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NATIONAL SENIOR CERTIFICATE

GRADE 12

JUNE 2026

PHYSICAL SCIENCES: (CHEMISTRY) P2

MARKS: **150**

TIME: **3 hours**

This question paper consists of 17 pages, including 2 data sheets.

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INSTRUCTIONS AND INFORMATION

1. Write your NAME and SURNAME in the appropriate space on the ANSWER BOOK.

2. This question paper consists of SEVEN questions. Answer ALL the questions in the ANSWER BOOK.

3. Start EACH question on a NEW page in the ANSWER BOOK.

4. Number the answers correctly according to the numbering system used in this question paper.

5. Leave ONE line between two subquestions, e.g. between QUESTION 2.1 and QUESTION 2.2.

6. You may use a non-programmable calculator.

7. You may use appropriate mathematical instruments.

8. Show ALL formulae and substitutions in ALL calculations.

9. Round off your FINAL numerical answers to a minimum of TWO decimal places.

10. Give brief motivations, discussions, etc. where required.

11. You are advised to use the attached DATA SHEETS.

12. 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 (1.1–1.10) in the ANSWER BOOK, e.g. 1.11 E.

1.1 Which ONE of the following combinations are correct regarding molecules from the same homologous series?

They have the same …

A molecular formula and functional group.

B general formula but different functional groups.

C functional group but different general formula.

D functional group and differ from each other by -CH_2- group. (2)

1.2 Which ONE of the following names is a possible name for an organic compound with the molecular formula $C_5H_{10}O$?

A Pentan-1-ol

B 2,2-dimethylpropanal

C 4-methylpentan-2-one

D Pentanoic acid (2)

1.3 Which ONE of the following compounds will have the highest boiling point?

A Butane

B 2-methylpropane

C Butan-1-ol

D Butanal (2)

1.4 Hydrogen gas (H_2) is passes through propene in the presence of platinum (Pt). The name for this reaction is …

A halogenation.

B hydrogenation.

C hydration.

D hydrohalogenation. (2)

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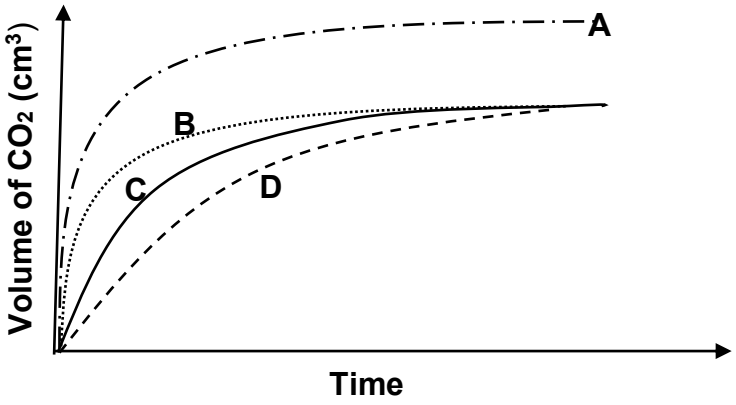
1.5 The reaction between sodium carbonate (Na_2CO_3) and EXCESS hydrochloric acid ($HC\ell$) is used to determine the factors that influences the reaction rate. The balanced equation for the reaction is:

$$Na_2CO_3\,(aq) + 2\,HC\ell\,(aq) \rightarrow 2\,NaC\ell\,(aq) + H_2O\,(\ell) + CO_2\,(g)$$

The reaction conditions used for four experiments is summarised in the table below.

EXP.	Mass of Na_2CO_3 (g)	Concentration of $HC\ell$ ($mol{\cdot}dm^{-3}$)	Initial Temperature (°C)
1	15	1	30
2	15	0,5	30
3	15	1	40
4	25	2	40

Which ONE of the graphs below represent the results for experiment **2**?



(2)

1.6 The following system reaches equilibrium in a closed container.

$$2\,H_2S\,(g) \rightleftharpoons 2\,H_2\,(g) + S_2\,(g) \qquad \Delta H > 0$$

Which ONE of the following changes will increase the amount of H_2 (g) in the container?

A Cool the container

B Remove S_2 (g)

C Decrease the volume of the container

D Add a catalyst

(2)

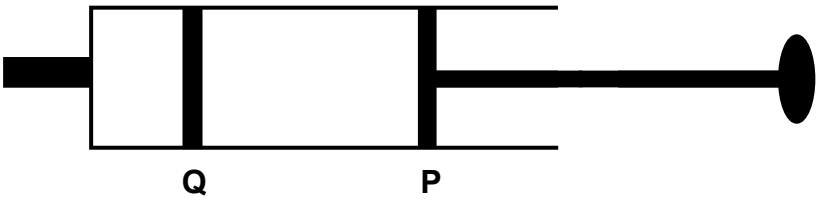
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1.7 $PC\ell_5$ (g) is sealed in a gas syringe. The $PC\ell_5$ (g) decomposes according to the balanced equation:

$$PC\ell_5\ (g) \rightleftharpoons PC\ell_3\ (g) + C\ell_2\ (g)$$

The plunger is currently at point **P**.



What will happen to the CONCENTRATION OF $PC\ell_3$ and the EQUILIBRIUM CONSTANT, Kc-VALUE if the plunger is pushed to position **Q**?

	[$PC\ell_3$]	**Equilibrium constant, Kc-value**
A	INCREASES	DECREASES
B	DECREASES	INCREASES
C	INCREASES	REMAINS THE SAME
D	DECREASES	REMAINS THE SAME

(2)

1.8 Consider the following equation:

$$(COOH)_2\ (aq) + 2H_2O\ (\ell) \rightleftharpoons (COO)_2^{2-}\ (aq) + 2H_3O^+\ (aq)$$

The Lowry-Brønsted acids in the above reaction are …

A $(COOH)_2$ and H_2O

B $(COOH)_2$ and H_3O^+

C H_2O and $(COO)_2^{2-}$

D $(COOH)_2$ and $(COO)_2^{2-}$

(2)

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1.9 One mole of NaOH and one mole HNO_3 is added to each other to make 1 dm^3 solution. The balanced equation for the reaction is:

$$NaOH\ (aq) + HNO_3\ (aq) \rightarrow NaNO_3\ (aq) + H_2O\ (\ell)$$

The concentration of the hydronium ion (H_3O^+) in the solution is …

A 7 $mol \cdot dm^{-3}$

B 1 x 10^{-14} $mol \cdot dm^{-3}$

C 0 $mol \cdot dm^{-3}$

D 1 x 10^{-7} $mol \cdot dm^{-3}$ (2)

1.10 If 12,5 cm^3 of sulphuric acid (H_2SO_4) with a concentration of x $mol \cdot dm^{-3}$ neutralises 25 cm^3 of NaOH according to the balanced equation:

$$2\ NaOH\ (aq) + H_2SO_4\ (aq) \rightarrow Na_2SO_4\ (aq) + 2\ H_2O\ (\ell)$$

What will the concentration of the NaOH be in terms of x?

A x $mol \cdot dm^{-3}$

B $2x$ $mol \cdot dm^{-3}$

C $\frac{1}{2}\ x$ $mol \cdot dm^{-3}$

D $3x$ $mol \cdot dm^{-3}$ (2)

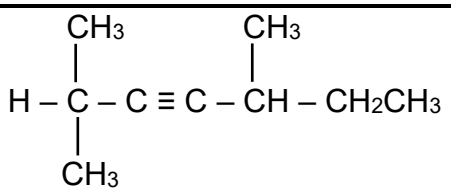
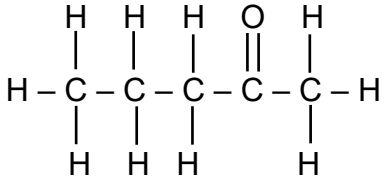
[20]

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QUESTION 2 (Start on a new page.)

The letters **A–D** in the table below represents four organic compounds.

A $CH_3CH_2CH(CH_2CH_3)CH(CH_3)CHO$	**B** 
C Butyl ethanoate	**D** 

2.1 Write down the:

2.1.1 NAME of the FUNCTIONAL GROUP that is in compound **A** (1)

2.1.2 GENERAL FORMULA of the homologous series to which compound **C** belong (1)

2.2 Is compound **B** a SATURATED or UNSATURATED hydrocarbon?

Give a reason for the answer. (2)

2.3 Write down the IUPAC name of:

2.3.1 Compound **A** (3)

2.3.2 Compound **B** (2)

2.4 Draw the STRUCTURAL FORMULA of compound **C**. (2)

2.5 Compound **D** has three STRUCTURAL ISOMERS.

2.5.1 Give the IUPAC name of its STRAIGHT CHAIN FUNCTIONAL ISOMER. (2)

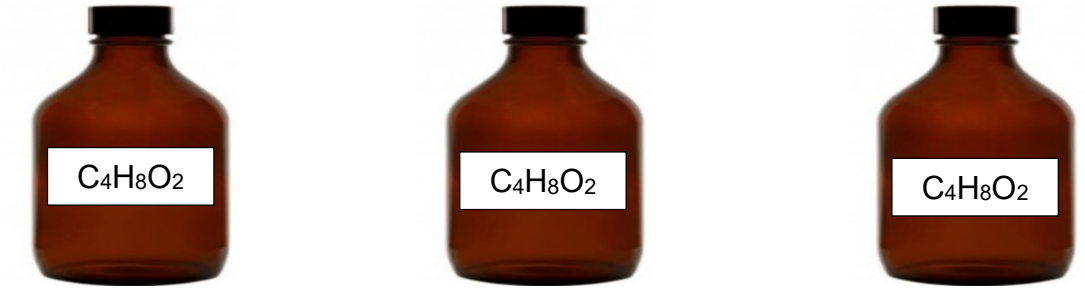
2.5.2 Draw the CONDENSED STRUCTURAL FORMULA of its POSITIONAL ISOMER. (2)

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QUESTION 3 (Start on a new page.)

Three bottles containing different organic compounds with the same molecular formula are shown below.



A **B** **C**

A lab technician wants to identify these compounds by determining their boiling points.

3.1 Explain how the technician will be able to identify the compounds through their respective boiling points. (2)

3.2 To which homologous series does the compounds belong to? (2)

3.3 The experimental boiling points for compounds **A–C** are shown in the table below.

COMPOUND	BOILING POINT (°C)
A	155
B	163,5
C	57,1

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

3.3.2 Which compound, **A**, **B** or **C**, will have the lowest vapour pressure?

Give a reason for the answer by referring to the data in the table. (2)

3.3.3 Give the IUPAC name of compound **A**. (2)

3.3.4 Fully explain the answer to QUESTION 3.3.3. (4)

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QUESTION 4 (Start on a new page.)

4.1 Consider the equations for reactions **I** to **III**.

I	$CH_3CHC(CH_3)CH_3 + H_2O \rightarrow$ Compound **A** **(Major product)**
II	Compound **A** + HBr $\rightarrow$ Compound **B** + H_2O
III	Compound **B** + NaOH $\rightarrow$ Organic compound **C** + **D**

Write down the type of:

4.1.1 Reaction for reaction **I** (1)

4.1.2 Reaction for reaction **II** (1)

4.1.3 Reaction for reaction **III** (1)

4.1.4 Draw the STRUCTURAL FORMULA for compound **A**. (2)

4.1.5 Write down the IUPAC name of compound **B**. (3)

4.1.6 Is NaOH CONCENTRATED or DILUTED in reaction **III**? (1)

4.1.7 Write down the reaction conditions needed to convert compound **C** to $CH_3CHC(CH_3)CH_3$. (2)

4.2 Consider the cracking of decane ($C_{10}H_{22}$) to produce organic compounds **X** and **Y** according to the following equation:

$$C_{10}H_{22} \rightarrow \mathbf{Y} + \mathbf{X}$$

4.2.1 Define the term *cracking*. (2)

Compound **Y** burns in oxygen and the following reaction occurs:

$$2\ \mathbf{Y} + 25\ O_2 \rightarrow 16\ CO_2 + 18\ H_2O$$

4.2.2 Write down ONE reaction condition besides EXCESS oxygen for above reaction. (1)

4.2.3 Determine the IUPAC name of compound **Y**. (3)

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4.2.4 Give a reason why the compound named in QUESTION 4.2.3 can be used as fuel. (1)

Bromine water (Br_2 (aq)) is added to compound **X**.

4.2.5 Write down ONE observation that can be seen in this reaction. (1)

4.2.6 Using STRUCTURAL FORMULAE, write down the balanced equation for the reaction. (5)

[24]

QUESTION 5 (Start on a new page.)

The reaction between magnesium carbonate ($MgCO_3$) and EXCESS hydrochloric acid ($HC\ell$) was used to investigate factors that affect the reaction rate. The balanced equation for the reaction is:

$$2\ HC\ell\ (aq) + MgCO_3\ (s) \rightarrow\ MgC\ell_2\ (aq) + H_2O\ (\ell) + CO_2\ (g)$$

The reaction conditions used and results for each experiment are summarised in the table below.

EXP.	CONCENTRATION $HC\ell$ ($mol{\cdot}dm^{-3}$)	INITIAL TEMPERATURE (°C)	STATE OF DIVISION OF $MgCO_3$	REACTION TIME (s)
1	1,0	25	Whole tablet	46
2	1,0	25	Crushed tablet	40
3	1,5	25	Whole tablet	39
4	2,0	30	Whole tablet	31
5	2,0	27	Whole tablet	35

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

5.2 Is the comparison between experiment **1** and **4** a fair comparison?

Give a reason for the answer. (2)

5.3 Write down the conclusion for the comparison of experiment **1** and **2**. (2)

5.4 Use the collision theory to explain the results when comparing experiment **1** and **3**. (3)

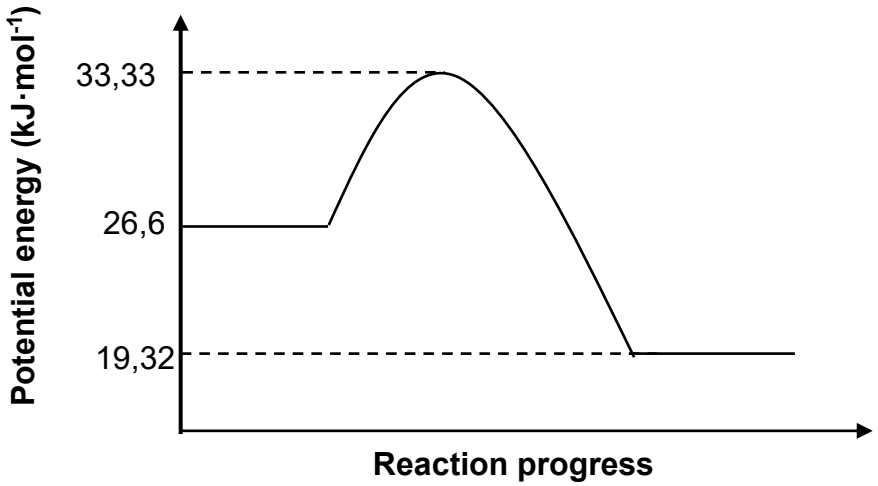
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5.5 Calculate the mass of magnesium carbonate used if the average reaction rate for the CO_2 production in experiment **2** is 1,488 x 10^{-4} mol·s^{-1}**.** (5)

5.6 The graph below shows the changes in potential energy during the decomposition of N_2O_5.

$$2\ N_2O_5\ (g) \rightarrow\ 2\ N_2O_4\ (g) + O_2\ (g)$$

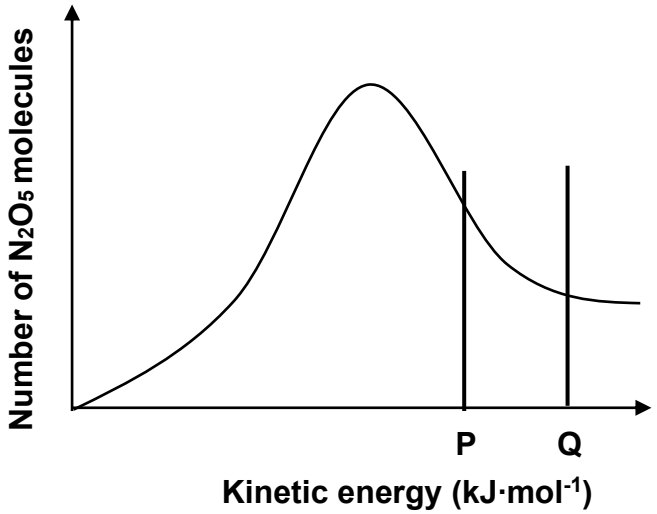


5.6.1 Is energy RELEASED or ABSORBED during this reaction?

Give a reason for the answer. (2)

5.6.2 Determine the activation energy. (2)

The Maxwell-Boltzmann distribution curve for the decomposition of N_2O_5 is shown below. **P** and **Q** represent the energy for a catalysed and uncatalyzed decomposition of N_2O_5.



5.6.3 Which one of, **P** or **Q**, is equal to the value calculated in QUESTION 5.6.2? (1)

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5.6.4 Redraw the distribution curve in the ANSWER BOOK and label this curve as **R**.

On the same set of axes sketch the curve that will be obtained for a higher temperature at which N_2O_5 decomposes. Label the curve as **S**. (2)

5.7 25 cm^3 of N_2O_5 was allowed to decompose. Only 10 cm^3 of O_2 gas was produced. Assume that the temperature and pressure remained constant during this reaction and the reaction occurred in a container that can expand.

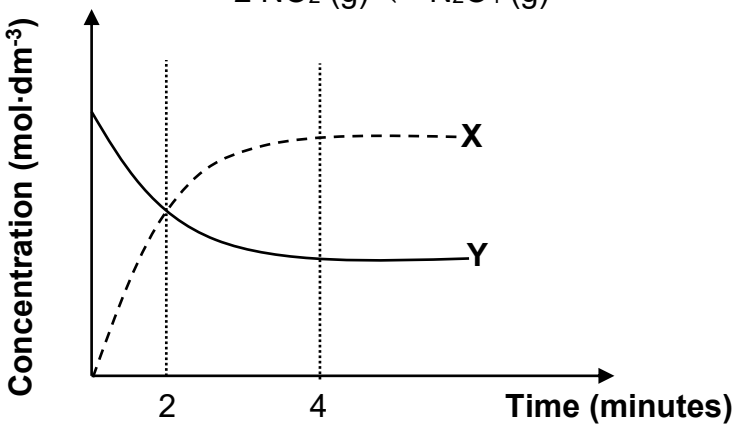
Calculate the volume of N_2O_5 that remain inside the container. (3)

[24]

QUESTION 6 (Start on a new page.)

6.1 Nitrogen dioxide (NO_2) gas is sealed inside an empty container. The graph below shows the changes in concentration for the given reaction that occurred inside the container over time:

$2\ NO_2\ (g) \rightleftharpoons N_2O_4\ (g)$



6.1.1 Explain what is meant by *chemical equilibrium*. (2)

6.1.2 Which one of, **X** or **Y**, represents N_2O_4? (1)

6.1.3 Is the forward reaction PRODUCT FAVOURED or REACTANT FAVOURED?

Give a reason for the answer. (2)

6.1.4 At what time interval, 2 minutes or 4 minutes, is the rate of the forward reaction equal to the rate of reverse reaction?

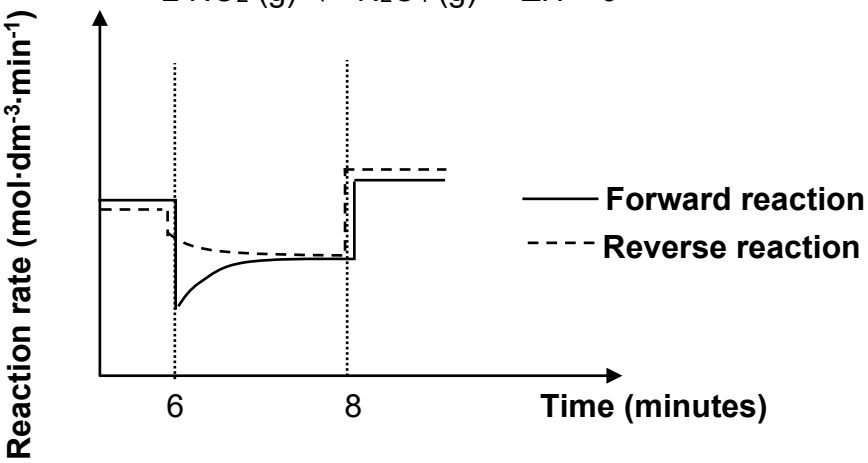
Give a reason for the answer. (2)

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6.2 The graph below shows the rates of the forward and reverse reaction for the following reaction:

$$2\,NO_2\,(g) \rightleftharpoons N_2O_4\,(g) \quad \Delta H < 0$$



6.2.1 What change was made to the equilibrium mixture at 6 minutes? Fully explain the answer. (4)

6.2.2 What change was made at 8 minutes? (1)

6.3 Consider the reversible reaction:

$$N_2\,(g) + O_2\,(g) \rightleftharpoons 2\,NO\,(g)$$

The table below shows the equilibrium constants, K_c-values for this reaction at varies temperatures.

TEMPERATURE	EQUILIBRIUM CONSTANT, K_c-VALUES
298 K	$4,5 \times 10^{-31}$
900 K	$6,5 \times 10^{-10}$
2 300 K	$1,7 \times 10^{-3}$

6.3.1 Define the term *reversible reaction.* (2)

6.3.2 Is the yield HIGH or LOW at 298 K?

Give a reason for the answer. (2)

6.3.3 Is the forward reaction EXOTHERMIC or ENDOTHERMIC?

Fully explain the answer by referring to Le Chatelier's principle. (4)

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6.4 Consider the equilibrium at 25 °C.

$$2\ NOBr\ (g) \rightleftharpoons 2\ NO\ (g) + Br_2\ (g)$$

Initially 0,157 mol of NOBr (g) is sealed in an empty 0,5 dm^3 container. At equilibrium the concentration of Br_2 (g) is 0,0195 $mol \cdot dm^{-3}$.

6.4.1 Calculate the equilibrium constant, K_c-value at 25 °C. (7)

The volume of the container is now doubled.

6.4.2 Will the equilibrium constant, K_c-value INCREASE, DECREASE or REMAIN THE SAME? (1)

[28]

QUESTION 7 (Start on a new page.)

7.1 The pH-values of three acids with a concentration of 0,1 $mol \cdot dm^{-3}$ at 25 °C is shown in the table below:

ACID	pH-VALUE
CH_3COOH	2,88
HNO_3	1,00
$H_2C_2O_4$	2,59

7.1.1 Define a *weak acid*. (2)

7.1.2 Is it fair to compare the strength of HNO_3 to $H_2C_2O_4$ using the pH-values?

Give a reason for the answer. (2)

7.1.3 Which acid, CH_3COOH or HNO_3, will have a higher K_a-value?

Explain the answer. (4)

7.2 $HC_2O_4^-$ is an ampholyte.

7.2.1 Describe the term *ampholyte*. (2)

7.2.2 Is $HC_2O_4^-$ a conjugate base or acid of $H_2C_2O_4$?

Give a reason for the answer. (2)

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7.3 Ammonium chloride ($NH_4C\ell$) is dissolved in water.

7.3.1 What is the name of the reaction between $NH_4C\ell$ and water? (1)

7.3.2 Will the solution be ALKALINE, ACIDIC or NEUTRAL?

Explain the answer by referring to the relevant equation. (4)

7.4 An unknown diprotic acid (H_2A) reacts with sodium hydroxide (NaOH) as shown in the equation below:

$$H_2A\ (aq) + 2\ NaOH\ (aq) \rightarrow\ Na_2A\ (aq) + 2\ H_2O\ (\ell)$$

45 g of the unknown diprotic acid (H_2A) is dissolved to make a 1 dm^3 solution. 25 cm^3 of the unknown diprotic acid (H_2A) is pipetted into an Erlenmeyer flask and phenolphthalein indicator is added.

7.4.1 Wat colour will the solution be if phenolphthalein indicator is added to the unknown diprotic acid? (1)

Sodium hydroxide (NaOH) with a concentration of 0,513 $mol{\cdot}dm^{-3}$ and an average volume of 29,1 cm^3 was used to neutralise the unknown diprotic acid.

The table below shows two possible acids that can be the unknown diprotic acid.

ACID	FORMULA
Tartaric acid	$H_2C_4H_4O_6$
Oxalic acid	$H_2C_2O_4$

7.4.2 Use a suitable calculation to identify the unknown acid from the table. (7)

[25]

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 teen 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 se 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* $c = \frac{m}{MV}$	$n = \frac{V}{V_m}$
$\frac{c_a V_a}{c_b V_b} = \frac{n_a}{n_b}$	$pH = -\log[H_3O^+]$
$K_w = [H_3O^+][OH^-] = 1 \times 10^{-14}$ at/*by* 298 K	

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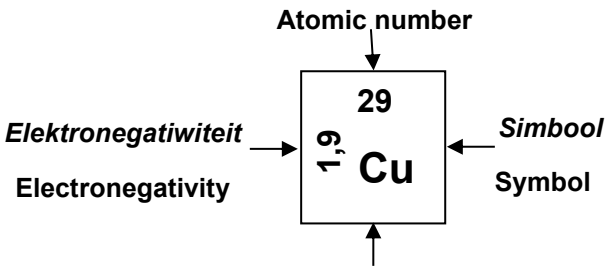
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TABLE 3: THE PERIODIC TABLE OF ELEMENTS/*TABEL 3: DIE PERIODIEKE TABEL VAN ELEMENTE*

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 7	1,5 Be 9											2,0 B 11	2,5 C 12	3,0 N 14	3,5 O 16	4,0 F 19	10 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	18 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	36 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	54 Xe 131
0,7 55 Cs 133	0,9 56 Ba 137	57 La 139	1,6 72 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	1,8 81 Tℓ 204	1,8 82 Pb 207	1,9 83 Bi 209	2,0 84 Po	2,5 85 At	86 Rn
0,7 87 Fr	0,9 88 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

KEY/ *SLEUTEL*



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