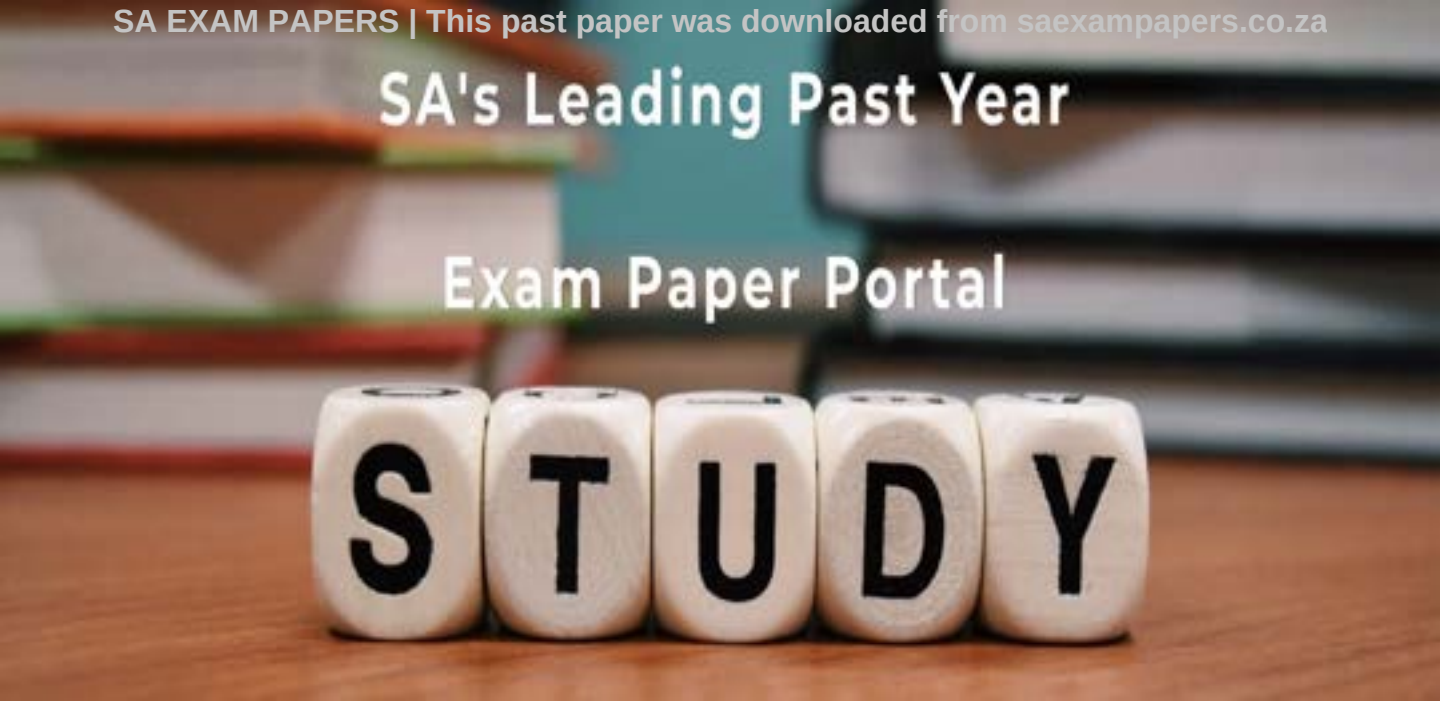


KWAZULU-NATAL PROVINCE
EDUCATION
REPUBLIC OF SOUTH AFRICA

GRADE 12

NATIONAL SENIOR CERTIFICATE

PHYSICAL SCIENCES P2 (CHEMISTRY)

COMMON TEST

JUNE 2024

MARKS: 100

TIME : 2 Hours

This question paper consists of 11 pages and 2 data sheets.

INSTRUCTIONS AND INFORMATION

1. Write your NAME 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

Four 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 (1.1–1.6) in the ANSWER BOOK, for example 1.11 E.

1.1 Which ONE of the following general formulae is a saturated hydrocarbon?

A C_nH_{2n}

B C_nH_{2n+1}

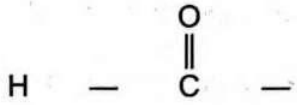
C C_nH_{2n+2}

D C_nH_{2n-2} (2)

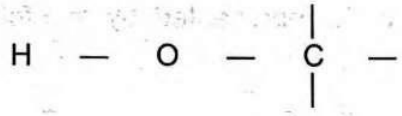
1.2 Which ONE of the following is the structural formula of the functional group of the ALDEHYDES?

A

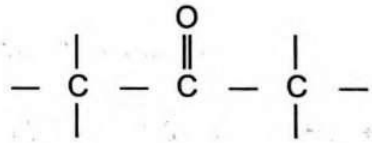
B



C



D



(2)

1.3 A haloalkane is strongly heated in the presence of a concentrated strong base. The organic product is an . . .

A Alkyne.

B Alkene.

C Alkane.

D Alcohol. (2)

1.4 Hydrogen gas is prepared in TWO experiments, EXPERIMENT 1 and EXPERIMENT 2 by adding hydrochloric acid to an excess of magnesium.

The balanced equation for the reaction is:
$Mg(s) + 2HC\ell(aq) \rightarrow Mg(C\ell)_2(aq) + H_2(g) \quad \Delta H < 0$

The same mass of magnesium and the same volume of hydrochloric acid is used in both experiments. The magnesium is completely covered by the hydrochloric acid in both experiments.
The table below shows the results obtained for the TWO experiments:

	Time in minutes	**1**	**2**	**3**	**4**
EXPERIMENT 1	Volume of hydrogen gas in cm^3	20	30	35	35
EXPERIMENT 2	Volume of hydrogen gas in cm^3	30	35	40	40

Which ONE of the following statements can be concluded from the results indicated in the table?

A A higher concentration of $HC\ell(aq)$ was used in EXPERIMENT 2.

B A higher concentration of $HC\ell(aq)$ was used in EXPERIMENT 1.

C Powdered magnesium at a higher temperature was used in EXPERIMENT 2.

D Powdered magnesium at a higher temperature was used in EXPERIMENT 1. (2)

1.5 A reaction at equilibrium in a closed container is represented by the following equation:

$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g) \quad \Delta H < 0$

Which ONE of the following changes will affect BOTH the value of Kc and the concentration of ammonia (NH_3) at equilibrium?

A Adding a suitable catalyst.

B Reducing the temperature.

C Increasing the mass of nitrogen.

D Increasing the pressure at constant temperature. (2)

1.6 Which ONE of the following aqueous solutions will have the LOWEST hydrogen ion $[H^+]$ concentration?

A 0,1 $mol{\cdot}dm^{-3}$ $HC\ell$

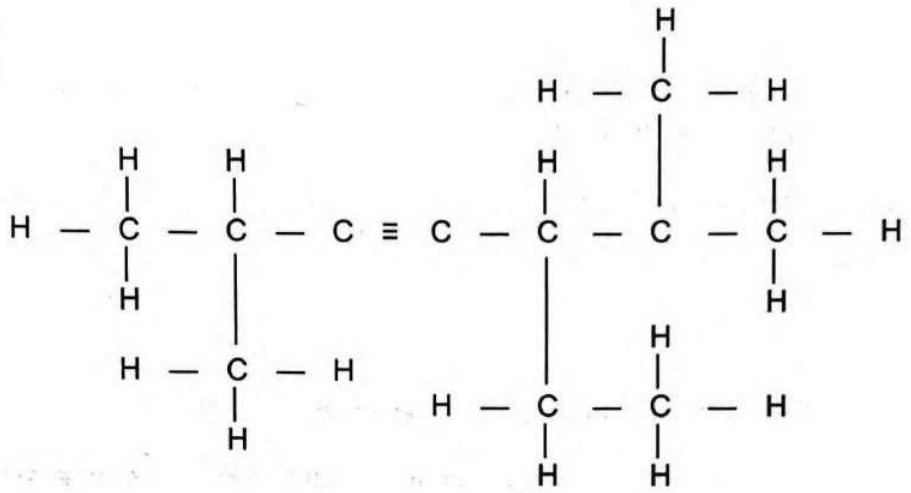
B 0,1 $mol{\cdot}dm^{-3}$ HNO_3

C 0,1 $mol{\cdot}dm^{-3}$ H_2SO_4

D 0,1 $mol{\cdot}dm^{-3}$ CH_3COOH (2)
[12]

QUESTION 2 (Start on a new page.)

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

A	2,3-dichloro-3-ethyl-4-methylheptane	**B**	$CH_3CH_2C(CH_3)OHCH_3$
C	hexanoic acid		
D			

2.1 Write down the IUPAC name of:

2.1.1 **B** (2)

2.1.2 **D** (2)

2.2 Classify compound **B** as a PRIMARY, SECONDARY or TERTIARY alcohol. Give a reason for the answer. (3)

2.3 Write down the:

2.3.1 Structural formula for compound **A**. (3)

2.3.2 EMPIRICAL FORMULA for compound **C**. (2)
[12]

QUESTION 3 (Start on a new page.)

Learners use two compounds A and B, to investigate a factor which influences the boiling point of organic compounds. The results are recorded in the table below.

	Condensed structural formula	BOILING POINT (°C)
A	$CH_3(CH_2)_3CHO$	103
B	$CH_3(CH_2)_2COOH$	163

3.1 Define *boiling point*. (2)

3.2 Which compound A, or B has a higher vapour pressure? Use the information in the table to give a reason for the answer. (2)

3.3 For this investigation, write down the:

3.3.1 Dependent variable. (1)

3.3.2 Independent variable. (1)

3.4 Fully explain the difference in the boiling points shown in the table. (5)

The boiling point of a third compound C, with molecular formula $C_5H_{12}O$ is determined under the same conditions and compared to the boiling points of compound A and B.

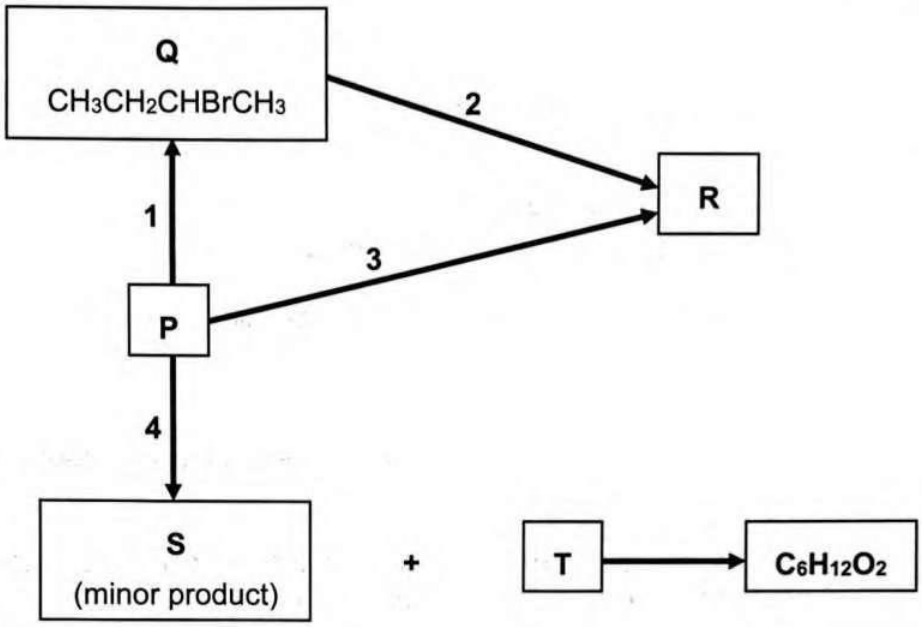
3.5 How will the boiling point of compound C compare to that of compound:
(Write down HIGHER THAN, EQUAL TO or LOWER THAN)

3.5.1 A? (1)

3.5.2 B? (1)
[13]

QUESTION 4 (Start on a new page.)

In the flow diagram below, **1, 2, 3,** and **4** represent organic reactions. **P**, **Q**, **R**, **S** and **T** represent organic compounds.



4.1 Reaction **2** is a HYDROLYSIS reaction.

4.1.1 Name the type of reaction that takes place. Choose from ADDITION, SUBSTITUTION or ELIMINATION. (1)

4.1.2 Using molecular formulae, write a balanced equation for reaction **2**. (3)

4.2 Reaction **4** occurs in the presence of steam and phosphoric acid to produce compound **S**.
Name the type of reaction that takes place. (1)

4.3 For compound **P** write down the:

4.3.1 Name of the homologous series to which it belongs. (1)

4.3.2 Structural formula for compound **P**. (2)

4.3.3 Structural formula for a chain isomer of compound **P**. Fully explain the answer. (5)

When Compound S and Compound **T** are heated together with some concentrated sulphuric acid, $C_6H_{12}O_2$, is produced.

4.4 Write down the IUPAC name of compound **T**. (1)
[14]

QUESTION 5 (Start on a new page.)

During an experiment, hydrogen gas is produced from reacting 600 cm^3 of hydrochloric acid of unknown concentration with a piece of magnesium ribbon at a temperature of 50 °C. The balanced equation for the reaction is:

$$Mg(s) + 2HC\ell(aq) \rightarrow Mg(C\ell)_2(aq) + H_2(g) \quad \Delta H < 0$$

The hydrochloric acid is the limiting reagent, and the magnesium ribbon is completely covered by the acid solution.

The following observation is made after **12 minutes**:
The volume of hydrogen gas remains unchanged.

5.1 The average rate of the reaction given above is 15 $cm^3 \cdot min^{-1}$.

5.1.1 Define *rate of the reaction*. (2)

5.1.2 Give a reason why increasing the length of the magnesium ribbon will not influence the results of above experiment. (1)

5.1.3 Calculate the concentration of the hydrochloric acid. Take the molar volume of the gas at 50 °C to be 26 490 $cm^3.mol^{-1}$ (8)

5.2 The experiment, is NOW, repeated. However, the magnesium ribbon is replaced with an equal mass of powdered magnesium. How will this change affect the:

5.2.1 final volume of hydrogen gas produced? Choose from INCREASES, REMAINS THE SAME or DECREASES. (1)

5.2.2 Fully explain the answer to question 5.2.1 in terms of the collision theory. (4)
[16]

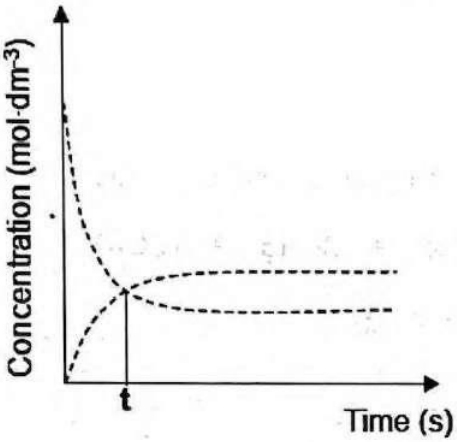
QUESTION 6 (Start on a new page.)

6.1 An unknown gas, A_2, is sealed in a container and allowed to form B_3 gas at 500 °C. The reaction reaches equilibrium according to the following balanced equation:

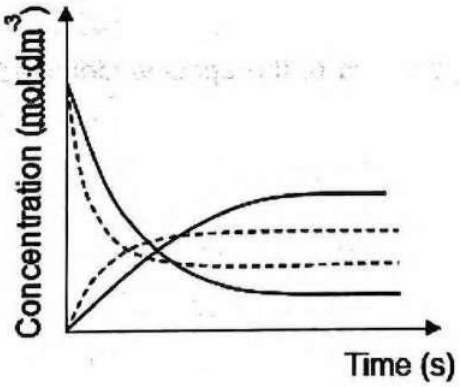
$3A_2(g) \rightleftharpoons 2B_3(g)$

6.1.1 Explain what is meant by the underlined words. (2)

The reaction mixture is analysed at regular intervals. The results obtained was used to sketch (not to scale) the graph below of concentration versus time.



The reaction is NOW repeated at a NEW temperature. The curves indicated by the continuous dark lines were obtained at the NEW temperature.



6.1.2 State Le Chatelier's Principle. (2)

6.1.3 Is the forward reaction EXOTHERMIC or ENDOTHERMIC. Fully explain the answer. (3)

6.2 A mixture of 120 g of nitrogen oxide gas (NO), 80 g of oxygen gas (O_2) and an unknown number of moles of nitrogen dioxide gas (NO_2) are sealed in a 500 cm^3 flask at 100 °C. The reaction reaches equilibrium according to the balanced equation below:

$2\,NO(g) + O_2(g) \rightleftharpoons 2\,NO_2(g)$

When equilibrium was established, it was found that the concentration of $O_2(g)$ present in the container was 4,25 $mol.dm^{-3}$. The equilibrium constant, Kc for this reaction at 100 °C is 0,25.

Calculate the unknown number of moles of $NO_2(g)$ that was initially sealed in the container.

(8)
[15]

QUESTION 7 (Start on a new page.)

7.1 Two separate reactions, **P** and **Q** are represented by the balanced equations below:

P: $2HNO_3(aq) + Na_2CO_3(aq) \rightarrow 2NaNO_3(aq) + CO_2(g) + H_2O(\ell)$

Q: $H_2SO_4(aq) + H_2O(\ell) \rightarrow HSO_4^-(aq) + H_3O^+(aq)$

7.1.1 Write down the formula of the acid in reaction **Q**. (1)

7.1.2 Give a reason for the answer to question 7.1.1 by referring to the Lowry-Bronsted theory for acids and bases. (1)

7.1.3 Write down the formula of the species from either reaction **P** or reaction **Q** other than H_2O which is an ampholyte. (1)

7.1.4 Write down the formula of the conjugate acid of the species identified in question 7.1.3 (1)

7.2 The table below shows some common indicators and the pH range in which the indicator will CHANGE COLOUR.

Indicator	pH range when a colour change takes place
Methyl orange	3,1 – 4,4
Bromothymol blue	6,0 – 7,6
Phenolphthalein	8,3 – 10

7.2.1 Define the term *endpoint*. (1)

7.2.2 Write down the name of the indicator that is suitable to identify the endpoint for reaction P. (1)

7.2.3 Explain the answer to question 7.2.2 (2)

7.3 An impure sample of potassium hydroxide pellets (KOH), of mass 8 g was dissolved in 175 cm^3 of a 1,20 $mol{\cdot}dm^{-3}$ nitric acid (HNO_3) solution. The nitric acid solution is in excess.

$HNO_3(aq) + KOH(s) \rightarrow KNO_3(aq) + H_2O(\ell)$

25 cm^3 of the resulting solution was then titrated using 12,94 cm^3 of a standard 0,65 $mol{\cdot}dm^{-3}$ sodium carbonate (Na_2CO_3) solution.

$2HNO_3(aq) + Na_2CO_3(aq) \rightarrow 2NaNO_3(aq) + CO_2(g) + H_2O(\ell)$

Calculate the percentage purity of the potassium hydroxide sample. (10)
[18]

TOTAL MARKS: [100]

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

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

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 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 Tℓ 204	1,8 Pb 207	1,9 Bi 209	2,0 Po	2,5 At	Rn
0,7 Fr	0,9 Ra 226	Ac															

KEY/*SLEUTEL*

- **Atomic number** / ***Atoomgetal***
- **Electronegativity** / ***Elektronegatiwiteit***
- **Symbol** / ***Simbool***
- **Approximate relative atomic mass** / ***Benaderde relatiewe atoommassa***

Example: 29 | 1,9 | Cu | 63,5

58	59	60	61	62	63	64	65	66	67	68	69	70	71
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
90	91	92	93	94	95	96	97	98	99	100	101	102	103
Th 232	Pa	U 238	Np	Pu	Am	Cm	Bk	Cf	Es	Fm	Md	No	Lr