WTS TUTORING

WTS

CHEMICAL CHANGE MEMO

GRADE : 12

COMPILED BY : PROF KWV KHANGELANI SIBIYA

: WTS TUTORS

CELL NO. : 0826727928

EMAIL : KWVSIBIYA@GMAIL.COM

FACEBOOK P. : WTS MATHS & SCEINCE TUTORING

WEBSITE : WWW.WTSTUTOR.COM

PAST PAPERS

QUESTION/*VRAAG* 5

5.1.1 (Use zinc) powder ✓ / Increase surface area (of zinc)
(Gebruik sink) poeier / Vergroot oppervlakarea (van sink) (1)

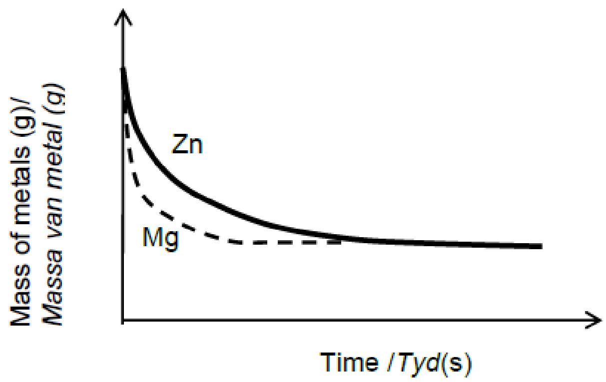
5.1.2 Increase (temperature) ✓ / Heat
Verhoog (temperatuur)/ Hitte (1)

5.2.1 Reaction is complete✓ / Reaction stops/Zinc is used up/ *Sink is opgebruik.*
Reaksie is volledig (voltooi) / Reaksie stop. (1)

5.2.2 t_1✓

Gradient highest✓ / Steepest gradient
Grootste gradient/Steilste gradiënt (2)

5.3.1



Criteria for graph Mg/Riglyne vir grafiek Mg

- Shape as shown with a steeper gradient below graph of Zn, starting from the same point and ends at the same point.✓
  Vorm soos aangedui met steiler gradient, onder grafiek van Zn, begin by dieselfde punt en eindig by dieselfde punt. ✓
- *Graph becomes horizontal in less time* ✓
  Grafiek word horisontaal in 'n korter tyd. ✓

(2)

5.3.2 Cu^{2+} is a stronger oxidising agent than H^+ ✓✓**OR** H^+ is a weaker oxidising agent than Cu^{2+}
Cu^{2+} is 'n sterker oksideermiddel as H^+ ***OF*** *H^+ is 'n swakker oksideermiddel as Cu^{2+}* (2)

5.4.1 Decrease in temperature ✓
Afname in temperatuur (1)

5.4.2
- Increase in temperature increases reaction rate. ✓
- Kinetic energy of particles increases as temperature increases. ✓
- More particles will have sufficient/enough (kinetic) energy/ $E_k \geq E_A$. ✓
- More effective collisions per unit time/second. ✓

- *Toename in temperatuur verhoog die reaksietempo.*
- *Kinetiese energie van deeltjies neem toe soos temperatuur toeneem.*
- *Meer deeltjies het genoegsame (kinetiese) energie/ $E_k \geq E_A$*
- *Meer effektiewe botsings per eenheidstyd/sekonde.*

OR/ OF
- Decrease in temperature decreases reaction rate ✓
- Kinetic energy of particles decreases as temperature decreases ✓
- Less particles will have sufficient/enough (kinetic) energy/$E_k \geq E_A$. ✓
- Less effective collisions per unit time/second. ✓

- *Afname in temperatuur verlaag die reaksietempo.*
- *Kinetiese energie van deeltjies neem af as temperatuur verlaag*
- *Minder deeltjies het genoegsame (kinetiese) energie/$E_k \geq E_A$.*
- *Minder effektiewe botsings per eenheidstyd./sekonde.* (4)

[14]

QUESTION/VRAAG 6

6.1 A reaction is reversible when products can be converted back to reactants.✓✓
'n Reaksie is omkeerbaar wanneer produkte terug omgeskakel kan word in reagense. **(2 or/of 0)** (2)

6.2.1 Decreases ✓ /*Verminder* (1)

6.2.2 Increases ✓ / *Vermeerder* (1)

6.3 10^{-3} ✓ (1)

6.4 **Marking Criteria/Nasienriglyne:**

- Equilibrium $n(AX_2)$ = Equilibrium $c(AX_2)$ x V ✓
  Ewewig $n(AX_2)$ = Ewewig $c(AX_2)$ x V
- Change in $n(AX_2)$ = equilibrium $n(AX_2)$ – initial $n(NH_3)$ ✓
  Verandering n(NH_3) = *ewewig n*(NH_3) – *aanvanklik n*(NH_3)
- USE RATIO for change in $n(AX_2)$ and change in $n(X_2)$ change.✓
  GEBRUIK VERHOUDINGS vir verandering in $n(AX_2)$ verandering in $n(X_2)$.
- n(equilibrium) = n(initial) – n (change) for $n(X_2)$ ✓
  n(ewewig) = n(aanvanklik) – n(verandering) vir $n(X_2)$
- Divide equilibrium $n(X_2)$ by V to calculate equilibrium $c(X_2)$.✓
  Verdeel ewewig $n(X_2)$ deur V om ewewig $c(X_2)$te bereken.
- Correct K_c expression (formulae in square brackets).✓
  Korrekte K_c-uitdrukking (formules in vierkant hakies)
- Substitution of concentrations into K_c expression. ✓
  Vervanging van konsentrasies in K_c-uitdrukking.
- *Final answer/Finale antwoord: 1,84 dm^{3}* ✓

POSITIVE MARKING from QUESTION 6.3
POSITIEWE NASIEN vanaf VRAAG 6.3
OPTION/*OPSIE 1*

	$3X_2$	$2AX_2$	
$n_{initial}$(mol) *$n_{aanvanklik}$(mol)*	0,46	0	
n_{change}(mol) *$n_{verandering}$(mol)*	0,15 V	+ 0,1 V ✓	Ratio ✓/*Verhouding*
$n_{equilibrium}$(mol) *n_{ewewig}(mol)*	0,46 – 0,15 V ✓	0,1 V ✓	
$c_{equilibrium}$($mol.dm^{-3}$) *c_{ewewig}($mol.dm^{-3}$)*	$\frac{0,46 - 0,15 \checkmark}{V}$	0,1	

$K_c = [AX_2]^2 / [X_2]^3$ ✓
$10^{-3} = (0,1)^2 / (0,46 / V – 0,15)^3$ ✓
V = 0,2 dm^{-3} ✓

OPTION/*OPSIE* 2

$K_c = [AX_2]^2 / [X_2]^3$ ✓
$10^{-3} = (0,1)^2 / [X_2]^3$
$[X_2] = 2,15 \text{ mol.dm}^{-3}$

	$3X_2$	$2AX_2$
$n_{initial}$(mol) *$n_{aanvanklik}$(mol)*	2,15 V + 0,15 V= 0,46	0
n_{change}(mol) *$n_{verandering}$(mol)*	✓ 0,15 V	0,1 V ✓
$n_{equilibrium}$(mol) *n_{ewewig}(mol)*	2,15 V ✓	0,1V ✓
$c_{equilibrium}$(mol.dm^{-3}) *c_{ewewig}(mol.dm^{-3})*	2,15	0,1

Ratio/Verhouding ✓

2,15 V + 0,15 V = 0,46 ✓
V = 0,2 dm^3 ✓

OPTION/*OPSIE* 3
USING CONCENTRATIONS/*GEBRUIK KONSENTRASIES*

$K_c = [AX_2]^2 / [X_2]^3$ ✓
$10^{-3} = (0,1)^2 / [X_2]^3$
$[X_2] = 2,15 \text{ mol.dm}^{-3}$

	$3X_2$	$2AX_2$	
Cinitial Caanvanklik	2,15 + 0,15 = 2,3	0	
Cchange Cverandering	✓ 0,15	0,1✓	Ratio/*Verhouding* ✓
Cequilibrium Cewewig	2,15	0,1✓	

$c = n/V$ ✓
$2,3 = 0,46 / V$ ✓
$V = 0,2 \text{ dm}^{-3}$ ✓ (8)

6.5 Decreases✓/*Neem af*

- An increase in temperature causes a decrease in K_c. ✓
- When the temperature is increased, the reaction that will oppose this increase in temperature, will be favoured. ✓
- Reverse reaction is favoured by a decrease in temperature. ✓

- *'n Toename in temperatuur veroorsaak 'n afname in K_c.*
- *Wanneer die temperatuur toeneem, sal die reaksie wat die toename in temperatuur teenwerk, bevoordeel word.*
- *Die terugwaartse reaksie word bevoordeel deur 'n afname in temperatuur.*

OR/*OF*

- The forward reaction is exothermic. ✓
- An increase in temperature favours the endothermic reaction. ✓
- The reverse reaction is favoured. ✓

- *Die voorwaartse reaksie is eksotermies.*
- *'n Toename in temperatuur bevoordeel die endotermiese reaksie.*
- *Die terugwaartse reaksie word bevoordeel.* (4)

[18]

QUESTION / *VRAAG* 4

4.1 4.1.1 10 kJ ✓ (1)

4.1.2 -20 kJ ✓ (1)

4.2 4.2.1 The particles with sufficient kinetic energy for a reaction to take place. ✓
Die deeltjies met genoegsame kinetiese energie vir 'n reaksie om plaas te vind. (1)

4.2.2 B ✓ (1)

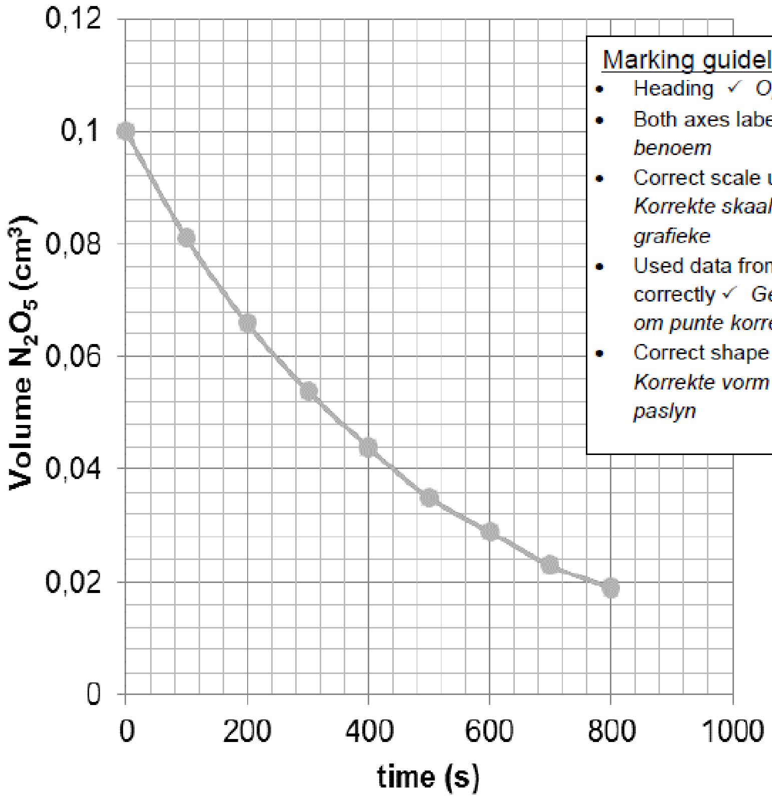
4.2.3 Increasing temperature increases the rate of reaction. ✓ Molecules must collide with sufficient energy for bonds to break ✓ and a reaction to occur (activation energy). When the temperature is increased, more particles have enough energy for more effective collisions to take place ✓ and more particles have energy greater than the activation energy. ✓
Vermeerdering van die temperatuur verhoog die tempo van die reaksie. Molecule moet bots met genoegsame energie vir die bindings om te breek en 'n reaksie om plaas te vind (aktiveringsenergie). Wanneer die temperatuur verhoog, het meer deeltjies genoeg energie vir meer effektiewe botsings om plaas te vind en meer deeltjies het energie groter as die aktiveringsenergie.

OR / *OF*

(4)

Increase in energy increases kinetic energy. As the kinetic energy of the particles increase, more particles have sufficient activation energy, the chances of colliding with correct orientation increases, more effective collisions per unit time takes place.
Toename in energie verhoog die kinetiese energie. Indien die kinetiese energie van die deeltjies verhoog, is daar meer deeltjies met genoegsame aktiveringsenergie, die kanse vir botsings met korrekte oriëntasie verhoog, meer effektiewe botsings per eenheid tyd vind plaas.

4.3 4.3.1 Graph of time of reaction taking place vs Volume of N_2O_5
Grafiek van tyd van reaksie wat plaasvind teenoor Volume van N_2O_5 (5)



Marking guideline / *Nasienriglyne*:
- Heading ✓ *Opskrif*
- Both axes labeled ✓ *Beide asse benoem*
- Correct scale used for both graphs ✓ *Korrekte skaal gebruik vir beide grafieke*
- Used data from table to plot points correctly ✓ *Gebruik data vanaf table om punte korrek te plot.*
- Correct shape of graph/line of best fit ✓ *Korrekte vorm van grafiek / beste paslyn*

4.3.2 The change in concentration of reactants or products per unit time. ✓ ✓
Die verandering in konsentrasie van reaktante of produkte per eenheid tyd. (2)

4.3.3 Rate of reaction *(Reaksietempo)* = $\frac{\text{volume } N_2O_5 \text{ used}}{\Delta t}$ ✓

$= \frac{0,06}{240}$ ✓ $= 2,5 \times 10^{-4}\ \text{mol·dm}^{-3}\text{·s}^{-1}$ ✓

(Allow for a range 2,4 – 2,6 x 10^{-4} – see learner's graphs)
(Laat toe vir 'n reeks van 2,4 – 2,6 x 10^{-4} -sien leerder se grafiek) (3)
[18]

QUESTION / *VRAAG* 5

5.1 When the rate of the forward reaction is equal to the rate of the reverse reaction. ✓✓

Or

When both reactants and products continue to form at the same time.

Wanneer die tempo van die voorwaartse reaksie gelyk is aan die tempo van die terugwaartse reaksie

Of

Wanneer beide reaktante en produkte aanhou vorm op dieselfde tyd. (2)

5.2

	$4AO_{2(g)}$ ⇌	$2A_2O_{3(g)}$ +	$O_{2(g)}$
Molar ratio *Molêre verhouding*	**4**	**2**	**1**
Initial concentration *Aanvanklike konsentrasie* ($mol \cdot dm^{-3}$)	**0 (given)**	**2,0 (given)**	**1,0 (given)**
Change in concentration *Verandering in konsentrasie* ($mol \cdot dm^{-3}$)	+4x	-2x	-x
Equilibrium concentration *Konsentrasie by ewewig* ($mol \cdot dm^{-3}$)	4x	2,0-2x	1,0-x

Use ratio 4:2:1 ✓ *Gebruik verhouding*

n at equilibrium ✓ *n by ewewig*

At equilibrium, AO_2 is 10% decomposed. / *By ewewig, AO_2 word 10% ontbind.*

$\therefore [A_2O_3]_{eq}$ = 10 % of 2,0 ✓ Use 10 % decomposition / *Gebruik 10% ontbinding*

$\therefore 2,0 - 2x$ ✓ $= \frac{10}{100} \times 2,0$

x = 0,9 $mol \cdot dm^{-3}$

OR / *OF*

$[O_2]$ = 10% of 1

$\therefore 1 - x = \frac{10}{100} \times 1$

x = 0,9 $mol \cdot dm^{-3}$

Marking criteria /*Nasienriglyne*:

- Use ratio 4:2:1 ✓
- $n(O_2)_{eq} = n(O_2)_{ini} - n(O_2)_{change}$ = 1,0 - x
- $n(A_2O_3)_{eq} = n(A_2O_3)_{ini} - n(A_2O_3)change$ = 2,0 - 2x
- $n(AO_2)_{eq} = n(AO_2)_{ini} + n(AO_2)_{change}$ = 0 +4x ✓
- Use 10% of decomposition ✓
- Equilibrium concentrations of all substances ✓✓✓

Therefore at equilibrium: / *Dus by ewewig:*

$[AO_2]$ = 4(0,9) = 3,6 $mol \cdot dm^{-3}$ ✓

$[A_2O_3]$ = 2,0 – 2(0,9) = 0,20 $mol \cdot dm^{-3}$ ✓

$[O_2]$ = 1,0 – 0,9 = 0,10 $mol \cdot dm^{-3}$ ✓

Positive marking from **x**
Positiewe nasien vanaf ***x*** (6)

5.3 5.3.1 COLOURLESS ✓ *KLEURLOOS* (1)

5.3.2 (Negative marking from 5.3.1) / *(Negatiewe nasien vanaf 5.3.1)*

Decreasing the volume will increase the pressure.
Reaction will reduce the stress on the system by favouring the reaction that will reduce the pressure, i.e. less number of moles ✓

Reaction will favour the forward reaction / production of $A_2O_{3(g)}$ + $O_{2(g)}$ / decomposition of $AO_{2(g)}$ ✓
More product / colourless gases will reduce the intensity of the mixture's reddish-brown colour ✓

Vermindering van volume sal die druk verhoog.
Reaksie sal die versteuring teenwerk om die sisteem deur die reaksie te bevoordeel wat die druk sal verminder, dit is minder aantal mol.

Die reaksie sal die voorwaartse reaksie bevoordeel / produksie van $A_2O_3(g)$ + $O_2(g)$ */ ontbinding van* $AO_2(g)$
Meer produkte / kleurlose gasses al die intensiteit van diemengsel se rooi-bruin kleur verminder. (3)

[12]

QUESTION 6

6.1 How does the rate of a reaction change with time? ✓✓ (2)
Any given investigative question

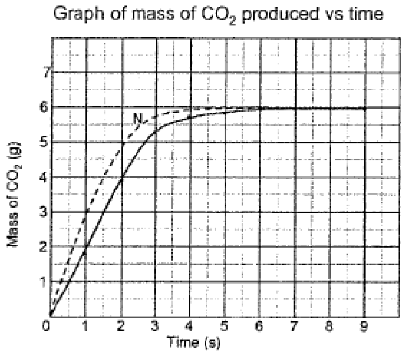
6.2 Time ✓ Mark based on given investigative question. (1)

6.3 (2)

Time (s)	0	1	2	3	4	5	6	7	8	9
Mass of flask and its contents (g)	178	176,2	174,1	172,7	172,3	172,2	172,1	172,1	172,1	172,1
Mass of CO_2 (g) produced (g)	0	1,8	3,9	5,3	5,7	5,8	5,9	5,9	5,9	5,9

✓✓

6.4



✓ Correct shape
✓✓ plotting of all points
✓Appropriate scale and labels on both axes
✓ Correct heading

But plotting 5 or less points subtract one mark.

(5)

6.5 The reaction has reached completion. ✓ (1)
OR
One of the reactants is finished. ✓

6.6
$$n = \frac{m}{M} \checkmark$$
$$= \frac{5,9}{44} \checkmark$$
$$= 0,13 \text{ mol}$$

1 mol occupies 24,46 dm^3

0,13 mol will occupy 3,18 dm^3 ✓

Accept range 3.18 – 3.28

(3)

6.7 Graph N has a steeper gradient ✓and finishes at the same point as the original graph✓ (2)

6.8 Higher temperature, molecules have greater kinetic energy ✓ (3)
More effective collisions per unit time ✓
Reaction rate increases ✓

[19]

QUESTION 7

7.1

CALCULATIONS USING NUMBER OF MOLES
BEREKENINGE WAT GETAL MOL GEBRUIK

Mark allocation/*Puntetoekenning:*

- Calculating number of moles of H_2, Cl_2 and HCl. ✓
- Molar ratio. ✓
- Number of moles at Equilibrium. ✓
- Dividing by 0,5 to get the concentration. ✓
- K_c expression. ✓
- Substitution in the K_c expression ✓
- Calculating concentration of Cl_2 ✓
- Substitution in n= cV.✓
- Substitution in m=nM ✓
- Final answer✓

7.1 $H_2 + Cl_2 \rightleftharpoons 2HCl$ (10)

	H_2	Cl_2	2HCl	
Initial mass	10g	355g	0g	Calc no. of
Initial n	5	5	0	✓ mol
React/Prod	x	x	2x	✓Ratio
n at equilibrium	5 - x	5 - x	2x	✓
Conc. at equilibrium	$\frac{5-x}{0,5}$	$\frac{5-x}{0,5}$	$\frac{2x}{0,5}$	✓dividing by 0,5

$$K_c = \frac{[HI]^2}{[H_2][I_2]} \checkmark$$

$$\checkmark\ 60 = \frac{(\frac{2x}{0,5})^2}{(\frac{5-x}{0,5})(\frac{5-x}{0,5})} \checkmark$$

$$x = 3,97$$

No K_c expression, correct substitution max $\frac{9}{10}$

Wrong KC expression max $\frac{4}{10}$

$$\text{Conc. } Cl_2 \text{ at equilibrium} = \frac{5-3,97}{0,5}\checkmark$$

$$n = C \cdot V$$
$$= \frac{5-3,97}{0,5} \cdot 0,5$$
$$= 1,03 \text{ mol}$$
$$m = n \cdot M$$
$$= 1,03 \cdot 71 \checkmark$$
$$= 73,13 \text{ g} \checkmark$$

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

7.3

7.3.1 Decrease ✓ (1)

7.3.2 Increase ✓ (1)

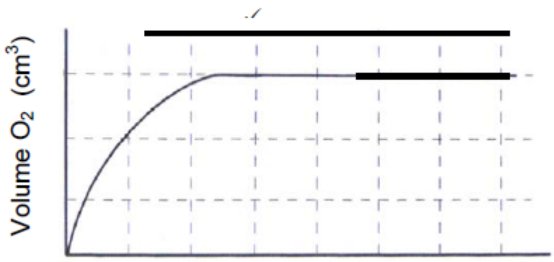
7.4 The temperature of the system was increased, according to Le Chatelier's principle, the system reacts by favouring the endothermic reaction.✓ Hence, the reverse reaction is favoured.✓

(2)
[16]

QUESTION 5/*VRAAG 5*

5.1 A catalyst is a chemical substance which increases the rate of a reaction ✓without undergoing a permanent change itself ✓//
'n Katalisator is 'n chemiese stof wat die tempo van 'n chemiese reaksie verhoog ✓ sonder om self 'n permanente verandering te ondergaan. ✓
OR/*OF*
A catalyst increases the rate of a reaction by providing an alternative route ✓with lower activation energy.✓ //
'n Katalisator verhoog die tempo van 'n reaksie deur 'n alternatiewe roete✓ van laer aktiveringsenergie ✓te verskaf. (2)

5.2.1



Line A: smaller gradient, same volume ✓
Lyn A: kleiner gradiënt, dieselfde volume ✓ (1)

5.2.2 Line B: More products✓ higher rate✓ / steeper gradient, greater volume.
Lyn B: Meer produkte ✓hoër tempo ✓/ steiler gradiënt, groter volume (2)

5.3 1 g✓ (1)

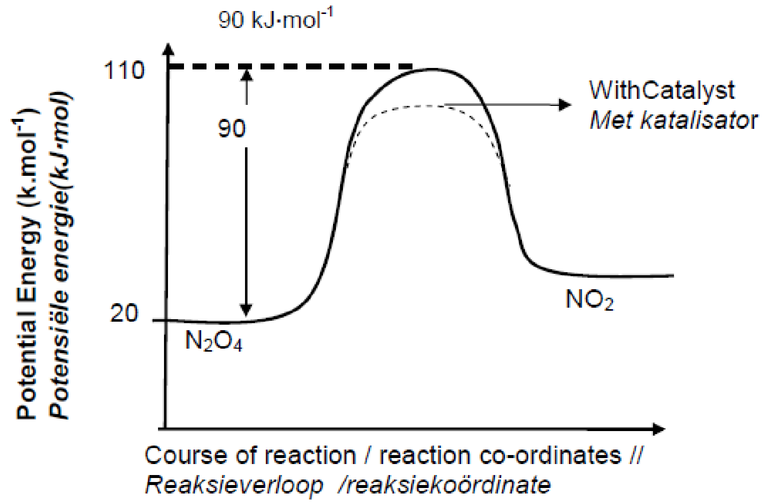
5.4 Reaction rate is the change in the concentration of the reactants or products✓ per unit time. ✓/ amount of products formed or reactants used up per unit time //
Reaksietempo is die verandering in die konsentrasie van die reaktante of produkte ✓per tydseenheid ✓/ hoeveelheid reaktante verbruik of produkte gevorm per tydseenheid. (2)

5.5 The minimum kinetic energy /activation energy is lowered✓therefore there are more effective collisions per unit time ✓//
Die minimum kinetiese energie /aktiveringsenergie te word verlaag. ✓ en dus is daar meer effektiewe botsings per tydseenheid✓ (2)

[10]

QUESTION 6/*VRAAG 6*

6.1.1



1 mark each: shape of graph, both 20 and 110 correctly indicated, activation energy correctly indicated (Teaching note: x-axis label NOT time)
1 punt elk: vorm van grafiek , 20 en 110 korrek aangedui, aktiveringsenergie korrek aangedui. (3)

6.1.2 See dotted line on graph.✓ // *Sien stippellyn op grafiek.* ✓ (1)

6.1.3 Forward✓//
Voorwaarts ✓ (1)

6.1.4 (The temperature increases) According to Le Chatelier's principle, the reaction that will lower the temperature of the reaction is favoured,✓ thus the endothermic reaction✓. The forward reaction is endothermic ✓ and therefore the forward reaction will be favoured.
(Die temperatuur neem toe.) Volgens Le Chatelier se Beginsel sal die sisteem die reaksie bevoordeel wat die temperatuur van die reaksie verlaag, ✓d.w.s. die endotermiese reaksie. ✓
Die voorwaartse reaksie is endotermies ✓en dus word die voorwaartse reaksie bevoordeel (3)

6.2 Exothermic✓
When temperature decreases, Kc decreases,
reverse reaction is favoured ✓
When temperature decreases, exothermic reaction is favoured, ✓
therefore the revere reaction is exothermic. //
Eksotermies ✓
As temperatuur afneem verminder Kc, die terugwaartse reaksie word bevoordeel. ✓
As temperatuur verlaag word die eksotermiese reaksie bevoordeel✓
dus is die terugwaartse reaksie eksotermies. (3)

6.3.1 CALCULATIONS USING NUMBER OF MOLES
BEREKENINGE WAT AANTAL MOL GEBRUIK

Option 1 / *Opsie 1:*

$n(H_2O)$ at equilibrium / *by ewewig* = 0,2 mol (given)

$n(H_2O)$ formed / *gevorm* = $n(CO)$ formed/*gevorm* = 0,2 (mol)
$n(H_2)$ reacted = (0,2 mol): $n(CO_2)$ reacted = (0,2 mol) ✓

At equilibrium / *By ewewig*:
$n(H_2)$ = (x – 0,2)/(x – change / *verandering*)
$n(CO_2)$ = 0,1 (mol)/(0,3 – change / *verandering*) ✓
$n(H_2O)$ = $n(CO)$ = 0,2 (mol) ✓

Equilibrium concentration / *Ewewigskonsentrasies:*

$$c(H_2) = \frac{n}{V} = \frac{x-0,2}{10}$$
$$c(CO_2) = \frac{n}{V} = \frac{0,1}{10}$$
$$c(H_2O) = \frac{n}{V} = \frac{0,2}{10}$$
$$c(CO) = \frac{n}{V} = \frac{0,2}{10}$$
✓

$$K_c = \frac{[CO][H_2O]}{[H_2][CO_2]} \checkmark \quad \therefore \frac{(0,02)(0,02)\checkmark}{\left(\frac{x-0,2}{10}\right)(0,01)\checkmark} = 4 \checkmark$$

$\therefore x = 0,3 \quad \therefore\ n(H_2) = 0,3$ mol ✓

Option 2/*Opsie 2*

	H_2	CO_2	H_2O	CO	
Initial quantity (mol) *Aanvangshoeveelheid (mol)*	x	0,3	0	0	
Change (mol) *Verandering (mol)*	-0,2	-0,2	+0,2	+0,2	ratio✓
Quantity at equilibrium (mol)/ *Hoeveelheid by ewewig(mol)*	x-0,2	0,1 ✓	0,2	0,2 ✓	
Equilibrium concentration (mol·dm⁻³) *Ewewigskonsentrasie (mol·dm⁻³)*	$\frac{x-0,2}{10}$	0,01	0,02	0,02	÷ 10✓

$K_c = \frac{[CO][H_2O]}{[H_2][CO_2]}$ ✓ $\therefore \frac{(0,02)(0,02)✓}{\left(\frac{x-0,2}{10}\right)(0,01)✓} = 4$ ✓

$\therefore x = 0,3$ $\therefore$ n(H_2) = 0,3 mol ✓

CALCULATIONS USING CONCENTRATION
BEREKENINGE WAT KONSENTRASIE GEBRUIK

	H_2	CO_2	H_2O	CO	
Initial concentration (mol·dm⁻³) *Aanvangskonsentrasie (mol·dm⁻³)*	$\frac{x}{10}$	0,03	0	0	÷10✓
Change in concentration (mol·dm⁻³) *Verandering in konsentrasie (mol·dm⁻³)*	0,02	0,02	0,02	0,02	ratio✓
Equilibrium concentration (mol·dm⁻³) *Ewewigskonsentrasie (mol·dm⁻³)*	$\frac{x}{10}$ -0,02	0,01 ✓	0,02	0,02 ✓	

$K_c = \frac{[CO][H_2O]}{[H_2][CO_2]}$ ✓ $\therefore \frac{(0,02)(0,02)✓}{\left(\frac{x-0,2}{10}\right)(0,01)✓} = 4$ ✓

$\therefore x = 0,3$ $\therefore$ n(H_2) = 0,3 mol ✓ (9)

6.3.2 Remains the same ✓//
Bly dieselfde ✓ (1)

QUESTION 5 / VRAAG 5

5.1 The reaction rate indicates the change in the concentration of the reactants or the products per unit time. ✓✓
Die verandering in konsentrasie van reaktante of produkte per eenheidstyd (2)

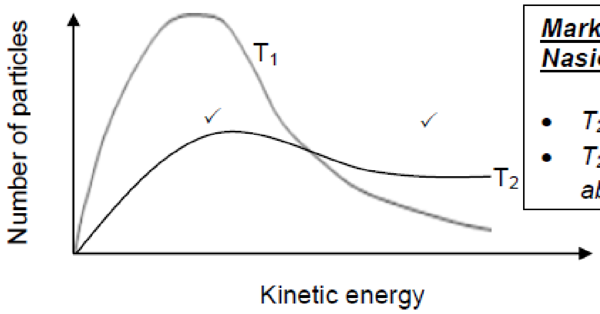
5.2.1 Temperature/State of division/Mass of magnesium✓ *(Any one)*
Temperatuur / Toestand van verdeeldheid / Massa van magnesium (Enige een) (1)

5.2.2 The higher the concentration of the sulphuric acid, the higher the rate of reaction. /
Hoe hoër die konsentrasie van swawelsuur, hoe hoër die tempo van reaksie. ✓✓ (2)

5.2.3 Decrease / *Afneem* ✓ (1)

5.2.4 If lumps of magnesium are used, the contact/surface area decreases. ✓
Less effective collisions per unit time. ✓
Less particles with $E_k < E_a$. ✓
As magnesiumstukkies gebruik word gaan die kontak / area oppervlakte verklein
Minder effektiewe botsings per tydseenheid
Minder deeltjies met $E_k < E_a$
(3)

5.2.5



Marking criteria/ Nasienriglyne

- *T_2 maximum below T_1*
- *T_2 at higher energy above T_1*

(2)

5.3
- *Formula / Formule* $n = \frac{V}{V_m}$ *or/of* $n = \frac{m}{M}$
- *0,004 mol*
- *Substituting 24 g / Vervang 24g*
- *Ratio 1:1*
- *Answer 0,096 g (0,096 – 0,10) / Antwoord 0,096g (0,096 – 0,10)*

Mg → H_2
100 cm^3

m = n X M
= 0,004 X 24 ✓
= 0,096 g✓ *(0,096 – 0,10)*
↑
0,004 mol ✓ ←

$n = \frac{V}{V_m}$ ✓
$= \frac{0{,}1}{24{,}04}$
= 0,004 mol ✓

(5)
[16]

QUESTION 6 / *VRAAG 6*

6.1.1 DECREASES / *VERLAAG*✓ (1)

6.1.2 INCREASES / *VERHOOG*✓ (1)

6.1.3 If the temperature is decreased, the system will react in such a way to increase the temperature. ✓
The exothermic✓, forward reaction✓ is favoured.
As die temperatuur verlaag, gaan die sisteem so reageer om die temperatuur te verhoog.
Die eksotermiese, voorwaartse reaksie, word bevoordeel (3)

6.2 **<u>CALCULATIONS USING NUMBER OF MOLES</u>**
<u>BEREKENINGE WAT GETAL MOL GEBRUIK</u>

Mark allocation/*Puntetoekenning*
- USING ratio 1:3:2 ✓
  Gebruik die verhouding 1:3:2
- Equilibrium: $n(N_2)$ = 2,5 mol; $n(H_2)$ = 2 mol (initial - change) ✓
  Ewewig: $n(N_2)$ = 2,5 mol; $n(H_2)$ = 2 mol (aanvanklik – verandering)
- Equilibrium: $n(NH_3)$ = 3 mol (initial + change) ✓
  Ewewig: $n(NH_3)$ = 3 mol (aanvanklik + verandering)
- Divide by volume = 2,0 dm^3 ✓
  Gedeel deur volume = 2,0 dm^3
- Correct K_c expression (<u>formulae in square brackets</u>) ✓
  Korrekte K_c-uitdrukking (<u>formules in vierkanthakies</u>)
- Correct substitution in K_c expression ✓
  Korrekte vervanging in K_c-uitdrukking
- Substitution of / *Vervanging van* 2 $g\cdot mol^{-1}$ in m =nM✓
- Final answer / *Finale antwoord* :13 g ✓

	N_2	$3\ H_2$	$2\ NH_3$
Mole start **Mol begin**	4	n=6,5	0
Mole react/form ***Mol reageer/ vorm***	-1,5	-4,5	+3 ✓
Mole equilibrium ***Mol by ewewig***	2,5✓	2	3✓
[ ]	1,25	1	1,5✓

$K_c = \frac{[NH_3]^2}{[N_2][H_2]^2}$✓

$1{,}8 = \frac{(1{,}5)^2}{(1{,}25)[H_2]^3}$✓

$[H_2] = 1\ mol\cdot dm^{-3}$

m = n X M
= 6,5 X 2✓
= 13 g✓ (8)

CALCULATIONS USING CONCENTRATION
BEREKENINGE WAT KONSENTRASIE GEBRUIK

Mark allocation/*Puntetoekenning*

- Divide/multiply by volume = 2,0 dm^3 ✓
  Deel / vermedigvuldig met volume = 2,0 dm^3
- USING ratio: 1:3:2 ✓
  Gebruik die verhouding: 1:3:2
- Equilibrium: $[N_2]$ = 0.75 mol/dm^3 $[H_2]$ = 2,25 mol/dm^3 (initial – change)✓
  Ewewig: $[N_2]$ = 0.75 mol/dm^3 $[H_2]$ = 2,25 mol/dm^3 (aanvanklik – verandering)
- Equilibrium: $[NH_3]$ = 1,5 mol/dm^3(initial + change) ✓
  Ewewig: $[NH_3]$ = 1,5 mol/dm^3(aanvanklik + verandering)
- Correct K_c expression (formulae in square brackets) ✓
  Korrekte K_c-uitdrukking (formules in vierkanthakies)
- Correct substitution in K_c expression✓
  Korrekte vervanging in K_c-uitdrukking
- Substitution of 2 $g\cdot mol^{-1}$ in m =nM✓
  Vervanging van 2 $g\cdot mol^{-1}$ in m =nM
- Final answer: 13 g✓
  Finale antwoord: 13g

QUESTION 5/VRAAG 5

5.1 The rate of a reaction is the change in concentration of reactant/product per unit time.✓✓*Reaksietempo is die verandering in konsentrasie van die reaktante/produkte per tydseenheid.* (2)

5.2

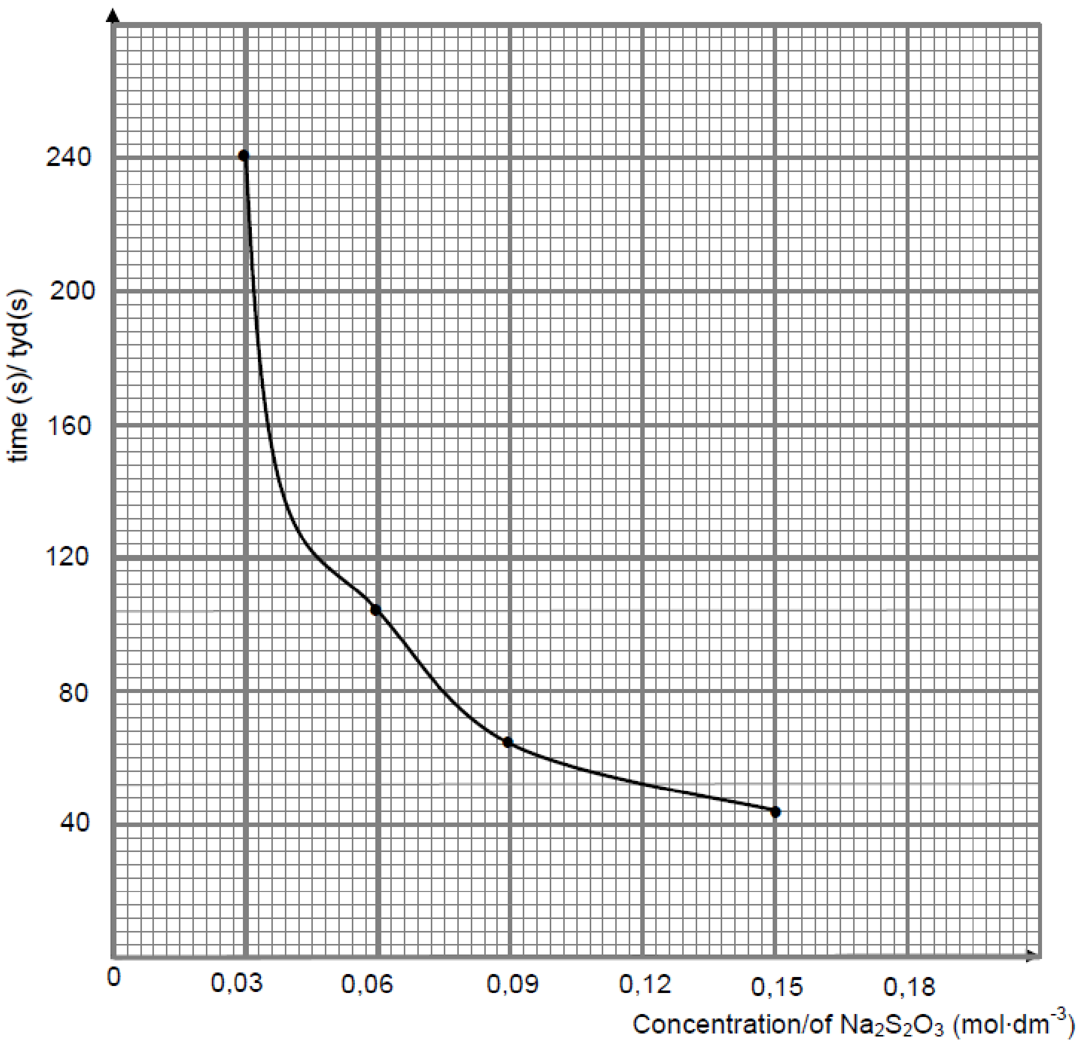
5.2.1 Concentration of sodium thiosulphate/*konsentrasie natriumtiosulfaat* ✓ (1)

5.2.2 ANY ONE✓
Concentration of hydrochloric acid/*konsentrasie soutsuur*
Temperature/*temperatuur* (1)

5.3 S (sulphur/swawel)✓ (1)

5.4 Trial 1✓/*Eksperiment 1* (1)

5.5



RUBRIC FOR THE GRAPH/*RUBRIEK VAN GRAFIEK*	
Both axes labelled correctly/Beide asse korrek benoem	1 mark
All the points plotted correctly/Alle punte korrek geplot	2 mark
A smooth curve/vorm 'n kurwe	1 mark

(4)

5.6 The rate of reaction increases as the concentration (of $Na_2S_2O_3$) increases✓✓/
Die reaksietempo verhoog as die konsentrasie van ($Na_2S_2O_3$) verhoog (2)

5.7 Increase the temperature of the reaction mixture✓/*Verhoog die temperatuur van die reaksiemengsel.*
Use a catalyst✓/*gebruik 'n katalisator* (2)
[14]

QUESTION 6/VRAAG 6

6.1 Exothermic ✓/Eksotermies
Products have a lower energy than the reactants✓/*produk verkeer by 'n laer energie as die reaktante* (2)

6.2 Correct orientation of the molecules ✓/*Korrekte oërientasie van molekule*
Must have enough kinetic energy to form an activation complex✓/*Moet oor genoeg kinetiese energie beskik om 'n geaktiveerde kompleks te vorm* (2)

6.3 Catalyst (vanadium pentoxide) lowers the activation energy✓ so that more molecules will have an energy equal or greater than the activation energy✓ to take part in the reaction.
Die katalisator *verlaag die aktiveringsenergie sodat meer molekule genoeg kinetiese energie het om te reageer.* (2)

6.4 $\Delta H = E_P - E_R$ ✓
$= -86 - 25$ ✓
$= -111 \text{ kJ·mol}^{-1}$ ✓ (3)

6.5 An unstable (transition) state from reactants to products✓✓/*Die geaktiveerde kompleks is 'n onstabiele tussentoestand bestaande uit die reaktante en produkte* (2)

6.6 $\Delta E_a = 68 - (-86) = 154 \text{ kJ.mol}^{-1}$ ✓✓ (2)
[13]

QUESTION 7/VRAAG 7

CALCULATIONS USING NUMBER OF MOLES
BEREKENINGE WAT AANTAL MOL GEBRUIK

Mark allocation:

- Change in n(NO) & n(O_2) ✓
- Ratio n(NO) : n(O_2) : n(NO_2) = 2 : 1 : 2 ✓
- n(NO_2) & n(O_2) at equilibrium ✓
- Divide three equilibrium amounts by 0,5 (calculation of concentration) ✓
- K_c expression✓
- Substitution into K_c expression✓
- Final answer : x = 2 ✓

Punte toekenning:

- Verandering in n(NO) & n(O_2) ✓
- Verhouding van n(NO) : n(O_2) : n(NO_2) = 2 : 1 : 2 ✓
- n(NO_2) & n(O_2) by ewewig ✓
- Deel die drie ewewigshoeveelhede deur 0,5 (konsentrasie berekening) ✓
- K_c-uitdrukking✓
- Substitusie in K_c-uitdrukking✓
- Finale antwoord : x = 2 ✓

7.1 **OPTION 1/*OPSIE 1:***

	2NO (g) +	O_2(s) →	$2NO_2$(g)
	2 moles/mol	1moles/mol	2moles/mol
Start/begin	4 moles/mol	2,5 moles/mol	x
Reacted/gereageer	1 moles/mol	0,5 moles/mol	✓ Ratio✓
Formed/gevorm	-----	----	1 moles/mol
Equilibrium/ewewig	3 moles/mol	2 moles/mol	x + 1 moles/mol ✓
Equilibrium concentration ($\frac{n}{V}$) *Ewewig konsentrasie*	$\frac{3}{0,5}$ = 6mol.dm^{-3}	$\frac{2}{0,5}$ = 4mol.dm^{-3}	$\frac{x+1}{0,5}$ mol.dm^{-3}✓

(7)

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

$$0,25 = \frac{\left[(\frac{x+1}{0,5})\right]^2}{[6]^2[4]} \checkmark$$

Taking square root on both sides/*trek 'n vierkantswortel aan albei kante*

$$\sqrt{0,25} = \frac{\sqrt{\left[(\frac{x+1}{0,5})\right]^2}}{\sqrt{(6^2)(4)}}$$

x = 2 mol✓

OPTION 2/*OPSIE 2:*

Amount of NO reacted/*Hoeveelheid* NO *wat reageer* = 4-3 = 1 mol ✓
Ratio n(NO) : n(O_2) : n(NO_2) = 2 : 1 : 2 ✓
n(O_2) at equilibrium = 2,5 - 0,5 = 2 mol
n(NO_2 formed) = x + 1 mol ✓

$$c(NO) = \frac{n}{V} = \frac{3}{0,5} = 6 \text{ mol·dm}^{-3}$$

$$c(O_2) = \frac{n}{V} = \frac{2}{0,5} = 4 \text{ mol·dm}^{-3}$$

$$c(NO_2) = \frac{n}{V} = \frac{X+1}{0,5} \text{ mol·dm}^{-3}$$

✓

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

$$0,25 = \frac{\left[(\frac{x+1}{0,5})\right]^2}{[6]^2[4]} \checkmark$$

Taking square root on both sides/*trek 'n vierkantswortel aan albei kante*

$$\sqrt{0,25} = \frac{\sqrt{\left[(\frac{x+1}{0,5})\right]^2}}{\sqrt{(6^2)(4)}}$$

x = 2 mol✓

7.2 Homogeneous, ✓ only one phase is present ✓
Homogeen, want daar is net een fase betrokke (2)

7.3 When the equilibrium in a closed system is disturbed, the system will re-instate a new equilibrium by favouring the reaction that will oppose the disturbance. ✓✓/*Wanneer die ewewig in 'n geslote sisteem versteur word, sal die sisteem 'n nuwe ewewig instel deur die reaksie te bevoordeel wat die versteuring teenwerk.* (2)

7.4 The system reacts to oppose by favouring the reaction that produces lesser number of moles. ✓ Favour the forward reaction and the concentration of NO_2 will increase.✓/*Die sisteem reageer om die versteuring teen te werk deur die reaksie wat lei tot volume vermindering (minder mol gevorm) te bevoordeel. Die voorwaartse reaksie word bevoordeel en dus sal die konsentrasie NO_2 verhoog.* (2)
[13]

QUESTION 5 (Start on a new page.)

5.1 $CO_2(g)$ forms during the reaction. ✓ (1)

5.2 40s. ✓ The mass of the beaker and its contents remained 60,00g. ✓ (2)

5.3

nCO_2 (reacted) = $\frac{m(CO_2)}{M(CO_2)}$ ✓
= $\frac{2,00}{44}$ ✓
= 0,05 mol✓

$V(CO_2)$ at STP = $n(CO_2) \times V_m$ ✓
= (0,05 x 22,4) ✓
= 1,12 dm^3✓ (6)

OR

1 mol → 22,4 dm^3
0,05 mol → X
X = 1,12 dm^3

5.4
- More particles per unit volume. ✓
- More HCℓ molecules have enough kinetic energy and correct orientation. ✓
- More effective collisions take place per second/ per unit time. ✓ (3)

N.B. Accept: Higher frequency of effective collisions

[12]

QUESTION 6 (Start on a new page.)

6.1 A reversible reaction in which the rate of the forward reaction equals to the rate of the reverse reaction. ✓✓ (2)

6.1.1 $n(NH_3) = \frac{m}{M}$
= $\frac{25,5}{17}$ ✓
= 1,5 mol

	$N_{2(g)}$	$3H_{2(g)}$	$2NH_{3(g)}$	
Initial quantity(mol)	3	8	0	
Change in (mol)	0,75	2,25	1,5✓	Ratio ✓
Quantity at equilibrium(mol)	2,25✓	5,75✓	1,5	
Equilibrium concentration ($mol.dm^{-3}$)	[redacted]			Divide by 5✓

$K_c = \frac{[NH_3]^2}{[N_2][H_2]^3}$ ✓

Wrong K_c expression Max 6/9
No Kc expression Max 8/9

= $\frac{(0,3)^2}{(0,45)(1.15)^3}$ ✓
= 0,13✓ (9)

6.1.2 Smaller than ✓
K_c 1✓ (2)

6.1.3 Decrease✓
Increases in temperature favours the reverse reaction (endothermic reaction) ✓ less product is formed✓, K_c value decreases. ✓ (4)

N.B. a) Accept: **equilibrium position** shifts to the left.
b) The sign ✓ means negative marking in **6.1.2** & **6.1.3** above

[17]

QUESTION/*VRAAG* 5

5.1 Exothermic/*Eksotermies* ✓ ΔT is positive/*ΔT is positief.* ✓
OR/OF
T_{final} is higher/*T_{finaal} is hoër* ✓
OR/OF
$T_{initial}$ is lower/*$T_{oorspronklik}$ is laer* ✓ (2)

5.2 Nature of reacting substances./*Aard van reaktante.* ✓ (1)

5.3 EQUAL TO ✓ Same amount of metal used. ✓
GELYK AAN. Dieselfde hoeveelheid metaal gebruik. (2)

5.4 5.4.1 Experiment 2/*Eksperiment 2*✓ (1)

5.4.2 Mg is a stronger reducing agent ✓ than Zn. ✓
Mg is 'n sterker reduseermiddel as Zn. (2)

5.5 Increase in temperature increases kinetic energy of particles. ✓
More particles will have sufficient/enough kinetic energy./$E_a \geq E_k$. ✓
More effective collisions per unit time/second. (Frequency of effective collisions increases). ✓
Toename in temperatuur verhoog kinetiese energie van deeltjies.
Meer deeltjies het voldoende/genoegsame kinetiese energie./$E_a \geq E_k$
Meer effektiewe botsings per eenheidstyd/sekonde. (Frekwensie van effektiewe botsings neem toe.) (3)
[11]

QUESTION/*VRAAG* 6

6.1 Homogeneous/*Homogene* ✓

Reactants and products are in the same phase. ✓
Reaktante en produkte is in dieselfde fase. (2)

6.2 6.2.1 (a) More N_2 added/Increase ✓in $[N_2]$ ✓
Meer N_2 bygevoeg/Toename in $[N_2]$ (1)

(b) Pressure ✓ decreases ✓ (by increase in volume)
Druk neem af (deur toename in volume) (1)

6.2.2 Equal to/*Gelyk aan*✓ (1)

6.3 6.3.1 **Marking Criteria/Nasienriglyne:**

- $n(H_2)$ change = $n(H_2)$ initial - $n(H_2)$ equilibrium. ✓
  $n(H_2)$ verandering = $n(H_2)$ aanvanklik - $n(H_2)$ ewewig
- USE RATIO for $n(N_2)$ change and $n(NH_3)$ change. ✓
  GEBRUIK VERHOUDINGS vir $n(N_2)$verandering en $n(NH_3)$verandering
- n(equilibrium) = n(initial) - n (change) for both $n(N_2)$ and $n(NH_3)$ ✓
  n(ewewig) = n(aanvanklik) – n(verandering) vir beide $n(N_2)$ en $n(NH_3)$
- Divide n(equilibrium) by 1 to calculate c(equilibrium). ✓
  Verdeel n(ewewig) deur 1 om c(ewewig)te bereken.

- Correct K_c expression (formulae in square brackets). ✓
  Korrekte K_c-uitdrukking (formules in vierkant hakies)
- Substitution of K_c value of *$1,426 \times 10^3$* /
  Vervanging van K_c-waarde van $1,426 \times 10^3$. ✓
- Substitution of concentrations into K_c expression. ✓
  Vervanging van konsentrasies in K_c-uitdrukking.
- Calculate n./*Bereken n.* ✓
- *Substitute value for n and 28 for M in n = m/M*
  Vervang waarde van n en 28 vir M in n = m/M ✓
- *Final answer/Finale antwoord* ✓

OPTION/*OPSIE* 1

	N_2	$3H_2$	$2NH_3$
$n_{initial/aanvanklik}$ (mol)	n	n	0
$n_{change/verandering}$ (mol)	0,3n	0,9n ✓	0,6n
$n_{equilibrium/ewewig}$ (mol)	0,7n	0,1n	✓ 0,6n
$c_{equilibrium/ewewig}$ ($mol \cdot dm^{-3}$)	0,7n	0,1n	0,6n ✓ ÷ div by 1

$K_c = [NH_3]^2 / [N_2][H_2]^3$ ✓

$1,426 \times 10^3$ ✓ $= (0,6n)^2 / (0,7n \times (0,1n)^3$ ✓

n = 0,6 mol ✓

m = n.M

= 0,6 × 28 ✓

= 16,8g ✓

OPTION/*OPSIE* 2: Concentrations/*Konsentrasies* in $mol \cdot dm^{-3}$

	N_2	$3H_2$	$2NH_3$
$c_{initial/aanvanklik}$ ($mol \cdot dm^{-3}$)	n/1	n/1 ✓ div by 1	0
$c_{change/verandering}$ ($mol \cdot dm^{-3}$)	0,3n	0,9n ✓	0,6n
$c_{equilibrium/ewewig}$ ($mol \cdot dm^{-3}$)	0,7n	0,1n ✓	0,6n

$K_c = [NH_3]^2 / [N_2][H_2]^3$ ✓

$1,426 \times 10^3$ ✓ $= (0,6n)^2 / (0,7n \times (0,1n)^3$ ✓

n = 0,6 mol ✓

m = n.M

= 0,6 × 28 ✓

= 16,8g ✓ (10)

6.3.2 K_c Decreases/K_c *neem toe* ✓

Increase in temperature favours the endothermic reaction. ✓

Reverse reaction is favoured ✓ (decreasing $[NH_3]$, increasing $[N_2]$ and $[H_2]$).

Toename in temperatuur bevoordeel die eksotermiese reaksie.

Terugwaartse reaksie is bevoordeel (verminder $[NH_3]$, vermeerder $[N_2]$ en $[H_2]$). (3)

[18]

QUESTION 5/*VRAAG 5*

5.1 A reaction which does not need (activation) energy to start. ✓✓
'n Reaksie wat nie (aktiverings-) energie benodig om te begin nie. (2)

5.2 Hydrochloric acid/HCℓ/*Soutsuur/ HCℓ* ✓ (1)

5.3.1 Decreases/*Neem af* ✓ (1)

5.3.2 Increases/*Neem toe* ✓ (1)

5.3.3 Increases/*Neem toe*✓ (1)

5.3.4

- At higher temperature more molecules have enough ✓✓/sufficient kinetic energy/more molecules have kinetic energy greater than activation energy.
  Teen 'n hoër temperatuur het meer molekule genoeg kinetiese energie/ meer molekule het kenetiese energie groter as die aktiveringsenergie
- More effective collisions per unit time/second. ✓
  Meer effektiewe botsings per eenheid tyd/sekonde (3)

[9]

QUESTION 6/ *VRAAG 6*

6.1 Haber (process)/*Haberproses*✓ (1)

6.2 Iron/ Fe/*Yster/ Fe* ✓ (1)

6.3

- The forward and reverse reactions take place simultaneously at the same rate.✓
  Die voorwaartse en terugwaartse reaksies vind gelyktydig teen dieselfde tempo plaas.
- The amount of energy given off by exothermic reaction is taken up by the endothermic reaction. ✓
  Die hoeveelheid energie wat deur die eksotermiese reaksie vrygestel word, word deur die endotermiese reaksie opgeneem. (2)

6.4

CALCULATIONS USING NUMBER OF MOLES/
BEREKENINGE WAT GETAL MOL GEBRUIK
Mark allocation/*Puntetoekenning:*

- Correct K_c expression (formulae in square brackets) ✓
  Korrekte K_c –uitdrukking (formules in vierkanthakies)
- Substitution of concentrations into K_C expression ✓
  Vervanging van konsentrasies in K_c-waardes
- Substitution of K_c 0,1/*Vervanging van K_c 0,1*✓
- Equilibrium/*Ewewig*: $n(N_2)$ ✓ $n(NH_3)$ ✓
- Equilibrium/*Ewewig*: $n(NH_3)$ = n : Change/*Verandering* ✓
- **USING** ratio: $N_2 : 3H_2 : 2NH_3 = 1 : 3 : 2$ ✓
  ***GEBRUIK** verhouding: $N_2 : 3H_2 : 2NH_3 = 1 : 3 : 2$*
- Initial mole of N_2 = Equilibrium + Change ✓
  Aanvangsmol van N_2 = Ewewig + Verandering
- Substitution of n & M into formula $n(N_2) = \frac{m}{M}$ ✓
  Vervanging van n & M in formule $n(N_2) = \frac{m}{M}$
- Final answer: 0,58g/*Finale antwoord*✓

$$K_C = \frac{[NH_3]^2}{[N_2][H_2]^3} \checkmark$$

$$\checkmark\ 0,1 = \frac{(2,7x10^{-3})^2}{(N_2)(1,221 \times 10^{-1})^3} \checkmark$$

$$[N_2] = 4x10^{-2} mol.dm^{-3}$$

	N_2	H_2	NH_3	
Initial quantity (mol) *Aanvangshoeveelheid (mol)*	2,07 x 10^{-2} ✓	2,936 x 10^{-3}	0	
Change (mol) *Verandering (mol)*	6,75 x 10^{-4}	2,025 x 10^{-3}	1,35 x 10^{-3} ✓	ratio ✓
Quantity at equilibrium (mol) n = cv *Hoeveelheid by ewewig (mol)*	0,02 ✓	6,105 x 10^{-2}	1,35 x 10^{-3} ✓	
Equilibrium concentration (mol·dm^{-3}) *Ewewigskonsentrasie (mol·dm^{-3})*	4 x 10^{-2}	1,221 x 10^{-1}	2,7 x 10^{-3}	

Mass/massa (N_2)
m = nM ✓
= (2,07 x 10^{-2}) x (28)
= 5,79 x 10^{-1}g/ 0,58g ✓

OR/OF

$$n = \frac{n}{M}$$

2,07 x 10^{-2} $= \frac{m}{28}$

m = 5,79 x 10^{-1}g/0,58g (10)

6.5 A decrease in temperature will increase the yield ✓, but the reaction will be slow ✓ and the profit margins will be low. ✓
'n Afname in temperatuur sal tot 'n toename in opbrengs lei, maar die reaksie sal stadig wees en die winsgrens laag.

OR/OF

Increase in temperature favours the reverse reaction ✓, but reaction takes place much quicker ✓ and the process is less expensive ✓.
'n Toename in temperatuur is voordelig vir die terugwaartse reaksie, maar reaksies sal baie vinniger wees en die proses goedkoper. (3)

[17]

QUESTION / *VRAAG* 5

5.1 *Examples*:
- How will a change in concentration influence the reaction rate?
- What is the relationship between concentration and reaction rate?
- *Hoe sal 'n verandering in die konsentrasie die reaksietempo beïnvloed?*
- *Wat is die verwantskap tussen die konsentrasie en reaksietempo?*

Marking criteria:
- Identify dependent and independent variables correct / *Identifiseer afhanklike en onafhanklike veranderlikes korrek* ✓
- Ask a question about the relationship between the variables / *Vra vraag oor verwantskap tussen afhanklike en onafhanklike veranderlikes* ✓
- If question has a **yes/no** answer, **no marks** / *Indien die vraag 'n* ***ja/nee*** *antwoord het,* ***geen punte.***

(2)

5.2 HNO_3 / Nitric acid / *Salpetersuur.* ✓
The magnesium is used up / the magnesium is the limiting reagent. ✓

Die magnesium word opgebruik / die magnesium is die beperkende reagens. ✓ (2)

5.3
- Change in concentration of products / reactants ✓ per (unit) time. ✓
- *Verandering in konsentrasie van produkte / reaktanse per (eenheids)tyd.*

OR / *OF*
- Rate of change in concentration
- *Tempo van verandering in konsentrasie.*

OR / *OF*
- Change in amount / number of moles / volume / mass of reactants / products ✓ per (unit) time. ✓
- *Verandering in hoeveelheid / aantal / mol / volume / massa van reaktanse / produkte per (eenheids)tyd.*

OR / *OF*
- Amount / number of moles / volume / mass of products formed or reactants used per (unit) time.
- *Die hoeveelheid / aantal / mol / volume / massa van produk gevorm of reaktanse gebruik per (eenheid) tyd.*

(2)

5.4 $\Delta n = 1{,}0 - 0{,}8$ ✓ $= 0{,}2$ mol

$$n = \frac{m}{M}$$

$$0{,}2 = \frac{m}{24} \checkmark$$

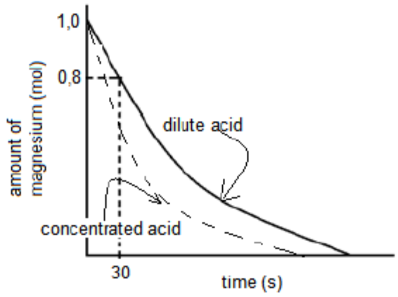
$m = 4{,}8$ g

Average rate / *gem. reaksietempo* $= \frac{\Delta m}{\Delta t}$

$$= \frac{4{,}8 \checkmark}{30(-0) \checkmark}$$

$= 0{,}16\ g{\cdot}s^{-1}$ ✓ (5)

5.5



Criteria for marking of graph / *nasienriglyne*:

- Steeper slope below original graph. / *Skuinser helling onder oorspronklike grafiek* ✓
- Intercepts x-axis earlier. / *Sny x-as vroeër* ✓

(2)
[13]

QUESTION / *VRAAG* 6

6.1 6.1.1 Activation energy / *Aktiveringsenergie* ✓ (1)

6.1.2 (a) An increase in the concentration of one or both of the reactants. ✓
'n Verhoging in die konsentrasie van een of beide reaktanse. ✓ (1)

(b) Increase in temperature / *Verhoging van temperatuur* ✓
- Increase in average kinetic energy of molecules. / More molecules have enough / sufficient kinetic energy. / *Verhoging in gemiddelde kinetiese energie van molekules / Meer molekules het voldoende of genoeg kinetiese energie.* ✓
- More effective collisions per (unit) time. / Meer effektiewe botsings per (eenheids)tyd. ✓
- Higher reaction rate. / Hoër reaksietempo ✓ (4)

6.2 6.2.1 **Marking criteria/*Nasienriglyne*:**

In terms of reducing agent/*In terme van die reduseermiddel*:
- Cu is a weaker reducing agent ✓ than H_2 ✓ and will not reduce H^+ (to H_2) ✓
- *Cu is 'n swakker reduseermiddel ✓ as H_2 ✓ en sal nie die H^+ (na H_2) reduseer nie.*

In terms of oxidising agent/*In terme van die oksideermiddel*:
- H^+ is a weaker oxidising agent ✓ than Cu^{2+} ✓ and will not oxidise Cu (to Cu^{2+})✓
- *H^+ is 'n swakker oksideermiddel ✓ as Cu^{2+} ✓ en sal nie die Cu (to Cu^{2+}) oksideer nie.* ✓

(NOTE: Compare the two reducing agents in the two half-reactions involved OR the two oxidising agents in the two half-reactions involved.
NOTA: Vergelyk die twee reduseermiddels in die twee half reaksies OF die twee oksideermiddels in die twee halfreaksies.)

OR / OF

H^+ (H_2SO_4) is a weaker oxidizing agent than Cu (to Cu^{2+}.)
H^+(H_2SO_4) is swakker oksideermiddel as die Cu (na Cu^{2+})

Note/Nota:
No marks if referring to relative positions on the table./ *Geen punte indien na die relatiewe posisies op die redokstabel verwys word nie.* (3)

6.2.2 (a) Greater than. / *Groter as.* ✓
Surface area / state of division is larger in B. / *Die oppervlak area (reaksie oppervlakte / toestand van verdeeldheid) in B is groter.* ✓ (2)

(b) Smaller than / *Kleiner as* ✓
The Cu acts as a catalyst ✓for the reaction in test tube D.
Die Cu tree as 'n katalisator ✓ *op in proefbuis D.* (2)

[13]

QUESTION / *VRAAG* 7

7.1 7.1.1 Exothermic / *Eksotermies* ✓ (1)

7.1.2 Negative marking from **QUESTION** 7.1.1/ *Negatiewe nasien van* ***VRAAG*** *7.1.1*

Marking criteria/*Nasienriglyne*:

- K_c decreases with increase in temperature. / *K_c verminder met verhoging in temperatuur.* ✓
- Reverse reaction is favoured. / [reactants] increase and [product] decreases. / *Terugwaartse reaksie word bevoordeel / [reaktanse] verhoog en [produk] verlaag.* ✓
- An increase in temperature favours the endothermic reaction. / *'n Verhoging in temperatuur bevoordeel die endotermiese reaksie.* ✓ (3)

7.1.3 Remains the same / *Bly dieselfde.* ✓ (1)

7.1.4 Only a change in temperature has an effect on the equilibrium constant / has an effect on K_c. / *Slegs 'n verandering in temperatuur beinvloed waarde van K_c* ✓ (1)

7.2

Marking criteria/*Nasienriglyne*:

- $n(O_2)$reacted/*gereageer* = $n(O_2)$eq - $n(O_2)$ini ✓
- Use ratio/*Gebruik verhouding* 2 : 20 : 0 ✓
- $n(SO_2)$eq = $n(SO_2)$ini + $n(SO_2)$change/*verandering* } ✓
- $n(SO_3)$eq = $n(SO_3)$ini - $n(SO_3)$change/verandering }
- n_{eq} divide by / *gedeel deur* 2 ✓
- K_c expression/*uitdrukking* ✓
- Substitute/*vervang* $[\ ]_{eq}$ into Kc expression/*uitdrukking* ✓
- Answer/*antwoord*: 125 ✓

	$2SO_3$	$2SO_2$	O_2
Initial mol *Aanvanklike mol*	24	0	0
Change mol *Verandering in mol*	20	20	10 Use ratio ✓
Equilibrium mol *Mol by ewewig*	24 – 2 (10) = 4 ✓	20	10 ✓
Concentration equilibrium *Ewewigskonsentrasie*	$c = \frac{n}{V} = \frac{4}{2} = 2$	$c = \frac{n}{V} = \frac{20}{2}$ = 10	$c = \frac{n}{V} = \frac{10}{2}$ ✓ = 5

$K_c = \frac{[SO_2]^2[O_2]}{[SO_3]^2}$ ✓

$= \frac{(10)^2(5)}{(2)^2}$ ✓

= 125 ✓ (7)

[13]

QUESTION 6

6.1.1 Increases ✓ (1)

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

6.1.3 Increase in temperature increases K_c ✓
Increase in K_c indicates that the forward reaction has been favoured ✓,
Increase in temperature favours the endothermic reaction ✓,
Therefore the forward reaction is endothermic ✓. (4)

6.1.4 Add a catalyst ✓
Increase pressure OR decrease volume of container ✓ (2)

6.2

	A_2 +	2B →	2AB
Initial (mol)	x	2	0 ✓
Used / formed	-0,2	-0,4	0,4 ✓ ⓥ ← RATIO
Equilibrium (mol)	x – 0,2	1,6	0,4 ✓ ← Addition for **all** three
[equilibrium]	x – 0,2	1,6	0,4 ✓

For conc. only ✓

	A_2 +	2B →	2AB
Initial conc.($mol.dm^{-3}$)	x	2	0 ✓
Used / formed	-0,2	-0,4	0,4 ✓ ⓥ → RATIO
[equilibrium]	x – 0,2	1,6	0,4 ✓ → Addition for **all** three

$$K_c = \frac{[AB]^2}{[A_2][B]^2} \checkmark$$

$$= \frac{(0,4)^2}{(x-0,2)(1,6)^2} \checkmark$$

$$= 0,5$$

$$\therefore 0,5\,[((x-0,2)(1,6)^2] = (0,4)^2$$

$$\therefore 1,28x - 0,256 = 0,16$$

$$\therefore X = 0,325 \text{ mol} \checkmark$$

Marking criteria:
- Initial mol/conc correctly indicated. ✓
- Mol/conc of AB produced = 0,4.✓
- Ratio applied correctly. ✓
- Equilibrium mol: ✓ initial – used / Initial + produced }
  OR
  Equilibrium conc: ✓✓ initial – used / Initial + produced }
- Equilibrium mol ÷ 1 = eq conc. ✓
- Correct Kc expression. ✓
- Substitution of eq conc to Kc expression. ✓
- Final answer. ✓

QUESTION/VRAAG 5

5.1 Carbon dioxide/CO_2 / koolstofdioksied (2)

5.2.1 The decrease in concentration of hydrochloric acid per unit time. ✓✓/ die afname in soutsuur konsentrasie per eenheidstyd (2)
(2 or 0)

5.2.2 Concentration(of the acid) ✓/ konsentrasie (1)

5.2.3 For a fair test/comparison✓ / vir 'n regverdige toets (1)

5.2.4 Higher acid concentration in experiment 2 means:

- More particles/molecules per unit volume✓
- More particles have kinetic energy equal to or greater than activation energy/More particles have enough kintetic energy ✓
- More effective collisions per unit time/frequency of effective collisions increases/Rate of effective collisions increases. ✓ (3)

Hoër konsentrasie suur vir eksperiment beteken:

- Meer deeltjies/ eenheidsvolume
- Meer deeltjies het genoeg E_K gelyk of groter as aktiverings energie/ genoeg E_K
- Meer effektiewe botsings/ eenheidstyd

5.2.5 $n(CaCO_3) = \frac{m}{M}$

$= \frac{4}{100}$ ✓

$= 0{,}04$ mol

$n(HC\ell):n(CaCO_3) = 2 : 1$

$\therefore n(HC\ell) = 2(0{,}04)$ ✓ $= 0{,}08$ mol

$c(HC\ell) = \frac{n}{V}$

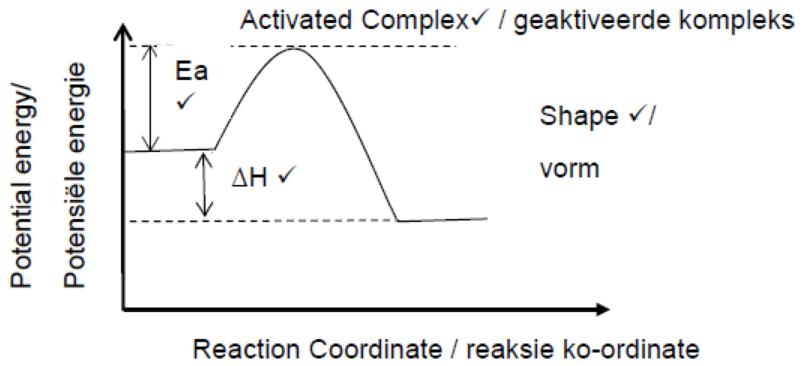
$0{,}4 = \frac{0{,}08}{V}$ ✓

$\therefore V = 0{,}2\ dm^3 = 200\ cm^3$ ✓ (4)

Marking Guidelines:

- Substitution into $n = \frac{m}{M}$
- Ratio $n(HC\ell) = \frac{1}{2}n(CaCO_3)$
- Substitution in $c = n/V$
- Final answer

5.3 POTENTIAL ENERGY VERSUS REACTION COORDINATE GRAPH



(4)
[17]

QUESTION/VRAAG 6

6.1 3 to 4 minutes (Any value from 3 min to 4 min can be accepted) / 3 - 4 minute (1)

6.2.1 Greater than✓/ groter as (1)

6.2.2 Equal to ✓/ gelyk aan (1)

6.3 **CALCULATION USING NUMBER OF MOLES / bereken met aantal mol**

Marking Criteria:

- Correct K_c expression/ korrekte K_c uitdrukking
- Substituting the K_c value in the expression/ vervanging van K_c waarde
- Substituting concentration value of $PC\ell_5$(g) in K_c/ vervanging van $[PC\ell_5]$ in K_c
- Equilibrium concentration $PC\ell_3$ and $C\ell_2$ = 0,91 $mol{\cdot}dm^{-3}$/ [ewewig] $PC\ell_3 = C\ell_2$ = 0,91
- Using n = cV to find the n of $PC\ell_5$ (multiplying c by 2)/ x 2 om n van $PC\ell_5$ te kry
- Ratio of $n(PC\ell_5)$: $n(PC\ell_3)$: $n(C\ell_2)$ = 1:1:1/ verhouding $[PC\ell_5]$: $[PC\ell_3]$: $[C\ell_2]$ = 1:1:1
- Calculating n ($PC\ell_5$) initial = 2,12 mol/ berekening van aanvanklik $PC\ell_5$ = 2,12

Assume that the equilibrium concentration of $PC\ell_3$(g) is *x*

$$K_c = \frac{[PCl_3][Cl_2]}{[PCl_5]} \checkmark$$

$$5.55 \checkmark = \frac{(x)(x)}{0,15} \checkmark$$

$$\therefore x = 0.91 \text{ mol}\cdot\text{dm}^{-3} \checkmark$$

	$PC\ell_5$	$PC\ell_3$	$C\ell_2$	
Initial Quantity (mol)	2,12 ✓	0	0	
Change in quantity (mol)	-1,82	+1,82	+1,82	R✓
Equilibrium quantity (mol)	0,30 ✓	1,82	1,82	X 2 ✓
Concentration at equilibrium ($mol{\cdot}dm^{-3}$) V = 2 dm^3	0,15	0,91	0,91	

$n = \frac{m}{M}$

$2,12 = \frac{m}{102}$ ✓

m = 216,24 g ✓

CALCULATION USING CONCENTRATION/ berekening met [ ]

- Correct K_c expression/ korrekte K_c uitdrukking
- Substituting the K_c value in the expression/ vervanging van K_c waarde
- Substituting concentration value of $PC\ell_5(g)$ in K_c / vervanging van $[PC\ell_5]$ in K_c
- Equilibrium concentration for $PC\ell_3$ and $C\ell_2$ = 0,91 $mol\cdot dm^{-3}$ / [ewewig] $PC\ell_3 = C\ell_2$ = 0,91
- Ratio of $[PC\ell_5]: [PC\ell_3]: [C\ell_2]$ = 1:1:1 / verhouding $[PC\ell_5]: [PC\ell_3]: [C\ell_2]$ = 1:1:1
- Initial concentration of $PC\ell_5(g)$ / aanvanklike $[PC\ell_5]$
- Substituting 2 in c = n/V / deel deur 2 vir [ ]
- Substituting 102 in n = m/M / vervanging van 102 in n = m/M
- Final answer / finale antwoord

Assume that the equilibrium concentration of $PC\ell_3(g)$ is x

$$K_c = \frac{[PCl_3][Cl_2]}{[PCl_5]} \checkmark$$

$$5.55 \checkmark = \frac{(x)(x)}{0,15} \checkmark$$

$$\therefore x = 0.91 \text{ mol}\cdot\text{dm}^{-3} \checkmark$$

	$PC\ell_5$	$PC\ell_3$	$C\ell_2$	
Initial concentration ($mol\cdot dm^{-3}$) aanvanklik	1,06 ✓	0	0	
Change in concentration ($mol\cdot dm^{-3}$) Verandering	-0,91	+0,91	+0,91	Ratio✓/ verhouding
Equilibrium concentration ($mol\cdot dm^{-3}$) Ewewig	0,15	+0,91	+0,91	

$$c = \frac{n}{V}$$

$$1.06 = \frac{n}{2} \checkmark$$

n = 2,12 mol

OR/ of

m = cMV

=(1,06)(102)(2)

=216,24 g

m = n M = (2,12)(31+5 x 31,5) ✓

= 443,02 g ✓ (9)

6.4 Endothermic. ✓ endotermies

Decrease in temperature **increases $[PC\ell_5]$** and **decreases $[C\ell_2]$** and **$[PC\ell_3]$**, which implies that the reverse reaction is favoured/equilibrium position shifts to the left. ✓According to Le Chatelier 's Principle, the decrease in temperature favours the exothermic reaction.✓
Therefore, the forward reaction is endothermic. /
Afname in temperatuur verhoog **$[PC\ell_5]$** en verlaag **$[C\ell_2]$** en **$[PC\ell_3]$**, dus word terugwaartse reaksie bevoordeel/ ewewig skuif na links
Volgens Le Chatelier se beginsel sal 'n afname in temperatuur die eksotermiese reaksie bevoordeel (d.w.s terugwaartse reaksie is endotermies)
Dus is die voorwaartse reaksie endotermies (3)

[15]

QUESTION 5

5.1

Amount of mole Zn available at 0 s: $n = \frac{m}{M}$

$= \frac{0,016}{65}$

$= 0,00025$ mol ✓ ($2,462 \times 10^{-4}$ mol)

Amount of mole Zn available at 12 s: $n = \frac{m}{M}$

$= \frac{0,009}{65}$

$= 0,00014$ mol ✓ ($1,385 \times 10^{-4}$ mol)

Ave Rate = $-\frac{\Delta c}{\Delta t}$ (no mark for formula)

$= \frac{0,00014 - 0,00025}{12 - 0}$ ✓

$= -9,167 \times 10^{-6}$ mol·s^{-1} ✓ (= $-8,975 \times 10^{-6}$ mol·s^{-1})

Ave Rate = $9,167 \times 10^{-6}$ mol·s^{-1} (= $8,975 \times 10^{-6}$ mol·s^{-1})

$\Delta n = \Delta m/MM$

$= (0,009 - 0,016)/65$ ✓

$= -1,077 \times 10^{-4}$ mol

∴ Average Rate = $-\Delta n/\Delta t$ ✓

$= -[-1,077 \times 10^{-4} / (12 - 0)]$ ✓

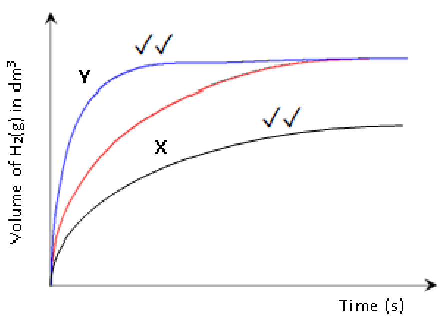
$= 8,974 \times 10^{-6}$ mol·s^{-1}. ✓

(4)

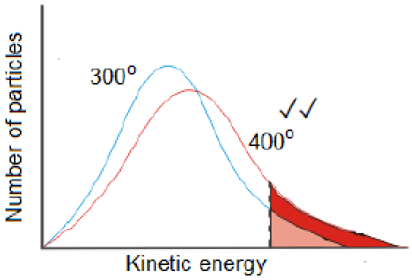
5.2 The HCℓ is used up/depleted / HCℓ is the limiting reactant ✓ (1)

5.3 The rate decreases as time passes. ✓ (1)

5.4.1
5.4.2



(4)

5.5			(2)
5.6	An increase in temperature increases the number of particles having minimum kinetic energy. ✓ Therefore there are more collisions per second/ unit time/ frequency of collision increases More effective collisions per second/ unit time / frequency of effective collision increases ✓ Which increases rate of reaction		(2) **[14]**

QUESTION 6

6.1 It is a dynamic equilibrium when the rate of the forward reaction equals the rate of the reverse reaction✓✓ and the reactions occur simultaneously.
[2 or 0] (2)

6.2

	N_2	$3\ H_2$	$2\ NH_3$
Initial moles	$^{33,6}/_{28} = 1,2$ ✓	$^{24}/_{2} = 12$ ✓	0
Change in moles	- 1	- 3	+ 2
Equilibrium moles	$^{5,6}/_{28} = 0,2$ ✓	9 ✓	2
Equilibrium conc (= n/V)	$^{0,2}/_{5} = 0,04$	$^{9}/_{5} = 1,8$	$^{2}/_{5} = 0,4$

$\therefore [N_2] = 0,04\ mol{\cdot}dm^{-3}$ ✓ AND $[H_2] = 1,8\ mol{\cdot}dm^{-3}$ ✓

mass of N_2 used during the reaction?
33,6 - 5,6 = 28 g
Therefore 1 mol N_2 was used during the reaction. ✓
1 mol N_2 react with three mole H_2
Therefore 6 g H_2 was used during the reaction✓

concentration N_2 at equilibrium: $c = \frac{m}{MV}$
$= \frac{5,6}{28 \times 5}$✓
$= 0,04\ mol{\cdot}dm^{-3}$✓

Amount H_2 at equilibrium: $c = \frac{m}{MV}$
$= \frac{24-6}{2 \times 5}$✓
$= 1,8\ mol{\cdot}dm^{-3}$✓

(6)

6.3 $K_c = \frac{[NH_3]^2}{[H_2]^3[N_2]}$✓
$= ^{(0,4)2}/_{(0,04)(1,8)3}$ ✓
$= 0,686$ ✓
(3)

6.4 Increases ✓ (1)

6.5 Exothermic ✓ (1)

6.6 When the temperature increases, the K_c value decreases, which means the concentration of the reactants increased and the concentration of the products decreased. ✓ Therefore the reverse reaction was favoured. ✓ An increase of temperature favours the endothermic reaction, ✓ therefore the forward reaction must be exothermic.
(3)
[16]

VRAAG 5

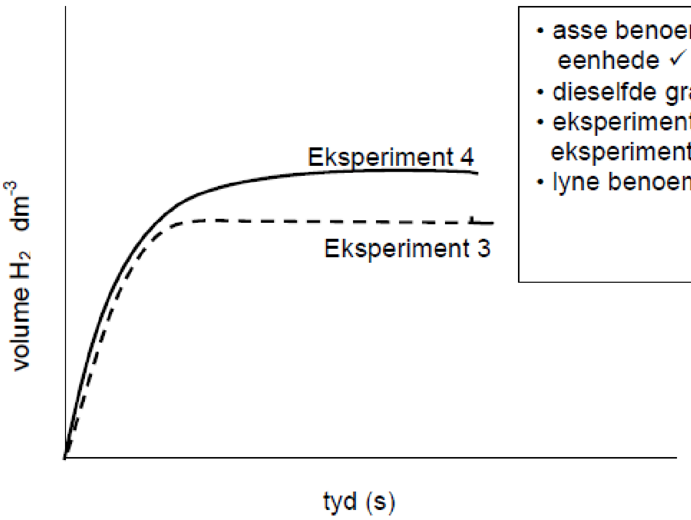
5.1 *Reaksietempo* is die verandering in konsentrasie van reaktante of produkte per eenheidstyd. ✓✓

5.2.1 Temperatuur ✓

5.2.2 Reaksietempo ✓

5.3 Die konsentrasie van die HCℓ in eksperiment 1 is hoër as in eksperiment 2. ✓ Daar is dus meer deeltjies wat genoegsame kinetiese energie ✓ het om die aktiverings energie te oorkom dws daar sal meer effektiewe botsings per tydseenheid ✓ wees en 'n hoër reaksietempo.

5.4.1 GELYK AAN. ✓



- asse benoem met eenhede ✓
- dieselfde gradient ✓
- eksperiment 3 laer as eksperiment 4 ✓
- lyne benoem ✓

5.5 **OPSIE 1**

1 mol Zn lewer 1 mol H_2 gas ✓

65 g Zn lewer 25,7 dm^3 H_2 gas

x g Zn lewer 8,6 dm^3 H_2 gas

$x = \frac{8{,}6 \times 65}{25{,}7}$ ✓

= 21,76 g Zn✓

% suiwerheid = $\frac{21{,}76}{25}$ x 100✓

= 87% ✓

OPSIE 2

$n_{(H2)} = \frac{8{,}6}{25{,}7}$

= 0,33 mol ✓

Zn : H_2

1:1✓

$m_{(Zn)}$ = nM

= 0,33 x 65

= 24,45 g✓

% suiwerheid = $\frac{21{,}45}{25}$ x 100✓

= 85,8% ✓

[17]

VRAAG 6

6.1

	2 NOBr	2 NO	1 Br_2
mol begin	55/110 = 0,5	0	0
mol reageer.vorm 78% NOBr	0,39	0,39	0,195
mol by ewewig	0,11	0,39	0,195
c by ewewig	**0,055**	**0,195**	**0,0975**

$$K_c = \frac{[NO]^2[Br_2]}{[NOBr]^2}$$

$$= \frac{(0,195)^2\,(0,0975)}{(0,055)^2}$$

$$= 1,23$$

- regte molhoeveelheid (NOBr) bereken ✓
- GEBRUIK regte verhouding van oorspronklike mol ✓
- Bereken 78% van oorspronklike mol✓
- Mol by ewewig reg afgetrek of bygetel ✓
- Gebruik c = n/V ✓

Kc uitdrukking ✓
Vervanging ✓
Antwoord ✓

6.2.1 BLY DIESELFDE ✓✓
6.2.2 NEEM TOE ✓✓
6.2.3 NEEM AF ✓✓

6.3 Wanneer die volume verklein, sal die druk verhoog. ✓Volgens Le Chatelier se beginsel sal dié reaksie wat die druk verlaag / minste molekules vorm bevoordeel word. ✓ Dit is die terugwaartse reaksie.✓

[17]

MERCY!!!!!

WHERE TO START MATHS AND SCIENCE TUTORING

“Where to Start Maths and Science tutoring” is aiming at assisting learners with understanding of basic skills for Maths and Sciences and also changes the stigma of learners towards Maths and Science subjects, we also help Schools around the country

- TO: LEARNERS

- ✓ JOIN US ON WHATSAP GROUP: 082 672 7928

- **WTS VISITING SCHOOL PROGRAM**

- ✓ DAYS : FRIDAYS, SATURDAYS & SUNDAYS
- ✓ SUBJECTS : MATHS, MATHS LIT AND PHYSCS
- ✓ TIME : ANY TIME AND EVEN CROSSNIGHTS
- ✓ BOOK US ON : 082 672 7928

- **WTS PRIVATE CLASSES**

- ✓ PLACE : RICHARDS BAY ARBORETUM
- ✓ GRADES : 8 TO 12

WTS SATURDAY & SUNDAYS CLASSES

- ✓ LEARNERS FROM DIFFERENT SCHOOLS ARE ALLOWED
- ✓ TIME : 09:00 TO 12:00
- ✓ SUBJECTS : MATHS & SCIENCES

- ✓ VENUE : SIPHUMELELE SCHOOL [MZINGAZI RESERVE]
- ✓ GRADE 12 : SUNDAYS
- ✓ GRADE 10 & 11 : SATURDAYS

WEEKDAYS: PRIVATE CLASSES

- ✓ MONDAY TO THUERDAY
- ✓ TIME : 17:30 TO 19:00
- ✓ SUBJECTS : MATHS & SCIENCES

WTS FINISHINING SCHOOL

- ✓ PLACE : KZN RICHARDS BAY @ MZINGAZI
- ✓ SUBJECTS : MATHS, PHYSCS, ACCOUNTING & LIFE SCIENCES
- ✓ TIME : 15:00 TO 16:30
- ✓ ACCOMMODATION IS AVAILABLE!!

ACKNOWLEDGEMENTS

- DEPARTMENT OF EDUCATION PAST PAPERS

ANY EDITIONS AND COMMENTS ARE ALLOWED

I THANK YOU!!!!!!!!!!!!!!

NB: WE CONDUCT CROSSNIGHTS AND CAMPS PER TERM

“WHERE TO START MATHS & SCIENCE IS FOR THE NATION”