Province of the
EASTERN CAPE
EDUCATION

NATIONAL SENIOR CERTIFICATE

GRADE 12

JUNE 2021

PHYSICAL SCIENCES: CHEMISTRY (P2) (EXEMPLAR)

MARKS: **150**

TIME: **3 hours**

This question paper consists of 20 pages, including 2 data sheets.

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, 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. You are advised to use the attached DATA SHEETS.
9. Show ALL formulae and substitutions in ALL calculations.
10. Round off your FINAL numerical answers to a minimum of TWO decimal places.
11. Give brief motivations, discussions, et cetera where required.
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 E.

1.1 The general formula for ALKANES is …

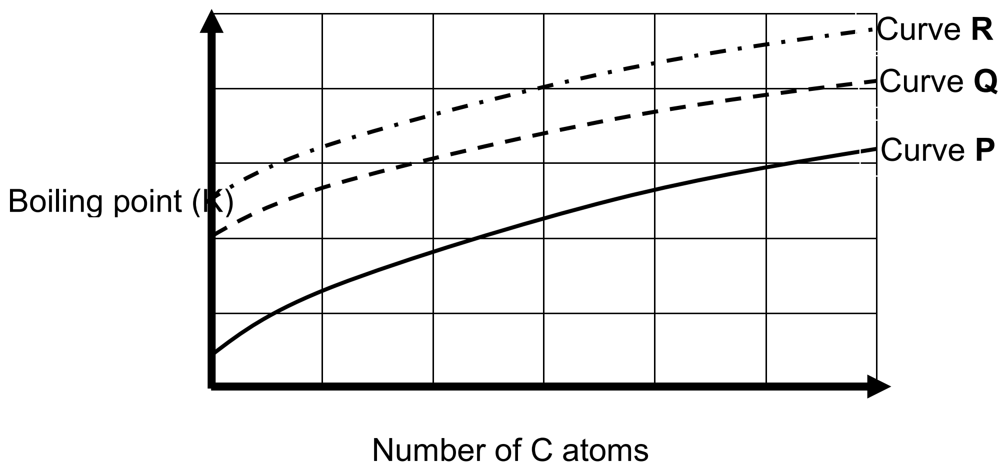
A C_nH_{2n}.

B C_nH_{2n-1}.

C C_nH_{2n-2}.

D C_nH_{2n+2}. (2)

1.2 The following graph shows the relationship between the number of carbon atoms in a straight chain molecules of alkanes, alcohols and aldehydes. Curves **P**, **Q** and **R** is obtained.



Which ONE of the following CORRECTLY describes the homologous series against the curve?

	Curve **P**	Curve **Q**	Curve **R**
A	Alcohols	Aldehydes	Alkanes
B	Aldehydes	Alcohols	Alkanes
C	Alcohols	Alkanes	Aldehydes
D	Alkanes	Aldehydes	Alcohols

(2)

1.3 An alkene reacts with an EXCESS amount of water in the presence of an acid catalyst to produce compound **P** as shown in the equation below.

$$\text{ALKENE} + H_2O \rightarrow \text{compound } \mathbf{P}$$

Compound **P** is a(n) …

A alcohol.

B alkane.

C haloalkane.

D carboxylic acid. (2)

1.4 Activation energy of a chemical reaction is defined as:

A Net energy released

B Net energy absorbed

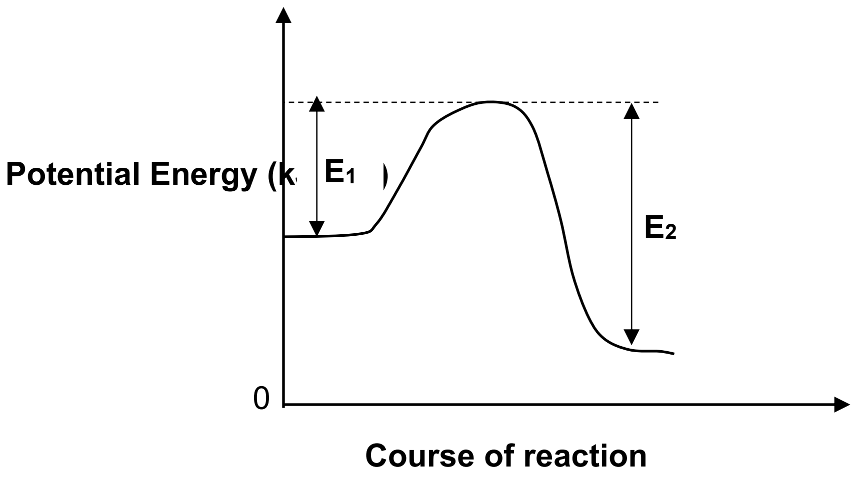
C Minimum energy needed to start the reaction

D Maximum energy needed to start the reaction (2)

1.5 Consider the potential energy diagram for a reversible hypothetical reaction represented by the balanced equation below.

$$X_2(g) \rightleftharpoons 2X(g)$$

POTENTIAL ENERGY DIAGRAM



E₁ and **E₂** are the activation energies for the forward and reverse reactions respectively.

The difference (**$E_2 – E_1$**) is equal to …

A energy of the product.

B ΔH for the forward reaction.

C ΔH for the reverse reaction.

D energy of the activated complex. (2)

1.6 A chemical reaction reaches chemical equilibrium in a closed system.

At equilibrium concentration of products and reactants remains constant because the rate of the forward reaction is …

A zero.

B higher than the rate of the reverse reaction.

C lower than the rate of the reverse reaction.

D equal to the rate of the reverse reaction. (2)

1.7 Consider the following reaction at equilibrium in a closed system.

$Cu(H_2O)_6^{2+}$ (aq) + 4 $C\ell^-$ (aq) ⇋ $CuC\ell_4^{2-}$ (aq) + 6 H_2O (ℓ) ΔH > 0
BLUE GREEN

Which ONE of the following changes to the equilibrium mixture above will ensure a COLOUR change from GREEN to BLUE?

A Increase in pressure

B Addition of silver nitrate

C Increase in temperature

D Addition of hydrochloric acid (2)

1.8 The endpoint in a titration is the exact point where …

A neutralisation occurs.

B the indicator changes colour.

C equal masses of base and acid have reacted.

D equal number of moles of acid and base have reacted. (2)

1.9 In the table below the ionisation constant values for bases, K_b at 25 ˚C are given.

Which ONE of the following bases is the STRONGEST?

	BASE	**K_b at 25 ˚C**
A	SO_4^{2-}	8,3 x 10 $^{-13}$
B	PO_4^{3-}	5,9 x 10^{-3}
C	HCO_3^-	2,4 x 10 $^{-8}$
D	CH_3COO^-	5,6 x 10 $^{-10}$

(2)

1.10 Water undergoes auto-ionisation according to the balanced equation:

$$H_2O(\ell) + H_2O(\ell) \leftrightharpoons H_3O^+(aq) + OH^-(aq) \quad \Delta H > 0$$

The ionisation constant K_w for water is 1,00 x 10 $^{-14}$ at 25 ˚C

Which ONE of the following is TRUE when the temperature of water in a beaker is increased from 25 ˚C to 30 ˚C?

A **K_w** remains the same and the water becomes acidic

B **K_w** remains the same and the water remains neutral

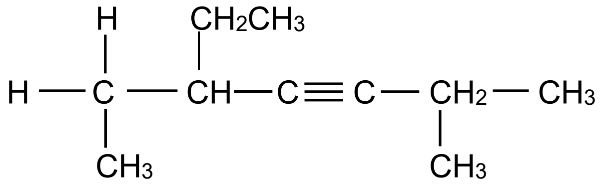
C **K_w** increases and the water remains neutral

D **K_w** decreases and the water remains neutral (2)

[20]

QUESTION 2 (Start on a new page.)

2.1 The compound **P**, shown below, belongs to alkynes which is <u>a group of organic compounds with the same general formula and functional group</u>.



2.1.1 Write down a general term for the underlined phrase. (1)

2.1.2 Is compound **P** a SATURATED or UNSATURATED compound?

Give a reason for the answer. (2)

For compound **P** write down the:

2.1.3 Empirical formula (1)

2.1.4 IUPAC name (3)

2.2 Consider compounds **A** and **B** given below.

A: propan-1-ol **B**: HCOOH

2.2.1 Write down the STRUCTURAL formula of compound **A**. (2)

Compounds **A** and **B** are heated together in the presence of a catalyst in a test tube to produce an ESTER.

2.2.2 Describe how the mixture of **A** and **B** in the test tube is heated. (2)

For the reaction between compounds **A** and **B** write down the:

2.2.3 Name of the reaction taking place (1)

2.2.4 Formula of the catalyst used (1)

2.2.5 STRUCTURAL formula of the ester that is produced (2)

2.3 Haloalkanes, compounds **C, D** and **E** are *structural isomers*.

Compounds **C** and **D** are shown below and compound **E** is not shown:

C: $CH_3CH_2CH_2CH_2Br$ **D**: $(CH_3)_3CBr$

2.3.1 Define the term *structural isomer.* (2)

2.3.2 Give a reason why compound **C** is classified as a PRIMARY haloalkane. (2)

2.3.3 Write down the IUPAC name of compound **E**, the POSITIONAL isomer of compound **D**. (3)

[22]

QUESTION 3 (Start on a new page.)

A group of learners investigated the effect of intermolecular forces on the boiling points of compounds.

They tabulated their results below:

	Compounds	**Boiling point (˚C)**
A	Propan-1-ol	97
B	Butan-1-ol	117,7
C	Pentan-1-ol	138

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

3.2 Which compound (**A**, **B** or **C**) will have the highest vapour pressure at a given temperature?

Refer to the data in the table to explain the answer. (2)

3.3 For this investigation, write down the:

3.3.1 Independent variable (1)

3.3.2 Controlled variable (1)

3.4 Explain the trend in boiling point in the table above by referring to the MOLECULAR STRUCTURE, INTERMOLECULAR FORCES and ENERGY involved. (4)

3.5 The compound, 2-methylpropan-1-ol is a CHAIN ISOMER of one of the compounds in table.

3.5.1 Write down the structural formula for 2-methylpropan-1-ol. (2)

3.5.2 Which compound (**A**, **B**, or **C**) in the table above is a CHAIN ISOMER of 2-methylpropan-1-ol?

Give a reason for the answer. (2)

3.5.3 How will the boiling point of 2-methylpropan-1-ol compare to the isomer named in QUESTION 3.5.2?

Write only HIGHER THAN, LOWER THAN or EQUAL TO. (1)

3.5.4 Explain the answer to QUESTION 3.5.3 by referring to the MOLECULAR STRUCTURE, INTERMOLECULAR FORCES and ENERGY involved. (3)

3.6 Methanoic acid is a smaller compound than propan-1-ol. The boiling point of methanoic acid is HIGHER than propan-1-ol.

Fully explain why the boiling point of methanoic acid is higher than propan-1-ol.

Refer to the TYPE OF INTERMOLECULAR FORCES and energy involved. (4)
[22]

QUESTION 4 (Start on a new page.)

Hexane undergoes thermal cracking according to the balanced equation below.

$$C_6H_{14} \rightarrow \text{Alkane } \mathbf{X} + C_2H_4$$

4.1 Define *cracking.* (2)

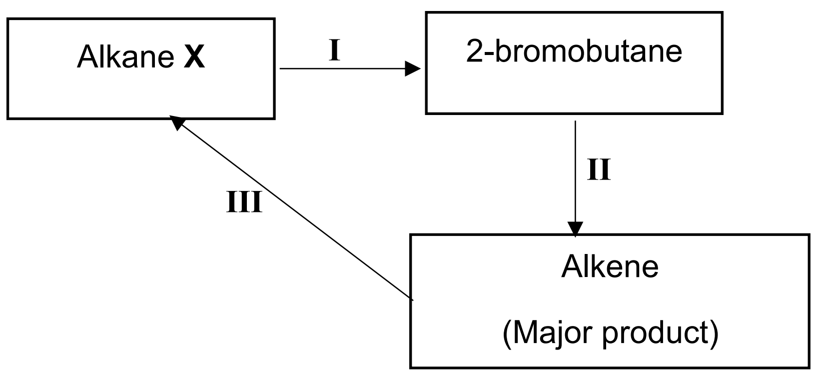
4.2 Write down the:

4.2.1 Molecular formula of alkane **X** (2)

4.2.2 One reaction condition (1)

The alkane **X**, produced in the cracking reaction above, is used to produce other organic compounds as shown in the flow diagram below.

The numbers **I**, **II** and **III** represent organic reactions.



4.3 Write down the TYPE of reaction represented by:

4.3.1 **I** (1)

4.3.2 **II** (1)

4.4 Write down the NAME of the type of addition reaction represented by reaction **III.** (1)

4.5 Write down the NAME or FORMULA of the:

4.5.1 Inorganic reactant used in reaction **I** (1)

4.5.2 Catalyst used in reaction **III** (1)

4.6 Write down a balanced equation using CONDENSED structural formulae of organic reagents for reaction **II.** (5)
[15]

QUESTION 5 (Start on a new page.)

A group of learners conduct experiments to investigate a factor that affects the rate of reactions.

In the experiments, the learners use the reaction between zinc granules and EXCESS hydrochloric acid of concentration 0,5 mol·dm^{-3} at 20 °C as shown below:

Experiment **A**: $Zn\ (s) + 2\ HC\ell\ (aq) \rightarrow ZnC\ell_2\ (aq) + H_2\ (g)\quad \Delta H < 0$

5.1 Define *reaction rate*. (2)

5.2 Is net energy ABSORBED or RELEASED during the reaction?

Give a reason for the answer. (2)

5.3 How will the rate of reaction in experiment **A** be affected by the following changes?

Choose from INCREASES, DECREASES or NO EFFECT.

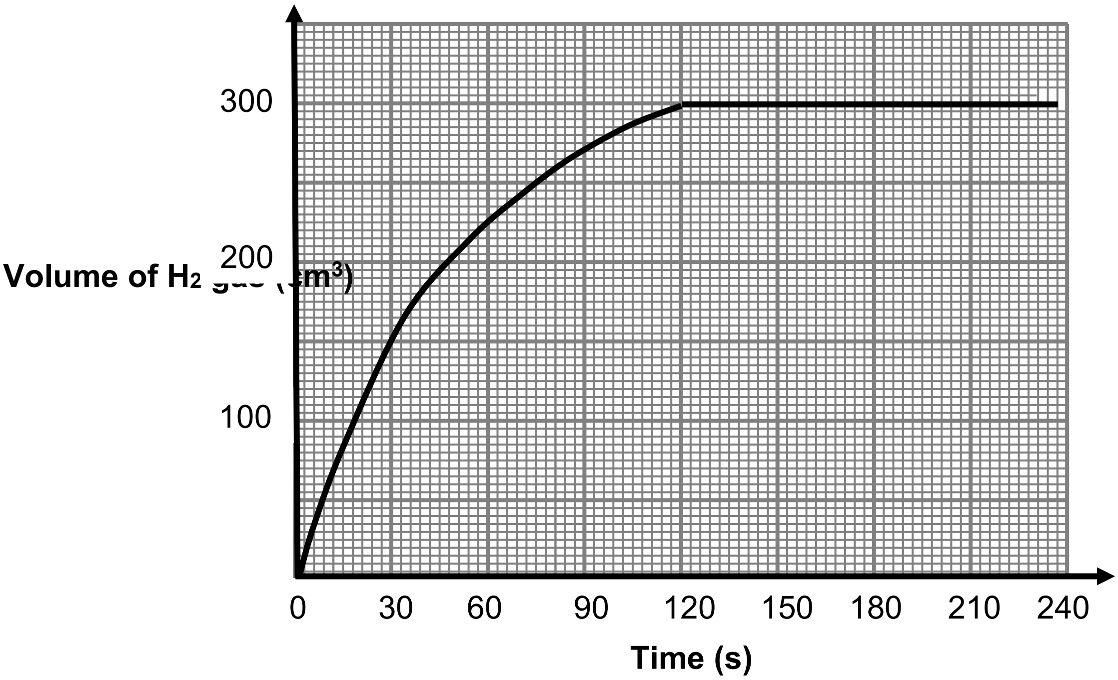
5.3.1 Using H_2SO_4 solution of concentration 0,5 mol·dm^{-3} in place of the HCℓ. (1)

5.3.2 Pressure is increased. (1)

5.4 In experiment **A**, 50 cm^3 of hydrochloric acid (HCℓ) solution of concentration 0,5 $mol \cdot dm^{-3}$ reacts with 7,15 g of zinc (Zn) granules.

The volume gas formed versus time for the reaction in experiment **A** is shown below.

GRAPH OF VOLUME OF H_2 VERSUS TIME



5.4.1 How many seconds did the reaction take to reach completion? (1)

It is observed that the rate of reaction is HIGHEST during the interval 0 to 30 s.

5.4.2 Write down TWO factors that influence reaction rate that explains this observation. (2)

5.5 Calculate the:

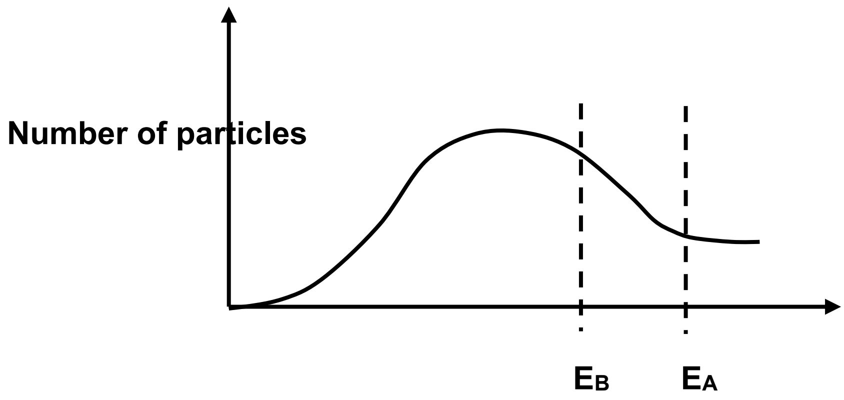
5.5.1 Average rate of reaction (in $cm^3 \cdot s^{-1}$) for the first 120 s (3)

5.5.2 Mass of the EXCESS reactant remaining in the flask if the molar volume of hydrogen gas at 20 ˚C is 24 $dm^3 \cdot mol^{-1}$ (7)

5.6 In experiment **B**, the reaction in experiment **A** is repeated under the same conditions, but copper is also added to the reaction mixture.

Experiment **B**: $Zn\ (s) + HC\ell\ (aq) \xrightarrow{Cu} ZnC\ell_2\ (aq) + H_2\ (g)$

The Maxwell-Boltzman distribution curve for the reaction in experiment **A** and in experiment **B** is shown below:



E_A and **E_B** represent the activation energy for the reaction in experiments **A** and **B** respectively.

5.6.1 What is the function of copper in experiment **B**? (1)

5.6.2 Explain how the addition of copper in reaction **B** affects the rate of reaction by referring to the collision theory. (4)

[24]

QUESTION 6 (Start on a new page.)

The reversible reaction given below reaches equilibrium at 350 ˚C in a closed container.

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

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

6.2 The temperature of the equilibrium mixture is decreased.

How will the decrease in temperature affect the following?

Choose from INCREASES, DECREASES or REMAINS CONSTANT.

6.2.1 Rate of the forward reaction (1)

6.2.2 Number of moles of NH_3 at equilibrium (1)

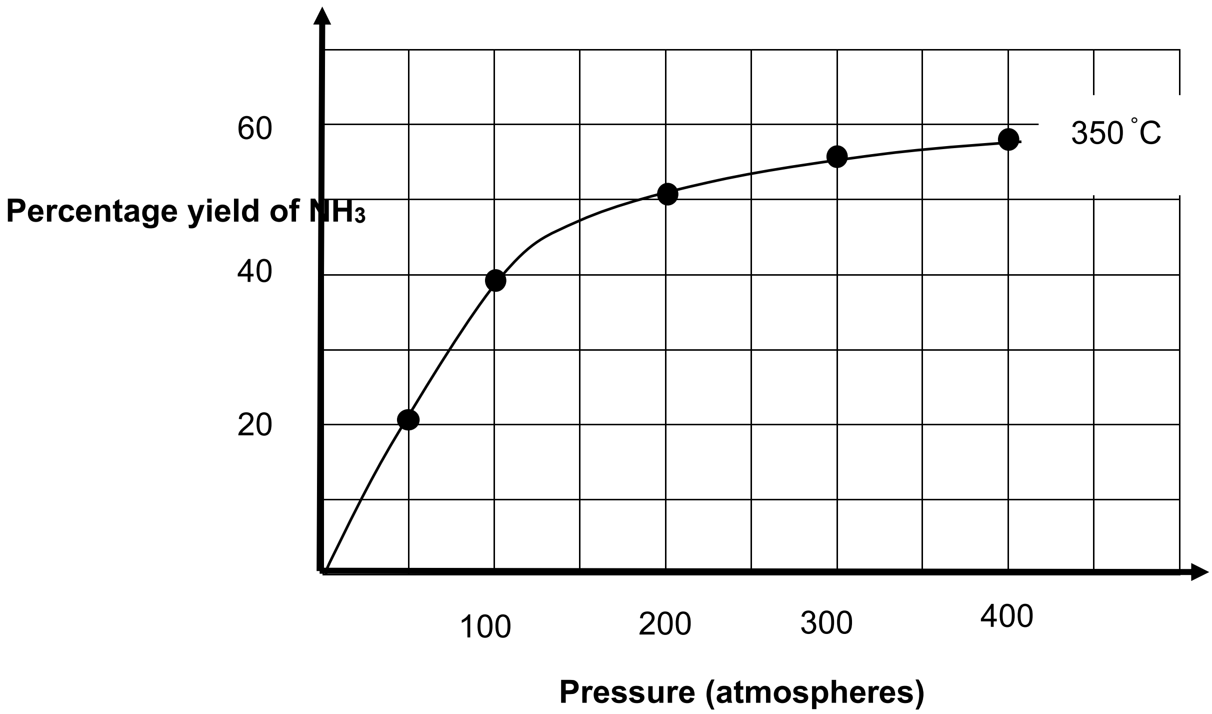
6.3 Explain the answer to QUESTION 6.2.2 above by referring to Le Chatelier's principle. (2)

6.4 The reaction is started by placing 7,84 grams of N_2 and 0,6 moles of H_2 in an empty flask which is then sealed. When equilibrium is reached at 350 ˚C the amount of NH_3 present is 0,12 moles. The volume of the container is 2 dm^3.

Calculate the value of the equilibrium constant at 350 ˚C. (8)

The graph shown below shows the percentage yield of NH_3 at 350 ˚C at different pressure values.

GRAPH OF PERCENTAGE YIELD VS PRESSURE



6.5 Write down a CONCLUSION that can be drawn from the graph about the relationship between percentage yield of NH_3 and pressure at constant temperature. (2)

6.6 Use information from QUESTION 6.4 and the graph to determine the pressure at which the reaction reached equilibrium. (5)

[21]

QUESTION 7 (Start on a new page.)

7.1 Sodium carbonate ionises in water into sodium ions (Na^+) and carbonate ions (CO_3^{2-}).

Carbonate ions in solution undergo hydrolysis according to the balanced equation:

$$CO_3^{2-}(aq) + H_2O(\ell) \rightleftharpoons HCO_3^-(aq) + OH^-(aq)$$

7.1.1 Define *hydrolysis.* (2)

7.1.2 Give a reason why a solution of sodium carbonate in water is alkaline by referring to substance(s) in the equation above. (2)

7.1.3 Write down the FORMULAE of the TWO acids in the equation. (2)

7.1.4 Give a reason why HCO_3^- can act as an ampholyte. (2)

7.2 A solution of a strong diprotic acid **X** has pH = 1.

7.2.1 Define an *acid* according to the Lowry-Bronsted theory. (2)

7.2.2 Calculate the concentration of acid **X.** (4)

A solution of acid **X** of concentration 0,049 mol.dm^{-3} is diluted by adding 15 cm^3 of the acid to water to produce 90 cm^3 of a dilute standard solution.

7.2.3 Explain the meaning of the term *standard solution*. (2)

The DILUTE solution of acid **X** is titrated with a solution of potassium hydroxide.

The following list of indicators are available for the titration.

Indicator	**pH-range**
Methyl orange	3,1 – 4,4
Bromothymol blue	6,0 – 7,6
Phenolphthalein	8,3 – 10,0

7.2.4 Which ONE of the indicators is the most suitable for this titration?

Explain the answer. (3)

During the titration 25 cm^3 of the DILUTE acid **X** solution neutralises exactly 28,5 cm^3 of a potassium hydroxide solution.

7.2.5 Calculate the concentration of the potassium hydroxide solution. (7)
[26]

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

$n = \frac{m}{M}$ or/of $n = \frac{N}{N_A}$ or/of $n = \frac{V}{V_o}$	$c = \frac{n}{V}$ or/of $c = \frac{m}{MV}$ $\frac{c_a V_a}{c_b V_b} = \frac{n_a}{n_b}$	pH= $-\log[H_3O^+]$ $K_w = [H_3O^+][OH^-] = 1 \times 10^{-14}$ at/by 298 K

$E^{\theta}_{cell} = E^{\theta}_{cathode} - E^{\theta}_{anode}$ / $E^{\theta}_{sel} = E^{\theta}_{katode} - E^{\theta}_{anode}$

$E^{\theta}_{cell} = E^{\theta}_{reduction} - E^{\theta}_{oxidation}$ / $E^{\theta}_{sel} = E^{\theta}_{reduksie} - E^{\theta}_{oksidasie}$

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

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

KEY/ *SLEUTEL*

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

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/*GRAAD* 12

JUNE/*JUNIE* 2021

PHYSICAL SCIENCES: CHEMISTRY P2 MARKING GUIDELINE/
FISIESE WETENSKAPPE: CHEMIE V2 NASIENRIGLYN
(EXEMPLAR/*EKSEMPLAAR)*

MARKS/*PUNTE*: 150

This marking guideline consists of 15 pages./
Hierdie nasienriglyn bestaan uit 15 bladsye.

QUESTION 1/*VRAAG 1*

1.1	D ✓✓	(2)
1.2	D ✓✓	(2)
1.3	A ✓✓	(2)
1.4	C ✓✓	(2)
1.5	C ✓✓	(2)
1.6	D ✓✓	(2)
1.7	B ✓✓	(2)
1.8	B ✓✓	(2)
1.9	B ✓✓	(2)
1.10	C ✓✓	(2)
		[20]

QUESTION 2/*VRAAG 2*

2.1 2.1.1 Homologous series ✓
Homoloë reeks (1)

2.1.2 Unsaturated. ✓
Contains a triple bond ✓/multiple bonds
Onversadig
Bevat driedubbelbinding/veelvoudige bindings (2)

2.1.3 C_5H_9 ✓ (1)

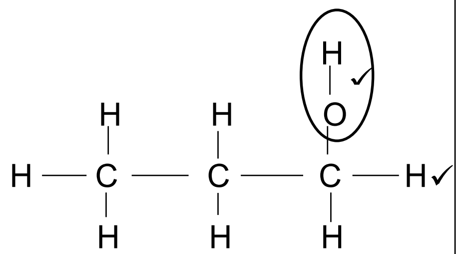
2.1.4 5-ethlyl ✓ -2-methyl ✓ hex-3-yne ✓
OR 5-ethlyl-2-methyl-3-hexyne
5-etiel-2-metielheks-3-yn
OF *5-etiel-2-metiel-3-heksyn*

Marking Criteria/*Nasien-kriteria*

- Hexyne ✓
  heksyn
- Side chains (ethyl and methyl) ✓
- *Syketting (etiel en metiel)*
- Whole name correct ✓
  Volledige naam korrek

(3)

2.2.1



Marking criteria/Nasien-kriteria

- Functional group correct (1/2)
  Funksionele groep korrek (1/2)
- Whole structure correct (2/2)
  Volle struktuur korrek (2/2)

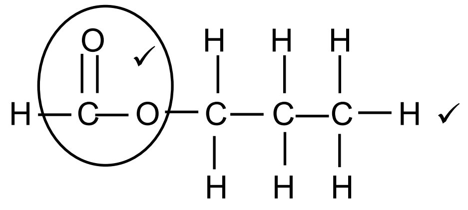
(2)

2.2.2 (Mild) heat ✓ in a water bath ✓
(Matige) hitte in ŉ waterbad (2)

2.2.3 Esterification/ Condensation ✓
Esterifikasie/kondensasie (1)

2.2.4 H_2SO_4 ✓ (1)

2.2.5



Marking criteria/*Nasien riglyne*

- Functional group correct (1/2)
  Funksionele groep (1/2)
- Whole structure correct (2/2)
  Volle struktuur korrek (2/2)

(2)

2.3 2.3.1 Compounds with the same molecular formula. ✓
but different structural formula. ✓

Verbindings met dieselfde molekulêre formule maar verskillende struktuurformule. (2)

2.3.2 The C atom bonded to Br is bonded to one other C atom ✓✓ **OR**
The C atom bonded to Br is bonded to two hydrogen atoms
Die C atoom wat aan die Br gebind is, is aan een ander C atom gebind

OF

Die C atoom gebind aan die Br is aan twee waterstofatome gebind. (2)

2.3.3 1-bromo-2-methylpropane ✓✓✓
1-bromo-2-metielpropaan

Marking Criteria/*Nasien-kriteria*

- Propane ✓
  Propaan
- (bromo and methyl) ✓
  (bromo en metiel)
- Whole name correct ✓
  Volle naam korrek

(3)
[22]

QUESTION 3/*VRAAG 3*

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

Die temperatuur waarteen die dampdruk van 'n vloeistof gelyk is aan die atmosferiese druk. (2)

3.2 A ✓ Compound A has the lowest boiling point. ✓

Verbinding A het die laagste kookpunt. (2)

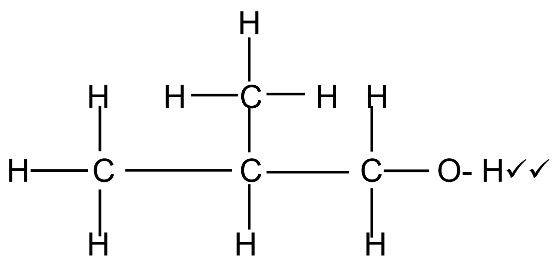
3.3.1 Molar mass/ Molecular size/ Surface area ✓
Molêre massa/ Molekulêre grootte/Oppervlakte (1)

3.3.2 Hydrogen bond ✓
Waterstofbinding (1)

3.4
- The molar mass/Molecular size/ surface area of the compounds increases from top to bottom in the table. ✓
- The compounds have London forces and (Hydrogen bonds) ✓
- The strength of London forces increases with an increase in molar mass/molecular size/surface area. ✓
- More energy is needed to overcome the intermolecular forces ✓

- *Die molêre massa/molekulêre grootte/oppervlakte van die verbinding neem toe van bo na onder in die tabel.*
- *Die verbindings het Londonkragte en (waterstofbindings)*
- *Die sterkte in Londonkragte neem toe met 'n toename in molêre massa/molekulêre grootte/oppervlakte*
- *Meer energie word benodig om die intermolekulêrekragte te oorkom* (4)

3.5.1



Marking criteria/*Nasien kriteria*

- 3 Carbon atoms in longest chain with correct functional group
  3 koolstofatome in die langste ketting en korrekte funksionele groep

(2)

3.5.2 B ✓ It has the same molecular formula ✓
Dit het dieselfde molekulêre formule (2)

3.5.3 Lower than ✓
Laer as. (1)

3.5.4
- 2-methylpropan-1-ol has a smaller surface area than butan-1-ol. ✓
- Both compounds have London forces and (hydrogen bonds) ✓
- 2-methylpropan-1-ol have weaker London forces than butan-1-ol ✓
- Less energy is needed to overcome the intermolecular forces in 2-methylpropan-1-ol ✓

- *2-metielpropan-1-ol het 'n Kleiner oppervlakte as butan-1-ol*
- *Beide verbindings het Londonkragte en (waterstofbinding)*
- *2-metielpropan-1-ol het swakker Londonkragte as butan-1-ol*
- Minder energie word benodig om die intermolekulêrekragte in 2-metielpropan-1-ol te oorkom

OR/*OF*

- Butan-1-ol has a larger surface area than 2-methylpropan-1-ol ✓
- Both compounds have London forces and (hydrogen bonds) ✓
- Butan-1-ol have stronger Londonforces than 2-methylpropan-1-ol ✓
- More energy is needed to overcome the intermolecular forces in butan-1-ol ✓

- *Butan-1ol het 'n groter oppervlakte as 2-metielpropan-1-ol*
- *Beide verbindings het Londonkragte en (waterstofbinding)*
- *Butan-1-ol ol het sterker Londonkragte as 2-metielpropan-1-ol*
- *Meer energie word benodig om die intermolekulêrekragte in butan-1-ol te oorkom* (3)

3.6
- Methanoic acid and propan-1-ol have both Hydrogen bond and (London forces) ✓
- Methanoic acid have two sites for hydrogen bonds while propan-1-ol have only one site for hydrogen bonds. ✓
- Methanoic acid has stronger intermolecular forces than propan-1-ol ✓
- More energy is needed to overcome the intermolecular forces in methanoic acid. ✓

- *Metanoësuur en propan-1-ol het beide waterstofbinding en (Londonkragte)*
- *Metanoësuur het twee plekke vir waterstofbinding terwyl propan-1-ol slegs een plek het vir waterstofbinding*
- *Metanoësuur het sterker intermolekulêrekragte as propan-1-ol*
- *Meer energie word benodig om die intermolekulêrekragte te oorkom metanoësuur*

OR/*OF*

- Methanoic acid and propan-1-ol have both Hydrogen bond and (London forces) ✓
- Methanoic acid have two sites for hydrogen bonds while propan-1-ol have only one site for hydrogen bonds. ✓
- Propan-1-ol has weaker intermolecular forces than methanoic acid ✓
- Less energy is needed to overcome the intermolecular forces in propan-1-ol. ✓

- *Metanoësuur en propan-1-ol het beide waterstofbinding en (Londonkragte)*
- *Metanoësuur het twee plekke vir waterstofbinding terwyl propan-1-ol slegs een plek het vir waterstofbinding*
- *Propan-1-ol het swakker intermolekulêrekragte as metanoësuur*
- *Minder energie word benodig om die intermolekulêrekragte te oorkom in propan-1-ol* (4)

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QUESTION 4/*VRAAG 4*

4.1 Process of breaking down long chain hydrocarbons ✓/alkanes into smaller more useful chains ✓
Proses van opbreek van lang ketting koolwaterstowwe/alkane na kleiner meer bruikbare kettings (2)

4.2 4.2.1 C_4H_{10} ✓✓ (2)

4.2.2 HIGH TEMPERATURE ✓ **OR** HIGH PRESSURE
*HOË TEMPERATUUR **OF** HOË DRUK* (1)

4.3 4.3.1 Substitution ✓
Substitusie (1)

4.3.2 Elimination ✓
Eliminasie (1)

4.4 Hydrogenation ✓
Hidrogenasie (1)

4.5 4.5.1 Br_2/Bromine ✓
Br_2/ Broom (1)

4.5.2 Pt/Ni/Pd/Platinum/Nickel/Palladium ✓
Pt/Ni/Pd / Platinum/Nikkel/ Palladium (1)

4.6 $CH_3CH_2CH_2CHBr$ ✓✓+ KOH → $CH_3CH = CHCH_3$ ✓✓ + KBr + H_2O

Marking criteria/*Nasienkriteria*

- Organic reactant ✓✓
  Organiese reaktant
- Organic product ✓✓
  Organiese produk
- ALL Inorganic reagents correct ✓ (KOH, KBr and H_2O)
  ALLE anorganiese reagense korrek (KOH, KBr en H_2O

(5)
[15]

QUESTION 5/*VRAAG 5*

5.1 Change in concentration (of reactant/products) per unit time ✓✓
Verandering in konsentrasie (van reaktante/produkte) per eenheidstyd

OR/*OF*

Amount/Volume/Mass of reactant/product used/formed per unit time
Hoeveelheid/volume/Massa van reaktante/produkte gebruik/gevorm per eenheidstyd (2)

5.2 RELEASED ✓
VRYGESTEL
ΔH < 0 ✓/Energy of products is less than the energy of reactants/ Reaction exothermic
ΔH < 0/ Energie van produkte is minder as die energie van die reaktante/ Reaksie is eksotermies (2)

5.3 5.3.1 INCREASES ✓
VERHOOG (1)

5.3.2 NO EFFECT ✓
GEEN EFFEK (1)

5.4 5.4.1 After 120 s ✓
Na 120 s (1)

5.4.2 Concentration (of HCℓ) ✓ Surface area (of Zinc) ✓ **OR** temperature
Konsentrasie (van HCℓ) *Oppervlak (van Sink)* ***OF*** *temperatuur* (2)

5.5 5.5.1 Rate / *Tempo* = Δv/Δt= 300 -0✓ /120 – 0 ✓= 2,50 $cm^3{\cdot}s^{-1}$ ✓ (3)

5.5.2 $n = V/V_m$ ✓ OR/*OF* $pV = nRT$

$n = \frac{250 \times 10^{-3}}{24}$ ✓ $(101,3\times10^{3})(250\times10^{-6}) = n\,(8,31)(20+273)$✓

n= 0,01 mol H_2 produced/*geproduseer* n = 0,01 mol H_2 produced/*geproduseer*

Mole ratio HCℓ : H_2
Mol verhouding 2 : 1

n((HCℓ) = 2 n (H_2)
n((HCℓ) = 2(0,01) ✓
n((HCℓ) = 0,02 mol reacted

NOTE/*LET WEL*:

If the above formula was used to calculate the mole of H_2 then award formula mark for m= nM

As die bostaande formule gebruik was om die mol van H_2 te bereken, dan die toekenningsformule- punt vir m=nM

Mole Option/ *Mol Opsie*	**Mass Option/*Massa Opsie***
n= cV n = (0,5)(50×10^{-3}) ✓ n = 0,025 mol initially *aanvanklik*	m = nM m = (0,02)(36,5) ✓ m = 0,73 g reacted *reageer*
n (left) = n (initially) – n (reacted) n (left) = 0,025 – 0,02 ✓ n (left) = 0,005 mol	m = cMV m = (0,5)(36,5)(50×10^{-3}) ✓ m = 0,9125 g initially
m = nM m = (0,005)(36,5) ✓ m = 0,1825 g ✓	m(left) = m (i) – m (r) m (left) = 0,9125 – 0,73 ✓ m (left) = 0,1825 g ✓

(7)

5.6 5.6.1 Catalyst ✓ **OR** Increases reaction rate
*Katalisator **OF** Toename in reaksie-tempo* (1)

5.6.2
- Catalyst lowers activation energy/provides an alternative path of lower activation energy ✓
  Katalisator verlaag die aktiveringsenergie/ bied 'n alternatiewe pad van laer aktiveringsenergie
- More particles have sufficient Ek OR more particles have Ek>Ea ✓
  Meer deeltjies het genoeg Ek OF meer deeltjie het Ek>Ea
- More effective collisions per unit time/Frequency of effective collisions increase ✓✓
  Meer effektiewe botsings per eenheidstyd/ Frekwensie van die effektiewe botsings neem toe (4)

[24]

QUESTION 6/*VRAAG 6*

6.1 Reaction in which products can be converted back to reactants ✓✓ **(2 or 0)**
Reaksie waarin produkte terug na reaktante oorgeskakel word ***(2 of 0)*** (2)

6.2 6.2.1 Decreases ✓
Verlaag (1)

6.2.2 Increases ✓
Verhoog (1)

6.3
- (When the temperature is decreased) the exothermic reaction is favoured ✓
- Forward reaction is favoured ✓
(Wanner die temperatuur verlaag) word die eksotermiese reaksie bevoordeel
Voorwaartse reaksie word bevoordeel (2)

6.4 **CALCULATION USING MOLES/*BEREKENINGE DEUR MOL TE GEBRUIK***
Marking guideline/Nasienriglyn

- Formula/*formule* n=m/M
- Substitution of/*Substitusie van* 28 $g·mol^{-1}$
- Use of ratio/*Gebruik van verhouding* $N_2:H_2:NH_3$
- Equilibrium amounts of N_2 and H_2 formed/ *Ewewigshoeveelheid van N_2 en H_2 gevorm*
- Division $n_{equilibrium}$ of N_2, H_2 and NH_3 by 2 / *Deel van n_{ewewig} van N_2, H_2 en NH_3 deur 2*
- Correct Kc expression/*Korrekte Kc uitdrukking*
- Substitution into Kc expression/*substitusie in Kc uitdrukking*
- Final answer/*Finale antwoord*

n = m/M ✓
= 7,84/28 ✓
= 0,28 mol

$$N_2 + 3H_2 \rightleftharpoons 2NH_3$$

	N_2	$3H_2$	$2NH_3$
n_i (mol)	0,28	0,6	0
Δn (mol)	0,06	0,18	0,12 Ratio ✓/*Verhouding*
n_e (mol)	0,22	0,42 ✓	0,12
c_e	0,22/2	0,42/2	0,12/2 Division by 2 ✓/*Deel met 2*
($mol·dm^{-3}$)	=0,11	0,21	0,06

$Kc = [NH_3]^2/[N_2].[H_2]^3$ ✓

$= 0,06^2/(0,11 \times 0,21^3)$ ✓

= 3,53 ✓

CALCULATION USING CONCENTRATION/*BEREKENIGE DEUR GEBRUIK TE MAAK VAN KONSENTRASIE*

<u>Marking guidelines/ *Nasienriglyne*</u>

- Formula / Formule c=m/MV or c=n/v
- Substitution into*/ Substitusie in* c=m/MV or c=n/V
- Dividing by 2 for all concentration/ *Deel deur 2 vir alle konsentrasies*
- Use of ratio/ *Gerbuik van verhoudings* N_2:H_2:NH_3
- Equilibrium concentrations of*/ Ewewig konsentrasies van* N_2, H_2 and NH_3
- Correct Kc expression/*Korrekte Kc uitdrukking*
- Substitution into Kc expression/ *Substitusie in Kc uitdrukking*
- Final answer /*Finale antwoord*

✓ (Any one/*Enige een*)

c (N_2) = m/MV	c (H_2) = n/V	c (NH_3) = n/V
c (N_2) = 7,84/(28)(2) ✓	c (H_2) = 0,6/2	c (NH_3) = 0,12/2
c (N_2) = 0,14 mol·dm^{-3}	c (H_2) = 0,3 mol·dm^{-3}	c (NH_3) = 0,06 mol·dm^{-3}

(dividing by/*deel van* 2) ✓

	N_2	+ 3 H_2	→ 2 NH_3
c_i	0,14	0,3	0
Δc	-0,03	-0,9	+0,06 ratio ✓/*verhouding*
c_{eq}	0,11	0,21	0,06 ✓

Kc = $[NH_3]^2/[N_2]\cdot[H_2]^3$ ✓

= $0,06^2/(0,11 \times 0,21^3)$ ✓

= 3,53 ✓ (8)

6.5 As pressure increases percentage yield increases. ✓✓
As die druk toeneem, neem die persentasie opbrengs toe. (2)

6.6 **MOLE OPTION / *MOLOPSIE***

Ratio/*Verhouding* $N_2 : H_2$ 1: 3 $n(H_2) = 3 (0,28)$ ✓ $n(H_2) = 0,84$ mol of H_2 needed only 0,6 mol of H_2 is available	Ratio/*Verhouding* $N_2 : H_2$ 1 : 3 $n(N_2) = 1/3 (0,6)$ $n(N_2) = 0,2$ mol of N_2 needed 0,28 mol of N_2 is available

0,84 *mol van* H_2 *word benodig* *Slegs 0,6 mol van* H_2 *is beskikbaar* ∴ H_2 is the limiting reagent ✓ ∴H_2 *is die beperkende reagens*	*0,2 mol* N_2 *word benodig* *0,28 mol* N_2 *is beskikbaar* ∴ H_2 is the limiting reagent ∴ H_2 *is die beperkende reagens*

Theoretical yield/*Teoretiese opbrengs* = 0,6 x 2/3 = 0,4 mol ✓

% Yield/*Opbrengs* = actual yield (*werklike opbrengs)/*theoretical yield(*teoretiese opbrengs)* × 100 %
= 0,12/0,4 x 100 ✓
= 30%

Pressure / *Druk*= 100 (atmospheres/*atmosfeer*) ✓

CONCENTRATION OPTION/*KONSENTRASIE-OPSIE*

• V is constant/*V is konstant* • Concentration ratio $N_2 : H_2$ *Konsentrasie-verhouding 1*: 3 $c(H_2) = 3 (0,14)$ ✓ $c(H_2) = 0,42\ mol \cdot dm^{-3}$ of H_2 required *H_2 benodig* only $0,3\ mol \cdot dm^{-3}$ is available *slegs 0,3* $mol \cdot dm^{-3}$ *is beskikbaar*	Concentration ratio $N_2 : H_2$ *Konsentrasie-verhouding* 1 : 3 $c(N_2) = 1/3 (0,3)$ $c(N_2) = 0,1\ mol \cdot dm^{-3}$ $0,14\ mol \cdot dm^{-3}$ is available *0,14* $mol \cdot dm^{-3}$ *is beskikbaar*

∴ H_2 is the limiting reagent/*is die beperkende reagens* ✓

Theoretical yield/*teoretiese opbrengs* = 0,3×2/3 ✓= $0,2\ mol \cdot dm^{-3}$

% yield/*opbrengs* = actual yield (*werklike opbrengs)*/theoretical yield/*teoretiese opbrengs* ×100 %
% yield/*opbrengs* = 0,06/0,2 ×100 % ✓
% yield/*opbrengs* = 30 %
Pressure/*druk* 100 (atmosphere/*atmosfeer*) ✓ (5)

[21]

QUESTION 7/*VRAAG 7*

7.1 7.1.1 Reaction of a salt with water ✓✓
Reaksie van 'n sout met water (2)

7.1.2 (Excess) Hydroxide/OH^- ions are formed ✓
Hydroxide/ OH^- is basic/alkaline ✓

(Oormaat) Hidroksied/ OH^- ione word gevorm
Hidroksied/ OH^- is basies/alkalies (2)

7.1.3 H_2O ✓ and HCO_3^- ✓ (2)

7.1.4 HCO_3^- can accept a proton (H^+) (to form H_2CO_3) ✓
HCO_3^- can donate a proton (H^+) (to form CO_3^{2-}) ✓

HCO_3^- kan 'n proton (H^+) aanvaar (om H_2CO_3 te vorm)
HCO_3^- kan 'n proton (H^+) skenk (om CO_3^{2-} te vorm) (2)

7.2 7.2.1 Acid is a proton donor ✓✓
Suur is 'n protonskenker (2)

7.2.2 $pH = -\log [H_3O^+]$ ✓
$1 = -\log [H_3O^+]$ ✓
$[H_3O^+] = 0,1 \text{ mol·dm}^{-3}$ ✓
$[X] = 2 [H_3O^+]$
$[X] = 2(0,1)$
$[X] = 0,2 \text{ mol·dm}^{-3}$ ✓ (4)

7.2.3 It is a solution of <u>known concentration</u> ✓✓
Dit is 'n oplossing met <u>bekende konsentrasie</u>. (2)

7.2.4 Bromothymol blue ✓
Acid X is a strong acid.
<u>KOH is a strong base</u>. ✓
There is <u>no hydrolysis of the salt produced, therefore the equivalence point of the titration would be within the range of indicator</u>. ✓

Broomtimolblou
Suur X is 'n sterk suur.
KOH is 'n sterk basis.
Daar is geen hidrolisereaksie van die sout wat vorm, dus sal ekwivalente punt van die titrasie binne die grense van die indikator wees. (3)

7.2.5

$c_1V_1=c_2V_2$ 0,049 x 15 ✓ = c_2 x 90 ✓ c_2 = 8,17 $\times 10^{-3}$ mol·dm^{-3}	
$n_{Acid/suur}$ = cV ✓ = 8,17 $\times 10^{-}$x 25$\times 10^{-3}$ ✓ = 2,04$\times 10^{-4}$ mol n(KOH) = 2 x 2,04$\times 10^{-4}$ ✓ = 4,08 x 10^{-4} mol c = n/V = 4,08 x 10^{-4}/ 28,5 x 10^{-3} ✓ = 0,014 mol·dm^{-3} ✓	caVa/cb.Vb = na/nb ✓ 8,17 $\times 10^{-3}$ x 25 ✓/ cb.28,5 ✓ = ½ ✓ c_b = 0,014 mol·dm^{-3} ✓

(7)
[26]

TOTAL/*TOTAAL:* 150