GAUTENG PROVINCE
EDUCATION
REPUBLIC OF SOUTH AFRICA

JUNE EXAMINATION
GRADE 12
2026

PHYSICAL SCIENCES: CHEMISTRY

(PAPER 2)

PHYSICAL SCIENCES P2

C2842E

TIME: 3 hours

MARKS: 150

14 pages + 2 data sheets

X05

INSTRUCTIONS AND INFORMATION

1. This question paper consists of SEVEN questions. Answer ALL the questions in the ANSWER BOOK.
2. Start EACH question on a NEW page in the ANSWER BOOK.
3. Number the answers correctly according to the numbering system used in the question paper.
4. Leave ONE line open between subquestions, e.g., between QUESTION 2.1 and QUESTION 2.2.
5. You may use a non-programmable calculator.
6. You may use appropriate mathematical instruments.
7. Show ALL formulae and substitutions in ALL calculations.
8. Round-off your FINAL numerical answers to a minimum of TWO decimal places.
9. Provide brief discussions, etc. where required.
10. You are advised to use the attached DATA SHEETS.
11. Write neatly and legibly.

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QUESTION 1: MULTIPLE-CHOICE QUESTIONS

Various 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 numbers (1.1 to 1.10) in the ANSWER BOOK, e.g. 1.11 E.

1.1 Which of the following is an example of an unsaturated hydrocarbon?

A $C_2HC\ell_3$
B C_4H_8
C C_3H_8
D C_3H_7OH (2)

1.2 A compound with the molecular formula $C_6H_{12}O$ could be either of the following:

i. An ester
ii. A ketone
iii. An aldehyde

A (i) only
B (i) and (ii) only
C (ii) and (iii) only
D (i), (ii) and (iii) (2)

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1.3 The equation below represents the cracking of a long hydrocarbon chain.

$$C_7H_{16} \rightarrow C_5H_{10} + X$$

Which of the following represents compound X?

A Ethanol
B Ethyne
C Ethene
D Ethane (2)

1.4 Give the IUPAC name of the organic compound below.

$CH_3CH_2CH(C_2H_5)CH(CH_3)CH(CH_3)CH_2CH_3$

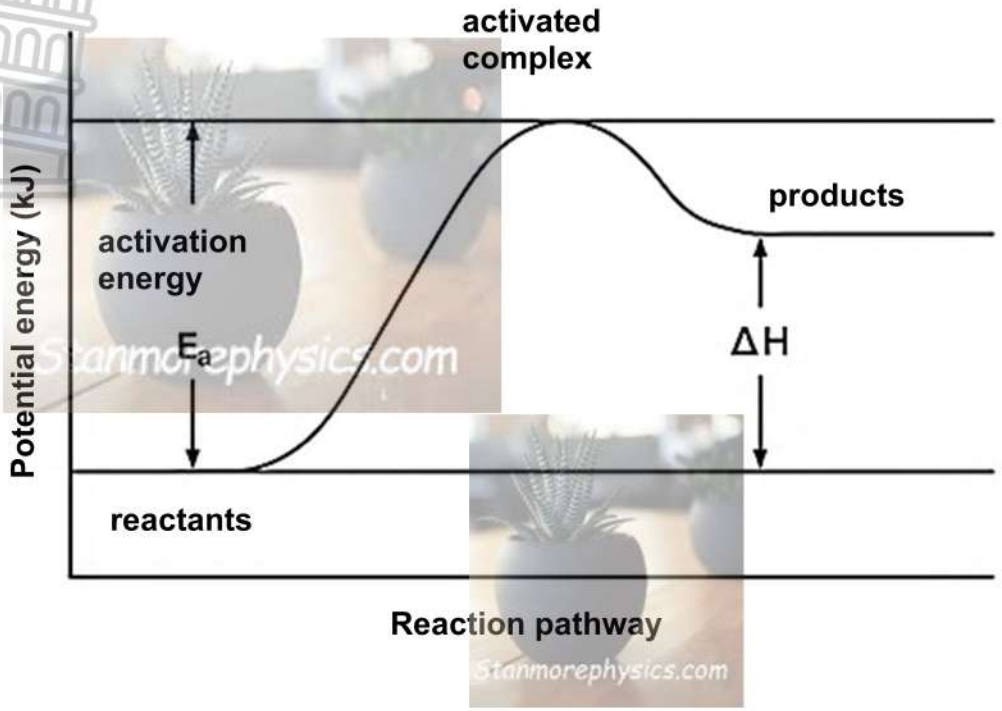
A 4-ethyl-2,3-dimethylheptane
B 3-ethyl-4,5-dimethylheptane
C 4-ethyl-5,6-dimethylheptane
D 2,3-dimethyl-4-ethylheptane (2)

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1.5 Which of the following compounds has the strongest Van der Waals forces?

A $CH_3(CH_2)_2CH_3$
B $CH_3COCH_2CH_3$
C $CH_3COOCH_2CH_3$
D $CH_3CH(OH)CH_2CH_3$ (2)

1.6 The diagram below shows the energy profile of an endothermic reaction.



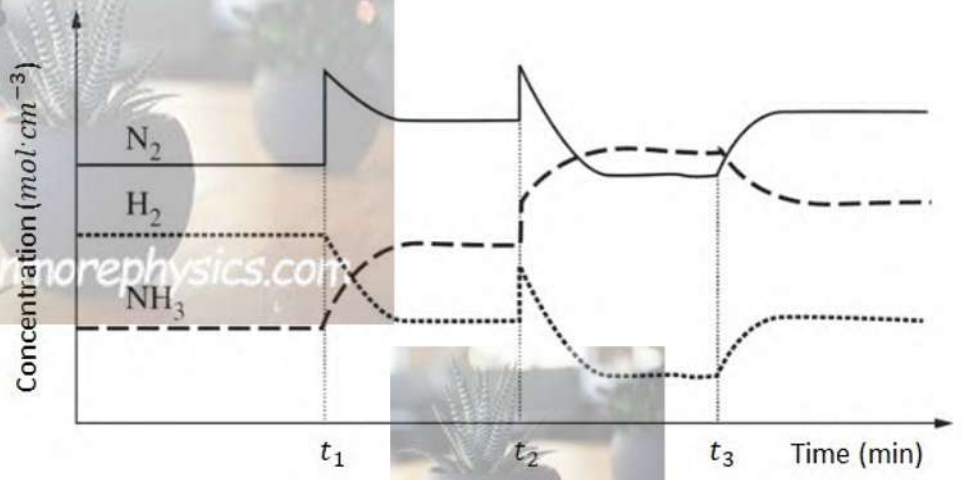
Which of the following correctly describes the effect of a CATALYST on the activation energy, and the enthalpy change for the reverse reaction?

	ACTIVATION ENERGY	ENTHALPY CHANGE
A	Increases	Positive
B	Decreases	Negative
C	Decreases	Remains unchanged
D	Increases	Remains unchanged

(2)

1.7 The graph below shows the concentrations of N_2, H_2, and NH_3 against time for the reaction:

$$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g) \qquad \Delta H = -93\ kJ \cdot mol^{-1}$$



Which is the CORRECT representation for each time in the graph?

	t_1	t_2	t_3
A	$[NH_3]$ is increased	Pressure is decreased	Temperature is decreased
B	$[N_2]$ is increased	Pressure is increased	Temperature is increased
C	$[NH_3]$ is decreased	Temperature is increased	Pressure is increased
D	$[N_2]$ is increased	Temperature is decreased	Pressure is decreased

(2)

1.8 The reaction between sodium and oxygen is:

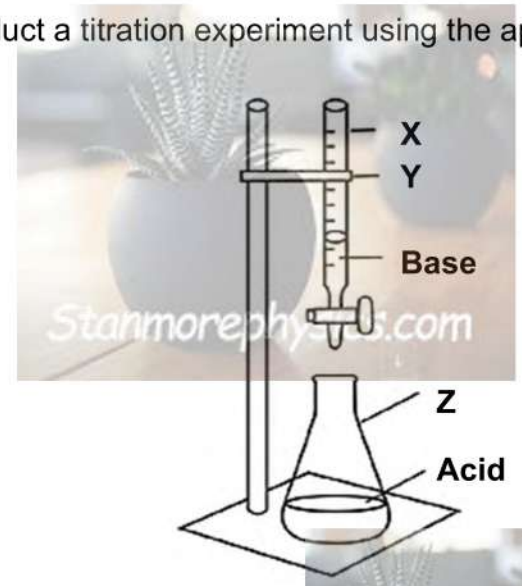
$$2Na(s) + O_2(g) \rightarrow 2Na_2O(s) \qquad \Delta H = -418{,}8\ kJ \cdot mol^{-1}$$

If the equilibrium concentration of $O_2(g)$ at 25°C is equal to Y $mol \cdot dm^{-3}$, the value of the equilibrium constant at this temperature will be equal to:

A	$\frac{1}{[Y]}$
B	$\frac{1}{[Y]^2}$
C	$[Y]^2$
D	Y

(2)

1.9 Learners conduct a titration experiment using the apparatus below.



The correct labels for **X**, **Y**, and **Z** are …

	X	Y	Z
A	Burette	Tripod stand	Beaker
B	Pipette	Tripod stand	Conical flask
C	Pipette	Retort stand	Beaker
D	Burette	Retort stand	Conical flask

(2)

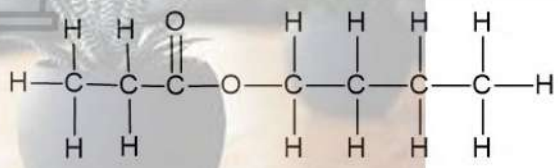
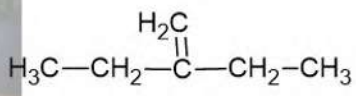
1.10 According to the Lowry-Brønsted theory, a base …

A is a proton donor.
B is a proton acceptor.
C produces hydroxide ions in an aqueous solution.
D produces hydrogen ions in an aqueous solution. (2)

[20]

QUESTION 2 (Start on a new page.)

The letters **A** to **H** in the table below represent organic compounds.

A	Propanoic acid	**B**	$CH_3CH(CH_3)CH_2CH_2COCH_3$
C		**D**	$CH_3CH_2CH_2CH_2CH_2COOH$
E	$CH_3CHBrCH_2CH_2CH(CH_3)CH_3$	**F**	$C_7H_{14}O$
G	$CH_3(CH_2)_4CH_3$	**H**	

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

2.2 What is the name of the functional group of the homologous series to which compound **A** belongs? (1)

2.3 Using the table above, write down the letter that represents each of the following:

2.3.1 An aldehyde (1)

2.3.2 An ester (1)

2.3.3 An unsaturated hydrocarbon (1)

2.3.4 A chain isomer of 2,2-dimethylbutane (1)

2.4 Write down the IUPAC name of:

2.4.1 Compound **C** (2)

2.4.2 Compound **E** (2)

2.5 Compound **D** reacts with a primary alcohol containing four carbon atoms in the presence of a catalyst.

Write down the:

2.5.1 Name of the catalyst (1)

2.5.2 Type of reaction (1)

2.5.3 Name AND formula of the inorganic product that is formed (2)

2.6 Compounds **B** and **F** are isomers.

2.6.1 Define the term *structural isomers*. (2)

2.6.2 Identify the type of isomers. Write only CHAIN, POSITIONAL or FUNCTIONAL. (1)

2.6.3 Write down the structural formula of compound **F**. (2)

2.7 Write down the empirical formula of compound **G**. (2)

2.8 Give the general formula of compound **H**. (1)

2.9 Compound **G** undergoes complete combustion. Using molecular formulae, write down the balanced equation for this reaction. (3)

[26]

QUESTION 3 (Start on a new page.)

The melting points of five organic compounds with known molar masses were determined during a practical investigation. The results are recorded in the table below.

	COMPOUND	MOLAR MASS ($g \cdot mol^{-1}$)	MELTING POINT ($^{\circ}C$)
P	$CH_3CH_2CH_3$	44	-188
Q	$CH_3CH_2CH_2CH_3$	58	-138
R	$CH_3CH_2CH_2CH_2CH_3$	72	-130
S	$CH_3CH(CH_3)CH_2CH_3$	72	-160
T	$CH_3C(CH_3)_2CH_3$	72	-16

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

3.2 For compounds **P, Q** and **R**, write down:

3.2.1 The dependent variable (1)

3.2.2 The controlled variable (1)

3.2.3 An investigative question (2)

3.2.4 An explanation for the trend of the melting points of these compounds. (3)

3.3 Consider compound **R** and compound **S**.

3.3.1 Which compound will have a higher boiling point? (1)

3.3.2 Which compound will have a lower vapour pressure? (1)

3.3.3 Explain the answer to QUESTION 3.3.1. (3)

3.4 Consider compound **T:**

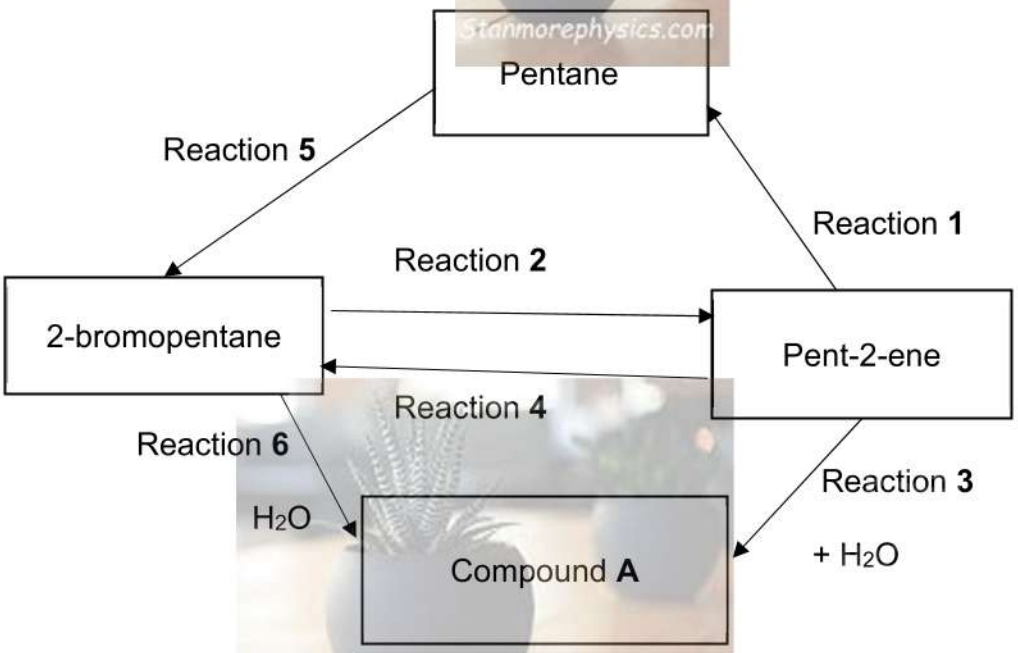
3.4.1 To which homologous series does this compound belong? (1)

3.4.2 Write down the IUPAC name of this compound. (2)

[17]

QUESTION 4 (Start on a new page.)

The flow diagram below represents 6 different organic reactions undergone by various organic compounds.



4.1 Name the TYPE of addition reaction that takes place at:

4.1.1 Reaction **1** (1)

4.1.2 Reaction **3** (1)

4.1.3 Reaction **4** (1)

4.2 For reaction **2**, write down the:

4.2.1 Type of reaction that takes place (1)

4.2.2 Two reaction conditions required (2)

4.2.3 Balanced chemical equation using STRUCTURAL FORMULAE (5)

4.3 Consider reaction **3**.

4.3.1 To which homologous series does compound **A** belong? (1)

4.3.2 Write down the structural formula of compound **A**. (2)

4.3.3 Write down the IUPAC name of compound **A**. (2)

4.4 Write down a balanced chemical equation for reaction **4** using condensed structural formulae. (4)

4.5 Name the type of reaction represented by reaction **5**. (1)

4.6 Consider reaction **6**.

4.6.1 Identify the type of substitution reaction. (1)

4.6.2 Suggest an alternative reactant if water is not available. (1)
[23]

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QUESTION 5 (Start on a new page.)

When chromium metal is added to hydrochloric acid, it undergoes a reaction that produces a characteristic green solution of chromium(III)chloride, as well as hydrogen gas.

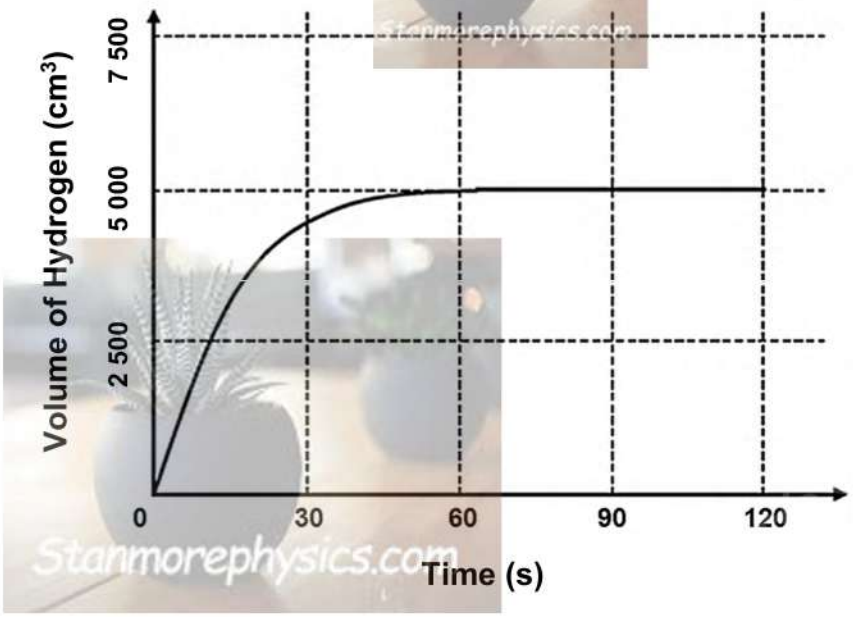
The balanced equation can be represented as follows:

$$2Cr(s) + 6HC\ell(aq) \rightarrow 2CrC\ell_3(aq) + 3H_2(g) \qquad \Delta H<0$$

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

5.2 Name TWO experimental methods that could be used to measure the rate of this reaction in a school laboratory. (2)

5.3 In the experiment, 8,67 g of powdered chromium metal was added to excess hydrochloric acid in a flask. The reaction produced hydrogen gas, which was collected at STP. The volume of hydrogen gas formed was measured at regular time intervals, and the results were used to plot the graph shown below.



5.3.1 Calculate the average rate (in $dm^3 \cdot s^{-1}$) of the above reaction for the first 60 s. (4)

5.3.2 Calculate the mass of hydrogen gas produced. (4)

5.3.3 Calculate the percentage yield of hydrogen gas in this reaction. (5)

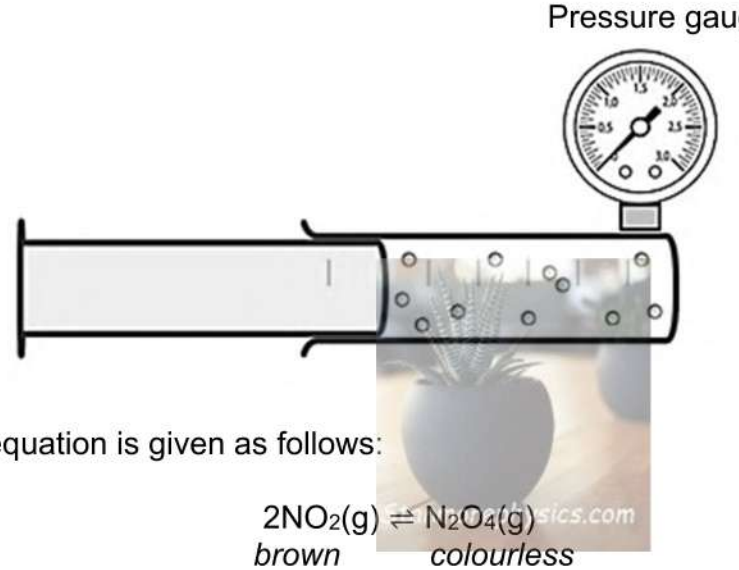
5.3.4 If a LUMP of chromium is used, how will this affect the rate of the reaction? Choose from INCREASE, DECREASE or REMAIN THE SAME. (1)

5.3.5 Use the collision theory to fully explain the answer to QUESTION 5.3.4. (3)

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QUESTION 6 (Start on a new page.)

The equilibrium mixture of nitrogen dioxide (NO_2), a brown gas with a sharp, pungent smell, and colourless dinitrogen tetroxide (N_2O_4) is investigated using a sealed industrial gas syringe. This colour change allows the progress of the equilibrium to be observed visually.



The balanced equation is given as follows:

$$2NO_2(g) \rightleftharpoons N_2O_4(g)$$
brown *colourless*

6.1 State *Le Chatelier's principle*. (2)

6.2 Is the system above OPEN or CLOSED? Give a reason for the answer. (2)

6.3 How will EACH of the following changes affect the concentration of $N_2O_4(g)$ at equilibrium?

Choose from INCREASES, DECREASES or REMAINS THE SAME.

6.3.1 The plunger is pressed to decrease the volume. (1)

6.3.2 A catalyst is added. (1)

6.4 The syringe is now placed into a water bath filled with ice cubes. The gas in the syringe starts to turn colourless.

6.4.1 Is the forward reaction ENDOTHERMIC or EXOTHERMIC? (1)

6.4.2 Using Le Chatelier's principle, explain the answer to QUESTION 6.4.1. (3)

6.5 The sealed industrial gas syringe is removed from the water bath and allowed to reach equilibrium at 298 K. At equilibrium, the mixture contains 0,52 moles of NO_2 and 0,08 moles of N_2O_4. The volume of the syringe is 1 000 cm³.

The syringe is then placed in a hot water bath at 373 K. A new equilibrium is established at which point the mixture contains 8,28 g of N_2O_4.

Calculate the:

6.5.1 Number of moles of N_2O_4 at the new equilibrium (3)

6.5.2 Value of the equilibrium constant, K_c, at this temperature (7)

[20]

QUESTION 7 (Start on a new page.)

Hydrochloric acid (HCℓ) is a strong acid. It dissolves in water, as shown in the equation below:

$$HC\ell\,(aq) + H_2O(\ell) \rightleftharpoons H_3O^+(aq) + C\ell^-(aq)$$

7.1 Explain what is meant by the term *strong acid*. (2)

7.2 Identify ONE conjugate acid-base pair. (2)

7.3 Hydrochloric acid is a monoprotic acid. Give a reason for this. (1)

7.4 A 150 cm^3 hydrochloric acid, HCℓ(aq), solution with a concentration of 0,8 $mol \cdot dm^{-3}$ is available for laboratory experiments.

7.4.1 Calculate the number of moles of hydrochloric acid in this solution. (3)

All of the 150 cm^3 hydrochloric acid solution, HCℓ(aq), is allowed to react with **X** g of calcium carbonate, $CaCO_3(s)$, according to the balanced chemical equation:

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

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The hydrochloric acid solution is found to be in excess.

The excess hydrochloric acid, HCℓ(aq), is neutralised by a 60 cm^3 sodium hydroxide, NaOH(aq), solution with a concentration of 0,5 $mol \cdot dm^{-3}$.

The neutralisation reaction is as shown below:

$$NaOH(aq) + HC\ell(aq) \rightarrow NaC\ell(aq) + H_2O(\ell)$$

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7.4.2 Calculate the value of **X**. (7)

7.4.3 Will the salt that is formed in the neutralisation reaction undergo hydrolysis? Give a reason for the answer. (2)

7.4.4 Bromothymol blue is used as the indicator. Explain why it is the most suitable indicator for this titration by referring to the pH at the equivalence point. (2)

7.5 In aqueous solutions, the concentrations of hydronium ions and hydroxide ions determine the acidity or alkalinity of a solution.

Calculate the pH of potassium hydroxide, KOH(aq), solution with concentration of $2,5 \times 10^{-7}$ $mol \cdot dm^{-3}$ at a temperature of 298 K. (4)

[23]

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}

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

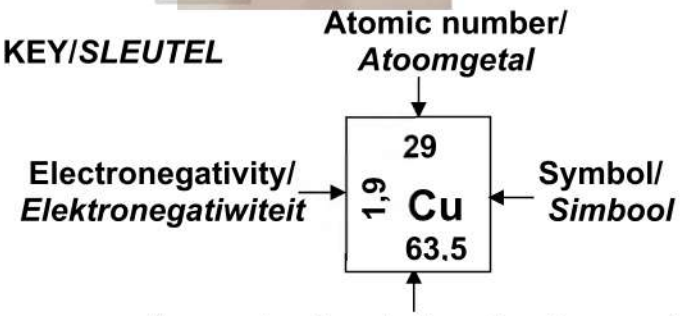
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TABLE 3: THE PERIODIC TABLE OF ELEMENTS/*TABEL 3: DIE PERIODIEKE TABEL VAN ELEMENTE*

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

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

KEY/*SLEUTEL*



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