60,8}{44}$ ✓

= 1,382 mol

	CO_2	CO
Initial quantity (mol) *Aanvangshoeveelheid (mol)*	1,382	0
Change (mol) *Verandering (mol)* ✓	1,22	2,44
Quantity at equilibrium (mol)/ *Hoeveelheid by ewewig (mol)*	0,162	2,44
Equilibrium concentration ($mol·dm^{-3}$) *Ewewigskonsentrasie ($mol·dm^{-3}$)*	0,054	0,813

Use ratio/*Gebruik verhouding* ✓

Divide/multiply by 3/*Deel/ vermenigvuldig met 3* ✓

$K_c = \frac{[CO]^2}{[CO_2]}$ ✓

$= \frac{(0,813)^2}{0,054}$ ✓

= 12,24 ✓

No K_c expression, correct substitution/*Geen K_c-uitdrukking, korrekte substitusie:* Max./*Maks.* $\frac{6}{7}$
Wrong K_c expression/*Verkeerde K_c- uitdrukking*: Max./*Maks.* $\frac{4}{7}$

OPTION 2/*OPSIE 2*

$n(CO_2) = \frac{m}{M}$

$= \frac{60,8}{44}$ ✓

= 1,382 mol

$n(CO_2)_{change} = n(CO_2)_{initial/begin} - n(CO_2)_{final/finaal}$

= 1,382 – 0,162

= 1,22 mol

$n(CO)_{change} = 2(CO_2)$

= 2(1,22) ✓

= 2,44 mol

$n(CO)_{eq} = n(CO)_{change}$ = 2,44 mol ✓

$c(CO) = \frac{n}{V}$

$= \frac{2.44}{3}$ ✓

= 0,813 $mol·dm^{-3}$

$K_c = \frac{[CO]^2}{[CO_2]}$ ✓

$= \frac{(0,813)^2}{0,054}$ ✓

= 12,24 ✓ (Accept range/*Aanvaar gebied*: 11,85 – 12,66).

CALCULATIONS USING CONCENTRATION
BEREKENINGE WAT KONSENTRASIE GEBRUIK

Marking guidelines/*Nasienriglyne*

- Substitute 44 $g\cdot mol^{-1}$. ✓
- Initial $n(CO_2)$divide by 3 dm^3. ✓
  Aanvanklike $n(CO_2)$ gedeel deur 3 dm^3.
- **USE** ratio/***GEBRUIK*** *verhouding:* $c(CO_2) : c(CO) = 1 : 2$ ✓
- $\Delta c(CO_2) = c(CO_2)_{initial/begin} - c(CO_2)_{eq/ewe}$.
  $c(CO)_{eq/ewe} = c(CO)_{initial/begin} + \Delta c(CO)$. ✓
- Correct K_c expression (formulae in square brackets). ✓
  Korrekte K_c uitdrukking (formules in vierkanthakies).
- Substitution of concentrations into K_c expression. ✓
  Vervanging van konsentrasies in K_c-uitdrukking.
- Final answer/*Finale antwoord*: 12,15 (range/*gebied*: 11,85 – 12,66) ✓

OPTION 3/*OPSIE 3*

$$n(CO_2) = \frac{m}{M}$$
$$= \frac{60,8}{44} ✓$$
$$= 1,382 \text{ mol}$$

	CO_2	CO	
Initial concentration ($mol\cdot dm^{-3}$) *Aanvanklike konsentrasie ($mol\cdot dm^{-3}$)*	0,4607	0	Divide by /*Deel deur* 3 dm^3 ✓
Change ($mol\cdot dm^{-3}$) *Verandering ($mol\cdot dm^{-3}$)*	0,4067	0,813	ratio ✓ *verhouding*
Equilibrium concentration ($mol\cdot dm^{-3}$) *Ewewigskonsentrasie ($mol\cdot dm^{-3}$)*	0,054	0,813	

$$K_c = \frac{[CO]^2}{[CO_2]} ✓$$
$$= \frac{(0,813)^2}{0,054} ✓$$
$$= 12,15 ✓$$

No K_c expression, correct substitution/*Geen K_c-uitdrukking, korrekte substitusie:* Max./*Maks.* $\frac{6}{7}$

Wrong K_c expression/*Verkeerde K_c-uitdrukking*: Max./*Maks.* $\frac{4}{7}$

(7)

6.2.2 **POSITIVE MARKING FROM Q6.2.1/*POSITIEWE NASIEN VANAF V6.2.1***

$n(C)_{reacted/reageer} = n(CO_2)_{reacted/reageer}$
$= 1,22$ mol ✓

$m(C) = nM$
$= 1,22(12)$ ✓
$= 14,64$ g ✓

Marking guidelines
- **USE** mol ratio/ ***GEBRUIK*** *molverhouding*: $n(C) = n(CO_2)$. ✓
- Substitute/*Vervang*: 12 $g\cdot mol^{-1}$. ✓
- Final answer/*Finale antwoord*: 14,64 g. ✓

(3)

6.3

6.3.1 Remains the same/*Bly dieselfde* ✓ (1)

6.3.2 Decreases/*Afneem* ✓

- (When pressure is increased) the reaction that leads to the smaller amount/number of moles/volume of gas is favoured. ✓
  (Wanneer die druk verhoog word,) word die reaksie wat tot die kleiner hoeveelheid/aantal mol/volume gas lei, bevoordeel.
- The reverse reaction is favoured. / More CO_2 is formed. ✓
  Die terugwaartse reaksie word bevoordeel./ meer CO_2 word gevorm. (3)

6.4

6.4.1 Endothermic/*Endotermies* ✓

- When the temperature increases the mol/percentage CO(g)/product increases/forward reaction is favoured./*Wanneer die temperatuur toeneem, neem die mol/persentasie CO(g)/produk toe/voorwaartse reaksie word bevoordeel.* ✓
- An increase in temperature favours the endothermic reaction/*Toename in temperatuur bevoordeel die endotermiese reaksie*. ✓ (3)

6.4.2

POSITIVE MARKING FROM Q6.2.1./*POSITIEWE NASIEN VANAF V6.2.1.*

Marking guidelines/*Nasienriglyne*

- Calculate total volume/mol of gas at equilibrium/*Bereken totale volume/mol gas by ewewig:* 0,162 + 2,44 = 2,606 dm^3 /mol ✓
  OR/*OF*
  Calculate the total concentration at equilibrium/*Bereken die totale konsentrasie by ewewig*: 0,054 + 0,813 = 0,867 $mol\cdot dm^{-3}$
- Calculate percentage of ANY one gas/*Bereken persentasie van ENIGE een gas* (CO_2 or/*of* CO). ✓
- Final answer/*Finale antwoord*: T = 827 °C ✓

OPTION 1/*OPSIE 1*

$V_{total\ eq} = 0,162 + 2,44$ ✓
$= 2,606\ dm^3$

$\%\ CO_2 = \frac{0,162}{2,606} \times 100$ ✓
$= 6,225\ \%$

OR/*OF*

$\%\ CO = \frac{2,44}{2,606} \times 100$ ✓
$= 93,63\ \%$

OPTION 2/*OPSIE 2*

$c_{total\ eq} = 0,054 + 0,813$
$= 0,867\ mol\cdot dm^{-3}$

$\%\ CO_2 = \frac{0,054}{0,867} \times 100$ ✓
$= 6,228\ \%$

OR/*OF*

$\%\ CO = \frac{0,813}{0,867} \times 100$ ✓
$= 93,77\ \%$

$\therefore$ T = 827 °C ✓ (3)

[22]

QUESTION 7/*VRAAG 7*

7.1 Strong (acid)/*Sterk (suur)* ✓

Large/*Groot* K_a value/*waarde*/ $K_a > 1$ / (HBr) ionises completely/*ioniseer volledig* ✓ (2)

7.2 H_2O ✓

Br^- ✓ (2)

7.3

7.3.1

Marking guidelines/*Nasienriglyne*

- Formula/*Formule:* $c = \frac{n}{V}$ /n = cV / $\frac{c_a \times V_a}{c_b \times V_b} = \frac{n_a}{n_b}$ ✓
- Substitution of/*Vervanging van:* (0,5)(0,0165)/(0,5)(16,5) ✓
- Use mol ratio/*Gebruik molverhouding:* 1:1/n(HBr) = n(NaOH) ✓
- Substitute/*Vervang*: V = 0,09 dm^3 /90 cm^3 ✓
- Formula/*Formule:* pH = -log[H_3O^+] ✓
- Substitute [H_3O^+] in pH formula. ✓
- Final answer/*Finale antwoord*: pH = 1,04 (range/*gebied*: 1,036 – 1,05) ✓

OPTION 1/*OPSIE 1*	**OPTION 2/*OPSIE 2***
$n(NaOH)_{reacted/reageer}$ = cV ✓ = 0,5(0,0165) ✓ = 0,00825 mol $n(HBr)_{excess/oormaat}$ = n(NaOH) = 0,00825 mol ✓ $c(H_3O^+) = \frac{n}{V}$ $= \frac{0,00825}{0,09}$ ✓ = 0,092 mol·dm^{-3} pH = -log[H_3O^+] ✓ = -log(0,092) ✓ = 1,04 ✓	$\frac{c_aV_a}{c_bV_b} = \frac{n_a}{n_b}$ ✓ $\frac{c_a(90)}{(0,5)(16,5)} = \frac{1}{1}$ ✓✓✓ c_a = 0,092 mol·dm^{-3} pH = -log[H_3O^+] ✓ = -log(0,092) ✓ = 1,04 ✓

(7)

7.3.2

Marking guidelines/*Nasienriglyne*

- Calculate/*Bereken* n(HBr)$_{initial/aanvanklik}$: substitute/*vervang* (0,45)(0,09) in n = cV ✓
- Subtraction/*Aftrekking:*
  n(HBr)$_{reacted/reageer}$ = n(HBr)$_{initial/aanvanklik}$ – n(HBr)$_{reacted\ with/reageer\ met\ NaOH}$. ✓✓
  OR/*OF*: c(HBr)$_{reacted/reageer}$ = c(HBr)$_{initial/aanvanklik}$ – c(H_3O^+)$_{excess/oormaat}$
- Use mol ratio/*Gebruik molverhouding:* n($Zn(OH)_2$) : n(HBr) = 1 : 2 ✓
- Substitution of/*Vervanging van:* 99 g·mol^{-1} ✓
- Final answer/*Finale antwoord:* 1,5964 g (range/*gebied:* 1,58 – 1,68) ✓

POSITIVE MARKING FROM Q7.3.1/*POSITIEWE NASIEN VANAF V7.3.1*

OPTION 1/*OPSIE 1*

n(HBr)$_{initial/begin}$ = cV
= (0,45)(0,09) ✓
= 0,0405 mol

n(HBr reacted with/*reageer met* $Zn(OH)_2$) = 0,0405 – 0,00825 ✓✓
= 0,03224 mol

n($Zn(OH)_2$) = ½n(HBr) = ½(0,03224) ✓= 0,016125 mol

m($Zn(OH)_2$) = nM
= (0,016125)(99) ✓
= 1,596 g ✓

OPTION 2/*OPSIE 2*

c(HBr) = 0,45 – 0,092 ✓✓
= 0,358 mol·dm^{-3}

n(HBr reacted/*reageer*) = cV
= 0,358 x 0,09 ✓
= 0,0322 mol

n($Zn(OH)_2$) = ½n(HBr) = ½(0,0322) ✓= 0,01611 mol

m($Zn(OH)_2$) = nM
= 0,01611 x 99 ✓
= 1,595 g ✓ (1,60 g)

(6)

[17]

QUESTION 8/*VRAAG 8*

8.1 Chemical to electrical/*Chemies na elektries* ✓ (1)

8.2 Provides path for movement of ions./ Completes the circuit./Ensures electrical neutrality in the cell./Restore charge balance. ✓
Verskaf pad vir beweging van ione./Voltooi die stroombaan./Verseker elektriese neutraliteit in die sel./Herstel balans van lading. (1)

8.3 **OPTION 1/*OPTION 1***

$E^{\theta}_{cell} = E^{\theta}_{cathode} - E^{\theta}_{anode}$ ✓

$1{,}49 = 1{,}36 - E^{\theta}_{anode}$ ✓ ✓

$E^{\theta}_{anode} = 1{,}36 - 1{,}49$

$= -0{,}13$ (V) ✓

X is Pb/Lead/*Lood* ✓

Notes/*Aantekeninge*
- Accept any other correct formula from the data sheet. /*Aanvaar enige ander korrekte formule vanaf gegewensblad.*
- Any other formula using unconventional abbreviations, e.g. $E°_{cell} = E°_{OA} - E°_{RA}$ followed by correct substitutions:/*Enige ander formule wat onkonvensionele afkortings gebruik, bv.* $E°_{sel} = E°_{OM} - E°_{RM}$ *gevolg deur korrekte vervangings*: $\frac{4}{5}$

OPTION 2/*OPSIE 2*

✓ $C\ell_2 + 2e^- \rightarrow 2C\ell^-$ $E^{\theta} = 1{,}36$ V ✓
$X \rightarrow X^{2+} + 2e^-$ $E^{\theta} = 0{,}13$ V ✓

$C\ell_2 + X \rightarrow X^{2+} + 2C\ell^-$ $E^{\theta} = 1{,}49$ V ✓

X is Pb/Lead/*Lood* ✓ (5)

POSITIVE MARKING FROM Q8.3/*POSITIEWE NASIEN VANAF V8.3*

8.4 X/Pb/Lead/*Lood* ✓ (1)

8.5

8.5.1 Reaction reached equilibrium./(In each half cell) the rate of oxidation is equal to rate of reduction./Rate of the forward reaction is equal to the rate of the reverse reaction. ✓
Reaksie bereik ewewig./(In elke halfsel) die t*empo van oksidasie is gelyk aan tempo van reduksie./Tempo van die voorwaartse reaksie is gelyk aan die tempo van die terugwaartse reaksie.* (1)

8.5.2 Increases/*Toeneem* ✓ (1)

8.5.3
- $[C\ell^-]$ decreases/*neem af*. ✓
- Forward reaction is favoured./*Voorwaartse reaksie word bevoordeel.* ✓ (2)

[12]

QUESTION 9/*VRAAG 9*

9.1

> **Marking guidelines/*Nasienriglyne***
> If any one of the underlined key phrases in the **correct context** is omitted, deduct 1 mark./*Indien enige van die onderstreepte frases in die **korrekte konteks** uitgelaat is, trek 1 punt af.*

The chemical process in which electrical energy is converted to chemical energy. ✓✓
Die chemiese proses waarin elektriese energie omgeskakel word na chemiese energie.
OR/*OF*
The use of electrical energy to produce a chemical change.
Die gebruik van elektriese energie om 'n chemiese verandering teweeg te bring.
OR/*OF*
The process during which an electrical current passes through a solution/molten ionic compound.
Die proses waar 'n elektriese stroom deur 'n oplossing/gesmelte ioniese verbinding gestuur word. (2)

9.2
9.2.1 $2H_2O(\ell) + 2e^- \rightarrow H_2(g) + 2OH^-(aq)$ ✓✓
Ignore phases/*Ignoreer fases*

> **Marking guidelines/*Nasienriglyne***
> - $H_2(g) + 2OH^-(aq) \leftarrow 2H_2O(\ell) + 2e^-$ $(\frac{2}{2})$ $2H_2O(\ell) + 2e^- \rightleftharpoons H_2(g) + 2OH^-(aq)$ $(\frac{1}{2})$
> $H_2(g) + 2OH^-(aq) \rightleftharpoons 2H_2O(\ell) + 2e^-$ $(\frac{0}{2})$ $2H_2O(\ell) + 2e^- \leftarrow H_2(g) + 2OH^-(aq)$ $(\frac{0}{2})$
> - Ignore if charge omitted on electron./*Ignoreer indien lading weggelaat op elektron.*
> - If charge (-) omitted on OH^- /*Indien lading (-) weggelaat op* OH^-:
>   Example/*Voorbeeld:* $2H_2O(\ell) + 2e^- \rightarrow H_2(g) + 2OH(aq)$ ✓ Max./*Maks:* $\frac{1}{2}$

(2)

9.2.2 Water/ H_2O ✓ (1)

9.3 H_2O is a stronger oxidising agent ✓ than Na^+ ✓ and will be reduced ✓ (to H_2).
H_2O is 'n sterker oksideermiddel as Na^+ en sal gereduseer word (na H_2).
OR/*OF*
Na^+ is a weaker oxidizing agent ✓ than H_2O ✓ and therefore H_2O will be reduced ✓ (to H_2)
Na^+ is 'n swakker oksideermiddel as H_2O en daarom sal H_2O gereduseer word (na H_2)

OR/*OF*
The half-reaction that produces $H_2(g)$ has a more positive reduction potential (-0,83 V) ✓ than the half-reaction that produces Na (-2,71 V). ✓
Therefore water/H_2O will be reduced ✓ to H_2./Na^+ will not be reduced to Na.
Die halfreaksie wat $H_2(g)$ *vorm, het 'n meer positiewe reduksiepotensiaal (-0,83 V) as die halfreaksie wat Na vorm (-2,71 V).*
Daarom word water/H_2O na H_2 *gereduseer./Na^+ sal nie gereduseer word na* (3)

Na nie.

[8]

QUESTION 10/*VRAAG 10*

10.1

10.1.1 Hydrogen/*Waterstof*/H_2 ✓ (1)

10.1.2 Nitrogen monoxide/*Stikstofmonoksied*/NO ✓ (1)

10.1.3 Nitric acid/*Salpetersuur*/HNO_3 ✓ (1)

10.2

10.2.1 (Catalytic) oxidation/Redox/*(Katalitiese) oksidasie/Redoks* ✓ (1)

10.2.2 NH_3 + HNO_3 ✓ → NH_4NO_3 ✓ Bal ✓

<u>Notes/*Aantekeninge*</u>
- Reactants ✓ Products ✓ Balancing ✓
  Reaktanse *Produkte* *Balansering*
- Ignore double arrows (⇌) and phases./Ignoreer dubbelpyle (⇌)*en fases*.
- Marking rule 6.3.10./Nasienreël 6.3.10.

(3)

10.3

10.3.1 (Total) percentage of nutrients/fertiliser/N,P,K. ✓
(Totale) persentasie nutriente/ kunsmis/N,P, K. (1)

10.3.2

Marking guidelines/*Nasienriglyne*

- Calculate mass fertiliser in A./*Bereken massa kunsmis in A* ✓
- Calculate mass fertiliser in B./ *Bereken massa kunsmis in B* ✓
- Calculate mass P in A and B ./*Bereken massa P in A en B*✓
- Final answer/*Finale antwoord*:
  B has more phosphorous than/*het meer fosfor as* A. ✓

OPTION 1/*OPSIE 1*

Mass fertiliser in A:
Massa kunsmis in A:

$m = \frac{21}{100} \times 50$ ✓ = 10,5 kg

Mass fertiliser in B:
/*Massa kunsmis in B*:

$m = \frac{27}{100} \times 40$ ✓ = 10,8 kg

Mass phosphorous in A/
Massa fosfor in A:

$\frac{3}{8} \times 10{,}5 = 3{,}94$ kg

Mass phosphorous in B/
Massa fosfor in B:

$\frac{3}{8} \times 10{,}8 = 4{,}05$ kg ✓

Fertiliser B has more phosphorous than fertiliser A. ✓

OPTION 2/*OPSIE 2*

Mass phosphorous in A/
Massa fosfor in A:

$m = \frac{3}{8} \times \frac{21}{100} \times 50$ ✓ = 3,94 kg

Mass(P) in B
Massa (P) in B:

$m = \frac{3}{8} \times \frac{27}{100} \times 40$ ✓ = 4,05 kg ✓

Fertiliser B has more phosphorous than fertiliser A. /*Kunsmis B het meer fosfor as kunsmis A.*✓

OPTION 3/*OPSIE 3*

Mass phosphorous in A/
Massa fosfor in A:

$\%P = \frac{3}{8} \times 21 = 7{,}88\%$

$m(P) = \frac{7{,}88}{100} \times 50$ ✓ = 3,94 kg

Mass(P) in B
Massa (P) in B:

$\%(P) = \frac{3}{8} \times 27 = 10{,}13\%$

$m = \frac{10{,}13}{100} \times 40$ ✓ = 4,05 kg ✓

Fertiliser B has more phosphorous than fertiliser A. /*Kunsmis B het meer fosfor as kunsmis A* ✓

OPTION 4/*OPSIE 4*

Mass fertiliser in A:
Massa kunsmis in A:

$m = \frac{21}{100} \times 50$ ✓ = 10,5 kg

Mass fertiliser in B:
/*Massa kunsmis in B*:

$m = \frac{27}{100} \times 40$ ✓ = 10,8 kg

For the same NPK ratio ✓
the bag with more fertiliser will have more phosphorous ∴ bag B✓
Vir dieselfde NPK verhouding, die sake met meer kunsmis sal meer fosfor het ∴ sak B

(4)
[12]

TOTAL/*TOTAAL*: 150