LIMPOPO
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REPUBLIC OF SOUTH AFRICA

DEPARTMENT OF EDUCATION

NATIONAL SENIOR CERTIFICATE

GRADE 12

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PHYSICAL SCIENCES

PAPER 2: JUNE 2025

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MARKS: 150

TIME: 3 Hours

This paper consist of 13 pages including the Data Sheets

NB Be careful of the MISSING Data in paper

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QUESTION 1

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

1.1 Which one of the following compounds is not an ester?

A $C_3H_8O_2$
B $C_2H_4O_2$
C $C_3H_6O_2$
D $C_4H_8O_2$

(2)

1.2 In which ONE of the following options are the three compounds arranged in order of increasing boiling points?

A	CH_3CH_2COOH	$CH_3CH_2CH_2CH_2CH_3$	$CH_3CH_2CH_2CH_2OH$
B	$CH_3CH_2CH_2CH_2OH$	$CH_3CH_2CH_2CH_2CH_3$	CH_3CH_2COOH
C	$CH_3CH_2CH_2CH_2CH_3$	$CH_3CH_2CH_2CH_2OH$	CH_3CH_2COOH
D	$CH_3CH_2CH_2CH_2CH_3$	CH_3CH_2COOH	$CH_3CH_2CH_2CH_2OH$

(2)

1.3 Which of the following reactions can be used to prepare ethane from octane?

A Addition
B Hydrogenation
C Cracking
D Substitution

(2)

1.4 The molecular formula of 1,2-dichlorobutane is:

A $C_4H_{11}C\ell$
B $C_5H_5C\ell$
C $C_4H_8C\ell_2$
D $C_6H_8C\ell_2$

(2)

1.5 According to the Collision Theory, reaction rate increases if there is:

A Decrease in temperature.
B Decrease in activation energy.
C Decrease in concentration.
D Decrease in kinetic energy of molecules.

(2)

1.6 Which one of the following statements correctly describes the characteristics of an endothermic reaction?

A ΔH is positive and the products have less energy than the reactants.
B ΔH is positive and the products have more energy than the reactants.
C ΔH is negative and the products have less energy than the reactants.
D ΔH is negative and the products have more energy than the reactants. (2)

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A system is at chemical equilibrium. Which of the following will change as the temperature of the equilibrium mixture is changed?
(i) Total mass of reactants and products.
(ii) K_c value.
(iii) Rate of the reverse reaction.

A (i) only
B (i) and (iii) only
C (ii) and (iii) only
D (i), (ii) and (iii)

(2)

Consider the balanced chemical equation for the following reaction in equilibrium.

$$2NO_{2(g)} \rightleftharpoons N_2O_{4(g)}$$

The equilibrium constant, K_c, for this reaction is 170,3 at 30°C.
What is the equilibrium constant for the reverse reaction?

A $\sqrt{170,3}$
B $\frac{170,3}{2}$
C $\frac{1}{170,3}$
D $170,3^2$

(2)

Which one of the following is true for an acidic solution at 25°C?

A It contains both H_3O^+ ions and OH^- ions.
B It contains H_3O^+ ions only.
C It contains OH^- ions only.
D It contains neither H_3O^+ ions nor OH^- ions.

(2)

Which one of the following is a strong acid?

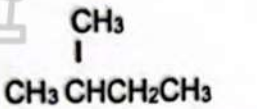
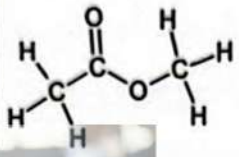
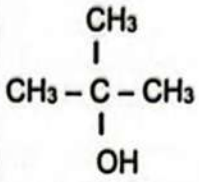
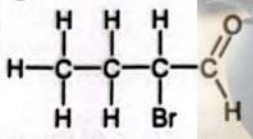
A H_2O.
B HBr.
C H_2S.
D CH_3COOH.

(2)

[20]

QUESTION 2

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

A But-1-ene	**B** 1-bromopropan-2-one	**C** Propanoic acid
D 	**E** 	**F** 
G 	**H** $CH_3CH_2C(CH_3)_2CCH$	

2.1 Write down the LETTER(S) which represents:

2.1.1 An alcohol. (1)

2.1.2 A carboxylic acid. (1)

2.1.3 A positional isomer of but-2-ene. (1)

2.1.4 A product formed by the hydrolysis of a haloalkane. (1)

2.1.5 Unsaturated compound(s). (2)

2.1.6 A compound with a formyl functional group. (1)

2.1.7 A compound with a pleasant smell. (1)

2.2 Write down the IUPAC name of:

2.2.1 Compound D. (2)

2.2.2 Compound F. (3)

2.2.3 Compound G. (2)

2.2.4 Compound H. (3)

2.3 Write down the structural formula of:

2.3.1 Compound A. (2)

2.3.2 Compound C. (2)

2.4 Write down:

2.4.1 The molecular formula of a functional isomer of compound E. (1)

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2.4.2 The structural formula of the functional group of compound B. (1)

2.4.3 The condensed structural formula of the acid that was used to make compound E. (2)

2.4.4 Name of the alcohol used for the preparation of compound E. (1)

2.4.5 The name of the functional group of compound G. (1)

2.4.6 The homologous series to which compound H belongs. (1)

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!UESTION 3

Five carboxylic acids represented by the letters **A** to **E** are listed in the table below.

A	Butanoic acid	**D**	3-methylpentanoic acid
B	Hexanoic acid	**E**	2,2-dimethylbutanoic acid
C	Octanoic acid		

Learners conduct an investigation to compare the boiling points of the first three carboxylic acids (A, B and C) in the table above.

3.1.1 Define the term "boiling point". (2)

3.1.2 Name one MAIN item of apparatus they used in their investigation. (1)

State for this investigation:

3.2.1 The independent variable. (1)

3.2.2 The dependent variable. (1)

3.2.3 A suitable hypothesis. (2)

The boiling point of compound B is higher than the boiling point of compound A. Which intermolecular force(s) is/are responsible this difference? (2)

Which one of D or E has the higher vapour pressure at room temperature? (1)

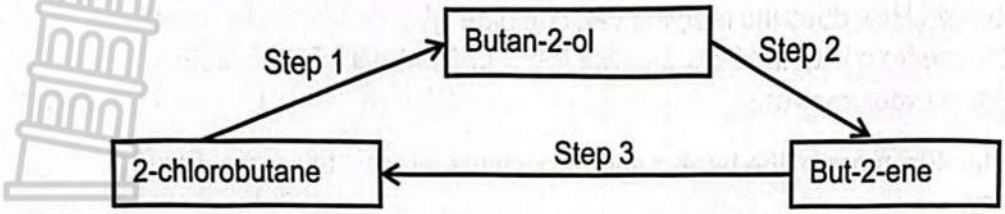
Refer to the intermolecular forces in D and E to explain your answer in 3.4 (3)

[13]

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QUESTION 4

Under the appropriate reaction conditions, 2-chlorobutane can be converted to but-2-ene and but-2-ene can be converted back to 2-chorobutane. The flow diagram below illustrates a method to do this.



4.1 Is 2-chlorobutane a PRIMARY, SECONDARY or TERTIARY haloalkane? Give a reason for your answer. (3)

4.2 Name the type of reaction taking place in Step 1. (2)

4.3 Use condensed structural formulae to write a balanced chemical equation for the reaction taking place in Step 2. (3)

4.4 Write down the reaction conditions for Step 1. (2)

4.5 Write down the NAME and FORMULA of an acid catalyst that can be used in the Step 2. (2)

4.6 Write down the type of addition reaction that takes place in step 3. (1)

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QUESTION 5

When excess dilute HCℓ is used to dissolve 1,00 g of powdered $CaCO_3(s)$ in a beaker in an experiment on reaction rate, the following reaction takes place:

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

The results obtained are summarised in the table below:

Mass of beaker, HCℓ and $CaCO_3(s)$ (g)	31,0	30,60	30,3	30,1	30,0	30,0
Time (s)	0	10	20	30	40	50

5.1 Define the term 'limiting reagent'. (2)

5.2 The "excess HCℓ" does not influence the results. Give a reason for this. (1)

5.3 Calculate the amount of $CaCO_3(s)$ that was used up in the first 10s of the reaction in moles. (3)

5.4 Write down the amount of $CaC\ell_2(s)$ that was produced in the first 10s of the reaction. (1)

5.5 Use your answer in 5.3 to calculate the rate of the reaction in the first 10s in $mol.s^{-1}$. (3)

5.6 Calculate the volume of $CO_2(g)$ that was collected at STP in this experiment. (4)

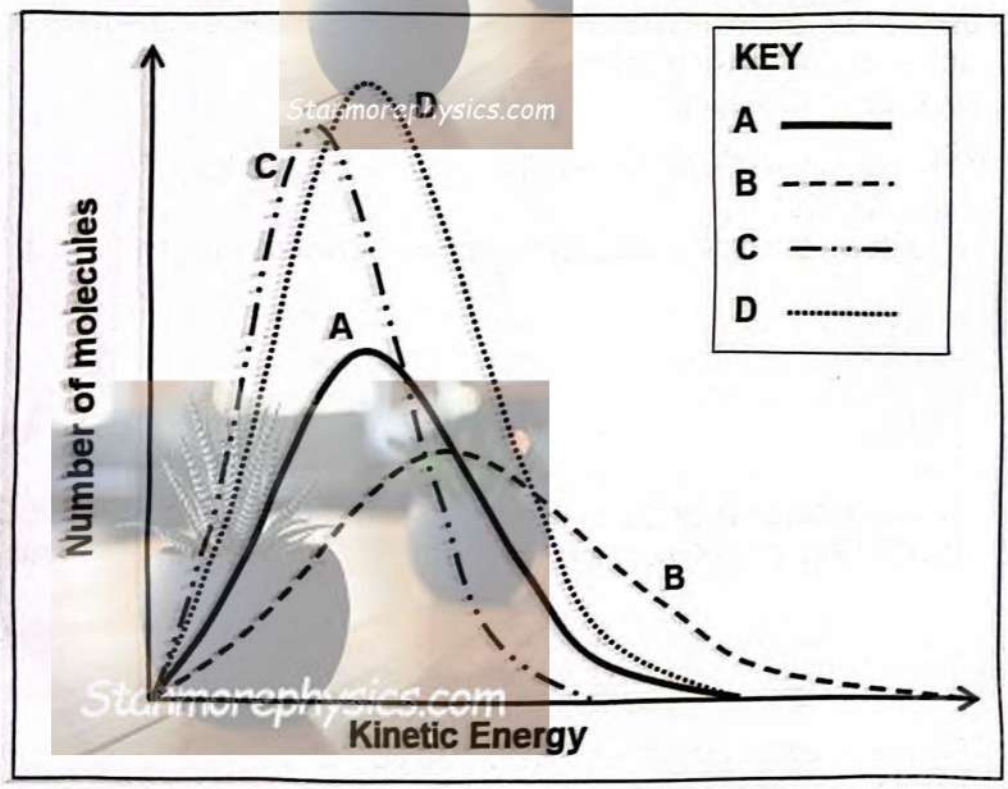
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When the dilute HCℓ is replaced by concentrated HCℓ, the rate of the reaction between HCℓ and $CaCO_3$ increases. Use the collision theory to explain this observation. (3)

The same experiment was repeated using $CaCO_3$ granules instead of powder. How does the reaction rate compare with the first experiment? Choose from INCREASES, DECREASES or REMAINS THE SAME. Explain your answer. (3)

After 40s, mass of the beaker and its contents remains the same. Explain why. (1)

The Maxwell-Boltzmann curve labelled **A** shows the distribution of molecular energies in **0,4 mol** of nitrogen gas (N_2) at STP.



10.1 Which of the curves **B, C** or **D** represents 0,4 mol of nitrogen gas at a **lower** temperature? (1)

10.2 Which of curves **B, C** or **D** represents **0,8 mol** of nitrogen gas at STP? (1)

10.3 Explain your answer to 5.10.2 above. (3)

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QUESTION 6

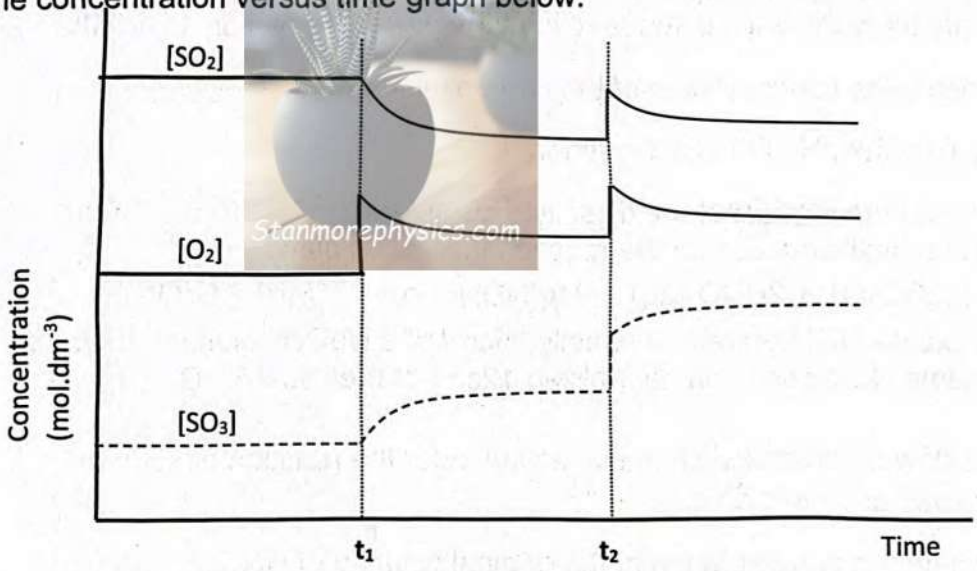
6.1 x moles of $SO_2(g)$ and 40g of $O_2(g)$ are injected into a 500cm^3 container at 450°C. The container is then sealed and the following equilibrium is established:

$$2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g) \qquad \Delta H = -198 \text{ kJ}$$

An analysis of the reaction mixture showed that the concentration of $O_2(g)$ at equilibrium was 1,5 mol.dm^{-3}. The K_c value for this reaction at 450^{0}C is 42,67.

Calculate the initial number of moles (x) of SO_2. (8)

Changes are made to the equilibrium at times t_1 and t_2 respectively, as shown in the concentration versus time graph below.



6.2 Identify the change that was made to the equilibrium at:

6.2.1 t_1 (2)

6.2.2 t_2 (2)

6.2.3 Give an explanation for your answer in Question 6.2.2 using Le Chatelier's principle. (4)

6.3 Potassium dichromate is a salt that dissolves in water to establish the following equilibrium.

$$Cr_2O_7^{2-} + H_2O \rightleftharpoons 2CrO_4^{2-} + 2H^+$$

Orange Yellow

6.3.1 Explain what is meant by the term 'closed system' as applied to chemical equilibrium. (2)

6.3.2 Sodium hydroxide is added to the orange solution. What observation is made upon this addition? (1)

6.3.3 Explain your answer to Question 6.3.2 using Le Chatelier's principle. (3)

[22]

QUESTION 7

Define an acid according to the Lowry Bronsted theory. (2)

3,65 g of HCℓ(g) are dissolved in 200 cm^3 of distilled water to prepare an acidic solution. The final temperature of the mixture is 25°C. The balanced equation for the reaction taking place is:

$$HC\ell + H_2O \rightarrow C\ell^- + H_3O^+$$

7.2.1 Write down the conjugate acid-base pairs in this reaction. (2)

7.2.2 Define an ampholyte. (2)

7.2.3 Write down the formula of a substance in the reaction given above, which can act as an ampholyte. (1)

7.2.4 Identify the substance in the reaction that gives the solution its acidity. (1)

7.2.5 Calculate the concentration of the HCℓ solution prepared. (3)

7.2.6 Calculate the pH of the HCℓ solution. (3)

1,68g of pure $MgCO_3(s)$ are dissolved completely in 39cm^3 of HNO_3. The chemical equation for the reaction that takes place is:

$$MgCO_3(s) + 2HNO_3(aq) \rightarrow Mg(NO_3)_2(aq) + CO_2(g) + H_2O(\ell)$$

The excess HCℓ neutralizes exactly 25cm^3 of a NaOH solution. 15cm^3 of the same NaOH solution neutralized 12cm^3 of the initial HNO_3.

7.3.1 Write down a balanced chemical equation for the reaction of sodium hydroxide and nitric acid. (3)

7.3.2 Calculate the concentration of the original solution of HNO_3. (10)

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GRAND TOTAL = [150]

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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

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TABLE 2: FORMULAE/*TABEL 2: FORMULES*

$n = \frac{m}{M}$	$c = \frac{n}{V}$
$c = \frac{m}{MV}$	$E^\theta_{cell} = E^\theta_{cathode} - E^\theta_{anode}$ / $E^\theta_{sel} = E^\theta_{katode} - E^\theta_{anode}$
	$E^\theta_{cell} = E^\theta_{reduction} - E^\theta_{oxidation}$ / $E^\theta_{sel} = E^\theta_{reduksie} - E^\theta_{oksidasie}$
	$E^\theta_{cell} = E^\theta_{oxidising\ agent} - E^\theta_{reducing\ agent}$ / $E^\theta_{sel} = E^\theta_{oksideermiddel} - E^\theta_{reduseermiddel}$

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

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

Ce 140	**Pr** 141	**Nd** 144	**Pm**	**Sm** 150	**Eu** 152	**Gd** 157	**Tb** 159	**Dy** 163	**Ho** 165	**Er** 167	**Tm** 169	**Yb** 173	**Lu** 175
Th 232	**Pa**	**U** 238	**Np**	**Pu**	**Am**	**Cm**	**Bk**	**Cf**	**Es**	**Fm**	**Md**	**No**	**Lr**

KEY/*SLEUTEL*

Atomic number *Atoomgetal*

Electronegativity *Elektronegatiwiteit* → 29 Cu 63,5 ← Symbol *Simbool*

Approximate relative atomic mass *Benaderde relatiewe atoommassa*

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