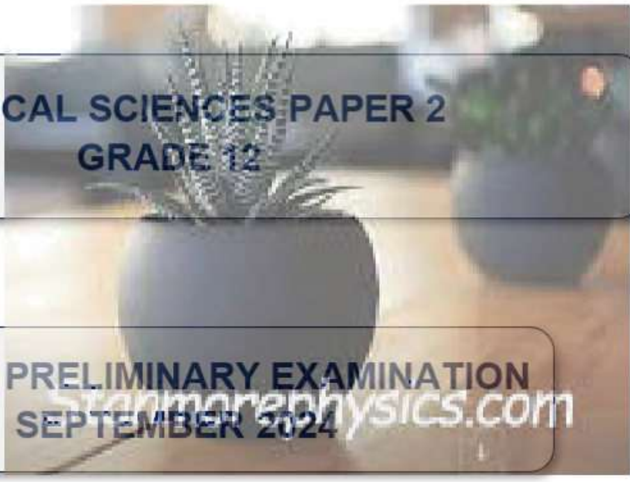
Western Cape Government

Education

FOR YOU

CAPE WINELANDS EDUCATION DISTRICT



PHYSICAL SCIENCES PAPER 2
GRADE 12

COMMON PRELIMINARY EXAMINATION
SEPTEMBER 2024

MARKS: 150

TIME: 3 hours

This exam paper consists of 15 pages and 4 datasheets

INSTRUCTIONS AND INFORMATION

1. Write your name in the space below and submit the Examination Paper with your Answer Book.

   NAME & SURNAME: ________________________________

   GRADE: ______

2. This question paper consists of 9 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 sub questions, 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 etc. where required.
12. Write neatly and legibly.

QUESTION 1 (MULTIPLE-CHOICE)

Four options are provided as possible answers to the following questions. Each question has only ONE correct answer. Write only the letter (A – D) next to the question number (1.1 – 1.10) on your ANSWER BOOK.

1.1 Which ONE of the following represents a SUBSTITUTION REACTION?

A $CH_2 = CH_2 + HBr \rightarrow CH_3CH_2Br$

B $CH_2 = CH_2 + H_2O \rightarrow CH_3CH_2OH$

C $CH_3CH_2OH \rightarrow CH_2 = CH_2 + H_2O$

D $CH_3CH_2OH + HBr \rightarrow CH_3CH_2Br + H_2O$ (2)

1.2 Which ONE of the following compounds will have the lowest melting point?

A propan-1-ol

B propanoic acid

C propane

D propanal (2)

1.3 Which ONE of the following equations represents a cracking process?

A $CH_2 = CH_2 + HBr \rightarrow CH_2BrCH_3$

B $CH_3(CH_2)_5CH = CH_2 + H_2 \rightarrow CH_3(CH_2)_6CH_3$

C $CH_3(CH_2)_6CH_3 \rightarrow CH_3(CH_2)_4CH_3 + CH_2 = CH_2$

D $CH_3(CH_2)_7OH \rightarrow CH_3(CH_2)_5CH = CH_2 + H_2O$ (2)

1.4 Which ONE of the following will RAPIDLY decolourise bromine water?

A $CH_3CH_2CH_3$

B CH_3CHCH_2

C CH_3COOCH_3

D CH_3CH_2COOH (2)

1.5 A catalyst is added to the following reaction mixture at equilibrium.

$$H_2(g) + S(s) \rightleftharpoons H_2S(g) \qquad \Delta H < 0$$

Which ONE of the following statements about the effect of the catalyst is FALSE?

A The equilibrium position remains unchanged.

B The equilibrium position shifts to the right.

C The rate of the forward reaction increases.

D The rate of the reverse reaction increases. (2)

1.6 A hypothetical reaction reaches equilibrium at 10 °C in a closed container according to the following balanced equation:

$$A(g) + B(g) \rightleftharpoons AB(g) \qquad \Delta H < 0$$

The temperature is now increased to 25 °C. Which ONE of the following is correct as the reaction approaches a new equilibrium?

	REACTION RATE OF REVERSE REACTION	YIELD OF PRODUCTS
A	Increases	Remains the same
B	Increases	Increases
C	Increases	Decreases
D	Decreases	Decreases

(2)

1.7 Which of the following is not a conjugate acid-base pair?

A HCl and Cl^-

B HCO_3^- and H_2CO_3

C HSO_4^- and H_2SO_4

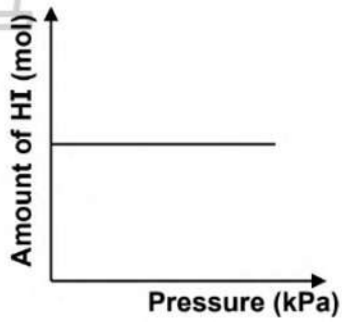
D OH^- and H_3O^+ (2)

1.8 The reaction between hydrogen gas and iodine gas reaches equilibrium in a closed container according to the following balanced equation:

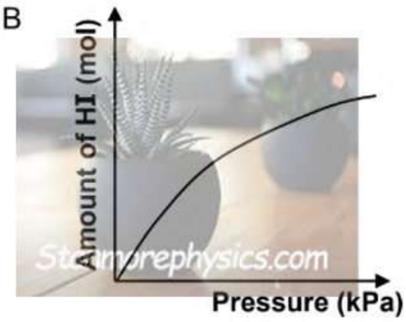
$$H_2(g) + I_2(g) \rightleftharpoons 2HI(g)$$

Which ONE of the graphs below shows the relationship between the amount of HI(g) at equilibrium and the pressure in the container at constant temperature?

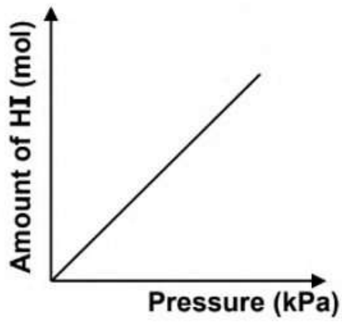
A



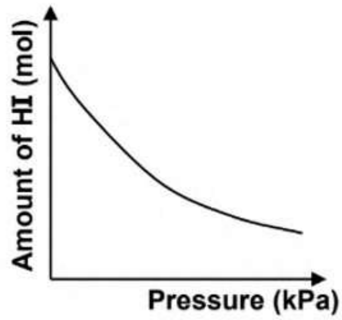
B



C



D



(2)

1.9 The cell notation of a galvanic cell is given as:

$Mg(s)|Mg^{2+}(aq)\ ||Sn^{2+}(aq)\ |Sn(s)$

A bulb connected across the two electrodes initially glows brightly. After some time the brightness of the bulb decreases. This is because the …

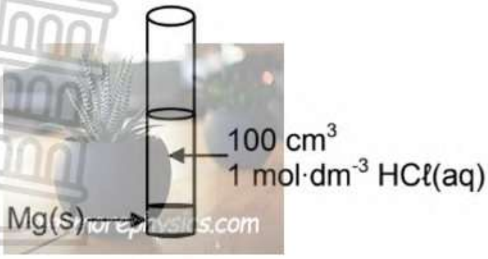
A concentration of Sn^{2+} decreases.

B concentration of Mg^{2+} decreases.

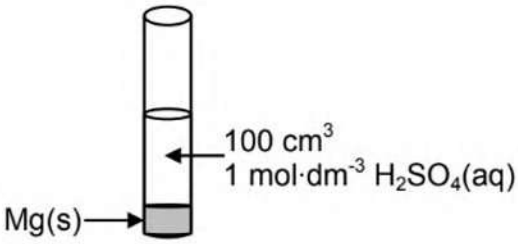
C Sn electrode is used up.

D Mg electrode is used up. (2)

1.10 Equal amounts of magnesium (Mg) powder react respectively with equal volumes and equal concentrations of HCl(aq) and H_2SO_4(aq), as shown below.



Test tube X



Test tube Y

The magnesium is in EXCESS.

Consider the following statements regarding these two reactions:

I: The initial rate of the reaction in test tube **X** equals the initial rate of the reaction in test tube **Y**.

II: After completion of the reactions, the mass of magnesium that remains in test tube **X** will be greater than that in test tube **Y**.

III: The amount of hydrogen gas formed in **X** is equal to the amount of hydrogen gas formed in **Y**.

Which of the above statements is/are TRUE?

A **I** only

B **II** only

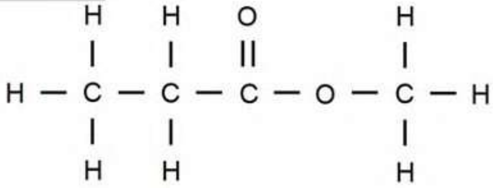
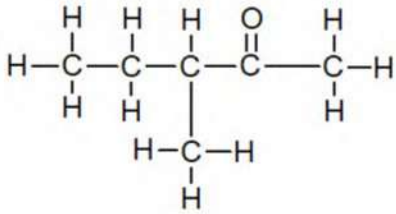
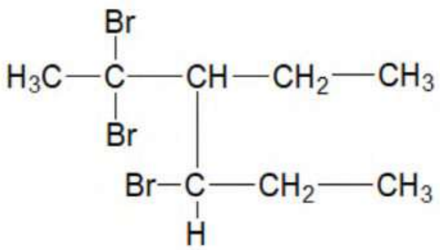
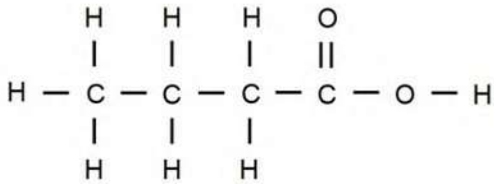
C **III** only

D **I** and **III** only (2)

[20]

QUESTION 2 (Start on a new page)

Letters **A** to **H** in the table below represent eight organic compounds of different *homologous series*.

A	C_9H_{20}	**B**	Pentanal
C	$CH_3CHOHCH_2CH_3$	**D**	$CHCC(CH_3)_2(CH_2)_3CH_3$
E		**F**	
G		**H**	

2.1 Define the term *homologous series.* (2)

2.2 Write down the letter(s) for:

2.2.1 A ketone (1)

2.2.2 TWO compounds that are FUNCTIONAL ISOMERS of each other. (1)

2.2.3 A compound with the general formula C_nH_{2n-2}. (1)

2.2.4 A compound containing the carboxyl group. (1)

2.3 Give the STRUCTURAL formula of a POSITIONAL ISOMER of compound **C**. (2)

2.4 Write down the IUPAC name of:

2.4.1 Compound **F** (2)

2.4.2 Compound **G** (3)

2.5 Give the STRUCTURAL formula of compound **B**. (2)

2.6 Using MOLECULAR formulae, write down the balanced equation for the complete combustion of compound **A**. (3)

[18]

QUESTION 3 (Start on a new page)

The boiling points of four organic compounds at a specific pressure are compared.

	COMPOUND	BOILING POINT (°C)
A	Pentane	36
B	2-methylbutane	28
C	2,2-dimethylpropane	10
D	Pentanal	103
E	Butanoic acid	………….

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

3.2 Consider compounds **A** to **C**.

3.2.1 Fully explain the trend in boiling points from compound **A** to **C**. (4)

3.2.2 Which compound will have the highest vapour pressure? (1)

3.2.3 Explain your answer to QUESTION 3.2.2. (1)

3.3 Compounds **D** and **E** are compared. Is the boiling point of compound **E** GREATER THAN, SMALLER THAN or EQUAL TO 103°C? Fully explain the answer. (4)

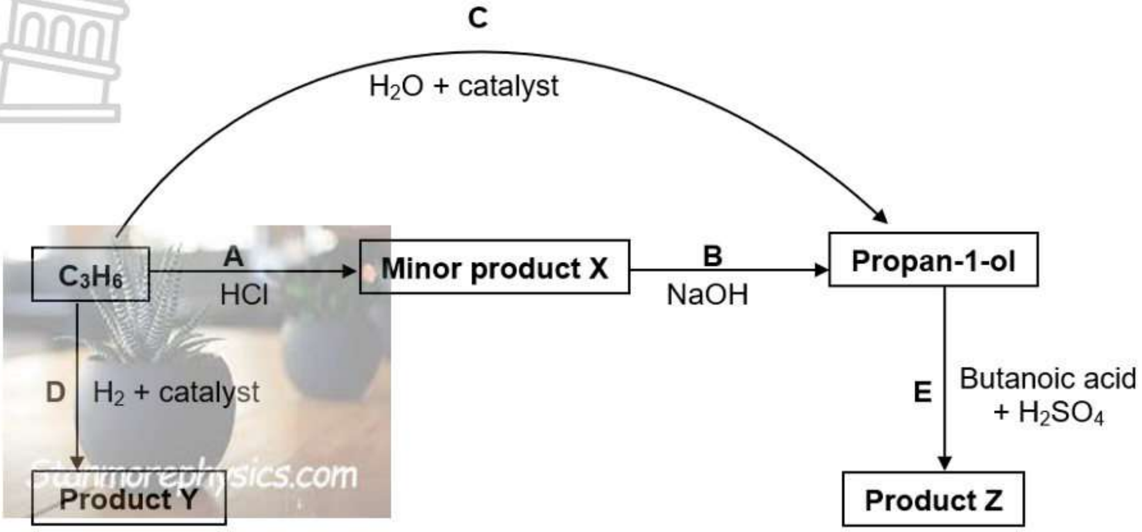
3.4 Is the comparison in QUESTION 3.3 fair? (1)

3.5 Explain the answer to QUESTION 3.4. (1)

[14]

QUESTION 4 (Start on a new page)

Unsaturated organic compounds are often used in the production of other organic compounds. **Propene (C_3H_6)** is used as a starting reactant to produce various other organic compounds as shown in the diagram below. Study the diagram and answer the questions that follow.



4.1 In reaction **A**, the addition of hydrochloric acid produces a minor product **X**.

4.1.1 Identify the type of addition reaction that takes place. (1)

4.1.2 Draw the STRUCTURAL formula of the minor product **X** that forms in the reaction and write down the IUPAC name. (3)

4.1.3 State the reaction condition for reaction **A**. (1)

4.2 In reaction **B**, the minor product **X** is added to water and there is an addition of a dilute strong base at room temperature.

4.2.1 Identify the type of reaction that takes place. (1)

4.2.2 Explain what will happen when a concentrated strong base is added instead of a dilute strong base. (1)

4.2.3 Is the alcohol formed in reaction **B** a PRIMARY, SECONDARY or TERTIARY alcohol? Motivate your answer. (2)

4.2.4 How would an increase in temperature affect the amount of propan-1-ol produced? Only write INCREASE, DECREASE or REMAIN THE SAME. (1)

4.3 Reaction **C**, produces propan-1-ol and a *positional isomer* of propan-1-ol.

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

4.3.2 Write down the chemical formula or name of the catalyst used in reaction **C.** (1)

4.4 Write the IUPAC name of product **Y** formed in reaction **D**. (2)

4.5 Reaction **E** is commonly used in the food industry.

4.5.1 Name the type of reaction represented. (1)

4.5.2 Write down the IUPAC name of the organic product **Z**. (2)

4.5.3 State the function of H_2SO_4 in the reaction. (1)

[19]

QUESTION 5 (Start on a new page)

Hydrogen peroxide, H_2O_2, decomposes to produce water and oxygen according to the following balanced equation:

$$2H_2O_2(\ell) \rightarrow 2H_2O(\ell) + O_2(g)$$

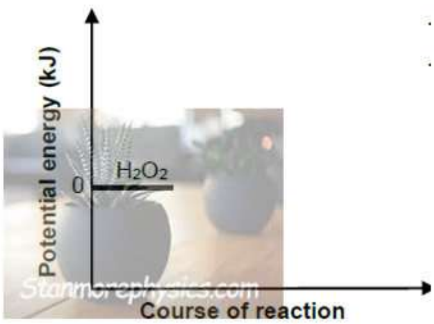
5.1 The activation energy (E_A) for this reaction is 75 kJ and the heat of reaction (ΔH) is –196 kJ.

5.1.1 Define the term *activation energy.* (2)

5.1.2 Redraw the set of axes alongside in your ANSWER BOOK and then complete the potential energy diagram for this reaction. Indicate the value of the potential energy of the following on the y-axis:

- Activated complex
- Products

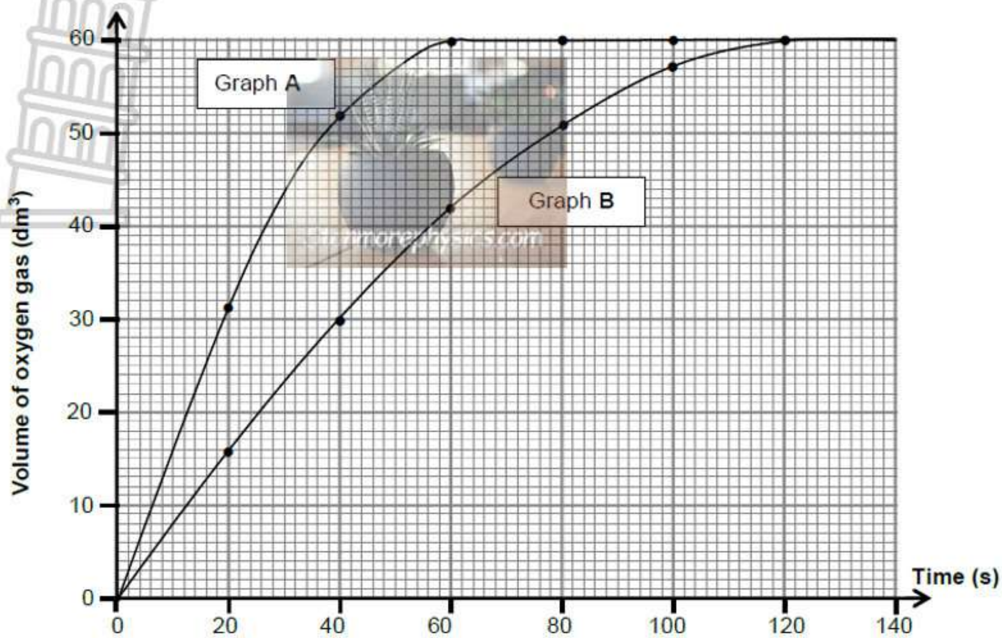
The graph does NOT have to be drawn to scale.) (3)



When powdered manganese dioxide is added to the reaction mixture, the rate of the reaction increases.

5.1.3 On the graph drawn for QUESTION 5.1.2, use broken lines to show the path of the reaction when the manganese dioxide is added. (2)

5.2 Graphs **A** and **B** below were obtained for the volume of oxygen gas produced over time under different conditions.

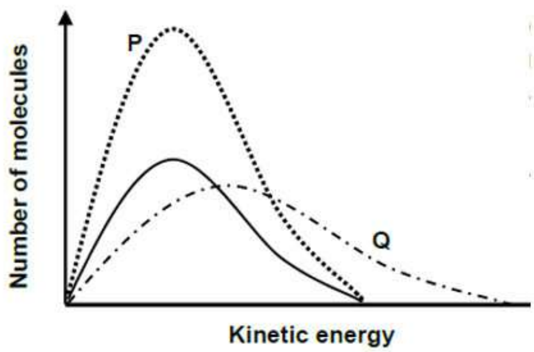


5.2.1 Calculate the average rate of the reaction (in $dm^3 \cdot s^{-1}$) between t = 10 s and t = 40 s for graph **A**. (3)

5.2.2 Use the information in graph **A** to calculate the mass of hydrogen peroxide used in the reaction. Assume that all the hydrogen peroxide decomposes. Use 24 $dm^3 \cdot mol^{-1}$ as the molar volume of oxygen. (4)

5.2.3 How does the mass of hydrogen peroxide used to obtain graph **B** compare to that used to obtain graph **A**? Choose from GREATER THAN, SMALLER THAN or EQUAL TO. (1)

5.3 Three energy distribution curves for the oxygen gas produced under different conditions are shown in the graph below. The curve with the solid line represents 1 mol of oxygen gas at 90 °C.



Choose the curve (**P** or **Q**) that best represents EACH of the following situations:

5.3.1 1 mol of oxygen gas produced at 120 °C (1)

5.3.2 2 moles of oxygen gas produced at 90 °C (1)

[17]

QUESTION 6 (Start on a new page)

6.1 The thermal decomposition of calcium carbonate ($CaCO_3$) that takes place in a closed container can be represented by the following equation:

$$CaCO_3(s) \rightleftharpoons CaO(s) + CO_2(g)$$

Equilibrium is reached at 700 °C.

6.1.1 State *Le Chatelier's principle* in words. (2)

6.1.2 It is found that the value of K_c increases when the container is heated to 900°C. Is the forward reaction EXOTHERMIC or ENDOTHERMIC? Use *Le Chatelier's principle* to explain your answer. (4)

6.2 The following reaction is investigated in a laboratory:

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

Initially 3,45 mol of $SO_2(g)$ and an unknown mass, **X**, of $O_2(g)$ are sealed in a 3 dm^3 flask and allowed to reach equilibrium at a certain temperature.

At equilibrium it is found that the concentration of $SO_3(g)$ present in the flask is 0,65 $mol{\cdot}dm^{-3}$.

6.2.1 Calculate the mass of $O_2(g)$ initially present in the flask if the equilibrium constant (K_c) at this temperature is 1,52. (9)

6.2.2 The volume of the container is now decreased to 1 dm^3 while the temperature is kept constant. How will each of the following be affected? Write down only INCREASES, DECREASES or REMAINS THE SAME.

6.2.2.1 The value of K_c. (1)

6.2.2.2 The number of moles of $O_2(g)$ present in the equilibrium mixture. (1)

[17]

QUESTION 7 (Start on a new page)

150 g of impure barium hydroxide is dissolved in 2 dm^3 of water. 2 dm^3 of a hydrochloric acid solution, with a concentration of 0,75 $mol.dm^{-3}$, is then added to the barium hydroxide solution. A scientist measures the pH of the solution after the addition of the hydrochloric acid solution and finds the combined solution to have a pH of 12. The reaction between barium hydroxide and hydrochloric acid is represented below:

$$Ba(OH)_2(aq) + 2HC\ell(aq) \rightarrow BaC\ell_2(aq) + 2H_2O(\ell)$$

7.1 Define an acid in terms of *Lowry-Brønsted*. (2)

7.2 Calculate the concentration of hydroxide ions present in the solution after the hydrochloric acid solution was added. (5)

7.3 Calculate the *percentage purity* of the sample of barium hydroxide. (7)

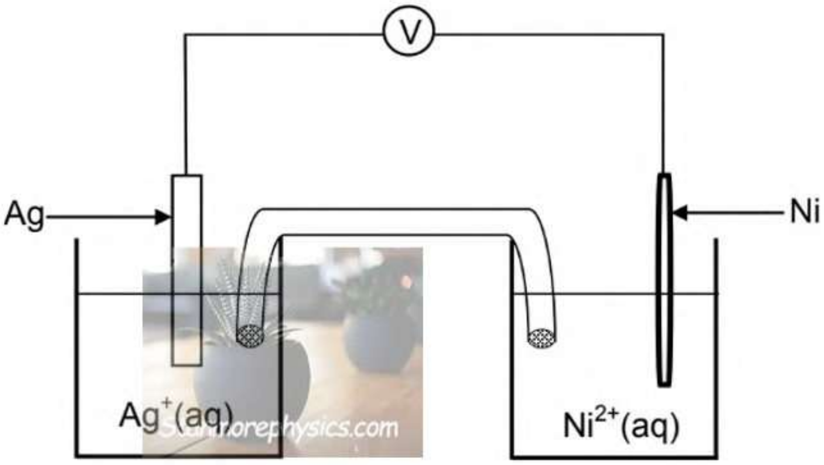
7.4 Suggest an indicator that would be appropriate to use to indicate the endpoint during a titration between barium hydroxide and hydrochloric acid. Choose from *methyl orange*, *bromothymol blue* or *phenolphthalein*. (1)

7.5 Explain your answer to QUESTION 7.4 by referring to the strengths of the acid and base as well as the pH. (3)

[18]

QUESTION 8 (Start on a new page)

A galvanic cell is set up using a nickel half-cell and a silver half-cell.



8.1 Which electrode (**Ni** or **Ag**) must be connected to the negative terminal of the voltmeter? Give a reason for the answer. (2)

8.2 Write down the cell notation for the galvanic cell above. (3)

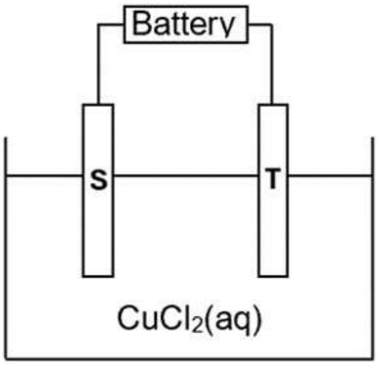
8.3 Calculate the initial reading on the voltmeter if the cell functions under standard conditions. (4)

8.4 How will the voltmeter reading in QUESTION 8.3 be affected if the concentration of the silver ions is increased? Choose from INCREASES, DECREASES or REMAINS THE SAME. (1)

[10]

QUESTION 9 (Start on a new page)

In the electrolytic cell below, two carbon rods are used as electrodes and a concentrated copper(II)chloride solution ($CuC\ell_2$) is used as an *electrolyte*.



When the cell is in operation, a gas is released at electrode **S** while electrode **T** is covered with a brown layer.

9.1 Write down a half reaction to explain the observation made at:

9.1.1 Electrode **S**. (2)

9.1.2 Electrode **T**. (2)

9.2 Which electrode, **S** or **T**, is the anode? Give a reason for the answer. (2)

9.3 A current of 2,5 A passes through the cell for 5 hours.
Calculate the:

9.3.1 Total charge that flows through the cell during this time. (2)

9.3.2 Increase in mass of the cathode. (5)

9.4 The carbon rods in the above cell are now replaced with COPPER RODS and the cell is allowed to operate for some time.

The following observations are made at electrode **S**:

- No gas is released.
- Its surface appears rough and corroded.

9.4.1 Refer to the RELATIVE STRENGTHS OF REDUCING AGENTS and explain these observations. (3)

9.4.2 This cell can be used for the purification of copper. Which electrode (**S** or **T**) will be replaced with the impure copper during this purification process? (1)

[17]

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	$22{,}4\ dm^{3}\cdot mol^{-1}$
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*

$n = \frac{m}{M}$	$n = \frac{N}{N_A}$
$c = \frac{n}{V}$ or/*of* $c = \frac{m}{MV}$	$n = \frac{V}{V_m}$
$\frac{c_aV_a}{c_bV_b} = \frac{n_a}{n_b}$	$pH = -log[H_3O^+]$
$K_w = [H_3O^+][OH^-] = 1 \times 10^{-14}$ 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* $E^{\theta}_{cell} = E^{\theta}_{oxidising agent} - E^{\theta}_{reducing agent}$ / $E^{\theta}_{sel} = E^{\theta}_{oksideermiddel} - E^{\theta}_{reduseermiddel}$	
$I = \frac{Q}{\Delta t}$	$n = \frac{Q}{q_e}$ where n = number of electrons

TABLE 3: THE PERIODIC TABLE OF ELEMENTS
TABEL 3: DIE PERIODIEKE TABEL VAN ELEMENTE

KEY/*SLEUTEL*

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

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
$\mathbf{2H^+ + 2e^-}$	$\rightleftharpoons$	$\mathbf{H_2(g)}$	**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 strength of oxidising agents /*Toenemende sterkte van oksideermiddels*

Increasing strength of reducing agents /*Toenemende sterkte van reduseermiddels*

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

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	$-0,06$
$2H^+ + 2e^-$	$\rightleftharpoons$	**$H_2(g)$**	**$0,00$**
$S + 2H^+ + 2e^-$	$\rightleftharpoons$	$H_2S(g)$	$+0,14$
$Sn^{4+} + 2e^-$	$\rightleftharpoons$	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+}	$+1,81$
$F_2(g) + 2e^-$	$\rightleftharpoons$	$2F^-$	$+2,87$

Increasing strength of oxidising agents /*Toenemende sterkte van oksideermiddels* ↓

Increasing strength of reducing agents /*Toenemende sterkte van reduseermiddels* ↑

Western Cape Government

FOR YOU

Education

CAPE WINELANDS EDUCATION DISTRICT

PHYSICAL SCIENCES MEMORANDUM PAPER 2
GRADE 12

COMMON PRELIMINARY EXAMINATION
SEPTEMBER 2024

MARKS: 150

TIME: 3 hours

This marking guideline consists of 14 pages

QUESTION 1/ VRAAG 1 (MULTIPLE-CHOICE/ MEERVOUDIGEKEUSE)

1.1	D✓✓	(2)
1.2	C✓✓	(2)
1.3	C✓✓	(2)
1.4	B✓✓	(2)
1.5	B✓✓	(2)
1.6	C✓✓	(2)
1.7	D✓✓	(2)
1.8	A✓✓	(2)
1.9	A✓✓	(2)
1.10	B✓✓	(2)
		[20]

QUESTION 2/ VRAAG 2

2.1 A series of organic compounds that can be described by the same general formula *OR* A series of organic compounds in which one member differs from the next with a CH_2 group. ✓✓

'n Reeks organiese verbindings wat deur dieselfde algemene formule beskryf kan word *OF* 'n Reeks organiese verbindings waarin een lid van die volgende verskil met 'n CH_2-groep. ✓✓

Marking criteria/Nasienkriteria:

If any of the underlined key phrases in the correct context is omitted, deduct 1 mark. Indien enige van die onderstreepte sleutelfrases in die korrekte konteks weggelaat word, trek 1 punt af.

(2)

2.2.1 F✓ (1)

2.2.2 E & H✓ (1)

2.2.3 D✓ (1)

2.2.4 H✓ (1)

2.3

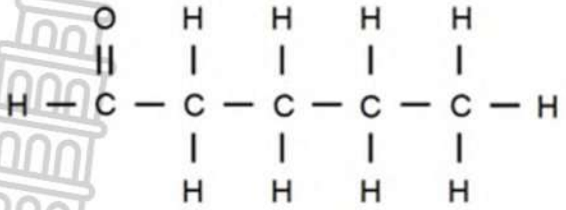
<u>Mark allocation/ Puntetoekenning:</u>
-OH on first carbon/ -OH op eerste koolstof✓
rest of molecule correct/ res van molekule korrek✓ (2)

2.4.1 3-methylpentan-2-one **Marking allocation:** 3-methyl✓pentan-2-one ✓
3-metielpentan-2-oon **Punte toekenning:** 3-metiel✓pentan-2-oon ✓ (2)

2.4.2 2,2,4-tribromo-3-ethylhexane / 2,2,4-tribromo-3-etielheksaan

Marking criteria / Nasienriglyne:
• Correct stem i.e. hexane. / Korrekte stam d.i. heksaan.
• All substituents correctly identified. / Alle substituente korrek geïdentifiseer.
• Substituents correctly numbered, in alphabetical order, hyphens and commas correctly used.
Substituente korrek genommer, in alfabetiese volgorde, koppeltekens en kommas korrek gebruik. (3)

2.5



Mark allocation/ Puntetoekenning:
Functional group (formyl group)/Funksionele groep (formielgroep)✓
Whole molecule correct/Hele molekule korrek✓ (2)

2.6 C_9H_{20} + $14O_2$ → $9CO_2$ + $10H_2O$
reactants/reaktante ✓ products/produkte ✓ balancing/balansering✓ (3)

[18]

QUESTION 3/ VRAAG 3

3.1 Boiling point is the <u>temperature</u> at which the <u>vapour pressure of a substance is equal to the atmospheric pressure.</u>✓✓
Kookpunt is die <u>temperatuur</u> waarby die <u>dampdruk van 'n stof gelyk is aan die atmosferiese druk.</u>✓✓
Marking criteria/Nasienkriteria:

If any of the underlined key phrases in the correct context is omitted, deduct 1 mark. Indien enige van die onderstreepte sleutelfrases in die korrekte konteks weggelaat word, trek 1 punt af.

(2)

3.2.1 **FROM A TO C**
- Increase branching/smaller surface area/more compact✓
- Weaker intermolecular forces✓
- Less energy needed to break the intermolecular forces✓
- Boiling point decreases✓

VANAF A TOT C
- Vergroot vertakking/kleiner oppervlakte/meer kompak
- Swakker intermolekulêre kragte
- Minder energie benodig om die intermolekulêre kragte te breek
- Kookpunt neem af

(4)

3.2.2 C/2,2-dimethylpropane / 2,2-dimetielpropaan ✓ (1)

3.2.3 Lowest boiling point / Laagste kookpunt✓ (1)

3.3 Greater than (103 °C)✓
• Between compound D/pentanal molecules are dipole-dipole forces✓ (and London forces) and between compound E/butanoic acid are hydrogen bonds✓ (dipole-dipole and London forces).
• Dipole-dipole forces are weaker than hydrogen bonds.✓
OR
Intermolecular forces between compound D/pentanal molecules are weaker than those between compound E/butanoic acid molecules.
OR
Less energy is needed to break the intermolecular forces between pentanal molecules.

Groter as (103 °C)
• Tussen verbinding D/pentanaal molekules is dipool-dipoolkragte (en Londen-kragte) en tussen verbinding E/butanoësuur is waterstofbindings (dipool-dipool en Londen-kragte).
• Dipool-dipoolkragte is swakker as waterstofbindings.
OF
Intermolekulêre kragte tussen verbinding D/pentanaal molekules is swakker as dié tussen verbinding E/butanoësuur molekules.
OF
Minder energie benodig om die intermolekulêre kragte tussen pentanaal molekules te breek. (4)

3.4 Yes/Ja✓ (1)

3.5 Comparable molecular masses OR only functional group (homologous series) changed/only 1 independent variable✓

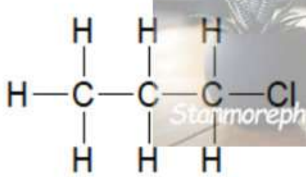
Vergelykbare molekulêre massas OF slegs funksionele groep (homoloë reeks) verander/slegs 1 onafhanklike veranderlike. (1)

[14]

QUESTION 4/ VRAAG 4

4.1.1 Hydrohalogenation/ Hydrochlorination✓
Hidrohalogenering/Hidrochlorinering (1)

4.1.2



1-chloropropane/ 1-chloropropaan

Mark allocation/Punte toekenning:
Cℓ on first carbon✓ Whole structural formula correct✓ Correct IUPAC name✓
Cℓ op eerste koolstof. Hele struktuurformule korrek. Korrekte IUPAC naam.
Note: Negative marking on naming if the structural formula is incorrect.
Let wel: Negatiewe nasien by benaming as die struktuurformule verkeerd is. (3)

4.1.3 No water present/ Geen water teenwoordig✓ (1)

4.2.1 Substitution/ Hydrolysis ✓
Substitusie/ Hidrolise (1)

4.2.2 The use of a concentrated strong base will result in an elimination reaction✓ thus producing propene and not a substitution reaction as desired.
Die gebruik van 'n gekonsentreerde sterk basis sal lei tot 'n eliminasiereaksie wat dus propeen produseer en nie 'n substitusiereaksie soos verlang nie. (1)

4.2.3 Primary✓
The carbon atom that is bonded to the hydroxyl group is attached to only one other carbon atom✓
OR
The functional group is attached to only one other carbon atom

Primêre
Die koolstofatoom wat aan die hidroksielgroep gebind is, is aan slegs een ander koolstofatoom geheg
OF
Die funksionele groep is aan slegs een ander koolstofatoom geheg (2)

4.2.4 Remain the same/ Bly dieselfde✓ (will only increase the rate of the reaction) (1)

4.3.1 Same molecular formula✓, but different positions of the side chain/substituents/functional groups on the parent chain. ✓
Dieselfde molekulêre formule, maar verskillende posisies van die syketting/ substituente/funksionele groepe op die moederketting. (2)

4.3.2 H_3PO_4/Phosphoric acid/Fosforsuur✓ **OR/OF** H_2SO_4/Sulphuric acid/Swaelsuur (1)

4.4 Propane/ Propaan✓✓ (2)

4.5.1 Esterification/ Condensation✓
Esterifikasie/ Kondensasie (1)

4.5.2 Propyl✓butanoate✓/ Propiel butanoaat (2)

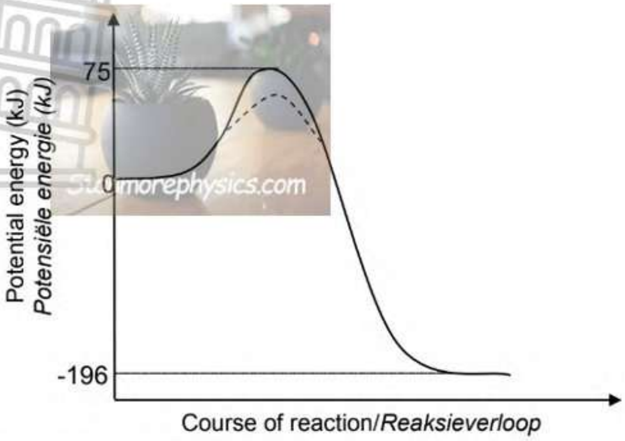
4.5.3 Catalyst/ Katalisator ✓ OR/OF Dehydrating agent/Dehidreermiddel (1)

[19]

QUESTION 5/ VRAAG 5

5.1.1 The minimum energy needed for a reaction to take place. ✓✓ (2 or 0)
Die minimum energie benodig vir 'n reaksie om plaas te vind. (2 of 0) (2)

5.1.2



Marking criteria/*Nasienriglyne*:	
Shape of curve for exothermic reaction as shown. *Vorme van kurwe vir eksotermiese reaksie soos getoon.*	✓
Energy of activated complex shown as 75 kJ in line with the peak. *Energie van geaktiveerde kompleks aangetoon as 75 kJ in lyn met die piek.*	✓
Energy of products shown as − 196 kJ below the zero. *Energie van produkte getoon as − 196 kJ onderkant die nulpunt.*	✓
IF/*INDIEN*: Wrong shape, e.g. straight line./*Verkeerde vorm bv. reguitlyn.*	$\frac{0}{3}$

(3)

5.1.3 **Marking criteria/Nasienriglyne**
- Dotted line (---) on graph in QUESTION 5.1.2 showing lower energy for activated complex.✓
  Stippellyn (---) op grafiek in VRAAG 5.1.2 wat laer energie vir geaktiveerde kompleks toon.
- Dotted curve starts at/above energy of reactants and ends at/above energy of products on the inside of the original curve.✓
  Stippellyn kurwe begin by/bokant energie van reaktanse en eindig by/bokant energie van produkte aan die binnekant van die oorspronklike kurwe.

Note/Aantekening:
Allocate marks only if curve for either exothermic or endothermic reaction drawn in QUESTION 5.1.2.
Ken punte slegs toe indien kurwe vir endotermiese of eksotermiese reaksie in VRAAG 5.1.2 geteken is.

(2)

5.2.1

$$\text{Ave rate/}\textit{Gem. tempo} = \frac{\Delta V}{\Delta t}$$
$$= \frac{52 - 16 ✓}{40 - 10 ✓}$$
$$= 1{,}2\ (dm^3 \cdot s^{-1})\ ✓$$

Accept/*Aanvaar*:
- Volume range/*gebied*: 16 to/*tot* 17 cm^3
- Answer range/*Antwoordgebied:* 1,167 to 1,2 $dm^3 \cdot s^{-1}$

(3)

5.2.2

Marking criteria/*Nasienriglyne:*

- $V(O_2) = 60\ dm^3$ AND/*EN* divide volume by 24./*deel volume deur* 24 ✓
- Use ratio/Gebruik *verhouding*: $n(H_2O_2) = 2n(O_2) = 1:2$ ✓
- Use $34\ g{\cdot}mol^{-1}$ in $n = \frac{m}{M}$ or in ratio calculation. ✓

  Gebruik 34 $g{\cdot}mol^{-1}$ *in* $n = \frac{m}{M}$ *of in verhoudingsberekening.*
- Final answer/*Finale antwoord:* 170 g ✓

OPTION 1/*OPSIE 1*	**OPTION 2/*OPSIE 2***	**OPTION 3/*OPSIE 3***
$n(O_2) = \frac{V}{V_M}$ $= \frac{60}{24}$ ✓ $= 2{,}5\ mol$ $n(H_2O_2) = 2n(O_2)$ $= 2(2{,}5)$ ✓ $= 5\ mol$ $n(H_2O_2) = \frac{m}{M}$ $\therefore 5 = \frac{m}{34}$ ✓ $\therefore m = 170\ g$ ✓	$24\ dm^3 : 1\ mol$ $60\ dm^3 : 2{,}5\ mol$ ✓ $n(H_2O_2) = 2n(O_2)$ $= 2(2{,}5)$ ✓ $= 5\ mol$ 34 g ✓: 1 mol x : 5 mol x = 170 g ✓	$n(O_2) = \frac{V}{V_M}$ $= \frac{60}{24}$ ✓ $= 2{,}5\ mol$ $n(O_2) = \frac{m}{M}$ $\therefore 2{,}5 = \frac{m}{32}$ $\therefore m = 80\ g$ 2(34) g ✓ H_2O_2 .... 32 g O_2 x g H_2O_2 .... 80 g O_2 $m(H_2O_2) = 170\ g$ ✓

(4)

5.2.3 Equal to / Gelyk aan ✓ (1)

5.3.1 Q ✓ (1)

5.3.2 P ✓ (1)

[17]

QUESTION 6/ VRAAG 6

6.1.1 When the equilibrium in a closed system is disturbed, the system will re-instate a new equilibrium by favouring the reaction that will cancel/oppose the disturbance. ✓ ✓

Wanneer die ewewig in 'n geslote sisteem versteur word, sal die sisteem 'n nuwe ewewig instel deur die reaksie te bevoordeel wat die versteuring kanselleer/teenwerk.

Marking criteria/Nasienkriteria:

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 underlined phrases must be in the correct context. / Die onderstreepte frases moet in korrekte konteks wees. (2)

6.1.2 Endothermic. ✓

According to Le Chatelier's principle an increase in temperature will favour the endothermic reaction. ✓

When the temperature was increased the K_c value increased, therefore [CO_2] increased/more product formed, ✓therefore the forward reaction was favoured.✓
Therefore the forward reaction is endothermic.

Endotermies.
Volgens Le Chatelier se beginsel sal 'n toename in temperatuur die endotermiese reaksie bevoordeel.
Toe die temperatuur verhoog is, the K_c toegeneem, dus het [CO_2] verhoog/produkte vermeeder en dus word die voorwaartse reaksie bevoordeel.
Dus is die voorwaartse reaksie endotermies. (4)

6.2.1 **Marking criteria OPTION 1-3/ Nasienkriteria OPSIE 1-3:**

a) Calculate $n(SO_3) = cV = (0,65)(3) = 1,95$ mol
b) Calculate $n(SO_3)_{formed/gevorm} = n_{equilibrium/ewewig} - n_{initial/begin} = 1,95$
c) Use mole ratio 2:1:2
d) $n(O_2)_{initial} = \frac{x}{32}$ (Show substitution of M = 32 $g.mol^{-1}$)
e) Calculate $n(SO_2)_{equilibrium/ewewig}$ & $n(O_2)_{equilibrium/ewewig}$: $n_{initial/begin} - n_{used/gebruik}$
f) Calculate concentration by dividing $n_{equilibrium/ewewig}$ by $3dm^3$
g) Correct K_c expression
h) Substitute equilibrium concentrations and K_c value into K_c expression
i) Answer: $x = m(O_2) = 137,94$ g (Answer range: 137,80g - 138,45g)

OPTION/OPSIE 1

	SO_2	O_2	SO_3	
Mole ratio/ Mol verhouding	**2**	**1**	**2**	
Initial mol/ Aanvanklike mol	**3,45**	$\frac{x}{32}$✓	0	
Change in mol/ Verandering in mol	1,95	0,975	1,95✓	*Ratio*✓
Mol at equilibrium/ Mol by ewewig	✓1,5	$\frac{x}{32} - 0,975$	1,95✓	
Concentration at equilibrium/ Konsentrasie by ewewig	0,5	$\frac{x-31,2}{96}$	**0,65**	*Divide by 3*✓

$$K_c = \frac{[SO_3]^2}{[SO_2]^2[O_2]}✓$$

$$1,52 = \frac{(0,65)^2}{(0,5)^2(\frac{x-31,2}{96})}✓$$

$$x = 137,94g✓$$

OPTION/OPSIE 2

	SO_2	O_2	SO_3	
Mole ratio/ Mol verhouding	**2**	**1**	**2**	
Initial mol/ Aanvanklike mol	**3,45**	y	0	
Change in mol/ Verandering in mol	1,95	0,975	1,95✓	*Ratio*✓
Mol at equilibrium/ Mol by ewewig	✓1,5	y - 0,975	1,95✓	
Concentration at equilibrium/ Konsentrasie by ewewig	0,5	$\frac{y-0,975}{3}$	**0,65**	*Divide by 3*✓

$$K_c = \frac{[SO_3]^2}{[SO_2]^2[O_2]} ✓$$

$$1,52 = \frac{(0,65)^2}{(0,5)^2(\frac{y-0,975}{3})} ✓$$

$$y = 4,3105\ mol$$

$$m(O_2) = nM = (4,3105)(32) ✓$$

$$x = m(O_2) = 137,94g ✓$$

OPTION/OPSIE 3

	SO_2	O_2	SO_3	
Mole ratio/ Mol verhouding	**2**	**1**	**2**	
Initial mol/ Aanvanklike mol	**3,45**	y	0	
Change in mol/ Verandering in mol	1,95	0,975	1,95✓	*Ratio*✓
Mol at equilibrium/ Mol by ewewig	1,5✓	y - 0,975	1,95✓	
Concentration at equilibrium/ Konsentrasie by ewewig	0,5	$[O_2]$	**0,65**	*Divide by 3*✓

$$K_c = \frac{[SO_3]^2}{[SO_2]^2[O_2]} ✓$$

$$1,52 = \frac{(0,65)^2}{(0,5)^2[O_2]} ✓$$

$[O_2] = 1,1118\ mol.dm^{-3}$

$$y - 0,975 = (1,1118)(3)$$

$$y = 4,3105\ mol$$

$m(O_2) = nM = (4,3105)(32)$ ✓

$x = m(O_2) = 137,94g$ ✓

Marking criteria OPTION 4-5/ Nasienkriteria OPSIE 4-5:

a) Calculate initial concentration by dividing $n_{initial/aanvanklik}$ by $3dm^3$
b) Calculate $c(SO_3)_{formed/gevorm} = c_{initial/aanvanklik} + c_{equilibrium/ewewig} = 0,65\ (mol.dm^{-3})$
c) Use mole ratio 2:1:2
d) $c(O_2)_{initial} = \frac{x}{32\times3}$ (Show substitution of M = 32 $g.mol^{-1}$)
e) Divide by 3 dm^3 to calculate concentration OR Multiply by 3 dm^3 to calculate mass$(m(O_2) = cMV)$
f) Calculate $c(SO_2)_{equilibrium/ewewig}$ & $c(O_2)_{equilibrium/ewewig} = c_{initial/begin} - c_{used/gebruik}$
g) Correct K_c expression
h) Substitute equilibrium concentrations and K_c value into K_c expression
i) Answer: x = $m(O_2)$ = 137,94 g (Answer range: 137,80g - 138,45g)

OPTION/OPSIE 4

	SO_2	O_2	SO_3	
Mole ratio/ Mol verhouding	**2**	**1**	**2**	
Initial concentration/ Aanvanklike konsentrasie	✓ $\frac{3,45}{3} = 1,15$	$\frac{x}{32\times3} = \frac{x}{96}$	0	*M = 32*✓ *Divide by 3*✓
Change in concentration/ Verandering in konsentrasie	0,65	0,325	0,65 ✓	*Ratio*✓
Concentration at equilibrium/ Konsentrasie by ewewig	0,5✓	$\frac{x}{96} - 0,325$	**0,65**	

$K_c = \frac{[SO_3]^2}{[SO_2]^2[O_2]}$ ✓

$1,52 = \frac{(0,65)^2}{(0,5)^2(\frac{x}{96} - 0,325)}$ ✓

$x = m(O_2) = 137,94g$ ✓

OPTION/OPSIE 5

	SO_2	O_2	SO_3	
Mole ratio/ Mol verhouding	**2**	**1**	**2**	
Initial concentration/ Aanvanklike konsentrasie	✓ $\frac{3,45}{3} = 1,15$	y	0	
Change in concentration/ Verandering in konsentrasie	0,65	0,325	0,65✓	*Ratio*✓
Concentration at equilibrium/ Konsentrasie by ewewig	0,5✓	$y - 0,325$	**0,65**	

$K_c = \frac{[SO_3]^2}{[SO_2]^2[O_2]}$✓

$1,52 = \frac{(0,65)^2}{(0,5)^2(y - 0,325)}$✓

$y = 1,4368\ mol.dm^{-3}$

$m(O_2) = cMV = (1,4368)(32)(3)$✓✓

$m(O_2) = 137,94g$✓

(9)

6.2.2.1 Remains the same✓
Bly dieselfde✓ (1)

6.2.2.2 Decrease✓
Verminder✓ (1)

[17]

QUESTION 7/ VRAAG 7

7.1 A proton donor. ✓✓ (2 or 0)
'n Proton skenker. (2 of 0) (2)

7.2

$pH = -\log[H_3O^+]$ ✓
12✓ $= -\log[H_3O^+]$
$[H_3O^+] = 1 \times 10^{-12}$

$K_w = [H_3O^+][OH^-]$✓
$1\times10^{-14} = [1\times10^{-12}][OH^-]$✓
$[OH^-] = 1 \times 10^{-2}\ mol.dm^{-3}$✓

Mark allocation:
a)pH formula/ pH formule
b)Substitution into pH formula/ Vervanging in pH formule
c)K_w formula/ K_w formule
d)Substitution into K_w formula/ Vervanging in K_w formule
e)Final answer correct/ Finale antwoord korrek (5)

7.3 $Ba(OH)_2(aq) + 2HC\ell(aq) \rightarrow BaC\ell_2(aq) + 2H_2O(\ell)$

$n(HC\ell) = cV$
$= (0,75)(2)$ ✓
$= 1,5$ mol

$n(Ba(OH)_2)_{reacts} = \frac{1}{2} n(HC\ell)$
$= (0,5)(1,5)$ ✓
$= 0,75$ mol

$n(Ba(OH)_2)_{excess} = \frac{1}{2} n(OH^-)$
$= \frac{1}{2} cV$
$= (0,5)(1\times10^{-2})(4)$ ✓ **Positive marking from Q7.2**
$= 0,02$ mol

$n(Ba(OH)_2)_{total} = 0,75 + 0,02$ ✓
$= 0,77$ mol

$m(Ba(OH)_2) = nM$
$= (0,77)(171)$ ✓ $M = (137 + (2 \times 16) + 2) = 171\ g.mol^{-1}$
$= 131,67$ g

$\%purity = \frac{131,67}{150} \times 100$ ✓
$= 87,78\%$ ✓

Mark allocation:	Puntetoekenning:
a)Calculate $n(HC\ell)$ b)Mole ratio of $Ba(OH)_2$ to $HC\ell$ used c)Calculate $n(Ba(OH)_2)_{excess}$ d)Calculate $n(Ba(OH)_2)_{total}$ e)Substitution of $M = 171\ g.mol^{-1}$ and $n(Ba(OH)_2)_{total}$ into $n = \frac{m}{M}$ f)$m(Ba(OH)_2) \div 150g \times 100$ g)Final answer = 87,78%	a)Bereken $n(HC\ell)$ b)Molverhouding van $Ba(OH)_2$ tot $HC\ell$ gebruik c)Bereken $n(Ba(OH)_2)_{oormaat}$ d)Bereken $n(Ba(OH)_2)_{totaal}$ e)Vervanging van $M = 171\ g.mol^{-1}$ en $n(Ba(OH)_2)_{totaal}$ in $n = \frac{m}{M}$ f)$m(Ba(OH)_2) \div 150g \times 100$ g)Finale antwoord = 87,78%

(7)

7.4 Bromothymol blue/ Broomtimolblou ✓ (1)

7.5 Barium hydroxide is a strong base ✓and hydrochloric acid is a strong acid.✓
The salt that is formed is neutral and at the endpoint the pH will be (around) 7. ✓

Bariumhidroksied is 'n sterk basis en soutsuur is 'n sterk suur.
Die sout wat gevorm word is neutral en die pH by die eindpunt is (ongeveer) 7. (3)

[18]

QUESTION 8/ VRAAG 8

8.1 Ni✓

Ni is a stronger reducing agent. / Ni has a higher reducing ability. / Ni is the anode. / Ni loses electrons. / Ni is oxidised.✓
Ni is die sterker reduseermiddel. / Ni het sterker reduserende vermoë. / Ni is die anode. / Ni verloor elektrone. / Ni word geoksideer. (2)

8.2 ✓ ✓ ✓ Ignore phase and concentrations
$Ni \mid Ni^{2+} \parallel Ag^{+} \mid Ag$ Ignoreer fases en konsentrasies (3)

8.3

<u>OPTION 1/*OPSIE 1*</u>	**<u>Notes/*Aantekeninge*</u>**
$E^{\theta}_{cell} = E^{\theta}_{reduction} - E^{\theta}_{oxidation}$ ✓ $= 0,80$ ✓ $- (-0,27)$ ✓ $= 1,07$ V ✓	• 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:* $\frac{3}{4}$

<u>OPTION 2/*OPSIE 2*</u>	
$Ag^{+} + e^{-} \rightarrow Ag$ ✓	$E^{\theta} = 0,80$ V ✓
$Ni \rightarrow Ni^{2+} + 2e^{-}$	$E^{\theta} = +0,27$ V ✓
$Ag^{+} + Ni \rightarrow Ag + Ni^{2+}$	$E^{\theta} = +1,07$ V ✓

(4)

8.4 Increases / Verhoog✓ (1)

[10]

QUESTION 9/ VRAAG 9

9.1.1 $2C\ell^- \rightarrow C\ell_2 + 2e^-$ ✓✓

$2C\ell^- \leftrightharpoons C\ell_2 + 2e^-$	1⁄2	$C\ell_2 + 2e^- \leftarrow 2C\ell^-$	2⁄2
$2C\ell^- \leftarrow C\ell_2 + 2e^-$	0⁄2	$C\ell_2 + 2e^- \rightleftharpoons 2C\ell^-$	0⁄2

(2)

9.1.2 $Cu^{2+} + 2e^- \rightarrow Cu$ ✓✓

$Cu^{2+} + 2e^- \leftrightharpoons Cu$	1⁄2	$Cu \leftarrow Cu^{2+} + 2e^-$	2⁄2
$Cu^{2+} + 2e^- \leftarrow Cu$	0⁄2	$Cu \rightleftharpoons Cu^{2+} + 2e^-$	0⁄2

(2)

9.2 S ✓
Oxidation occurs there / Cl^- is oxidised at S / Cl^- is a reducing agent✓
Oksidasie vind daar plaas / Cl^- word geoksideer by S / Cl^- 'n reduseermiddel✓ (2)

9.3.1 $Q = I\Delta t$
$= (2,5)(5 \times 60 \times 60)$✓ OR $(2,5)(18\ 000)$
$= 45\ 000\ C\ \ (4,5 \times 10^4\ C)$✓ (2)

9.3.2 $n = \frac{Q}{e}$ OR $n = \frac{Q}{q_e}$

$= \frac{45\ 000}{1,6 \times 10^{-19}}$ ✓ **Positive marking from Q9.3.1** (Divide by electron charge)

$= 2,8125 \times 10^{23}$ (electrons)

$N(\text{Cu atoms}) = \frac{2,8125 \times 10^{23}}{2}$ ✓ (Use ratio)
$= 1,40625 \times 10^{23}$

$n(Cu) = \frac{1,40625 \times 10^{23}}{6,02 \times 10^{23}}$ ✓ (Divide by Avogadro's number)
$= 0,23356$ mol

$m(Cu) = nM$
$= (0,23356)(63,5)$ ✓ (Substitute M_r in formula)
$= 14,83$ g ✓ (Answer range: 14,61g -14,83g) (5)

9.4.1 Cu is a stronger reducing agent✓ than Cl^- ✓ and thus Cu will be oxidised from Cu to Cu^{2+}✓. (no Cl_2 gas formed but Cu will dissolve/break up)
Cu is 'n sterker reduseermiddel ✓ as Cl^- ✓en sal dus van Cu word geoksideer na Cu^{2+}✓. (3)

9.4.2 S ✓ (1)

TOTAL: 150 **[17]**