education

Department of Education
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.

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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)

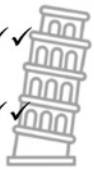
1.7 B ✓✓ (2)

1.8 D ✓✓ (2)

1.9 D ✓✓ (2)

1.10 B ✓✓ (2)

[20]





QUESTION 2 / *VRAAG 2*

2.1.1 C✓ (1)

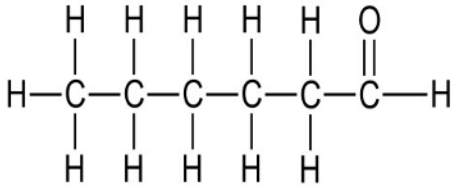
2.1.2 F✓ (1)

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

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

2.4.1 Aldehyde✓ / *Aldehied* (1)

2.4.2



Marking criteria
- Correct functional group✓
- Whole structure correct✓

Puntetoekenning
- *Korrekte funksionele groep*
- *Hele struktuur korrek*

(2)

2.4.3 $C_nH_{2n}O$ ✓ or/*of* RCHO ✓ (1)

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

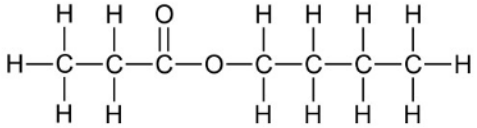
Marking criteria
- Correct stem-pentane ✓
- All substituents correctly identified (ethyl, dibromo, methyl) ✓
- IUPAC name completely correct including numbering, sequence, hyphens and commas. ✓

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 strutuur 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*

$2C_4H_{10} + 13O_2 \longrightarrow 8CO_2 + 10H_2O$ (3)

Positive marking
Merk positief

2.7.2

Marking criteria / *Puntetoekenning*
- Formula/*Formule* $n = \frac{m}{M}$ ✓
- Substitute/*Vervang* 58 g·mol^{-1} in $n = \frac{m}{M}$ ✓
- Use of mole ratio/ *Gebruik molverhouding*

  $n(C_4H_{10}) : n(CO_2) = 2 : 8$ ✓ **Accept/*Aanvaar* : 1 : 4**
- Substitute/*Vervang* 44 g·mol^{-1} in $n = \frac{m}{M}$ ✓
- Final answer/*Finale antwoord*: 667,57 g ✓
  Range/*Grens*: 665,3-691,68 g

Option 1 / *Opsie 1*

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

$n(CO_2) = 4n(C_4H_{10})$ ✓
$= 4(3{,}7931) = 15{,}172$ mol

$n(CO_2) = \frac{m}{M}$

$15.172 = \frac{m}{44}$ ✓

$m = 667{,}57\ g$✓

Option 2 / *Opsie 2*

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

Moles/*Mol* (mol)	2 C_4H_{10}	13 O_2	8 CO_2	10 H_2O
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 ✓	

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

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

$x = 1{,}89655\ g$

(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 geslote 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.*

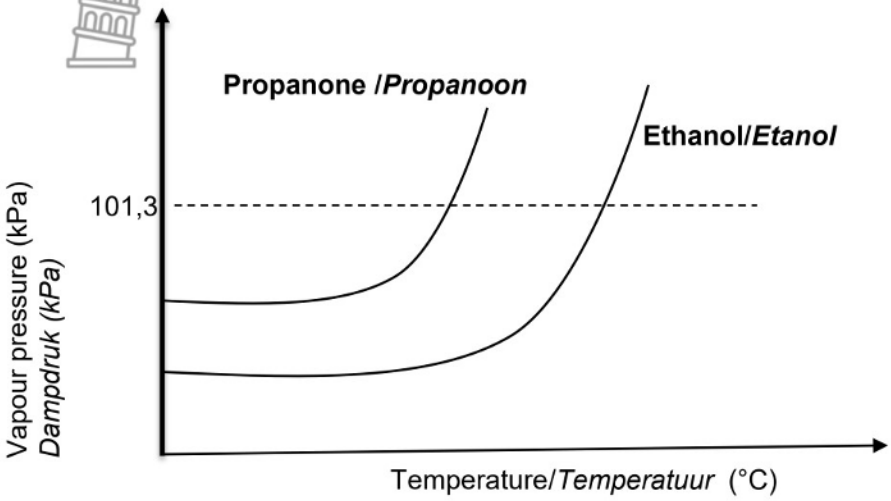
(4)

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)

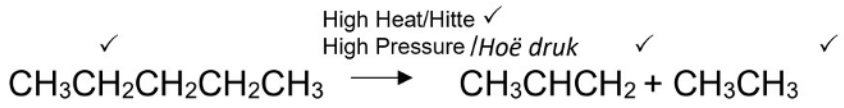
4.4.1 UNSATURATED✓/*ONVERSADIG*

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)

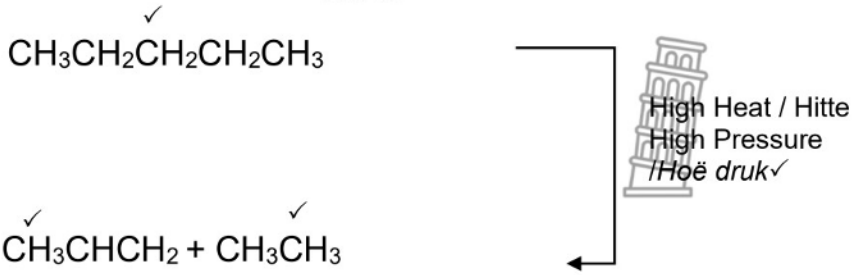
4.4.2 pent-1-ene ✓✓*pent-1-een* OR/*OF pent-2-ene / pent-2-een* (2)

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

4.5.2



OR/*OF*



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

6.3

Option 1 / *Opsie 1*

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

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

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

B = 39,67 s ✓

Option 2 / *Opsie 2*

Convert/*Verwerk*
0,15 $g{\cdot}s^{-1}$ to/*na* 2,31x 10^{-3} $mol{\cdot}s^{-1}$

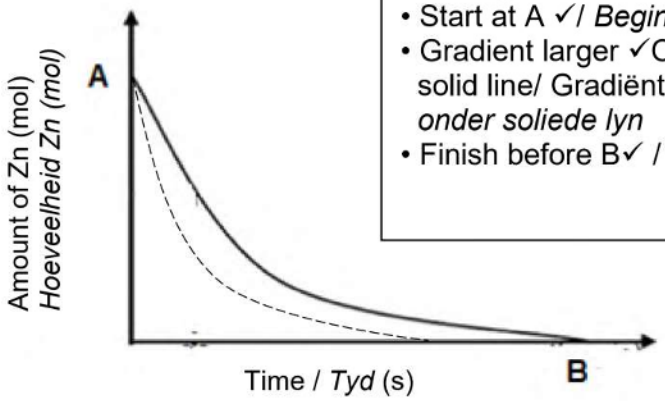
Average rate/*Gem. Tempo* = $-\frac{\Delta n}{\Delta t}\checkmark$

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

B = 39,67 s ✓

(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)

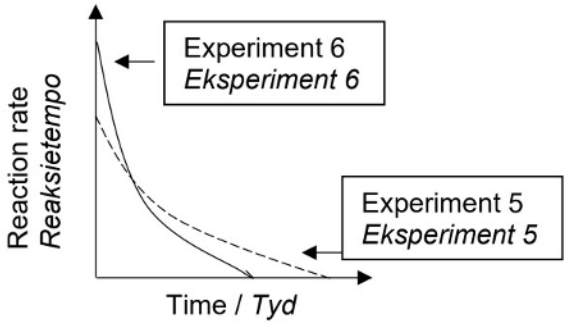
7.3 One of the experiments introduced a catalyst / *Een van die eksperimente gebruik 'n katalis* (1)

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 $CaCO_3$ OR Temperature✓
Toestand van verdeling OF kontakoppervlakte OF Massa van $CaCO_3$ OF Temperatuur (1)

7.5



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 N_2 increases ✓✓OR N_2 was added ✓✓ / *Konsentrasie N_2 verhoog OF N_2 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 NH_3 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 NH_3 sal verminder* (3)

9.4 t_1 ✓ and / *en* t_2 ✓ (2)

9.5.1 Option 1 / *Opsie 1*:

$n(NH_3) = \frac{m}{M} = \frac{20,4}{17}$✓ $= 1,2\ mol$✓ OR give two marks in table for 1,2 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	Ratio✓
Concentration (mol·dm^{-3})	0,88	0,64	0,24	Divide by 5✓

+ marking

$K_c = \frac{[NH_3]^2}{[N_2][H_2]^3}$✓ $= \frac{(0,24)^2}{(0,88)(0,64)^3}$✓ $= 0,25$✓

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

$n(NH_3) = \frac{m}{M} = \frac{20,4}{17}$ ✓ $= 1,2\ mol$ ✓ OF gee twee punte in die tabel vir 1,2 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 ($mol \cdot dm^{-3}$)	0,88	0,64	0,24

Verhouding ✓

Deel deur 5✓

+ merk

$K_c = \frac{[NH_3]^2}{[N_2][H_2]^3}$ ✓ $= \frac{(0,24)^2}{(0,88)(0,64)^3}$ ✓ $= 0,25$ ✓

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 $n(NH_3)$ = 1,2 mol ✓
- $n(NH_3)$ at equilibrium = 1,2 mol ✓
- Using ratio $n(N_2)$: $n(H_2)$: $n(NH_3)$ = 1:3:2 ✓
- $n(N_2)$ at equilibrium (initial - change) and $n(H_2)$ at equilibrium (initial - change) ✓
- Divide by volume ✓
- K_c expression ✓
- Substitution into K_c expression ✓

Option 2 / *Opsie 2*:

Calculations using concentration:

- Using $c = \frac{m}{M \times V}$ ✓
- $[NH_3]$ at equilibrium = 0,24$mol \cdot dm^{-3}$ ✓
- Use concentration ratio $[N_2]$: $[H_2]$: $[NH_3]$ = 1:3:2 ✓
- Divide by volume ✓
- Equilibrium concentration of N_2 (initial - change) ✓

- Equilibrium concentration of H_2 (initial - change) ✓
- Kc expression ✓
- Substitution into Kc expression ✓
- Final answer: 0,25 ✓

Berekeninge wat van konsentrasie gebruik maak:

- *Gebruik van* $c = \frac{m}{M \times V}$ ✓
- *[NH_3] by ewewig = 0,24mol·dm^{-3}* ✓
- *Gebruik konsentrasieverhouding [N_2]: n[H_2] : [NH_3] = 1:3:2* ✓
- *Gedeel deur volume* ✓
- *Ewewigskonsentrasie van N_2 (aanvanklike - verandering)* ✓
- *Ewewigskonsentrasie van H_2 (aanvanklike - verandering)* ✓
- *Kc-uitdrukking* ✓
- *Substitusie in Kc-uitdrukking* ✓
- *Finale antwoord: 0,25* ✓

n(NH_3) = $\frac{\text{m}}{\text{M}} = \frac{20,4}{17} = 1,2\ mol$ and $c = \frac{n}{V}$ ✓ $= \frac{1,2}{5} = 0,24\ mol \cdot dm^{-3}$ ✓

OR $c = \frac{m}{M \times V}$ $= \frac{20,4}{17 \times 5}$ ✓ $= 0,24\ mol \cdot dm^{-3}$ ✓ 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 ✓
Equilibirum concentration (mol·dm^{-3})	0,88 ✓	0,64 ✓	0,24 ✓✓	

$K_c = \frac{[NH_3]^2}{[N_2][H_2]^3}$ ✓ $= \frac{(0,24)^2}{(0,88)(0,64)^3}$ ✓ $= 0,25$ ✓

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

n(NH_3) = $\frac{m}{M} = \frac{20,4}{17} = 1,2\ mol$ en $c = \frac{n}{V}$ ✓ $= \frac{1,2}{5} = 0,24\ mol \cdot dm^{-3}$ ✓

OF $c = \frac{m}{M \times V} = \frac{20,4}{17 \times 5}$ ✓ $= 0,24\ mol \cdot dm^{-3}$ ✓ 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✓✓	

$K_c = \frac{[NH_3]^2}{[N_2][H_2]^3}$ ✓ $= \frac{(0,24)^2}{(0,88)(0,64)^3}$ ✓ $= 0,25$✓

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

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