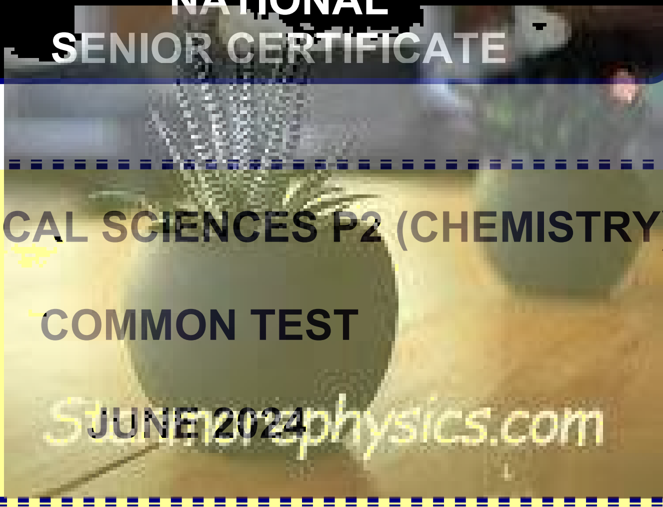
KWAZULU-NATAL PROVINCE

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}

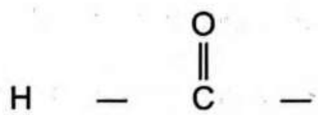
C C_nH_{2n+2}

D C_nH_{2n-2} (2)

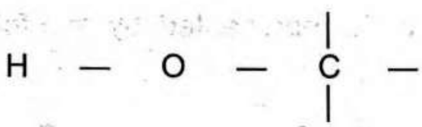
1.2 Which ONE of the following is the structural formula of the functional group of the ALDEHYDES?

A

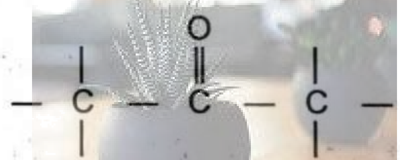
B



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

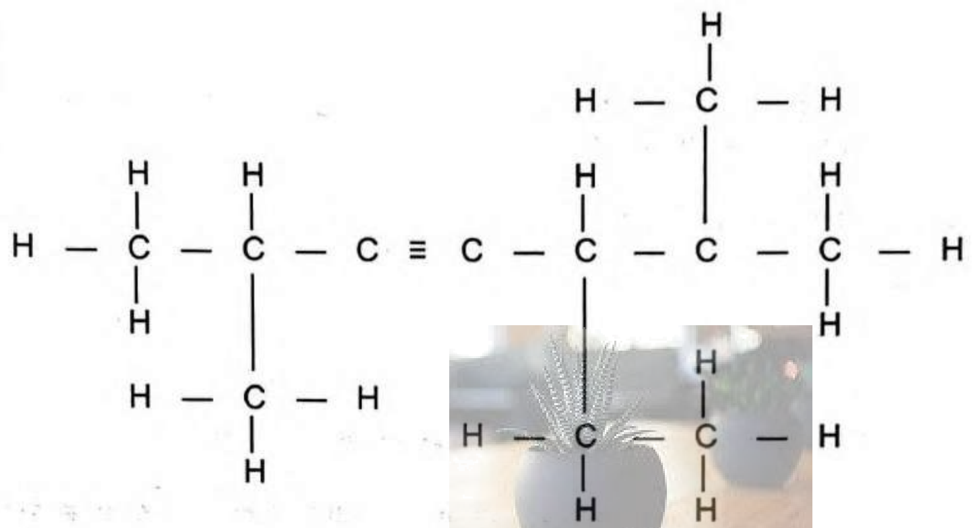
C $0,1\ mol \cdot dm^{-3}\ H_2SO_4$

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.

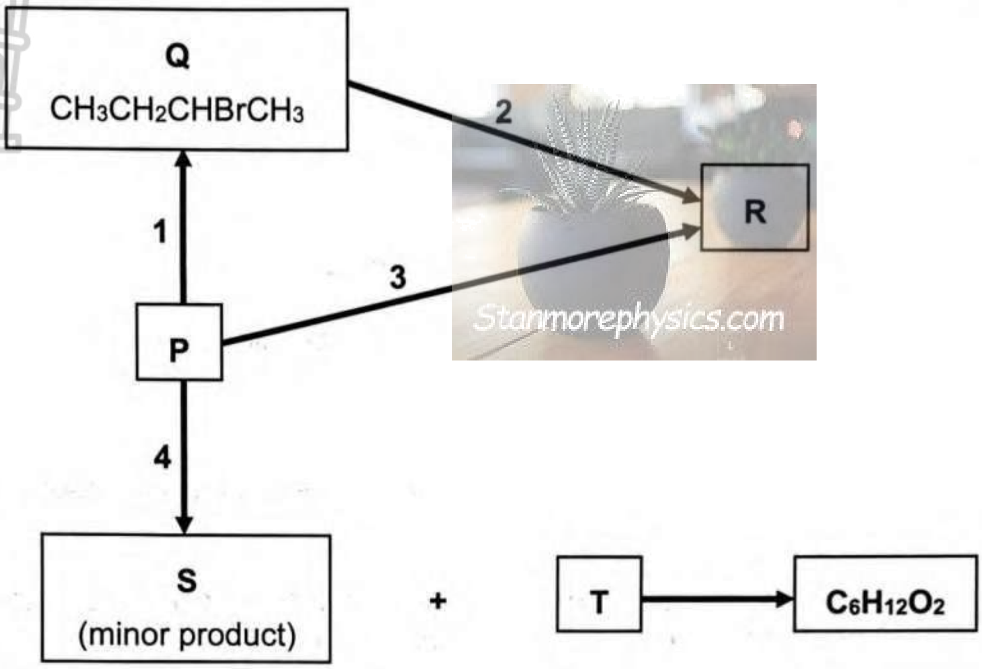
3.5 How will the boiling point of compound C compare to that of compound:
(Write down HIGHER THAN, EQUAL TO or LOWER THAN)

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·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]

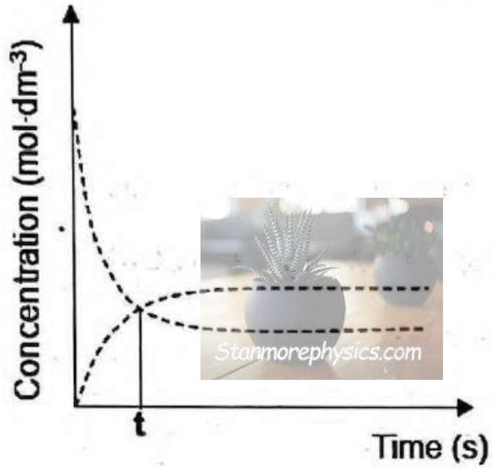
QUESTION 6 (Start on a new page.)

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:

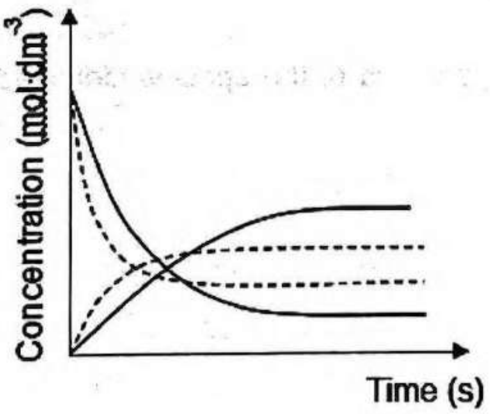
$3A_2(g) \rightleftharpoons 2B_3(g)$

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

KEY/*SLEUTEL*

		Atomic number ***Atoomgetal***	
Electronegativity ***Elektronegatiwiteit***	→	29 1,9 Cu 63,5	← **Symbol** ***Simbool***
		Approximate relative atomic mass ***Benaderde relatiewe atoommassa***	

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

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GRADE 12

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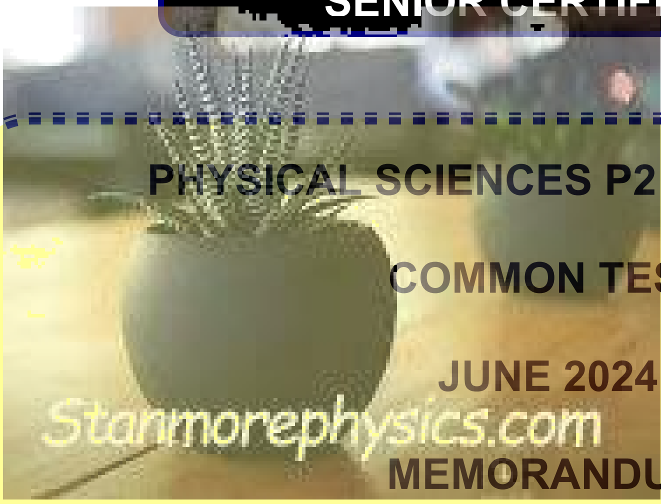


PHYSICAL SCIENCES P2 (CHEMISTRY)

COMMON TEST

JUNE 2024

MEMORANDUM FINAL

MARKS: 100

This memorandum consists of 10 pages.

QUESTION 1

1.1 C ✓✓ (2)

1.2 B✓✓ (2)

1.3 B ✓✓ (2)

1.4 A ✓✓ (2)

1.5 B✓✓ (2)

1.6 D✓✓ (2)
[12]

QUESTION 2

2.1.1 2 – methylbutan – 2 – ol✓✓

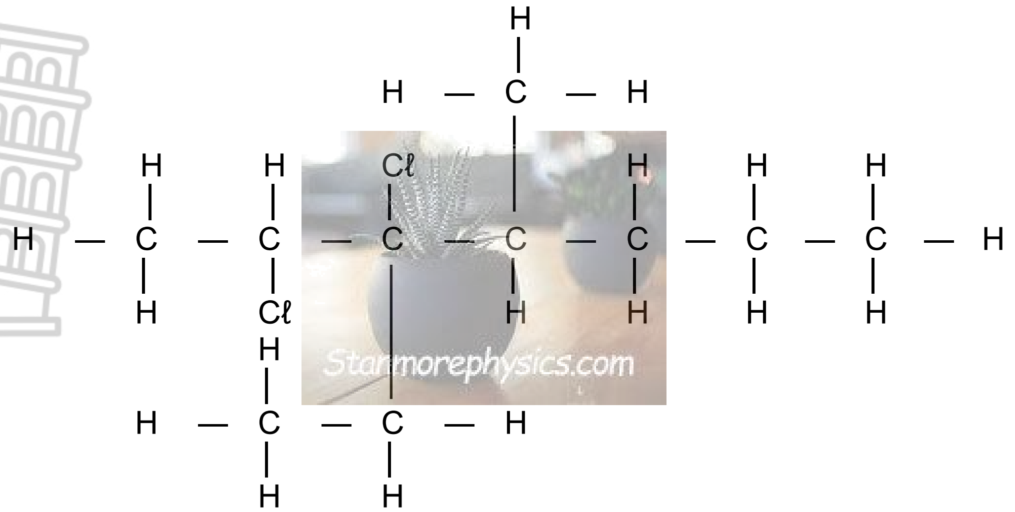
Marking criteria:
• correct stem i.e. butanol✓ • IUPAC name completely correct including numbering, sequence and hyphen ✓

(2)

2.1.2 DO NOT MARK

2.2 Tertiary. ✓
The hydroxyl group/OH✓ is bonded to a carbon that is bonded to 3 other carbon atoms/tertiary carbon. ✓ (3)

2.3.1



Marking criteria:
- Seven C atoms in longest chain.✓
- Cℓ on second and third carbon atoms, Ethyl substituent on third carbon and methyl substituent on fourth carbon. ✓
- Everything else correct✓

(3)

2.3.2

Marking criteria:
- The elements C, H and O.✓
- The correct ratio of the elements 3:6:1. ✓

C_3H_6O✓✓ (2)

CONVERSION TABLE

0	1	2	3	4	5	6	7	8	9	10
0	1	2	4	5	6	7	8	10	11	12

[12]

QUESTION 3

3.1 The temperature at which the vapour pressure of a substance equals atmospheric pressure. ✓✓

Marking criteria:
If any one of the underlined key words/phrases in the correct context is omitted, deduct 1 mark
NOTE: If "temperature" is not referred to, then 0/2.

(2)

3.2 A✓
A has a lower boiling point. ✓ (2)

3.3.1 Boiling point✓ (1)

3.3.2 Homologous series/functional group/type of intermolecular force✓ (1)

3.4

Marking criteria:

- Identify intermolecular forces in A ✓ and in B. ✓
- Compare the strength of the intermolecular forces✓ and
- Compare the energy required to overcome the intermolecular ✓ forces. ✓
- Compare boiling points. ✓

- Intermolecular forces between molecules of A are dipole-dipole✓ and between molecules of B hydrogen bonding.✓
- The intermolecular forces are stronger in B than that in A / Hydrogen bonding is stronger than dipole-dipole forces ✓
- More energy is required to overcome the intermolecular forces in B. ✓
- B has a higher boiling point than A.✓ [*If this is not stated, and the explanation is correct, award this mark to any of the preceding bullets*] (5)

3.5.1 Higher than✓ (1)

3.5.2 Lower than✓ (1)
[13]

QUESTION 4

4.1.1 Substitution✓ (1)

4.1.2 $C_4H_9Br + NaOH \rightarrow C_4H_{10}O + NaBr$
OR
$C_4H_9Br + KOH \rightarrow C_4H_{10}O + KBr$
OR
$C_4H_9Br + LiOH \rightarrow C_4H_{10}O + LiBr$
OR
$C_4H_9Br + H_2O \rightarrow C_4H_{10}O + HBr$

Marking criteria:
- Both reactants✓
- Both products✓
- Balancing ✓

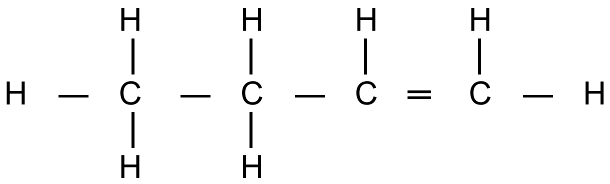
NOTE: *Accept if C_4H_9OH is given instead of $C_4H_{10}O$*

(3)

4.2 Addition/hydration ✓ (1)

4.3.1 alkenes✓ (1)

4.3.2

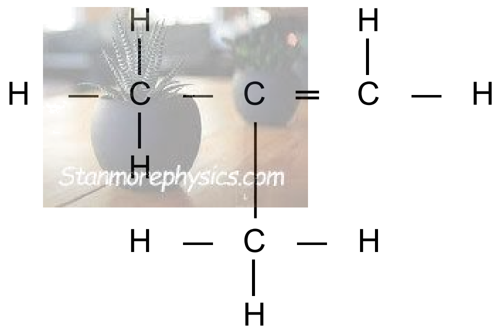


Marking criteria:
- double bond between the first and second carbon✓
- Whole structure correct ✓

NOTE: If correct structure given for but-2-ene: $^1/_2$

(2)

4.3.3



Marking criteria for structural formula:
- 3 carbon atoms in longest chain. ✓
- Methyl substituent and double bond.✓
- Whole structure correct ✓

The molecular formula is the same, ✓ but the isomer is branched/ length of the (parent) carbon chain is different. ✓ (5)

4.4 Ethanoic acid✓ (1)

[14]

QUESTION 5

5.1.1
- Change in concentration ✓ of products/reactants per (unit) time. ✓ OR
- Change in amount/number of moles/volume/mass ✓ of products/reactants per (unit) time. ✓ OR
- Amount/number of moles/volume/mass of products formed/reactants used✓ per (unit) time. ✓ OR
- Rate of change of concentration/amount/no. of moles/volume/mass. ✓✓ (**2 or 0**)

(2)

5.1.2 The HCℓ is the limiting reagent/reactant / Mg is the excess reagent✓ (1)

5.1.3 **Marking criteria:**

- Substitute 15 in $\frac{\Delta(V(H_2))}{\Delta t}$ ✓
- Substitute 12 in $\frac{\Delta(V(H_2))}{\Delta t}$ ✓
- Substitute V and V_m in $\frac{V}{V_m}$ ✓✓
- Correct Ratio of HCℓ to H_2 ✓
- Equation $c = \frac{n}{V}$ ✓
- Substitute for n and V in the above equation ✓
- Final answer 0,023 $mol.dm^{-3}$ ✓

$$\text{rate} = \frac{\text{change in volume of } H_2(g)}{\Delta t}$$

$$15 ✓ = \frac{\Delta(V(H_2)}{12 ✓}$$

$$\Delta(V(H_2)) = 180\ cm^{-3}$$
$$= 0{,}18\ dm^3$$

$$n(H_2)\text{produced} = \frac{V}{V_m}$$
$$= \frac{0{,}18 ✓}{26{,}49 ✓}$$
$$= 6{,}795 \times 10^{-3}\ \text{mols}$$

$$n(HCℓ) = 2n(H_2) ✓$$
$$= 2(6{,}795 \times 10^{-3})$$
$$= 0{,}01359\ \text{mol}$$

$$c(HCℓ) = \frac{n}{V} ✓$$
$$= \frac{0{,}01359}{0{,}6} ✓$$
$$= 0{,}02265\ mol.dm^{-3} ✓$$

(8)

5.2.1 REMAINS THE SAME ✓ (1)

5.2.2 Powdered magnesium increases the surface area but <u>mass remains the same</u> ✓
The rate of the reaction increases. ✓
HCl is the limiting reagent / Mg is the excess reagent. ✓
The number of effective collisions remains constant / The number of effective collisions per unit time increases ✓ (4)

[16]

QUESTION 6

6.1.1 The rate of the forward reaction equals the rate of the reverse reaction.
OR The amount/concentration of reactants and products remain constant. ✓✓ (2)

6.1.2

Marking criteria:
If any one of the underlined key words/phrases in the correct context is omitted, deduct 1 mark. The underlined phrase must be in the correct context.

When the equilibrium in a closed system is disturbed, the system will re-instate a new equilibrium by favouring the reaction that will oppose the disturbance.✓✓ (2)

6..1.3 EXOTHERMIC. ✓

- Reaction rate decreased/Temperature decreased. ✓
- Concentration of products increased/concentration of reactants decreased / Forward reaction favoured / According to Le Chatelier's principle a decrease in temperature favours the exothermic reaction. ✓ (3)

6.2

Marking criteria:
(a) Calculating initial number of moles of reactants. ✓
(b) Changing equilibrium concentration to equilibrium moles for O_2, and equilibrium moles to equilibrium concentrations for NO and NO_2.✓
(c) Calculating Δ moles of O_2 (0,375 mol), and equilibrium moles of NO and NO_2. ✓
(d) Apply ratio 2:1:2 to calculate change in number of moles of NO and NO_2. ✓
(e) K_c expression✓
(f) Correct substitution of K_c in expression✓
(g) Correct substitution of equilibrium concentrations into K_c expression ✓
(h) Final answer 2,6 mols✓

OPTION 1	NO	O_2	NO_2	
Initial quantity (mol)	4	2,5 ✓	x	
Change (mol)	0,75	0,375	0,75	✓
Quantity at equilibrium (mol)	3,25	2,125	x + 0,75	✓
Equilibrium concentration ($mol.dm^{-3}$)	6,5	4,25	$\frac{x+0,75}{0,5}$	✓

$K_c = \frac{[NO_2]^2}{[NO]^2[O_2]}$ ✓

$\therefore 0,25$✓ $= \frac{[\frac{x+0,75}{0,5}]^2}{(6,5)^2(4,25)}$✓

x = 2,6 mols ✓

No K_c expression, correct substitution: Max $\frac{7}{8}$

Wrong K_c expression: Max $\frac{5}{8}$

OPTION 2	NO	O_2	NO_2	
Initial quantity (mol)	4	2,5 ✓	✓2.6✓	
Change (mol)	0,75	0,375	0,75	✓
Quantity at equilibrium (mol)	3,25	2,125	3,35	✓
Equilibrium concentration ($mol.dm^{-3}$)	6,5	4,25	6,7	✓

$K_c = \frac{[NO_2]^2}{[NO]^2[O_2]}$ ✓

$\therefore 0,25$✓ $= \frac{[NO_2]^2}{(6,5)^2(4,25)}$✓

$[NO_2] = 6,7\ mol\cdot dm^{-3}$

No K_c expression, correct substitution: Max $\frac{7}{8}$

Wrong K_c expression: Max $\frac{5}{8}$

(8)
[15]

QUESTION 7.

7.1.1 H_2SO_4✓ (1)

7.1.2 H_2SO_4 donates a proton (to H_2O). ✓ (1)

7.1.3 HSO_4^-. ✓ (1)

7.1.4 H_2SO_4✓ (1)

7.2.1 (The point) where the indicator changes colour. ✓ (1)

7.2.2 Methyl orange✓ (1)

7.2.3 Reaction between strong acid and weak base. ✓
pH will be less than 7 at endpoint, ✓ which corresponds to pH range when indicator changes colour. (2)

7.3

Marking criteria:

- Substitute 1,2 and 0,175 in n = cV to calculate $n(HNO_3)_{initial}$ ✓
- Ratio $HNO_3 : Na_2CO_3 = 2:1$ ✓
- Substitute 0,65 and 0,01294 $n(HNO_3)_{initial}$ to calculate $n(HNO_3)_{excess}$ in 25 cm^3 ✓
- Calculate $n(HNO_3)_{excess}$ in 175 cm^3 ✓
- $n(HNO_3)_{inital}$ - $n(HNO_3)_{excess}$ = $n(HNO_3)_{reacted}$ ✓✓ (for subtraction)
- Ratio HNO_3 : KOH = 1:1 to calculate $n(KOH)_{pure}$ ✓
- Substitute molar mass of KOH (56 g) to calculate mass of $(KOH)_{pure}$ ✓
- Substitute pure and impure mass in percentage purity formula ✓
- Final answer: 64,57 % ✓ Range (63 – 64,57%)

$n(HNO_3)_{initial} = cV$

$= (1,2)\dfrac{(175)}{(1000)}$ ✓

$= 0,21$ mol

$n(HNO_3)_{excess}$ in 25 cm^3 $= 2n(Na_2CO_3)$ ✓

$= 2cV$

$= \boxed{2(0,65)\dfrac{(12,94)}{(1000)}}$ ✓

$= 0,016822$ mol

$n(HNO_3)_{excess}$ in 175 cm^3 $= (0,016822)(7)$ ✓

$= 0,117754$ mol

$n(HNO_3)_{reacted}$ with KOH $= 0,21 - 0,117754$ (for subtraction) ✓✓

$= 0,092246$ mol

$n(KOH)_{pure} = n(HNO_3)_{reacted}$ ✓

$= 0,092246$ mol

$n(KOH)_{pure} = \dfrac{m}{M}$

$0,092246 = \dfrac{m}{56}$ ✓

$m(KOH)_{pure} = 5,165776$ g

% purity $= \boxed{\dfrac{5,165776}{8} \times 100}$ ✓

$= 64,57$ % ✓

Range (63 – 64,57%)

(10)

[18]

TOTAL: 100