



Province of the  
**EASTERN CAPE**  
EDUCATION

**NATIONAL  
SENIOR CERTIFICATE**

**GRADE 12**

**SEPTEMBER 2020**



**PHYSICAL SCIENCES P2  
(CHEMISTRY)**

**MARKS: 150**

**TIME: 3 hours**

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This question paper consists of 16 pages including 2 data sheets.

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**INSTRUCTIONS AND INFORMATION**

1. Write your full NAME and SURNAME in the appropriate spaces 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 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. 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, et cetera where required
11. You are advised to use the attached DATA SHEETS.
12. Write neatly and legibly.

**QUESTION 1: MULTIPLE-CHOICE QUESTIONS**

Various options are provided as possible answers to the following questions. Choose the answer and write only the letter (A–D) next to the question numbers (1.1–1.10) in the ANSWER BOOK, for example 1.11 D.

- 1.1 Which ONE of the following factors will increase the rate of a chemical reaction by offering an alternative path of lower activation energy?
- A Pressure
- B Temperature
- C Surface area
- D Positive catalyst (2)

- 1.2 Structural isomers always have the same ...
- A carbon chain.
- B functional group.
- C molecular formula.
- D physical properties.  (2)

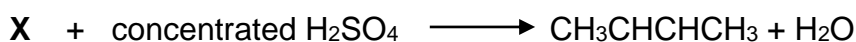
- 1.3 Which ONE of the following has the HIGHEST vapour pressure?
- A Pentane
- B Hexane
- C Heptane
- D Octane (2)

- 1.4 Which ONE of the following is the structural formula for the functional group of ethanoic acid?

A	$\begin{array}{c} \text{O} \\    \\ -\text{C}-\text{O}-\text{H} \end{array}$	B	$-\text{O}-\text{H}$
C	$\begin{array}{c} \text{O} \\    \\ -\text{C}- \end{array}$	D	$\begin{array}{c} \text{O} \\    \\ -\text{C}-\text{H} \end{array}$

 (2)

1.5 Consider the chemical reaction given below:

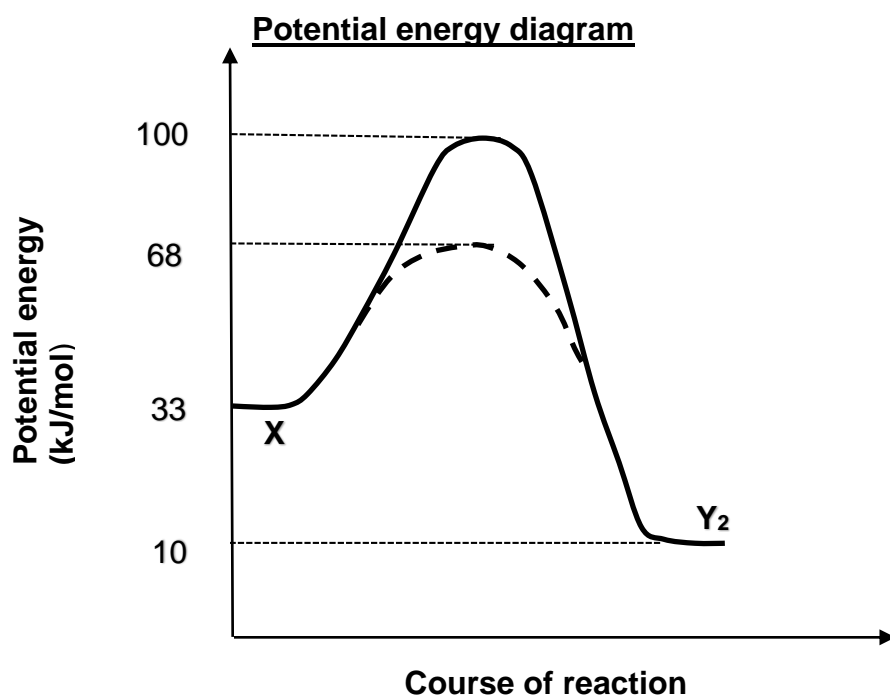
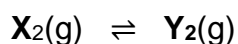


Which ONE of the following is CORRECT about reactant X?

Reactant X is a ...

- A tertiary alcohol.
- B primary alcohol.
- C secondary alcohol.
- D primary haloalkane. (2)

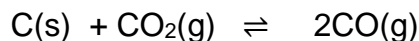
1.6 The potential energy diagram shown below is for the hypothetical reversible reaction shown below.



The value of  $\Delta H$  (in kJ/mol) for the catalysed forward reaction is equal to ...

- A 23
- B -23
- C 58
- D -58 (2)

- 1.7 The reaction represented by the balanced equation below reaches equilibrium in a closed container.



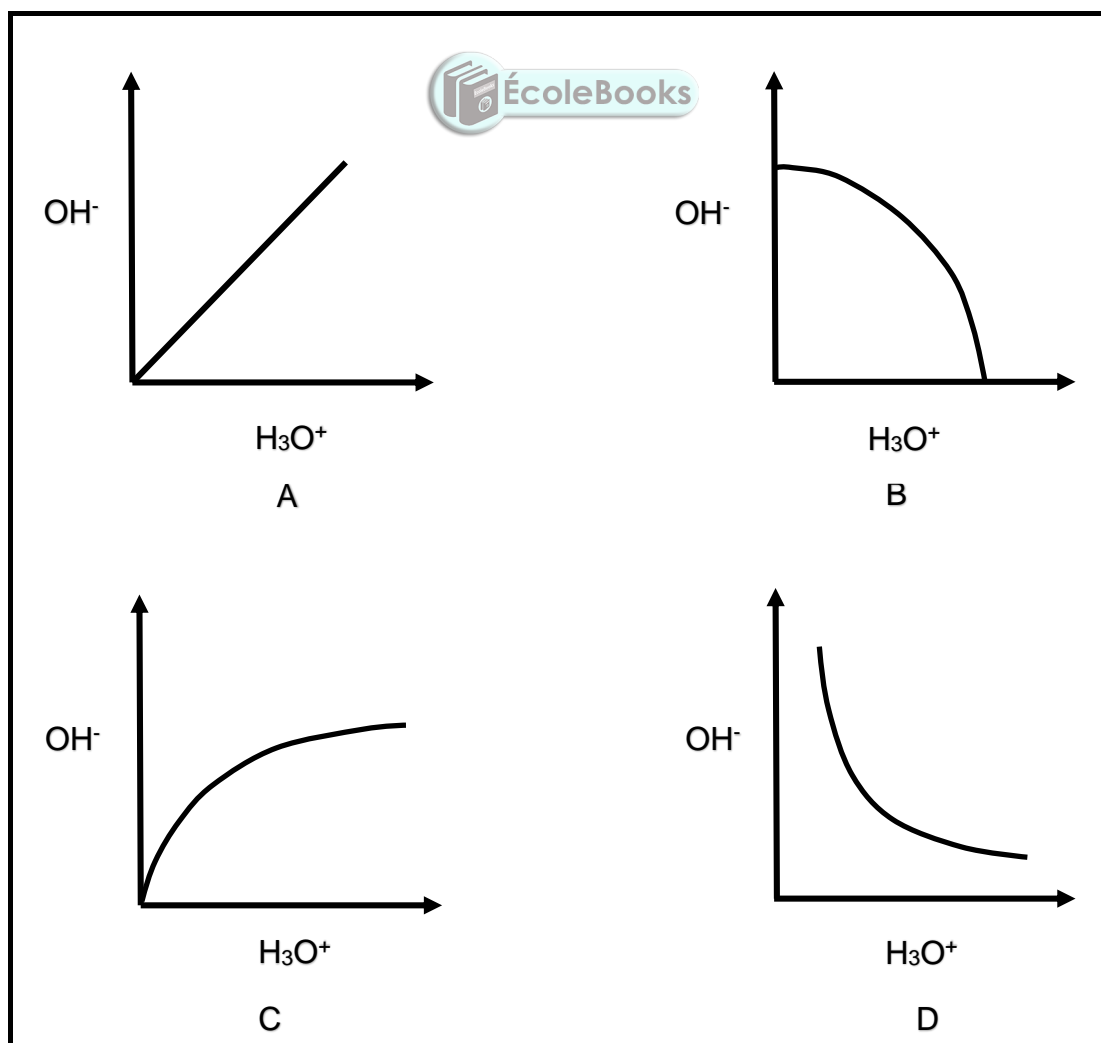
More C(s) and CO<sub>2</sub>(g) are added to the container at constant temperature.

How will the number of moles of CO(g) and the value of K<sub>c</sub> be affected at equilibrium?

	NUMBER OF MOLES OF CO	K <sub>c</sub>
A	Increases	Increases
B	Increases	Remains constant
C	Remains the same	Remains the same
D	Remains the same	Increases

(2)

- 1.8 The relationship between [H<sub>3</sub>O<sup>+</sup>] and [OH<sup>-</sup>] in an aqueous solution at constant temperature is best represented by ...



(2)

- 1.9 Gaseous chlorine ( $\text{Cl}_2$ ), used to disinfect water in public swimming pools reacts with water according to the following balanced equation.




The addition of chlorine changes the pH of water in swimming pools.

Which ONE of the following substances must be added to public swimming pools periodically to increase the pH?

- A  $\text{KCl}$
  - B  $\text{NH}_4\text{Cl}$
  - C  $\text{H}_2\text{SO}_4$
  - D  $\text{Na}_2\text{CO}_3$  (2)
- 1.10 Consider the reaction in which magnesium powder reacts with EXCESS  $50 \text{ cm}^3$  of a  $0,1 \text{ mol}\cdot\text{dm}^{-3}$  of sulphuric acid solution.



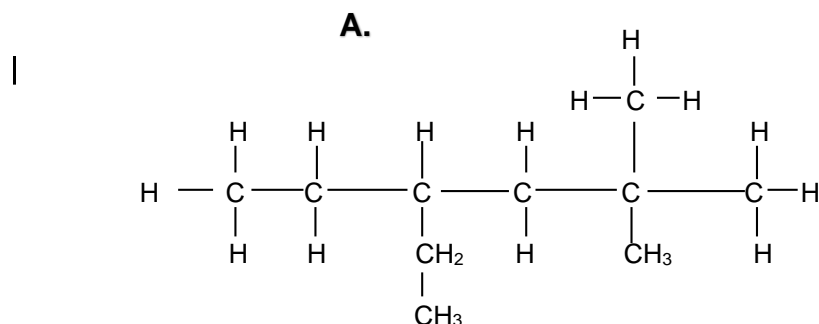
Which ONE of the following changes will increase the rate of production of hydrogen gas?

- A Increase in pressure. 
- B Heating the reaction mixture.
- C Using  $100 \text{ cm}^3$  of the same acid solution.
- D Adding water to the reaction mixture.

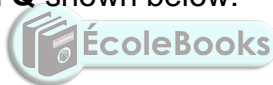
(2)  
[20]

**QUESTION 2 (Start on a new page.)**

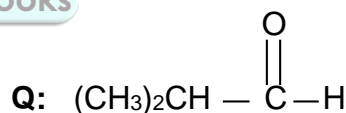
Consider compound **A** which is a member of homologous series of saturated hydrocarbons.



- 2.1 Define the term *homologous series*. (2)
- 2.2 Give a reason why compound **A** is classified as a hydrocarbon. (2)
- 2.3 For compound **A** write down the:
- 2.3.1 General formula of the homologous series to which it belongs (1)
- 2.3.2 IUPAC name (3)
- 2.4 Consider compounds **P** and **Q** shown below:

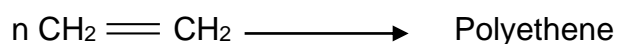


**P:** 2-methyl-2-propanol



Write down the:

- 2.4.1 Structural formula of compound **P** (2)
- 2.4.2 IUPAC name of a FUNCTIONAL isomer of compound **Q** (2)
- 2.4.3 Give a reason why compound **Q** CANNOT have a POSITIONAL isomer. (1)
- 2.5 Polyethene is produced when many ethene monomer units join together to form a polymer according to the equation:



- 2.5.1 Write down the type of reaction described by the underlined phrase. (1)
- 2.5.2 Give a reason why polyethene is regarded as saturated. (1)
- 2.5.3 Name ONE use of polyethene. (1)

**[16]**

**QUESTION 3 (Start on a new page.)**

The boiling points shown in the table were obtained during an investigation into the boiling points of compounds **A**, **B** and **C**. The compounds have a comparable molecular mass.

Compound		Boiling point (°C)
<b>A</b>	Hexane	68
<b>B</b>	Pentanal	103
<b>C</b>	Pentan-2-ol	119

- 3.1 Define the term *boiling point*. (2)
- 3.2 Give a reason why the compounds used in the investigation must have a comparable molecular mass. (1)
- 3.3 Explain the difference in boiling points of compound **A** and **B** by referring to the TYPE and STRENGTH of intermolecular forces and energy involved. (4)
- 3.4 How will the vapour pressure of a CHAIN isomer of compound **C** compare to that of compound **C**?  
Write down only HIGHER THAN, LOWER THAN or SAME AS. (1)
- 3.5 Explain the answer in QUESTION 3.4 by referring to MOLECULAR STRUCTURE and TYPE of INTERMOLECULAR FORCES. (3)
- 3.6 Using MOLECULAR FORMULAE write down a balanced equation for the complete combustion of hexane. (3)

**[14]**



**QUESTION 4 (Start on a new page.)**

Consider the THREE incomplete organic reactions below.



4.1 For reaction **I** write down the:

4.1.1 Type of reaction taking place (1)

4.1.2 IUPAC name of the organic product formed (2)

The dilute sodium hydroxide in reaction **I** is replaced with concentrated sodium hydroxide and the reaction mixture is strongly heated.

4.2 Write down a balanced equation for the reaction taking place when concentrated sodium hydroxide is used in reaction **I** using STRUCTURAL FORMULAE.

(Ignore the MINOR product.)  (6)

4.3 For reaction **II** write down the:

4.3.1 Name of the type of addition reaction taking place (1)

4.3.2 Name of the catalyst used (1)

4.3.3 Structural formula for compound **P** (2)

4.4 Consider reaction **III**.

Write down:

4.4.1 The name of the type of reaction taking place (1)

4.4.2 ONE reaction condition (1)

4.4.3 Name or formula of inorganic product **Q** (1)

4.4.4 The structural formula and IUPAC name of the ester produced (4)

**[20]**

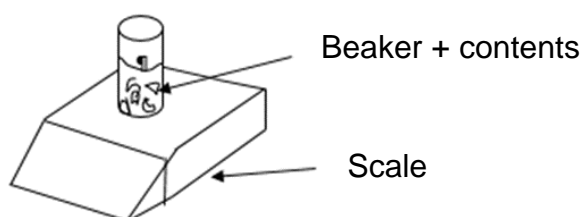
**QUESTION 5 (Start on a new page.)**

A factor influencing the rate of a chemical reaction is investigated by carrying out two experiments **1** and **2** in which the following reaction takes place.

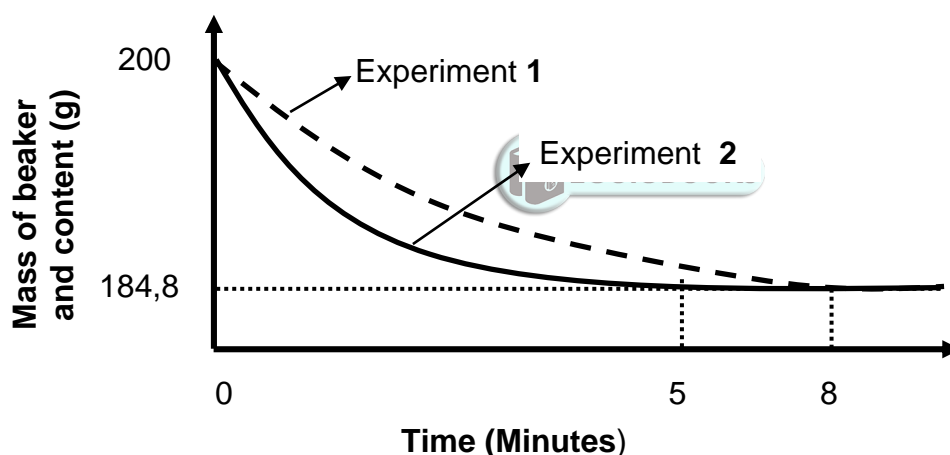


In both experiments chunks of pure calcium carbonate ( $\text{CaCO}_3$ ) of the same mass are added to EXCESS hydrochloric acid solution ( $\text{HCl}$ ) in OPEN flasks. One reaction condition is changed in experiment **2**.

Each flask is placed on a mass scale as shown in the diagram below.

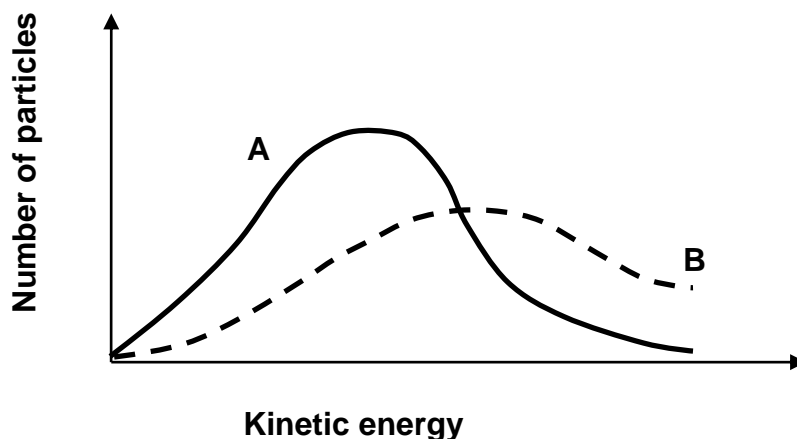


The graph below shows the changes in mass of the beaker and its contents during the reaction in experiments **1** and **2**.



- 5.1 Define *reaction rate* in words. (2)
- 5.2 Write down the FORMULA or NAME of the substance responsible for the decrease in mass of the beaker and its contents as the reaction proceeds. (1)
- 5.3 Write down ONE other apparatus needed to measure the rate of reaction besides the scale balance for the above experiments. (1)
- 5.4 Calculate the average rate of reaction in  $\text{g} \cdot \text{min}^{-1}$  for experiment **2**. (3)
- 5.5 Calculate the mass of calcium carbonate that was used in experiment **1**. (6)

- 5.6 The Maxwell-Boltzmann distribution curves for the reaction in experiments 1 and 2 are given below.

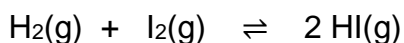


- 5.6.1 Which factor affecting reaction rate is investigated? (1)
- 5.6.2 Which curve (**A** or **B**) represents the reaction in experiment 2? (1)
- 5.6.3 Explain the answer to QUESTION 5.6.2 by referring to the collision theory. (3)
- 5.7 In a **second investigation** a third experiment (**experiment 3**), is carried out in which HCl of HIGHER CONCENTRATION is used. All the other conditions remain the same in **experiment 3** as in **experiment 1**.
- 5.7.1 Write down an investigative question for the second investigation, in which experiment 3 is compared to experiment 1. (2)
- How do the following quantities in **experiment 3** compare to **experiment 1**?
- Write down LOWER THAN or HIGHER THAN or EQUAL TO.
- 5.7.2 Time for the reaction taken to reach completion. (1)
- 5.7.3 Amount of CO<sub>2</sub> that is produced. (1)
- 5.8 Give a reason for the answer in QUESTION 5.7.3 above. (2)

**[24]**

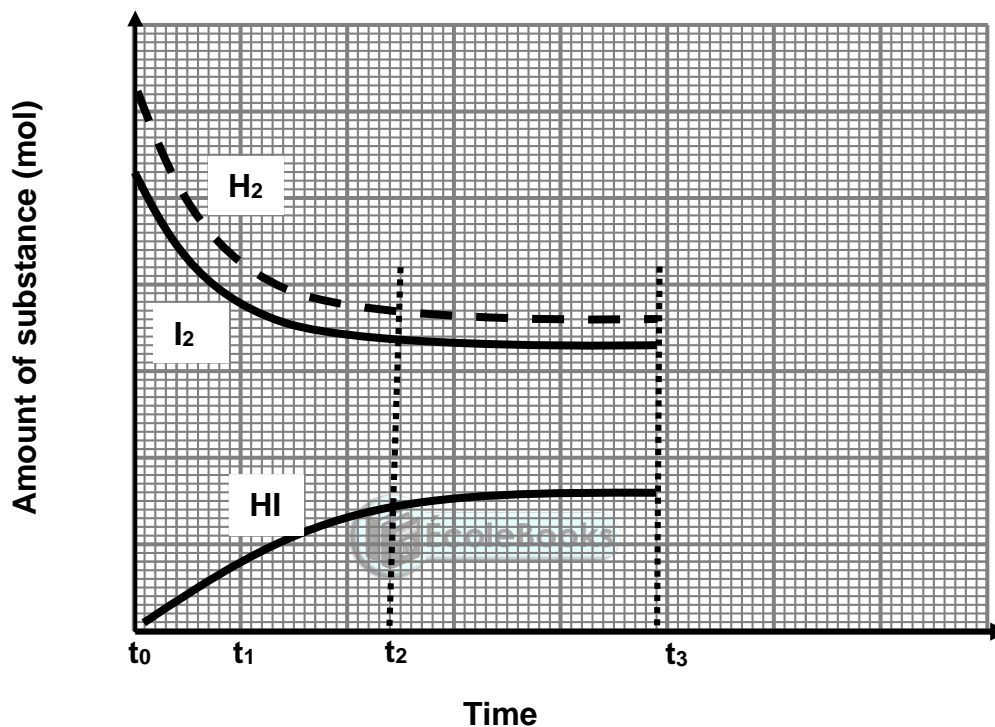
**QUESTION 6 (Start on a new page.)**

Consider the reversible reaction taking place in a closed container:



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

The graph below shows the changes in the amount of the substances  $\text{H}_2$ ,  $\text{I}_2$  and  $\text{HI}$  from the moment the reactants are pumped into an empty container.

**GRAPH OF AMOUNT OF SUBSTANCE VERSUS TIME**

6.2 Which reaction (FORWARD or REVERSE) has a HIGHER rate of reaction during the interval  $t_0$  to  $t_1$ ? (1)

6.3 Did the chemical reaction stop during the interval  $t_2$  to  $t_3$ ?

Write only YES or NO.

Give a reason for the answer. (3)

At time  $t_3$  the pressure on the equilibrium system is increased by decreasing the volume at constant temperature.

6.4 How will the increase in pressure affect the following?

Write down only INCREASES, DECREASES or REMAINS THE SAME.

6.4.1 Rate of reaction. (1)

6.4.2 Number of moles of  $\text{HI}$ . (1)

6.4.3 Concentration of  $\text{HI}$ . (1)

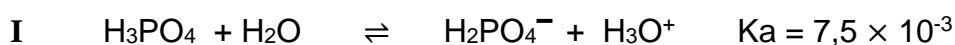
- 6.5 Explain the answer to QUESTION 6.4.3 above. (2)
- 6.6 The table below shows the equilibrium constants,  $K_c$  values for the reaction at different temperatures.

TEMPERATURE (°C)	$K_c$
448	50,3
227	129

- 6.6.1 Is there a HIGH or LOW YIELD at 227 °C?  
Give a reason for the answer. (2)
- 6.6.2 Is the forward reaction EXOTHERMIC or ENDOTHERMIC?  
Explain the answer by referring to Le Chatelier's principle. (4)
- 6.7 The reaction is started by placing hydrogen gas ( $H_2$ ) and iodine gas ( $I_2$ ) into an empty  $0,5 \text{ dm}^3$  container which is then sealed and heated.  
When the reaction reaches **equilibrium** at 448 °C it is found that the concentration of  $H_2$  and  $I_2$  are  $0,46 \text{ mol.dm}^{-3}$  and  $0,39 \text{ mol.dm}^{-3}$  respectively.  
The value of the equilibrium constant,  $K_c$  is equal to 50,3 at 448 °C.  
Calculate the:
- 6.7.1 Concentration of HI at equilibrium (4)
- 6.7.2 Percentage yield at 448 °C (7)
- [28]**

**QUESTION 7 (Start on a new page.)**

7.1 Study the following reactions which show the step-by-step ionisation reaction of phosphoric acid ( $\text{H}_3\text{PO}_4$ ).



7.1.1 Define an *acid* according to Lowry-Bronsted model. (2)

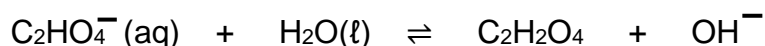
7.1.2 Write down the formula of the substance that acts as an ampholyte in reaction I and II. (1)

7.1.3 Give a reason for the answer in QUESTION 7.1.2 above. (2)

7.1.4 Which substance,  $\text{H}_2\text{PO}_4^-$  or  $\text{HPO}_4^{2-}$ , will have a HIGHER  $K_b$  value?

Give a reason for your answer. (3)

7.2 Consider the hydrolysis of the ion  $\text{C}_2\text{HO}_4^-$  represented by the balanced equation below.



7.2.1 Define the term *hydrolysis*. (2)

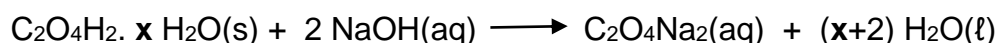
7.2.2 Write down the conjugate base of  $\text{C}_2\text{H}_2\text{O}_4$ . (2)

7.2.3 Give a reason by referring to substance(s) in the equation why the hydrolysis of  $\text{C}_2\text{HO}_4^-$  produces an ALKALINE solution? (2)

7.3 A group of learners perform a titration to determine  $x$  number of moles of water of crystallisation in hydrated oxalic acid ( $\text{C}_2\text{O}_4\text{H}_2 \cdot x \text{H}_2\text{O}$ ).

They first prepared a solution of hydrated oxalic acid, by adding 7,56 grams of hydrated oxalic acid to water and made a volume of  $250 \text{ cm}^3$  solution.

During a titration  $25 \text{ cm}^3$  of the solution of hydrated oxalic acid is neutralised by exactly  $24 \text{ cm}^3$  of a  $0,5 \text{ mol} \cdot \text{dm}^{-3}$  solution of sodium hydroxide according to the balanced equation:



(Water of crystallisation does not react with the base.)

7.3.1 Define a *strong* base. (2)

7.3.2 Calculate the pH of the  $0,5 \text{ mol} \cdot \text{dm}^{-3}$  sodium hydroxide solution. (5)

7.3.3 Determine the value of  $x$  by calculation. (7)

**[28]**

**TOTAL: 150**

**NATIONAL SENIOR CERTIFICATE  
NASIONALE SENIOR SERTIFIKAAT**

**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**

NAAM/NAME	SIMBOOL/SYMBOL	WAARDE/VALUE
<i>Standaarddruk</i> Standard pressure	$p^\theta$	$1,013 \times 10^5 \text{ Pa}$
<i>Molêre gasvolume teen STD</i> Molar gas volume at STP	$V_m$	$22,4 \text{ dm}^3 \cdot \text{mol}^{-1}$
<i>Standaardtemperatuur</i> Standard temperature	$T^\theta$	273 K
<i>Lading op electron</i> Charge on electron	$e$	$-1,6 \times 10^{-19} \text{ C}$
<i>Avogadro se konstante</i> Avogadro's constant	$N_A$	$6,02 \times 10^{23} \text{ mol}^{-1}$

**TABLE 2: FORMULAE/TABEL 2: FORMULES**

$n = \frac{m}{M}$ or/of $n = \frac{N}{N_A}$ or/of $n = \frac{V}{V_m}$	$c = \frac{n}{V}$ or/of $c = \frac{m}{MV}$ $\frac{c_a V_a}{c_b V_b} = \frac{n_a}{n_b}$	$\text{pH} = -\log[\text{H}_3\text{O}^+]$ $K_w = [\text{H}_3\text{O}^+][\text{OH}^-] = 1 \times 10^{-14}$ at /by 298K
$E^\theta_{\text{cell}} = E^\theta_{\text{cathode}} - E^\theta_{\text{anode}} / E^\theta_{\text{sel}} = E^\theta_{\text{katode}} - E^\theta_{\text{anode}}$		
$E^\theta_{\text{cell}} = E^\theta_{\text{reduction}} - E^\theta_{\text{oxidation}} / E^\theta_{\text{sel}} = E^\theta_{\text{reduksie}} - E^\theta_{\text{oksidasie}}$		
$E^\theta_{\text{cell}} = E^\theta_{\text{oxidising agent}} - E^\theta_{\text{reducing agent}} / E^\theta_{\text{sel}} = E^\theta_{\text{oksideermiddel}} - E^\theta_{\text{reduseermiddel}}$		

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)
KEY/ SLEUTEL																	
Atoomgetal Atomic number																	
Elektronegatiwiteit Electronegativity																	
Simbool Symbol																	
Benaderde relatiewe atoommassa Approximate relative atomic mass																	
1 1,0 H	2 4,0 He																
3 6,9 Li	4 9,0 Be																
11 22,99 Na	12 24,31 Mg																
19 39,10 K	20 40,08 Ca	21 44,96 Sc	22 47,88 Ti	23 50,94 V	24 51,996 Cr	25 54,94 Mn	26 55,85 Fe	27 58,93 Co	28 58,93 Ni	29 63,55 Cu	30 65,38 Zn	31 69,72 Ga	32 72,64 Ge	33 74,92 As	34 78,96 Se	35 79,90 Br	36 83,80 Kr
37 85,47 Rb	38 87,62 Sr	39 88,91 Y	40 91,224 Zr	41 92,906 Nb	42 95,94 Mo	43 98,01 Tc	44 101,07 Ru	45 102,91 Rh	46 106,42 Pd	47 107,87 Ag	48 112,41 Cd	49 114,82 In	50 118,71 Sn	51 121,76 Sb	52 127,60 Te	53 127,60 I	54 131,29 Xe
55 132,91 Cs	56 137,33 Ba	57 138,91 La	72 178,49 Hf	73 180,95 Ta	74 183,85 W	75 186,21 Re	76 190,23 Os	77 192,22 Ir	78 195,08 Pt	79 196,97 Au	80 200,59 Hg	81 204,38 Tl	82 207,2 Pb	83 208,98 Bi	84 209 Po	85 210 At	86 222 Rn
87 223,02 Fr	88 226,105 Ra	89 Ac															
			58 140,12 Ce	59 140,91 Pr	60 144,24 Nd	61 Pm	62 150,36 Sm	63 151,96 Eu	64 157,25 Gd	65 158,93 Tb	66 162,50 Dy	67 164,93 Ho	68 167,26 Er	69 168,93 Tm	70 173,05 Yb	71 174,97 Lu	
			90 232,04 Th	91 Pa	92 238,03 U	93 Np	94 Pu	95 Am	96 Cm	97 Bk	98 Cf	99 Es	100 Fm	101 Md	102 No	103 Lr	