



education

Department of
Education
FREE STATE PROVINCE

EXAMINATION

GRADE 12

PHYSICAL SCIENCES
(PAPER 2: CHEMISTRY)

JUNE 2022

Stanmorephysics

MARKS: 150

TIME: 3 HOURS

This question paper consists of 16 pages and two data sheets.

INSTRUCTIONS AND INFORMATION

1. Write your name and other information in the applicable spaces on the ANSWER BOOK.
2. This question paper consists of nine questions. Answer ALL 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 pocket 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 where applicable.
11. Give brief motivations, discussions, et cetera where required.
12. Write neatly and legibly.



QUESTION 1: MULTIPLE-CHOICE QUESTIONS

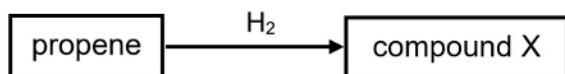
Four options are provided as possible answers to the following questions. Each question has only ONE correct answer. Choose the answer and write down only the letter A, B, C or D next to the question number (1.1–1.10) in your ANSWER BOOK.

- 1.1 Which one of the following compounds contains a formyl group?
- A Propanol

 B Propanal
 C Propan-2-one
 D Propanoic acid (2)
- 1.2 Which general formula represents haloalkanes?
- A $C_nH_{n+1}X$
 B $C_nH_{2n-1}X$
 C $C_nH_{2n-2}X$
 D $C_nH_{2n+1}X$ (2)
- 1.3 Which one of the following compounds is a hydrocarbon molecule?
- A $CH_3(CH_2)_2CH_3$
 B $CH_3COCH_2CH_3$
 C $CH_3CH_2CH_2COOH$
 D $CH_3CH(OH)CH_2CH_3$ (2)
- 1.4 Consider the IUPAC name below.
- Propyl butanoate**
- Which two organic molecules were used to prepare the molecule above?
- | | | |
|---|----------|----------------|
| A | Butanol | Propanoic acid |
| B | Propane | Butanoic acid |
| C | Propanol | Butanoic acid |
| D | Butane | Propanoic acid |
- (2)



1.5 Consider the flow diagram below:

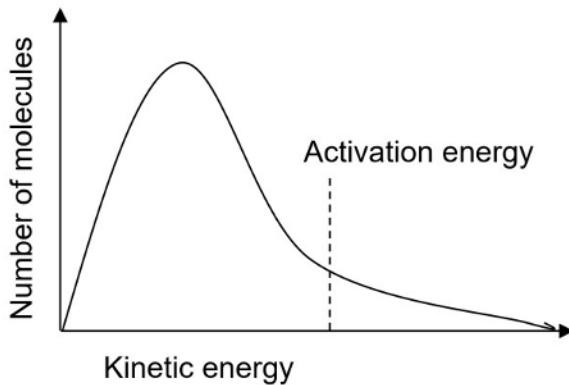


Which catalyst is most suitable for the reaction above?

- A H_2SO_4 
- B Pt
- C H_3PO_4
- D Zn

(2)

1.6 The given graph represents a Maxwell-Boltzman curve. The activation energy for a certain reaction is indicated by the dotted line.



A change was made and it was found that the activation energy moved to the RIGHT. What is a possible explanation for this?

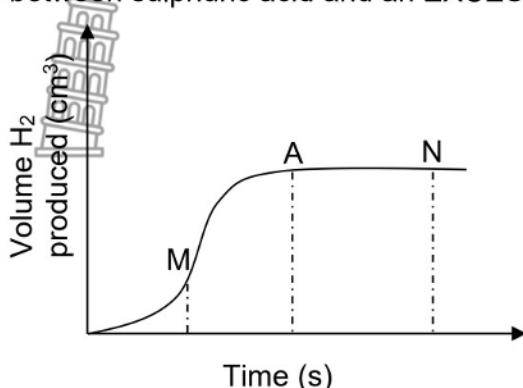
- A The catalyst was removed.
- B The temperature was increased.
- C The concentration was decreased.
- D The volume of the reaction vessel was increased.

(2)



**USE THE FOLLOWING INFORMATION AND GRAPH TO ANSWER
QUESTIONS 1.7 AND 1.8.**

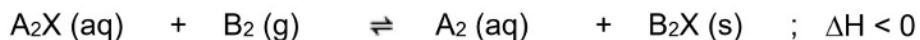
The graph shows how the total volume of hydrogen gas (H_2) produced by the reaction between sulphuric acid and an EXCESS of magnesium varied with time.



- 1.7 Which ONE of the statements about SECTION **AN** of the curve is correct?
- A All the magnesium has reacted.
 - B No more hydrogen gas is produced.
 - C The rate of the reaction is at a maximum.
 - D The concentration of the acid is decreasing. (2)
- 1.8 Which ONE of the statements about SECTION **MA** of the curve is correct?
- A A catalyst is introduced.
 - B The reaction is exothermic.
 - C The magnesium is in excess.
 - D The acid's concentration is decreasing. (2)



1.9 The following reaction reaches equilibrium in a closed container:



The pressure in the container is then decreased by releasing some of **B₂** from the container.

What effect does this have on the rate of the reverse reaction and the concentration of **A₂**?

	Rate of reverse reaction	Concentration of A ₂
A	Increases	Increases
B	Decreases	Decreases
C	Decreases	Increases
D	Increases	Decreases

(2)

1.10 Consider the following equilibrium reaction:



For this reaction the *K_c* value is **2 × 10⁻²** at a certain temperature. To change the *K_c* value to **6 × 10⁻²** ...

- A the temperature must be increased.
- B the temperature must be decreased.
- C the pressure must be increased.
- D a catalyst must be added.

(2)

[20]

QUESTION 2

The letters **A** to **F** in the table below represent six organic compounds.

A	Propanoic acid	B	Hexanal
			
C	Butane	D	$ \begin{array}{ccccccccc} & & & & \text{Br} & & & & \\ & \text{H} & & \text{C} & - & \text{H} \\ & & & & & & & & & & & & & & & \\ & \text{H} & & \text{H} & & \text{Br} & & \text{Br} & & \text{H} & & \text{H} & & \text{H} & & \text{H} \\ & & & & & & & & & & & & & & & \\ & \text{H} & & \text{H} \end{array} $
E	$ \begin{array}{ccccc} & \text{H} & \text{H} & \text{H} & \text{H} \\ & & & & \\ \text{H} & - & \text{C} & - & \text{C} & - & \text{C} & - & \text{C} & - & \text{OH} \end{array} $	F	$ \begin{array}{ccccccccc} & \text{H} & \text{H} & \text{H} & \text{H} & \text{H} & \text{O} & & \text{H} \\ & & & & & & \parallel & & \\ \text{H} & - & \text{C} & - & \text{C} & - & \text{C} & - & \text{C} & - & \text{H} \end{array} $

- 2.1 Write down the letter(s) that represent(s) a:

 - 2.1.1 Hydrocarbon (1)
 - 2.1.2 Ketone (1)

2.2 Define the term *functional isomer*. (2)

2.3 Write down the IUPAC name of the FUNCTIONAL ISOMER of compound A. (2)

2.4 For compound B, write down the:

 - 2.4.1 Homologous series to which it belongs. (1)
 - 2.4.2 Structural formula (2)
 - 2.4.3 General formula (1)

2.5 Write down the IUPAC name of compound D. (3)



- 2.6 A catalyst is needed during the reaction of compound **A** with compound **E**.
Write down the following:

2.6.1 Name or formula of the catalyst (1)

2.6.2 Structural formula of the ORGANIC product that is formed. (2)

- 2.7 **220 g** of compound **C** reacts with EXCESS oxygen.

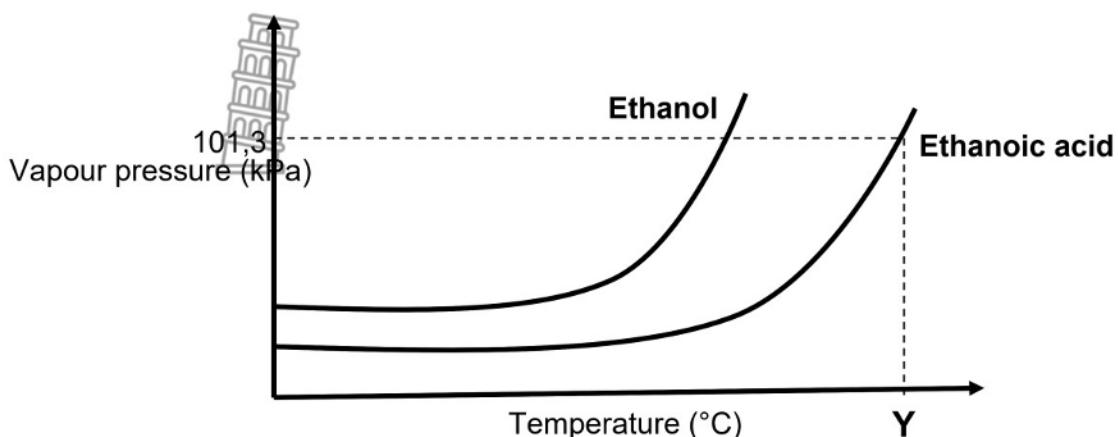
2.7.1 Write down the balanced chemical equation for the combustion of compound **C**. (3)

2.7.2 Calculate the mass of the carbon dioxide that is produced. (5)
[24]



QUESTION 3

The graph below, not drawn to scale, shows the VAPOUR PRESSURE of two organic compounds.



- 3.1 Define the term *vapour pressure*. (2)
- 3.2 Write down the independent variable for this investigation. (1)
- 3.3 Which compound has the lowest boiling point? (1)
- 3.4 Fully explain the answer in question 3.3. (4)
- 3.5 Name and define the term for the temperature represented by Y. (3)
- 3.6 Redraw the graph above in your answer book. On the same set of axes, sketch the curve that will be obtained when ethanoic acid is replaced with propanone. Clearly label the two curves. (2)
- 3.7 The table below shows the IUPAC names of three alkanes.

Alkane	IUPAC name
A	2,2-dimethylpropane
B	2-methylbutane
C	pentane

- 3.7.1 Is the vapour pressure of 2,2-dimethylpropane HIGHER THAN, LOWER THAN or EQUAL TO that of 2-methylbutane? Fully explain your answer. (4)
 - 3.7.2 Arrange the above alkanes in order of DECREASING strength of intermolecular forces. (2)
- [19]

QUESTION 4

Consider the following organic reactions **1** to **4** involving compounds **A** to **E**.

 Reaction 1	$\text{A} + \text{Br}-\text{Br} \xrightarrow{\text{Heat}} \text{B} + \text{H}-\text{Br}$
Reaction 2	$\text{B} + \text{KOH}_{(\text{conc})} \rightarrow \text{C} + \text{KBr} + \text{D}$
Reaction 3	$\text{C} + \text{H}_2\text{O} \rightarrow \begin{array}{c} \text{H} & \text{H} & \text{H} & \text{H} & \text{H} \\ & & & & \\ \text{H}-\text{C} & -\text{C} & -\text{C} & -\text{C} & -\text{C}-\text{H} \\ & & & & \\ \text{H} & \text{O} & \text{H} & \text{H} & \text{H} \end{array}$
Reaction 4	$\text{A} \rightarrow \text{C}_3\text{H}_6 + \text{E}$

4.1 Name the type of reaction represented by:

4.1.1 Reaction 1 (1)

4.1.2 Reaction 3 (1)

4.2 Consider **reaction 1**.

4.2.1 To which homologous series does compound **B** belong? (1)

4.2.2 Write down the IUPAC name of compound **A**. (2)

4.3 Consider **reaction 2**.

4.3.1 Name the TYPE of elimination reaction represented by this reaction. (1)

4.3.2 Write down one reaction condition needed. (1)

4.3.3 Write down the name of compound **D**. (1)

4.4 Consider reaction 3.

- 4.4.1 Is compound **C** SATURATED or UNSATURATED? Give a reason for your answer. (2)

- 4.4.2 Write down the IUPAC name of compound **C**. (2)

4.5 Consider reaction 4.

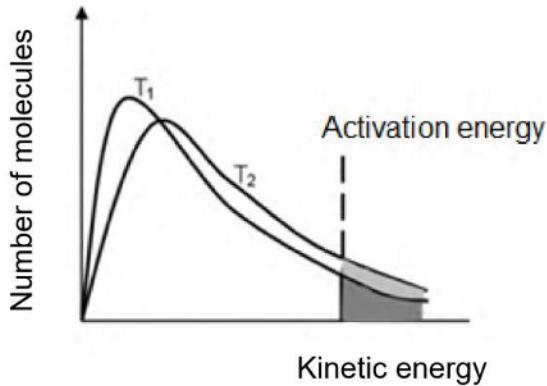
- 4.5.1 Name the type of reaction represented by reaction 4. (1)

- 4.5.2 Using CONDENSED STRUCTURAL FORMULAE, write down the balanced equation for this reaction. Indicate the reaction condition above the arrow. (4) [17]

QUESTION 5

The collision theory can be used to explain how different factors affect the rate of a chemical reaction.

- 5.1 Name TWO conditions that determine whether a collision between two molecules, **A** and **B**, will lead to a chemical reaction. (2)
- 5.2 The following graphs show two identical reactions taking place at different temperatures.



- 5.2.1 In terms of the collision theory, explain why the rate of a chemical reaction increases with increasing temperature. (2)
- 5.2.2 Which graph represents the reaction taking place at a higher temperature? Write only T₁ or T₂. (1)
- 5.2.3 What is represented by the TOTAL area under each graph? (1)
- 5.2.4 What is represented by the SHADeD area under both graphs? (2) [8]

QUESTION 6

A group of learners use the reaction between zinc and sulphuric acid to investigate one of the factors that affects reaction rate. The equation below represents the reaction that takes place.

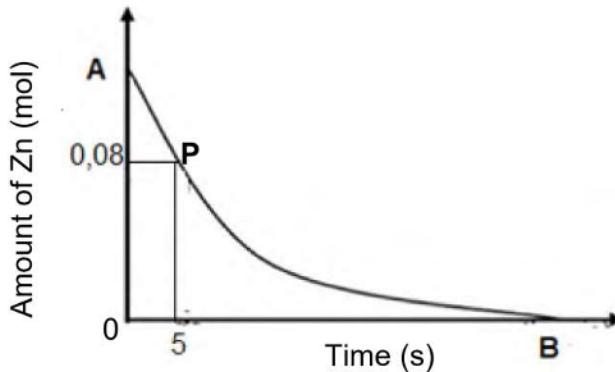


They add 6,5 g of zinc granules to excess DILUTE sulphuric acid and measure the **mass of zinc used per unit time**.

The learners then repeat the experiment using excess CONCENTRATED sulphuric acid.

- 6.1 Define the term *reaction rate*. (2)
- 6.2 Which factor influencing reaction rate is investigated? (1)
- 6.3 Write down a hypothesis for this investigation. (2)
- 6.4 The learners must use the same mass of ZINC GRANULES in both experiments. Which variable is controlled by doing this? (1)

The results obtained for the reaction using DILUTE sulphuric acid are represented in the graph below.



- 6.5 Calculate the value of **A** on the y-axis. (3)
- 6.6 Calculate the value of **B** on the x-axis if the average rate of the reaction was $0,15 \text{ g}\cdot\text{s}^{-1}$ for the part of the graph represented by **PB**, where **P** is at $t = 5 \text{ s}$. (5)
- 6.7 Copy the above graph into your ANSWER BOOK. ON THE SAME SET OF AXES, use a dotted line to draw the curve that will be obtained when concentrated sulphuric acid is used. (3)
[17]

QUESTION 7

Learners perform six experiments to study the factors which affect the rate of chemical reactions. They use the reaction between solid calcium carbonate (CaCO_3) and an excess hydrochloric acid solution (HCl), represented by the balanced equation below, in all the experiments.



An EXCESS HYDROCHLORIC ACID is used, and the calcium carbonate is COMPLETELY COVERED in all the experiments. The CO_2 is released into the atmosphere.

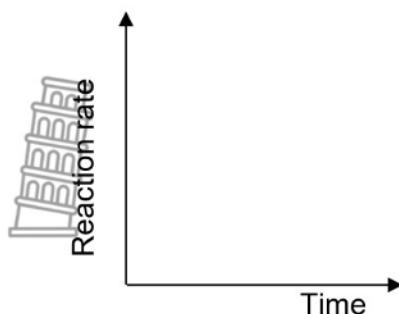
The conditions of the experiments are summarized in the table below:

	Mass of CaCO_3 (g)	State of CaCO_3	Concentration of HCl ($\text{mol}\cdot\text{dm}^{-3}$)	Temperature of HCl ($^{\circ}\text{C}$)
Experiment 1	2	powder	0,2	25
Experiment 2	2	lumps	0,2	25
Experiment 3	2	lumps	0,2	25
Experiment 4	2	lumps	1,0	25
Experiment 5	4	powder	0,2	25
Experiment 6	4	powder	0,2	35

- 7.1 Can the reaction reach equilibrium after some time? Write YES or NO.
Give a reason for your answer. (2)
- 7.2 Which factor influencing reaction rate is investigated using the conditions of experiments **1** and **2**? (1)
- 7.3 It was found that the reaction rate for experiments **2** and **3** are not the same. Give a possible reason for this observation. (1)
- 7.4 Compare experiments **3** and **4**. Write down the:
- 7.4.1 Independent variable (1)
 - 7.4.2 Dependant variable (1)
 - 7.4.3 One controlled variable (1)



- 7.5 The conditions of experiments **5** and **6** are now compared. Redraw the following set of axes in your answer book.

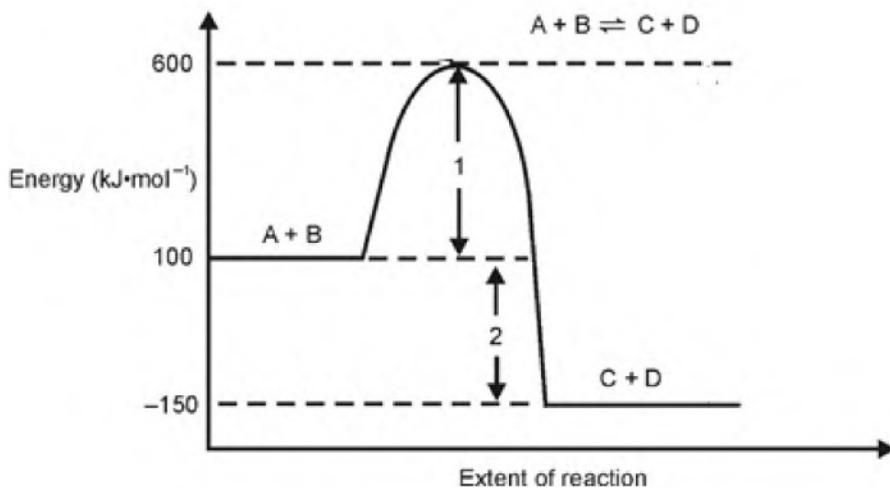


On the same set of axes, draw the expected graphs for experiments **5** and **6**; clearly showing their shapes and differences and label the two graphs.

(3)
[10]

QUESTION 8

In the following energy diagram, the x-axis represents the extent of reaction. The y-axis represents the energy of the reactants or products.



- 8.1 Give the name for:

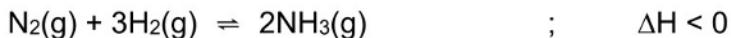
- 8.1.1 Label 1 (1)
- 8.1.2 Label 2 (1)
- 8.2 Is the reverse reaction ENDOTHERMIC or EXOTHERMIC? (1)
- 8.3 Calculate the activation energy for the reverse reaction shown on the diagram. (3)



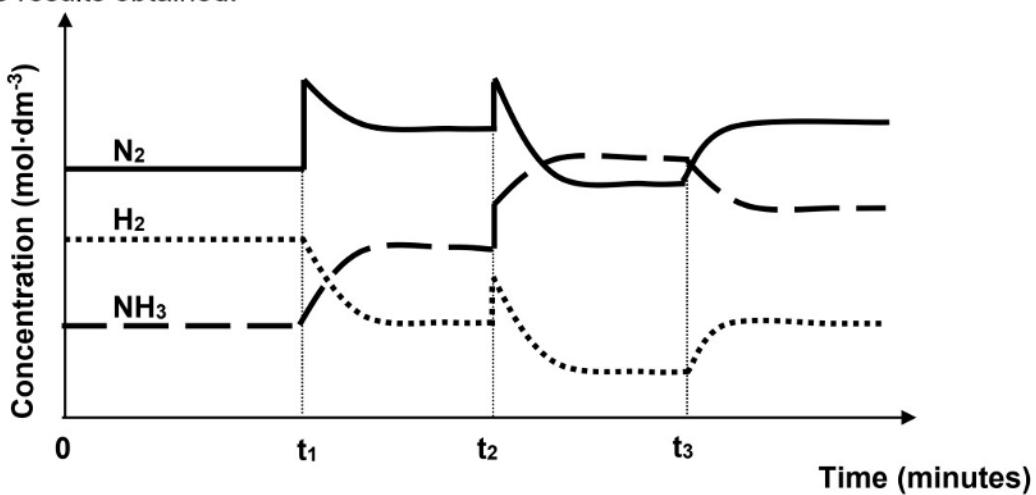
- 8.4 How will an increase in the concentration of **A** and **B** influence the activation energy for the reverse reaction? Write only INCREASES, DECREASES or REMAINS THE SAME. (1)
- 8.5 Calculate the heat of reaction (ΔH) for the reverse reaction. (3)
[10]

QUESTION 9


A laboratory produces ammonia at a temperature of 450 °C. The balanced equation below represents the reaction that takes place in a sealed container.



Adjustments are made to the TEMPERATURE, PRESSURE, CONCENTRATION and use of a CATALYST in the equilibrium mixture. The graphs below represent the results obtained.



- 9.1 Was the reaction at equilibrium at $t = 0$ s? Give a reason for your answer. (2)
- 9.2 Identify the changes made to the equilibrium mixture at each of the following times:
- 9.2.1 t_1 (2)
- 9.2.2 t_3 (2)



9.3 At t_2 a possible change in pressure took place.

9.3.1 Did the pressure INCREASE, DECREASE or REMAIN THE SAME? (1)

9.3.2 Give a reason for your answer in question 9.3.1. (2)

9.3.3 Refer to the principle of Le Chatelier and explain what would happen to the concentration of the NH_3 if the pressure was DECREASED. (3)



9.4 At which of the above time(s) did the change made to the reaction mixture lead to a higher yield of ammonia? Write down only t_1 and/or t_2 and/or t_3 . (2)

A laboratory technician now injects 5 mol of N_2 and 5 mol of H_2 into a 5 dm^3 sealed, empty container. Equilibrium is reached at 450 °C. Upon analysis of the equilibrium mixture, it is found that the mass of NH_3 is 20,4 g.

9.5 Calculate the value of the equilibrium constant (K_c) at 450 °C. (9)

9.6 What would happen to the K_c value calculated in question 9.5 if 10 mol of N_2 and 10 mol of H_2 were used? (2)
[25]

GRAND TOTAL: 150



**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 <i>Standaarddruk</i>	p^0	$1,013 \times 10^5 \text{ Pa}$
Molar gas volume at STP <i>Molére gasvolume by STD</i>	V_m	$22,4 \text{ dm}^3 \cdot \text{mol}^{-1}$
Standard temperature <i>Standaardtemperatuur</i>	T^0	273 K
Charge on electron <i>Lading op elektron</i>	e	$-1,6 \times 10^{-19} \text{ C}$
Avogadro's constant <i>Avogadro-konstante</i>	N_A	$6,02 \times 10^{23} \text{ mol}^{-1}$

TABLE 2: FORMULAE / TABEL 2: FORMULES

$n = \frac{m}{M}$	$n = \frac{N}{N_A}$
$c = \frac{n}{V}$	
OR/OF	
$c = \frac{m}{MV}$	$n = \frac{V}{V_m}$
$\frac{c_a V_a}{c_b V_b} = \frac{n_a}{n_b}$	$pH = -\log [H_3O^+]$
$K_w = [H_3O^+][OH^-] = 1 \times 10^{-14} \text{ at/by } 298 \text{ K}$	
$E_{cell}^\theta = E_{cathode}^\theta - E_{anode}^\theta$ OR $E_{cell}^\theta = E_{reduction}^\theta - E_{oxidation}^\theta$ OR $E_{cell}^\theta = E_{oxidising agent}^\theta - E_{reducing agent}^\theta$	$E_{sel}^\theta = E_{katode}^\theta - E_{anode}^\theta$ OR $E_{sel}^\theta = E_{reduksie}^\theta - E_{okstidasie}^\theta$ OR $E_{sel}^\theta = E_{oksideermiddel}^\theta - E_{reduseermiddel}^\theta$

THE PERIODIC TABLE OF ELEMENTS
DIE PERIODIEKE TABEL VAN ELEMENTE

	1	2	3	4	5	6	7	8	9	10	11	12	13	(III)	(IV)	(V)	(VI)	(VII)	(VIII)	18
(I)	H																		He	
(II)	Li	B	Be																Ne	
	7	9	12																20	
	6·0	11	12	Mg	24														4	
	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36		
	K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br	Kr		
	39	40	45	48	51	52	55	56	59	59	63,5	65	70	73	75	79	80	84		
	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	Xe	
	Rb	Sr	Y	Zr	Nb	Mo	Tc	Ru	Tc	Rh	Pd	Ag	Cd	In	Sb	Te	I			
	86	88	89	91	92	96	101	103	106	108	112	115	119	122	128	131				
	55	56	57	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86		
	Cs	Ba	La	Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	Tl	Pb	Bi	Po	At	Rn		
	133	137	139	179	181	184	186	190	192	195	197	201	204	207	209					
	87	88	89																	
	F	R	Ac																	
	140	141	226																	
	58	59	60	61	62	63	64	65	66	67	68	69	70	71						
	Ce	Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu						
	90	91	92	93	94	95	96	97	98	99	100	101	102	103						
	Th	Pa	U	Np	Pu	Am	Cm	Bk	Cf	Es	Fm	Md	No	Lr						
	232		238																	



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FREE STATE PROVINCE

EXAMINATION / EKSAMEN

GRADE 12 / GRAAD 12

PHYSICAL SCIENCES PAPER 2

FISIESE WETENSKAPPE VRAESTEL 2

MEMORANDUM

JUNE 2022 / JUNIE 2022

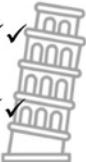
MARKS: 150 / PUNTE 150

TIME: 3 HOURS / TYD: 3 UUR



This memorandum consists of 15 pages.
Hierdie memorandum bestaan uit 15 bladsye.

QUESTION 1/VRAAG 1

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

[20]



QUESTION 2 / VRAAG 2

2.1.1 C✓ (1)

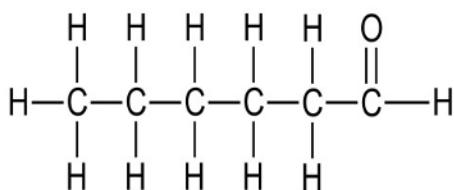
2.1.2 F✓ (1)

2.2 Compounds with the same molecular formula✓, but different functional groups✓ / Verbindings met dieselde molekuläre formule, maar verskillende funksionele groepe. (2)

2.3 Methyl✓ ethanoate✓ or ethyl✓ methanoate✓ / Metieletanoaat of Etielmetanoaat (2)

2.4.1 Aldehyde✓ / Aldehyied (1)

2.4.2



Marking criteria

- Correct functional group✓
- Whole structure correct✓

Puntetoekenning

- Korrekte funksionele groep
- Hele struktuur korrek

(2)

2.4.3 $\text{C}_n\text{H}_{2n}\text{O}$ ✓ or/of RCHO ✓ (1)

2.5 2,3-dibromo-3-ethyl-2-methylpentane / 2,3-dibromo-3-etiel-2-metielpentaan

Marking criteria

- Correct stem-pentane ✓
- All substituents correctly identified (ethyl, dibromo, methyl) ✓
- IUPAC name completely correct including numbering, sequence, hyphens and commas. ✓

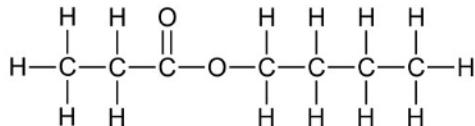
Puntetoekenning

- Korrekte stam – pentaan
- Alle vertakkings korrek (etiel, dibromo, metiel)
- IUPAC naam ten volle korrek insluitend volgorde en leestekens

(3)

2.6.1 Sulphuric acid or H_2SO_4 ✓ / Swawelsuur of H_2SO_4 (1)

2.6.2



Marking criteria

- Correct functional group✓
- Whole structure correct✓

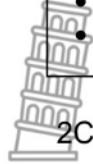
Puntetoekenning

- Korrekte funksionele groep
- Hele struktuur korrek

(2)

2.7.1

- Marking criteria / Puntetoekenning**
- Reactants ✓ / Reagense
 - Products ✓ / Produkte
 - Balancing ✓ / Balansering
 - Ignore phases / Ignoreer fases
 - Marking rule 6.3.10 / Reël 6.3.10



(3)

2.7.2

- Marking criteria / Puntetoekenning**

- Formula/Formule $n = \frac{m}{M}$ ✓
 - Substitute/Vervang $58 \text{ g}\cdot\text{mol}^{-1}$ in $n = \frac{m}{M}$ ✓
 - Use of mole ratio/ Gebruik molverhouding
- $n(\text{C}_4\text{H}_{10}) : n(\text{CO}_2) = 2 : 8$ ✓ **Accept/Aanvaar : 1 : 4**
- Substitute/Vervang $44 \text{ g}\cdot\text{mol}^{-1}$ in $n = \frac{m}{M}$ ✓
 - Final answer/Finale antwoord: $667,57 \text{ g}$ ✓
Range/Grens: $665,3$ - $691,68 \text{ g}$

Positive marking
Merk positief

Option 1 / Opsie 1

$$n(\text{C}_4\text{H}_{10}) = \frac{m}{M} \quad \checkmark \quad = \frac{220}{58} \checkmark \quad = 3,7931 \text{ mol}$$

$$\begin{aligned} n(\text{CO}_2) &= 4n(\text{C}_4\text{H}_{10}) \checkmark \\ &= 4(3,7931) = 15,172 \text{ mol} \end{aligned}$$

$$n(\text{CO}_2) = \frac{m}{M}$$

$$15,172 = \frac{m}{44} \checkmark$$

$$m = 667,57 \text{ g} \checkmark$$



Option 2 / Opsie 2

$$n(C_4H_{10}) = \frac{m}{M} \checkmark = \frac{220}{58} \checkmark = 3,7931 \text{ mol}$$

Moles/Mol (mol)	2 C ₄ H ₁₀	13 O ₂	8 CO ₂	10 H ₂ O
Initial/Aanvanklik	3,7931	Excess	0 ✓	0
Change/verandering	-2x		+8x	+10x
Equilibrium/Ewewig	3,7931-2x		+8x 15,174 ✓	+8x
Mass/Massa (m=nM)			m = (15,174)(44) m = 667, 59 g ✓	

$$x = \frac{\text{mol available}}{\text{mol used}} \quad / \quad x = \frac{\text{mol beskikbaar}}{\text{mol gebruik}}$$

$$x = \frac{3,7931}{2}$$

$$x = 1,89655 \text{ g}$$

(5)
[25]

QUESTION 3 / VRAAG 3

3.1 **Marking guidelines: Puntetoekenning**

If any one of the underlined key phrases in the **correct context** is omitted, deduct 1 mark / Indien enige een van die onderstreepte sleutelfrases in die korrekte konteks weggelaat word, trek 1 punt af

The pressure exerted by a vapor at equilibrium with its liquid in a closed system. ✓✓ / Die druk uitgeoefen deur 'n damp in ewewig met sy vloeistof in 'n geslotte sisteem. (2)

3.2 Functional group / Homologous series/Temperature/Boiling point ✓

Any one

Funksionele groep / Homoloë reeks / Temperatuur/Kookpunt.

Enige een

(1)

3.3 Ethanol ✓ / Etanol

(1)



3.4

Marking criteria

- State Ethanol has 1-site of Hydrogen bonds. ✓
- State Ethanoic acid has 2 sites of hydrogen bonds. ✓
- Compare strengths of intermolecular forces. ✓
- Compare energies required. ✓

Puntetoekenning

- Stel **Etanol** het 1-plek vir 'n waterstofbinding.
- Noem **Etanoësuur** het 2 plekke vir 'n waterstofbinding.
- Vergelyk sterkte van intermolukulêre kragte.
- Vergelyk energieë wat benodig word.

- There is 1-site of hydrogen bonds between molecules of **Ethanol** ✓ / Daar is een plek vir 'n waterstofbinding tussen molekules van **Etanol**
- There are 2-sites of hydrogen bonds between the molecules of **Ethanoic acid**. ✓ / Daar is twee plekke vir 'n waterstofbindings moontlik tussen **etanoësuur** molekules
- **Ethanoic acid** has stronger intermolecular forces than **Ethanol** between the molecules. ✓ / **Etanoësuur** het sterker intermolekulêre kragte as **etanol** tussen die molekules

OR/OF

Ethanol has weaker intermolecular forces than **Ethanoic acid** forces between the molecules. / **Etanol** het swakker/minder intermolekulêre kragte as **etanoësuur** tussen die molekules

- More energy is needed to overcome/break intermolecular forces between **Ethanoic acid** molecules. ✓ / Meer energie is nodig om die intermolekulêre kragte te oorkom/breek tussen **etanoësuur** molekules

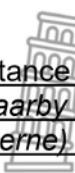
OR/OF

- Less energy is needed to overcome intermolecular forces between **Ethanol**. / Minder energie is nodig om die intermolekulêre kragte te oorkom tussen **etanol** molekules.

(4)

3.5 Boiling point ✓ / *Kookpunt*

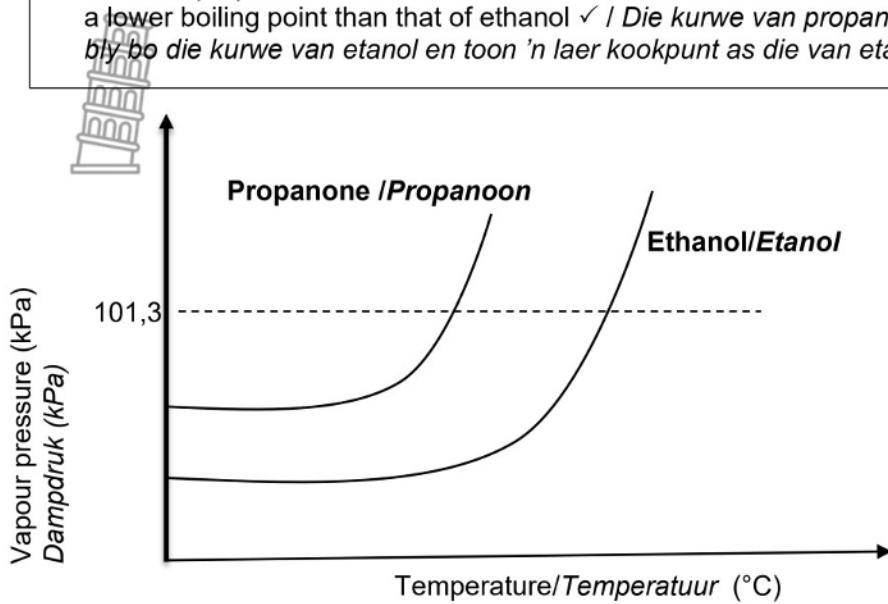
- The temperature at which the vapour pressure of a substance equals the atmospheric (external) pressure. ✓✓ / Die temperatuur waarby die dampdruk van 'n stof gelyk is aan die atmosferiese (eksterne) druk. (3)



3.6

Marking criteria / Puntetoekenning

- Curve of Propanone starts above the curve of Ethanol. ✓ / Die kurwe van propanoon begin bo die van etanol
- Curve of propanone remains above the curve of the Ethanol and shows a lower boiling point than that of ethanol ✓ / Die kurwe van propanoon bly bo die kurwe van etanol en toon 'n laer kookpunt as die van etanol.



(2)

3.7

Marking criteria/Puntetoekenning

- Higher than (Negative marking). ✓ Hoër as (Negatiewe nasien)
- Compare structures. ✓ Vergelyk strukture
- Compare the strengths of intermolecular forces. ✓ Vergelyk die sterkte van die intermolekulêre kragte
- Compare energies required. ✓ Vergelyk die energie benodig

3.7.1 Higher than ✓ Hoër as



- Compound A / 2,2-dimethylpropane has a smaller/lower surface area than compound B/2-methylbutane. ✓ / Verbinding A / 2,2-dimetielpropaan het 'n kleiner oppervlak as verbinding B / 2-metielbutaan
- The intermolecular forces of compound A/ 2,2-dimethylpropane are weaker than the intermolecular forces of Compound B / 2-methylbutane. ✓ / Die intermolekulêre kragte van verbinding A / 2,2-dimetielpropaan is swakker as die intermolekulêre kragte van verbinding B / 2-metielbutaan
- Less energy is needed to overcome the intermolecular forces of compound A/2,2-dimethylpropane. ✓ / Minder energie is nodig om die intermolekulêre kragte van verbinding A/2,2-dimetielpropaan te oorkom.

(4)

3.7.2 C B A ✓✓ OR pentane, 2-methylbutane, 2,2-dimethylpropane
 OF pentaan, 2-metielbutaan, 2,2 dimetielpropaan

Marking criteria / Puntetoekenning

- pentane stronger than 2-methylbutane ✓/ pentaan sterker as 2-metielbutaan
- 2-methylbutane/pentane stronger than 2,2-dimethylpropane. ✓ /
 2-metielbutaan /pentaan is sterker as 2,2 dimetielpropaan.

(2)
 [19]

QUESTION 4 / VRAAG 4

4.1.1 Substitution/Halogenation/Bromination ✓
 Substitusie/Halogenasie/Brominasie (1)

4.1.2 Addition/Hydration ✓ / Addisie/Hidrasie (1)

4.2.1 Haloalkane✓ (1)

4.2.2 pentane✓✓ / pentaan (2)

4.3.1 Dehydrohalogenation✓ Dehidrohalogenering (1)

4.3.2 (strong) Heat✓/(sterk) Hitte (1)

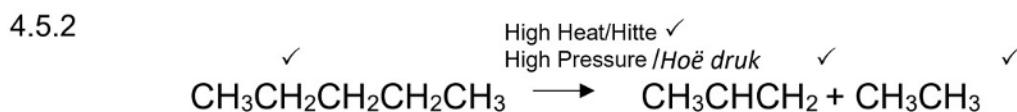
4.3.3 Water OR/OF H_2O ✓ (1)

4.4.1 UNSATURATED✓/ONVERSADIG

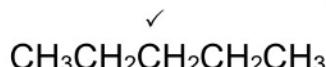
There are multiple or double bonds between C atoms in their hydrocarbon chains ✓/ Daar is meervoudige of dubbelbindings tussen C-atome in hul koolwaterstofkettings DO NOT ACCEPT TRIPLE BONDS/ MOET NIE TRIPPELBINDINGS AANVAAR NIE (2)

4.4.2 pent-1-ene✓✓ pent-1-een OR/OF pent-2-ene / pent-2-een (2)

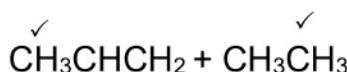
4.5.1 (Thermal) Cracking✓ / (Termiese) Kraking (1)



OR/OF



High Heat / Hitte
 High Pressure / Hoë druk ✓



(4)
 [16]

QUESTION 5 / VRAAG 5

- 5.1 Correct orientation ✓ and sufficient kinetic energy ✓ of the molecules A and B / Korrekte orientasie en voldoende kinetiese energie van molekules A en B (2)
- 5.2.1 Higher temperature causes an increase in average kinetic energy✓ of the reacting particles OR More particles will have sufficient kinetic energy OR More particles will have kinetic energy greater or equal to the activation energy. More effective collisions per unit time ✓ takes place because particles move faster. / Hoër temperatuur veroorsaak 'n toename in gemiddelde kinetiese energie✓ van die reagerende deeltjies. OF Meer deeltjie sal voldoende kinetiese energie hê OF Meer deeltjies sal kinetiese energie besit wat hoër of gelyk aan die aktiverings energie is. Meer effektiwe botsings per tydseenheid ✓ vind plaas omdat deeltjies vinniger beweeg. (2)
- 5.2.2 T_2 ✓ (1)
- 5.2.3 The (total) amount of molecules or particles,✓ which can participate in the reaction / Die (totale) hoeveelheid molekules of deeltjies wat kan reageer (1)
- 5.2.4 The (total) number of molecules ✓ with kinetic energy higher than the activation energy✓ OR The total number of molecules ✓ with sufficient kinetic energy to react. ✓ / Die (totale) aantal molekules met kinetiese energie hoër as die aktiveringsenergie OF Die totale aantal molekules met voldoende kinetiese energie om te reageer. (2)
[8]

QUESTION 6 / VRAAG 6

- 6.1.1 Reaction rate is the change in concentration of reactants or products per unit time. ✓✓ / Reaksietempo is die verandering in konsentrasie van die reagense of produkte per tydseenheid. (2)
- 6.1.2 Concentration✓/ Konsentrasie (1)
- 6.1.3 An increase in concentration of reactants will/will not lead to an increase in reaction rate✓✓ / 'n Toename in konsentrasie van reaktante sal/sal nie lei tot 'n toename in reaksietempo nie

Marking criteria / Puntetoekenning

- Both the independent and dependant variable needs to be included✓ Beide die onafhanklike en afhanklike veranderlike moet ingesluit word
- Some relationship between the variables needs to be stated✓ 'n Verwantskap tussen die veranderlikes moet gestel word

(2)

- 6.1.4 Surface area ✓/ Kontakoppervlak (1)

$$6.2 \quad n = \frac{m}{M} \checkmark = \frac{6,5}{65} \checkmark = 0,1 \text{ mol} \checkmark \quad (3)$$

6.3 Option 1 / Opsiie 1

Convert/Verwerk
0,08 mol to/na 5,2 g Zn

$$\text{Average rate/Gem. Tempo} = -\frac{\Delta m}{\Delta t} \checkmark$$

$$0,15 \checkmark = -\frac{0-5,2 \checkmark}{B-5 \checkmark}$$

$$B = 39,67 \text{ s} \checkmark$$

Option 2 / Opsiie 2

Convert/Verwerk
0,15 g·s⁻¹ to/na 2,31 × 10⁻³ mol·s⁻¹

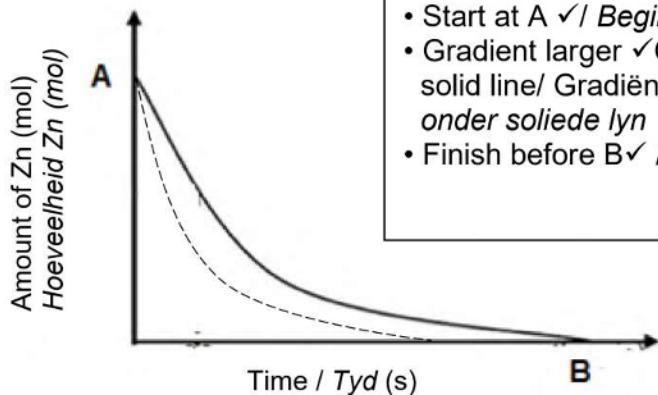
$$\text{Average rate/Gem. Tempo} = -\frac{\Delta n}{\Delta t} \checkmark$$

$$2,31 \times 10^{-3} \checkmark = -\frac{0-0,08 \checkmark}{B-5 \checkmark}$$

$$B = 39,67 \text{ s} \checkmark$$

(5)

6.4



Marking criteria: / Puntetoekening

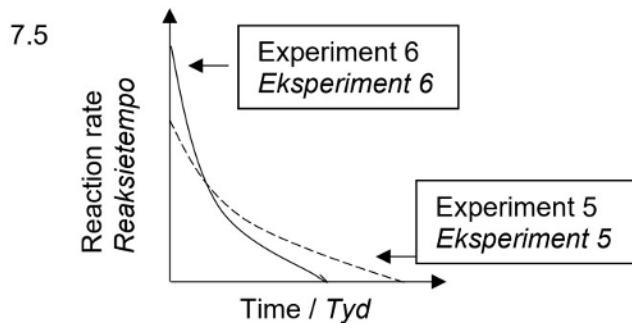
- Start at A ✓ / Begin by A✓
- Gradient larger ✓ OR dotted line below solid line/ Gradiënt groter✓ OF Stippellyn onder soliede lyn
- Finish before B✓ / Stop voor B✓

(3)
[17]



QUESTION 7 / VRAAG 7

- 7.1 No✓/Nee✓ (1)
- 7.2 State of division OR Surface area✓ / Toestand van verdeeldheid OF Kontakoppervlak (1)
- 7.3 One of the experiments introduced a catalyst / Een van die eksperimente gebruik n katalis (1)
- 7.4.1 Concentration✓ / Konsentrasie (1)
- 7.4.2 Reaction rate✓ / Reaksietempo (1)
- 7.4.3 State of division OR Surface area OR Mass of CaCO₃ OR Temperature✓ Toestand van verdeling OF kontakoppervlakte OF Massa van CaCO₃ OF Temperatuur (1)



Marking criteria: / Puntetoekenning

- Shape of the graphs ✓ / Vorm van die grafieke✓
- Experiment 6 higher on y-axis ✓ / Eksperiment 6 hoër op y-as✓
- Experiment 6 lower on x-axis ✓ / Eksperiment 6 laer op x-as✓

(3)

[9]

QUESTION 8 / VRAAG 8

- 8.1.1 Activation energy✓ / Aktiveringsenergie (1)
- 8.1.2 ΔH OR Enthalpy change OR Heat of reaction✓ ΔH OF Entalpieverandering OF Reaksiehitte of warmte (1)
- 8.2 Endothermic✓ / Endotermies (1)
- 8.3 Activation Energy / Aktiveringsenergie = 600✓ – (-150)✓ = 750 kJ·mol⁻¹✓ (3)
- 8.4 Remain the same✓ / Bly dieselfde (1)
- 8.5 ΔH = 100✓ – (-150)✓ = 250 kJ·mol⁻¹✓ (3)



[10]

QUESTION 9 / VRAAG 9

- 9.1 Yes,✓ the concentrations of the reactants and products remain constant✓
Ja, die konsentrasies van die reaktante en produkte bly konstant (2)
- 9.2.1 Concentration N₂ increases ✓✓ OR N₂ was added ✓✓ / Konsentrasie N₂ verhoog OF N₂ word bygevoeg (2)
- 9.2.2 Temperature was increased✓✓ / Temperatuur was verhoog (2)
- 9.3.1 Increase✓ / Verhoog (1)
- 9.3.2 The concentrations of the reactants and products increased. ✓✓ / Die konsentrasie van die reagense en produkte verhoog (2)
- 9.3.3 The system will react to increase the pressure by forming more gas molecules.✓ OR A decrease in pressure favours a reaction producing more moles of gas. The reverse reaction will be favoured✓ The concentration of NH₃ will decrease✓ / Die sisteem sal reageer om die druk te verhoog deur meer gasmolekules te vorm OF 'n Afname in druk bevoordeel 'n reaksie wat meer mol gas produseer. Die terugwaartse reaksie sal bevoordeel word. Die konsentrasie van die NH₃ sal verminder (3)
- 9.4 t₁ ✓ and / en t₂ ✓ (2)

9.5.1 Option 1 / Opsiie 1:

$$n(\text{NH}_3) = \frac{m}{M} = \frac{20,4}{17} \checkmark = 1,2 \text{ mol} \checkmark \text{ OR give two marks in table for } 1,2 \text{ mol}$$

	N ₂	H ₂	NH ₃
Mol ratio	1	3	2
Initial quantity (mol)	5	5	0
Change (mol)	0,6	1,8	1,2 ✓
Quantity at equilibrium (mol)	4,4 ✓	3,2	1,2
Concentration (mol·dm ⁻³)	0,88	0,64	0,24

Ratio✓

Divide by 5✓

$$K_c = \frac{[\text{NH}_3]^2}{[\text{N}_2][\text{H}_2]^3} \checkmark = \frac{(0,24)^2}{(0,88)(0,64)^3} \checkmark = 0,25 \checkmark$$

+ marking

No K_c expression, correct substitution: Max 8/9 Wrong K_c expression: Max 6/9

$$n(\text{NH}_3) = \frac{m}{M} = \frac{20,4}{17} \checkmark = 1,2 \text{ mol} \checkmark \quad \text{OF gee twee punte in die tabel vir } 1,2 \text{ mol}$$

	N ₂	H ₂	NH ₃
Molverhouding	1	3	2
Aanvanklike hoeveelheid (mol)	5	5	0
Verandering (mol)	0,6	1,8	1,2 ✓
Hoeveelheid by ewewig (mol)	4,4 ✓	3,2	1,2
Konsentrasie (mol·dm ⁻³)	0,88	0,64	0,24

Verhouding ✓

Deel deur 5 ✓

+ merk

$$K_c = \frac{[\text{NH}_3]^2}{[\text{N}_2][\text{H}_2]^3} \checkmark = \frac{(0,24)^2}{(0,88)(0,64)^3} \checkmark = 0,25 \checkmark$$

Geen Kc uitdrukking, korrekte substitusie: Maks 8/9
 Verkeerde Kc uitdrukking: Maks 6/9

Marking criteria/Nasienkriteria:

Calculation using number of moles

Mark allocation:

- Substitution ✓ in $n = \frac{m}{M}$ ✓
- Change in $n(\text{NH}_3) = 1,2 \text{ mol} \checkmark$
- $n(\text{NH}_3)$ at equilibrium = $1,2 \text{ mol} \checkmark$
- Using ratio $n(\text{N}_2) : n(\text{H}_2) : n(\text{NH}_3) = 1:3:2 \checkmark$
- $n(\text{N}_2)$ at equilibrium (initial - change) and $n(\text{H}_2)$ at equilibrium (initial - change) ✓
- Divide by volume ✓
- K_c expression ✓
- Substitution into K_c expression ✓

Option 2 / Opsie 2:

Calculations using concentration:

- Using $c = \frac{m}{M \times V} \checkmark$
- $[\text{NH}_3]$ at equilibrium = $0,24 \text{ mol} \cdot \text{dm}^{-3} \checkmark$
- Use concentration ratio $[\text{N}_2] : [\text{H}_2] : [\text{NH}_3] = 1:3:2 \checkmark$
- Divide by volume ✓
- Equilibrium concentration of N₂ (initial - change) ✓



- Equilibrium concentration of H₂ (initial - change) ✓
- K_c expression ✓
- Substitution into K_c expression ✓
- Final answer: 0,25 ✓

Berekening wat van konsentrasie gebruik maak:



- Gebruik van $c = \frac{m}{M \times V}$ ✓
- [NH₃] by ewewig = 0,24 mol · dm⁻³ ✓
- Gebruik konsentrasieverhouding [N₂] : n[H₂] : [NH₃] = 1:3:2 ✓
- Gedeel deur volume ✓
- Ewewigkonsentrasie van N₂ (aanvanklike - verandering) ✓
- Ewewigkonsentrasie van H₂ (aanvanklike - verandering) ✓
- K_c-uitdrukking ✓
- Substitusie in K_c-uitdrukking ✓
- Finale antwoord: 0,25 ✓

$$n(\text{NH}_3) = \frac{m}{M} = \frac{20,4}{17} = 1,2 \text{ mol} \text{ and } c = \frac{n}{V} \checkmark = \frac{1,2}{5} = 0,24 \text{ mol} \cdot \text{dm}^{-3} \checkmark$$

$$\text{OR } c = \frac{m}{M \times V} = \frac{20,4}{17 \times 5} \checkmark = 0,24 \text{ mol} \cdot \text{dm}^{-3} \checkmark \text{ OR give two marks in table}$$

	N ₂	H ₂	NH ₃	
Mol ratio	1	3	2	
Initial concentration (mol · dm ⁻³)	1	1	0	Devide by 5 ✓
Change in concentration (mol · dm ⁻³)	0,12	0,36	0,24	Ratio ✓
Equilibrium concentration (mol · dm ⁻³)	0,88 ✓	0,64 ✓	0,24 ✓✓	

$$K_c = \frac{[\text{NH}_3]^2}{[\text{N}_2][\text{H}_2]^3} \checkmark = \frac{(0,24)^2}{(0,88)(0,64)^3} \checkmark = 0,25 \checkmark$$

No K_c expression, correct substitution: Max 8/9
 Wrong K_c expression: Max 6/9



$$n(\text{NH}_3) = \frac{m}{M} = \frac{20,4}{17} = 1,2 \text{ mol en } c = \frac{n}{V} \checkmark = \frac{1,2}{5} = 0,24 \text{ mol} \cdot \text{dm}^{-3} \checkmark$$

OF $c = \frac{m}{M \times V} = \frac{20,4}{17 \times 5} \checkmark = 0,24 \text{ mol} \cdot \text{dm}^{-3} \checkmark$ OF gee twee punte in die tabel.



	N ₂	H ₂	NH ₃	
Molverhouding	1	3	2	
Aanvangskonsentrasie (mol·dm ⁻³)	1	1	0	Deel deur 5 ✓
Verandering in konsentrasie (mol·dm ⁻³)	0,12	0,36	0,24	Verhouding ✓
Ewewigskonsentrasie (mol·dm ⁻³)	0,88✓	0,64✓	0,24✓✓	

$$K_c = \frac{[\text{NH}_3]^2}{[\text{N}_2][\text{H}_2]^3} \checkmark = \frac{(0,24)^2}{(0,88)(0,64)^3} \checkmark = 0,25 \checkmark$$

Geen Kc uitdrukking, korrekte substitusie: Maks 8/9
 Verkeerde Kc uitdrukking: Maks 6/9

(9)

- 9.5.2 The Kc value will remain the same. ✓ Only temperature changes will influence the Kc value. ✓

(2)

[26]

TOTAL/ TOTAAL: 150

