LIMPOPO
PROVINCIAL GOVERNMENT
REPUBLIC OF SOUTH AFRICA

DEPARTMENT OF EDUCATION

NATIONAL SENIOR SERTIFICATE

GRADE 12

PHYSICAL SCIENCES: CHEMISTRY (P2)

SEPTEMBER 2024

MARKS: 150

TIME: 3 HOURS

EPHSCP2

This paper consists of 14 pages and 4 data sheets

INSTRUCTIONS AND INFORMATION

1. The question paper consists of nine questions. Answer ALL the questions.
2. Start EACH question on a NEW page.
3. Number your answers correctly according to the numbering system used in this question paper.
4. Leave ONE line between two sub-questions, e.g., between QUESTION 2.1 and QUESTION 2.2.
5. A non-programmable calculator may be used.
6. Appropriate mathematical instruments may be used.
7. Show ALL formulae and substitutions in ALL calculations.
8. Round off your FINAL numerical answers to a minimum of TWO decimal places.
9. Give brief motivations, discussions, etc. where required.
10. You are advised to use the attached data sheets.
11. 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 number (1.1 – 1.10), for example 1.10 E

1.1 What is the IUPAC name for the compound $CH_3CH_2CHFCH_3$?

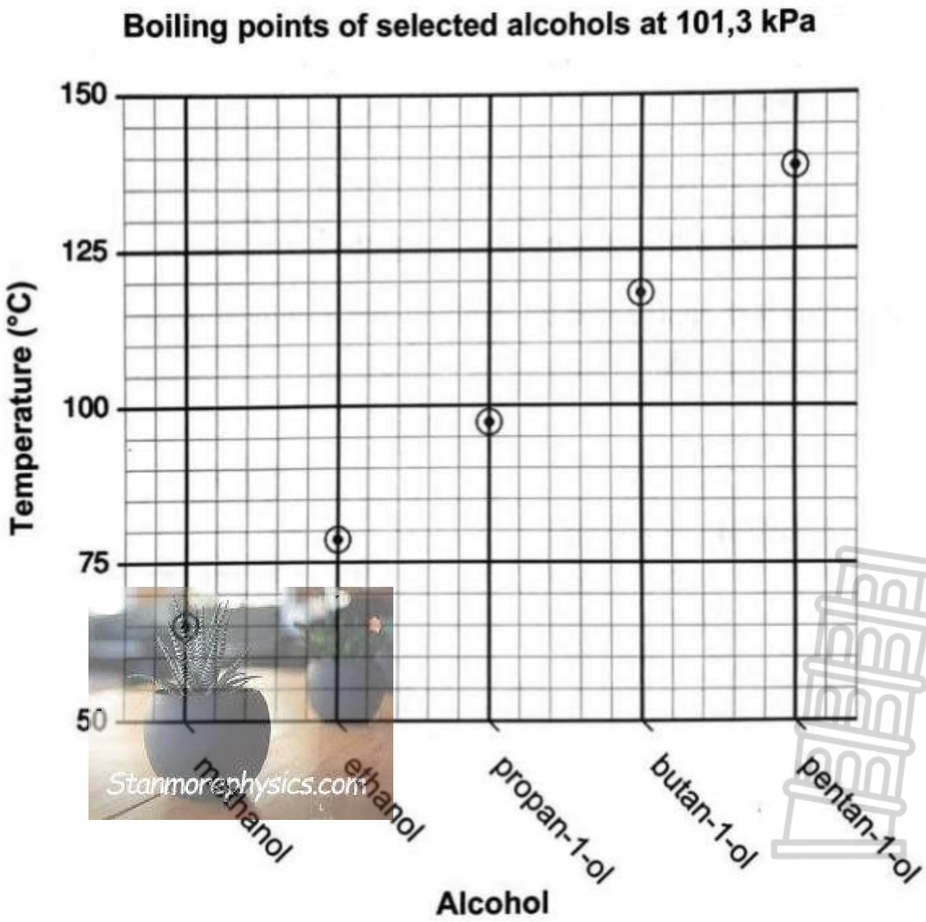
A. 2-fluorobutane

B. 3-fluorobutane

C. fluoro-3-butane

D. fluorobutane (2)

Base your answers to questions 1.2 and 1.3 on the graph below.



1.2 What is represented by the number "1" in the IUPAC name for three of these alcohols?

A. The number of isomers for each alcohol.

B. The number of –OH groups for each carbon atom in each alcohol molecule.

C. The location of an –OH group on one end of the carbon chain in each alcohol molecule.

D. The location of an –OH group in the middle of the carbon chain in each alcohol molecule. (2)

1.3 What can be concluded from this graph?

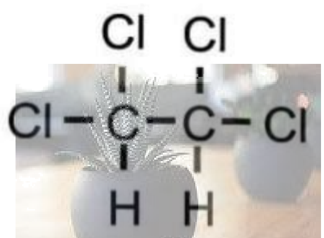
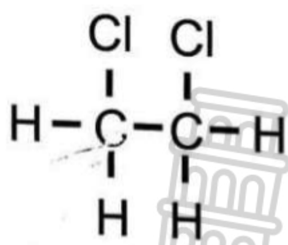
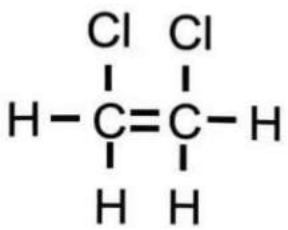
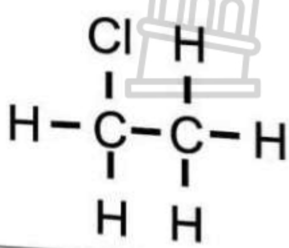
A. At 101,3 kPa, water has a higher boiling point than butan-1-ol.

B. At 101,3 kPa, water has a lower boiling point than ethanol.

C. The greater the number of carbon atoms per alcohol molecule, the lower the boiling point of the alcohol.

D. The greater the number of carbon atoms per alcohol molecule, the higher the boiling point of the alcohol. (2)

1.4 Which formula represents the product of the addition reaction between ethene and chlorine, Cl_2?

A. 	B. 
C. 	D. 

(2)

1.5 A reaction is most likely to occur when the reacting particles collide with proper orientation and proper:

A. Charge

B. Energy

C. Mass

D. Volume (2)

1.6 Catalysts can increase the rate of a chemical reaction by providing.......

A. an alternate reaction pathway with a higher activation energy.

B. the same reaction pathway with a higher activation energy.

C. an alternate reaction pathway with a lower activation energy.

D. the same reaction pathway with a lower activation energy. (2)

1.7 Given the equation representing a system at equilibrium in a sealed, rigid container:

$$2HI(g) \rightleftharpoons H_2(g) + I_2(g) + \text{energy}$$

Increasing the temperature of the system causes the concentration of.........

A. HI to increase.

B. H_2 to increase.

C. HI to remain constant.

D. H_2 to remain constant. (2)

1.8 How will the pH change if there is a tenfold increase in the hydronium ion concentration?

A. A decrease of one unit of pH.

B. A decrease of 10 units of pH.

C. An increase of one unit of pH.

D. An increase of 10 units of pH. (2)

1.9 Which positive ion must be present in an aqueous solution of an Arrhenius acid?

A. Na^+

B. NH_4^+

C. OH^-

D. H_3O^+ (2)

1.10 Consider the reaction below.

$2Al(s) + 6H^+(aq) \leftrightarrows 2Al^{3+}(aq) + 3H_2(g)$

In this reaction, electrons are transferred from:

A. Al to H^+

B. H to H^+

C. Al to Al^{3+}

D. H to Al (2)

[20]

QUESTION 2 (Start on a new page.)

Carbon is the basic building block of organic compounds that recycles through the earth's air, water, soil, and living organisms including human beings.

2.1 Discuss ONE special property of carbon that makes it possible to form a variety of bonds. (2)

2.2 The IUPAC name of an organic compound is:

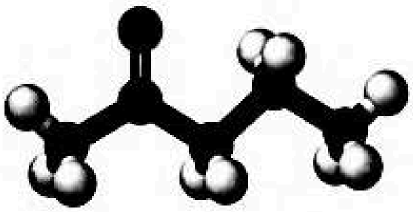
1-chloro-2,3-dimethylpentane

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

2.2.2 Draw the condensed STRUCTURAL formula of this compound. (3)

2.2.3 Is this compound SATURATED or UNSATURATED? (1)

2.3 The organic compound below ($CH_3COCH_2CH_2CH_3$) has one POSITIONAL isomer and one FUNCTIONAL isomer.



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

For this compound, write down the:

2.3.2 Name of the functional group present in this compound. (1)

2.3.3 IUPAC name of its POSITIONAL isomer. (2)

2.3.4 Structural formula of its FUNCTIONAL isomer. (2)

2.4 Consider this condensed structural formula of an alcohol.

$(CH_3)_3C - OH$

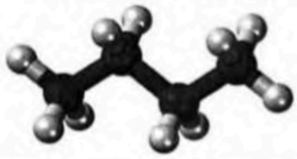
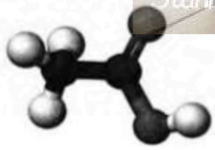
2.4.1 Is this a PRIMARY, SECONDARY or TERTIARY alcohol? Give a reason for the answer. (2)

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

[18]

QUESTION 3 (Start on a new page.)

The table below shows data collected for three organic compounds, represented by the letters **A**, **B** and **C**, during a practical investigation:

	Organic compound	Mr ($g.mol^{-1}$)	Boiling Point (°C)
A	$CH_3CH_2CH_2CH_3$ 	58	– 0,5
B	$CH_3CH_2CH_2OH$ 	60	97
C	CH_3COOH 	60	118

3.1 Which variable was controlled during this investigation? (1)

3.2 Identify the:

3.2.1 Dependent variable. (1)

3.2.2 Independent variable. (1)

3.3 Consider compound **A**:

3.3.1 2-methylpropane is an isomer of compound **A**.

Predict whether the boiling point of 2-methylpropane will be HIGHER THAN, LOWER THAN or THE SAME as the boiling point of compound **A**. (1)

3.3.2 Explain your prediction in QUESTION 3.3.1. (3)

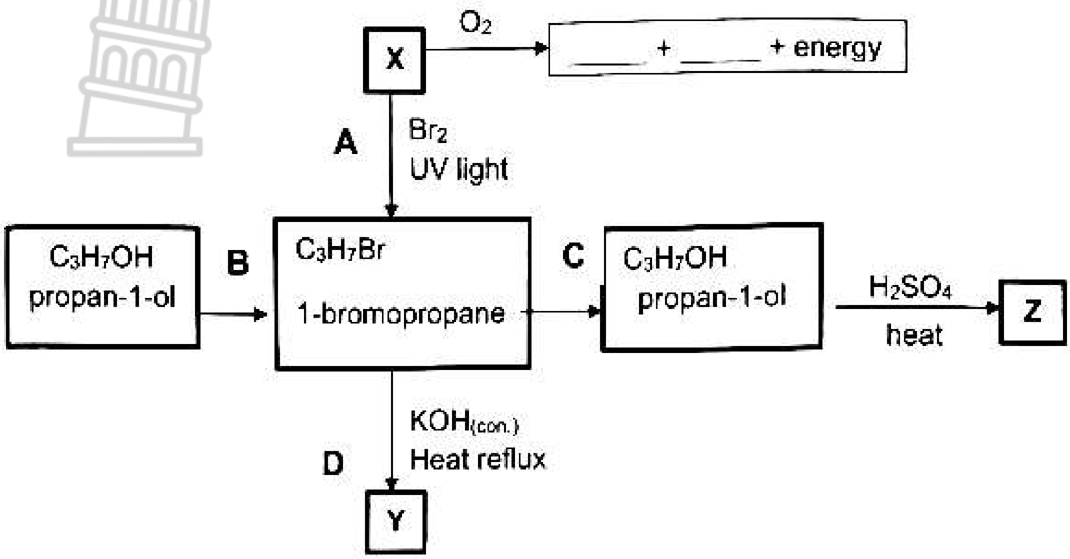
3.4 Define the term *vapor pressure*. (2)

3.5 Refer to intermolecular forces and energy to explain why compound **B** will have a higher vapour pressure than compound **C** at 20 °C. (3)

[12]

QUESTION 4 (Start on a new page.)

Various organic reactions are shown in the flow diagram.



4.1 Name the type of reaction illustrated by:

4.1.1 A (1)

4.1.2 B (1)

4.1.3 C (1)

4.1.4 D (1)

4.2 Use condensed structural formulas and write a balanced equation for reaction **C**. (4)

4.3 Write down the structural formula for compound **X**. (2)

4.4 Compound **X** undergoes combustion in the presence of oxygen. Write down the molecular formulas of the two products that form. (2)

4.5 Use structural formulas to write a balanced equation for the reaction to produce product **Y**. (3)

*Instead of heating concentrated potassium hydroxide under reflux during the formation of **Y**, dilute sodium hydroxide is used.*

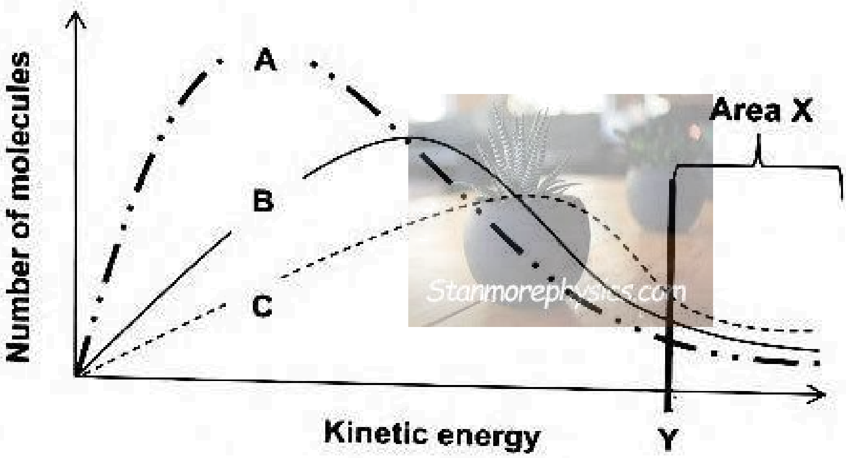
4.6 Write the IUPAC name of the organic compound that will form. (2)

4.7 To which homologous series does product **Z** belong? (1)

4.8 Write down the IUPAC name of product **Z** if ethanoic acid was used during the reaction. (2)
[20]

QUESTION 5 (Start on a new page.)

Graph **B** represents the Maxwell-Boltzmann energy distribution curve for a reaction mixture at 300°C. Area **X** represents the number of molecules in the mixture that have enough kinetic energy for the reaction to take place.



5.1 Give a term for the "*minimum energy needed for a reaction to take place*", as indicated by **Y**. (1)

5.2 The temperature of the mixture is now increased to 500 °C.

5.2.1 Which ONE of graph **A** or **C** represents the distribution curve of the mixture at this higher temperature? (1)

5.2.2 Give a reason for the answer. (1)

5.2.3 Use the collision theory to explain how this increase in temperature will influence the rate of the reaction. (4)

5.3 A catalyst is added to the mixture.

5.3.1 Write down the definition of a *catalyst*. (2)

5.3.2 How will the above-mentioned action affect the size of area **X** (area to the right of vertical line Y)? Write down only INCREASES, DECREASES or REMAINS THE SAME. (1)

5.3.3 Explain your answer to QUESTION 5.3.2. (2)
[12]

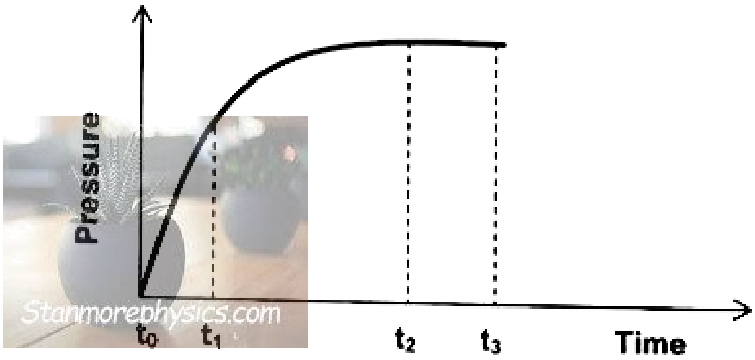
QUESTION 6 (Start on a new page.)

2,0 g of $CaCO_3$ is sealed in an evacuated 1,0 dm^3 metal flask and a pressure gauge is connected to the flask, in order to determine the equilibrium constant for the decomposition of calcium carbonate ($CaCO_3$).

The flask is heated to a 800°C at which equilibrium was reached.

$$CaCO_3(s) \rightleftharpoons CaO(s) + CO_2(g) \qquad \Delta H > 0$$

The graph obtained for pressure versus time for the decomposition of calcium carbonate is shown below.



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

6.2 How does the rate of the reverse reaction change from t_0 to t_1? (2)

6.3 What is the reason for the horizontal line between t_2 and t_3? (1)

6.4 Draw a sketch graph to show how the mass of $CaCO_3$ changes for the period t_0 to t_3. (3)

6.5 During a power failure the temperature of the oven drops to 500°C. What effect (only write INCREASES, DECREASES or STAYS THE SAME) does this decrease in temperature have on the following:

6.5.1 The rate of the forward reaction. (1)

6.5.2 The concentration of CO_2. (1)

6.5.3 The value of K_c. (1)

6.6 Give a reason for your answer to QUESTION 6.5.3. (4)

6.7 When equilibrium was established at 800°C, the concentration of CO_2 present in the flask was 1,4 x 10^{-2} mol·dm^{-3}. Calculate the equilibrium constant (K_c) at 800°C for this reaction. (2)

[17]

QUESTION 7 (Start on a new page.)

7.1 Sulphuric acid is a diprotic acid.

7.1.1 Define an *acid* in terms of the Lowry-Brønsted theory. (2)

7.1.2 Give a reason why sulphuric acid is a *diprotic acid*. (1)

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

$$HCO_3^-(aq) + H_2O(l) \leftrightharpoons H_2CO_3(aq) + OH^-(aq)$$

7.2.1 Write down ONE word for the underlined phrase. (1)

7.2.2 $HCO_3^-(aq)$ acts as a base in the above reaction.
Write down the formula of the conjugate acid of $HCO_3^-(aq)$. (1)

7.3 A chemist spills sulphuric acid of concentration 6 mol·dm^{-3} from a flask on a laboratory bench. She neutralises the spilled acid by sprinkling sodium hydrogen carbonate powder onto it. The reaction that takes place is: (Assume that the H_2SO_4 ionises completely.)

$$H_2SO_4\ (aq) + 2NaHCO_3\ (s) \rightarrow Na_2SO_4\ (aq) + 2H_2O\ (l) + 2CO_2(g)$$

The fizzing, due to the formation of carbon dioxide, stops after the chemist has added 27 g sodium hydrogen carbonate to the spilled acid.

7.3.1 Calculate the volume of sulphuric acid that spilled. Assume that all the sodium hydrogen carbonate reacts with all the acid. (6)

The chemist now dilutes some of the 6 mol·dm^{-3} sulphuric acid solution in the flask to 0,1 mol·dm^{-3}.

7.3.2 Calculate the volume of the 6 mol·dm^{-3} sulphuric acid solution needed to prepare 1 dm^3 of the dilute acid. (2)

During a titration 25 cm^3 of the 0,1 mol·dm^{-3} sulphuric acid solution is added to an Erlenmeyer flask and titrated with a 0,1 mol·dm^{-3} sodium hydroxide solution.

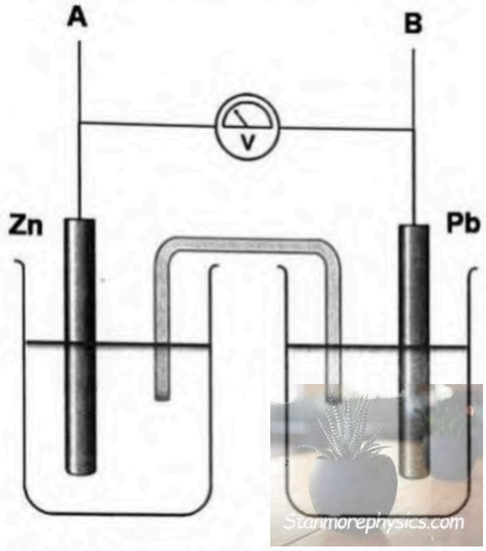
7.3.3 The chemist uses bromothymol blue as indicator.
What is the purpose of this indicator? (1)

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

[22]

QUESTION 8 (Start on a new page.)

A learner wants to investigate the effect of the area of the metal plates used as electrodes in a galvanic cell on the emf of the cell.
The learner sets up the following cell under standard conditions and measures the emf.



8.1 Which electrode will show an increase in mass when this cell is functioning? (1)

8.2 Write the equation for the half-reaction occurring at the anode. (2)

8.3 Calculate the emf that the learner will read on the voltmeter. (4)

8.4 Name TWO variables that should be controlled during this investigation. (2)

8.5 The learner now replaces the two metal plates with ones of larger surface area and takes the voltmeter reading again.

8.5.1 How would you expect the new emf to compare with the one calculated in QUESTION 8.3? (Only write SMALLER THAN, LARGER THAN or EQUAL TO.) (1)

8.5.2 Explain your answer to QUESTION 8.5.1. (2)

8.6 The learner now connects a resistor of low resistance across terminals **A** and **B**. The learner notes that the reading on the voltmeter immediately drops.

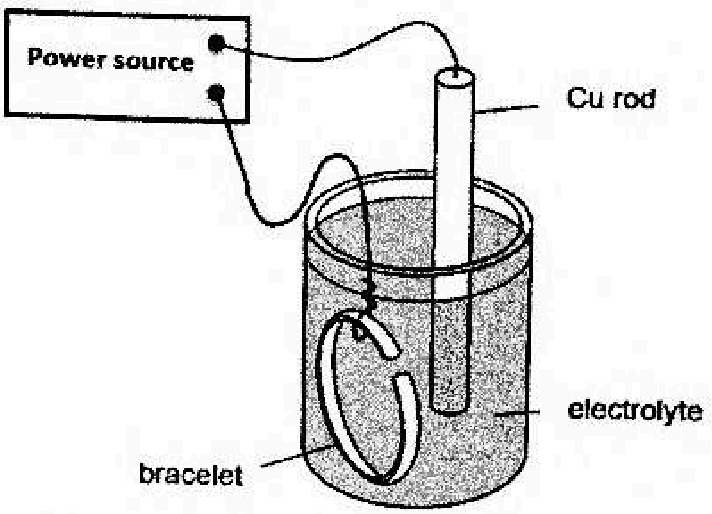
8.6.1 Give a reason for this observation. (1)

8.6.2 After some time the learner observes a further gradual drop in the reading on the voltmeter. Give a reason for this observation. (1)

[14]

QUESTION 9 (Start on a new page.)

Electroplating is an electrolytic process that can be used to coat metal objects with a less reactive metal. The diagram below shows an electroplating cell that includes a power source connected to a copper rod and a bracelet made from a different metal. The rod and bracelet are in an aqueous copper (II) sulphate solution.



9.1 Define the term *electrolyte*. (2)

9.2 Is the electrolytic process endothermic or exothermic? (1)

9.3 Which electrode, the BRACELET or the Cu rod is the cathode? (1)

9.4 Initially the $CuSO_4(aq)$ has a blue colour.

9.4.1 How will the intensity of the blue colour change whilst the cell is functioning? Write down INCREASES, DECREASES or REMAINS THE SAME. (1)

9.4.2 Give a reason for the answer in QUESTION 9.4.1. (2)

9.4.3 Write down the half-reaction that takes place at the pure copper electrode. (2)

9.5 During the process, the bracelet is plated with 0,86 g of copper. Calculate the number of electrons transferred during the process. (6)

[15]

TOTAL: 150

GEGEWENS VIR FISIESE WETENSKAPPE GRAAD 12 VRAESTEL 2 (CHEMIE) DATA FOR PHYSICAL SCIENCES GRADE 12 PAPER 2 (CHEMISTRY)

TABLE 1: PHYSICAL CONSTANTS/TABEL 1: FISIESE KONSTANTES

NAME/*NAAM*	SYMBOL/*SIMBOOL*	VALUE/*WAARDE*
Avogadro's constant *Avogadro-konstante*	N_A	$6{,}02 \times 10^{23}\ mol^{-1}$
Charge on electron *Lading op elektron*	e	$-1{,}6 \times 10^{-19}$ C
Electron mass *Elektronmassa*	m_e	$9{,}11 \times 10^{-31}$ kg
Molar gas volume at STP *Molêre gasvolume by STD*	V_m	$22{,}4\ dm^3 \cdot mol^{-1}$
Standard pressure *Standaarddruk*	p^θ	$1{,}013 \times 10^5$ Pa
Standard temperature *Standaardtemperatuur*	T^θ	273 K

TABLE 2: FORMULAE/TABEL 2: FORMULES

$n = \frac{m}{M}$	$n = \frac{N}{N_A}$
$c = \frac{n}{V}$ or/of $c = \frac{m}{MV}$	$n = \frac{V}{V_m}$ $\frac{C_aV_a}{C_bV_b} = \frac{n_a}{n_b}$
$K_W = [H_3O^+][OH^-] = 1\times10^{-14}$ at / by 298 K	pH = $-\log[H_3O^+]$

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

or / of

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

or / of

$$E^\theta_{cell} = E^\theta_{oxidising\ agent} - E^\theta_{redusing\ agent} \ / \ E^\theta_{sel} = E^\theta_{oksideermiddel} - E^\theta_{reduseermiddel}$$

$I = \frac{Q}{\Delta t}$ $n = \frac{Q}{q_e}$ where n is the number of electrons

NSC

THE PERIODIC TABLE OF ELEMENTS // DIE PERIODIEKE TABEL VAN ELEMENTE

KEY/ SLEUTEL

Atomic number / *Atoomgetal*	29
Electronegativity / *Elektronegatiwiteit* — Symbol / *Simbool*	1,9 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

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GRADE 12

PHYSICAL SCIENCES: CHEMISTRY (P2)

MARKING GUIDELINES

SEPTEMBER 2024

This marking guideline consists of a cover page and 10 pages.

TOTAL: 150

TIME: 3 HOURS

GRADE 12 TRIAL EXAMINATION – LIMPOPO

2024 SEPTEMBER — PAPER 2: CHEMISTRY — MARKS: 150

MARKING GUIDELINES

QUESTION 1

1.1 A ✓✓ (2)

1.2 C ✓✓ (2)

1.3 D ✓✓ (2)

1.4 B ✓✓ (2)

1.5 B ✓✓ (2)

1.6 C ✓✓ (2)

1.7 A ✓✓ (2)

1.8 A ✓✓ (2)

1.9 D ✓✓ (2)

1.10 A ✓✓ (2)

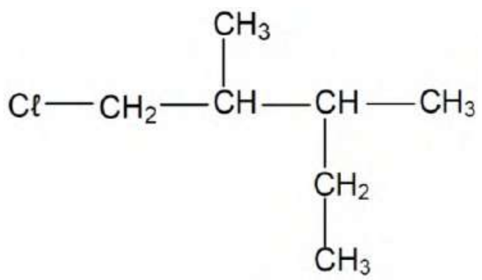
[20]

QUESTION 2

2.1 Carbon has four valence electrons✓, so it can achieve a full outer energy level by forming four covalent bonds✓ (this property is known as tetravalency). Carbon can form single, double, or triple covalent bonds with other carbon atoms to produce long chain or ring structures. (2)

2.2.1 C_nH_{2n+2} ✓ (1)

2.2.2 (3)



Marking criteria

- Two methyl substituents✓
- Chlorine substituent✓
- Whole structure correct✓

2.2.3 SATURATED ✓ (1)

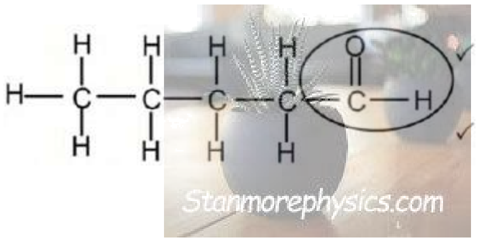
2.3.1 Compounds with the <u>same molecular formula</u>, ✓ but <u>different positions of the side chain/substituents/functional groups</u> ✓ on the parent chain. (2)

2.3.2 carbonyl ✓ (1)

2.3.3 pentan-3-one / 3-pentanone (2)

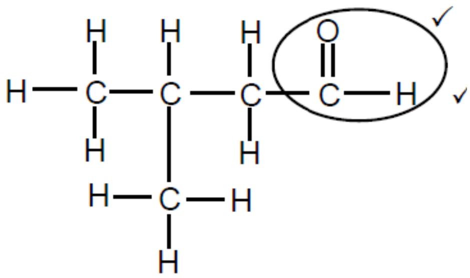
Marking criteria
• Functional group and correct position i.e., 3 ✓
• *Correct IUPAC name* ✓

2.3.4

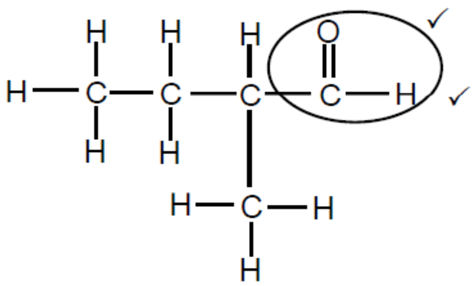


Marking criteria
• Correct functional group✓
• Whole structure correct✓

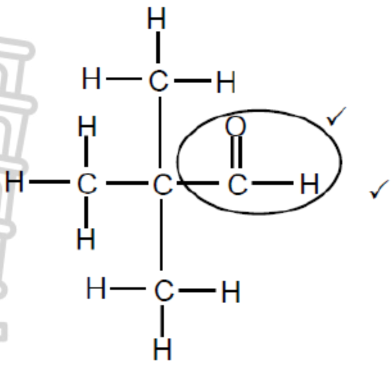
OR: Any correct structure of an aldehyde with five carbon atoms.



OR



OR



(2)

2.4.1 TERTIARY ✓
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. ✓ (2)

2.4.2 2-methylpropan-2-ol / 2-methyl-2-propanol (2)

> **Marking criteria**
> - 2-methyl ✓
> - propan-2-ol / 2-propanol ✓
> - Any errors e.g., hyphens omitted and/or incorrect sequence:
>   Max: 1/2

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QUESTION 3

3.1 Relative molecular mass/molar mass/*Mr* ✓ (1)

3.2.1 Boiling point ✓ (1)

3.2.2 Type of organic compound/homologous series/functional group✓ (alkane,alcohol,carboxylic acid) (1)

3.3.1 LOWER THAN ✓ (1)

3.3.2 ***Negative marking from question 3.3.1***

- 2-methylpropane is a spherical molecule, therefore smaller surface area ✓ is presented to other molecules (sphere is 3D shape with lowest surface-to-volume ratio).
- Less surface area at which van der Waals interactions with other molecules can occur ✓ /fewer van der Waals interactions/fewer cohesive interactions.
- Less energy required ✓ to overcome cohesive forces as liquid hydrocarbon is vaporised. (3)

3.4 The pressure exerted by a vapour at equilibrium with its liquid in a closed system. ✓✓(2 or 0) (2)

3.5 *Ethanoic acid* (***C***) – It is possible for <u>2 H-bonds</u>✓ (at C=O and O-H) to form between adjacent carboxylic acid molecules. Therefore <u>H-bonds stronger</u> ✓ in carboxylic acid. Therefore, <u>more energy required</u>✓ to overcome the stronger forces of attraction/to overcome the IMF BETWEEN molecules.

OR

propan-1-ol (***B***) – <u>H-bonds weaker in alcohol</u> ✓ as it is only possible for <u>1 H bond</u>✓ at O-H to form between adjacent molecules of alcohol therefore <u>less energy required</u> ✓ to overcome the strong forces of attraction/to overcome the IMF BETWEEN molecules. (3)

[12]

QUESTION 4

4.1.1 Substitution ✓ / halogenation (1)

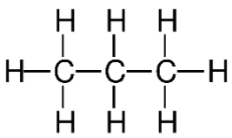
4.1.2 Substitution ✓ (1)

4.1.3 Substitution ✓ (1)

4.1.4 Substitution ✓/ dehydrohalogenation (1)

4.2 $CH_3CH_2CH_2Br$ ✓ + H_2O ✓ → $CH_3CH_2CH_2OH$ ✓ + HBr ✓ (4)

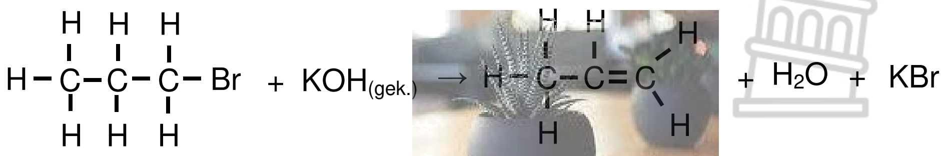
4.3 (2)



3-C atoms in chain ✓ Whole structure correct✓

4.4 H_2O ✓
CO_2 ✓ (2)

4.5 (3)



<u>Marking criteria</u>
- *Correct structural formula of 1-bromopropane* ✓
- *Correct structural formula of prop-1-ene* ✓
- *<u>H_2O + KBr</u>* ✓

4.6 Propan-1-ol /

Marking criteria

- *Functional group and correct position, ie.1.* ✓
- *Propanol* ✓

(2)

4.7 Esters ✓ (1)

4.8 propyl✓ethanoate✓ (2)

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QUESTION 5

5.1 Activation energy ✓ (1)

5.2.1 C ✓ (1)

–

5.2.2 ***Negative marking*** (1)

Total area under graphs **A** and **C** approximately the same, but more molecules with greater average E_k therefore area **X** of graph **C** greater – more molecules with greater average E_k.✓

5.2.3
- Increased temperature therefore increased average kinetic energy ✓of molecules.
- More of these molecules will have sufficient kinetic energy ✓ to react./ Ek≥activation energy
- More effective collisions per second ✓/unit time.
- Increased rate of reaction. ✓ (4)

5.3.1 A catalyst will speed up a chemical reaction ✓ without itself undergoing permanent change. ✓ (2)

5.3.2 INCREASES ✓ (1)

5.3.3 A catalyst will create an alternative path of lower activation energy ✓ "line Y" moves to the left ✓ – therefore area X increases in size. (2)

[12]

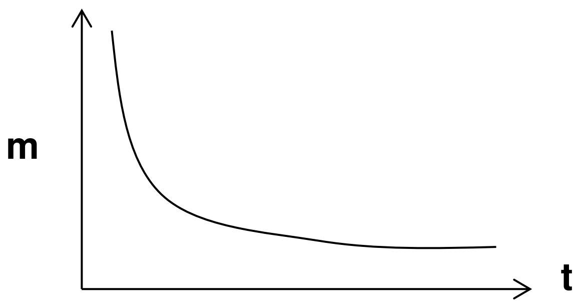
QUESTION 6

6.1 The change in concentration of reactants or products ✓ per unit time. ✓ or any other acceptable definition(see Guideline) (2)

6.2 It starts at zero in $\mathbf{t_0}$ ✓ and increases to time $\mathbf{t_1}$✓ (2)

6.3 Equilibrium ✓ is reached. (1)

6.4



Criteria for graph
Axes labelled correctly. ✓
Gradient of graph initially high and then decreases with time. ✓

Graph ends parallel to x-axis to represent equilibrium. ✓ (3)

6.5.1 Decreases ✓ (1)

6.5.2 Decreases ✓ (1)

6.5.3 Decreases ✓ (1)

6.6 At lower T, the exothermic (forward) reaction is favoured. ✓
Therefore, the reverse reaction is favoured, ✓
reducing the concentration of the gas (products). ✓If concentration of products decrease then Kc will also decrease✓

(4)

6.7 $Kc = [CO_2]✓ = 1,4 \times 10^{-2}✓$ (2)

[17]

QUESTION 7

7.1.1 An acid is a proton (H^+-ion) -donor. ✓✓ (2)

7.1.2 It ionises to form 2 protons/2 mol H^+-ions. ✓ (1)
OR
It donates $2H^+$-ions per H_2SO_4 -molecule.

7.2.1 Amphiprotic (substance)/Ampholyte ✓ (1)

7.2.2 H_2CO_3 (aq) ✓ (1)

7.3.1 $n(H_2CO_3) = \frac{m}{M}$ ✓

$= \frac{27}{84}$ ✓

$= 0,32\ mol$ $(0,3214285714\ mol)$

$n(H_2SO_4) = \frac{1}{2} n(NaHCO_3)$

$= \frac{1}{2}(0,32)$ ✓

$= 0,16\ mol$ $(0,1607142857\ mol)$

$c = \frac{n}{V}$

$6 = \frac{0,16}{V}$ ✓✓ (6 and 0,16)

$\therefore V = 0,03\ dm^3$✓ $(30\ cm^3\ /\ 0,027\ dm^3\ /\ 27\ cm^3)$ (6)

7.3.2 $n_a(initial) = n_a(final)$
$c_a v_a(initial) = c_a v_a(final)$

$\therefore (6)v_a = (0,1)(1)$ ✓

$\therefore v_a = 0,02\ dm^3$ ✓

$(20\ cm^3\ /\ 0,0167\ dm^3\ /\ 16,7\ cm^3)$ (2)

7.3.3 Shows end point (of titration). ✓ /Shows when neutralisation occurs. (1)

7.3.4

Marking criteria:

- Substitute initial [acid] and volume
- Substitute initial [base] and volume
- Use ratio 1 : 2
- Initial mole acid – mole acid reacted
- Substitute volume acid + volume base
- pH formula
- Substitute 2 x c_a in pH formula
- Final answer: 1,44

$n_a(initial) = c_a v_a$

$= (0,1)(25 \times 10^{-3})$ ✓

$= 2,5 \times 10^{-3}\ mol$

$n_b(reacted) = c_b v_b$

$= (0,1)(30 \times 10^{-3})$ ✓

$= 3 \times 10^{-3}\ mol$

$\frac{n_a}{n_b} = \frac{1}{2}$

$\therefore n_a(neutralised) = \frac{1}{2} n_b = \frac{1}{2}(3 \times 10^{-3})$ ✓ $= 1,5 \times 10^{-3}\ mol$

$n_a(left) = n_a(initial) - n_a(neutralised)$

$= 2,5 \times 10^{-3} - 1,5 \times 10^{-3}$ ✓

$= 1 \times 10^{-3}\ mol$

$c_a = \frac{n}{V}$

$= \frac{1 \times 10^{-3}}{(25 \times 10^{-3} + 30 \times 10^{-3}\ ✓)}$

$= 0,018\ mol.dm^{-3}$

$pH = -log[H_3O^+]$ ✓

$= -\log[2(0,018)$ ✓ $]$

$= 1,44$ ✓

(8)

[22]

QUESTION 8

8.1 Pb ✓ (lead) (1)

8.2 $Zn \rightarrow Zn^{2+} + 2e^-$ ✓✓ (2 or 0) (2)

8.3 $E^{\theta}_{cell} = E^{\theta}_{oxidising\ agent} - E^{\theta}_{reducing\ agent}$ ✓
$= -0{,}13$ ✓ $- (-0{,}76)$ ✓
$= 0{,}63\ (V)$ ✓ (4)

8.4
- Temperature ✓ (2)
- (initial) concentration of the electrolytes. ✓

8.5.1 EQUAL TO ✓ (1)

8.5.2 Area/size of electrodes has no effect on the emf of a cell. ✓✓ / It is still a standard cell. (2)

8.6.1 The cell has internal resistance. ✓ (1)

8.6.2 The emf decreases as the concentration of Pb^{2+}(aq) decreases. ✓ / The cell is running flat as the electrolyte concentration in the Pb cell decreases. (1)

[14]

QUESTION 9

9.1 A substance of which the aqueous solution contains ions. ✓✓ / A substance that dissolves in water to give a solution that conducts electricity. (2)

9.2 Endothermic ✓ (1)

9.3 Bracelet ✓ (1)

9.4.1 REMAINS THE SAME ✓ (1)

9.4.2 The rate of oxidation of copper at the anode is equal ✓ to the rate of reduction of copper (II) ions at the cathode. ✓ (2)

9.4.3 $Cu \rightarrow Cu^{2+} + 2e^-$ ✓✓ (2)

Notes:

$Cu \rightleftharpoons Cu^{2+} + 2e^-$ $(^1/_2)$

$Cu^{2+} + 2e^- \rightarrow Cu$ $(^0/_2)$

$Cu^{2+} + 2e^- \leftarrow Cu$ $(^2/_2)$

$Cu^{2+} + 2e^- \leftrightharpoons Cu$ $(^0/_2)$

9.5 $n(Cu) = \frac{m}{M}$

$= \frac{0,86}{63,5} \checkmark$

$= 0,0135\ mol \checkmark$

$(0,01354330709\ mol)$

$n(electrons) = 2n(Cu) = 2(0,0135) = 0,027\ mol \checkmark$

$n = \frac{N}{N_A} \checkmark$

$0,027 = \frac{N}{6,02 \times 10^{23} \checkmark}$ (6)

$\therefore N = 1,63 \times 10^{22} \checkmark\ electrons$

[15]

TOTAL: 150