basic education

Department:
Basic Education
REPUBLIC OF SOUTH AFRICA

NATIONAL SENIOR CERTIFICATE
NASIONALE SENIOR SERTIFIKAAT

GRADE/*GRAAD* 12

PHYSICAL SCIENCES: CHEMISTRY (P2)
FISIESE WETENSKAPPE: CHEMIE (V2)

NOVEMBER 2014

MEMORANDUM

MARKS/*PUNTE*: 150

This memorandum consists of 20 pages.
Hierdie memorandum bestaan uit 20 bladsye.

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QUESTION 1 / *VRAAG 1*

1.1 C ✓✓ (2)

1.2 B ✓✓ (2)

1.3 D ✓✓ (2)

1.4 D ✓✓ (2)

1.5 A ✓✓ (2)

1.6 B ✓✓ (2)

1.7 B ✓✓ (2)

1.8 A ✓✓ (2)

1.9 D ✓✓ (2)

1.10 C ✓✓ (2)

[20]

QUESTION 2 / *VRAAG 2*

2.1

2.1.1 B ✓ (1)

2.1.2 E ✓ (1)

2.1.3 F ✓ (1)

2.2

2.2.1 2-bromo-3-chloro-4-methylpentane
2-bromo-3-chloro-4-metielpentaan / 2-broom-3-chloor-4-metielpentaan

Marking criteria / *Nasienriglyne:*
- Correct stem i.e. pentane. / *Korrekte stam d.i. pentaan.* ✓
- All substituents correctly identified. / *Alle substituente korrek geïdentifiseer.* ✓
- Substituents correctly numbered, in alphabetical order, hyphens and commas correctly used. ✓
  Substituente korrek genommer, in alfabetiese volgorde, koppeltekens en kommas korrek gebruik.

(3)

2.2.2 Ethene / *Eteen* ✓ (1)

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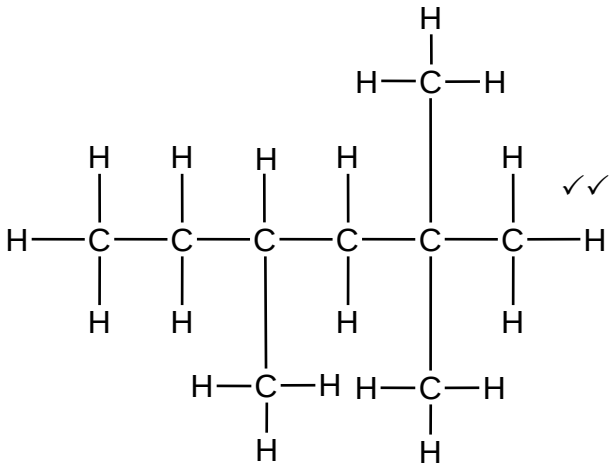
2.3
2.3.1

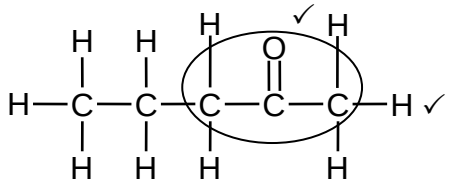


Marking criteria / *Nasienriglyne:*
- Six saturated C atoms in longest chain i.e. hexane. ✓ *Ses versadigde C-atome in langste ketting d.i. heksaan.*
- Three methyl substituents on second C and fourth C. ✓ *Drie metielsubstituente op tweede C en vierde C.*

Notes / *Aantekeninge:*
- If correct structure and number of bonds, but H atoms omitted / *Indien korrekte struktuur en getal bindings, maar H-atome weggelaat:* Max / *Maks.* $\frac{1}{2}$
- Condensed or semi-structural formula: *Gekondenseerde of semistruktuurformule*: Max./*Maks.* $\frac{1}{2}$
- Molecular formula / *Molekulêre formule*: $\frac{0}{2}$

(2)

2.3.2



Marking criteria / *Nasienriglyne:*
- Whole structure correct / *Hele struktuur korrek:* $\frac{2}{2}$
- Only functional group correct / *Slegs funksionele groep korrek:* $\frac{1}{2}$

Notes / *Aantekeninge:*
- Condensed or semi-structural formula: *Gekondenseerde of semistruktuurformule*: Max / *Maks* $\frac{1}{2}$
- Molecular formula / *Molekulêre formule*: $\frac{0}{2}$

(2)

2.4
2.4.1 (Compounds with) the same molecular formula ✓ but different functional goups / different homologous series. ✓
(Verbindings met) dieselfde molekulêre formule, maar verskillende funksionele groepe / verskillende homoloë reekse. (2)

2.4.2 B & F ✓ (1)

[14]

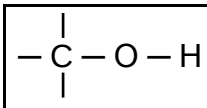
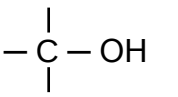
QUESTION 3 / *VRAAG 3*

3.1 **ANY ONE / ENIGE EEN:**

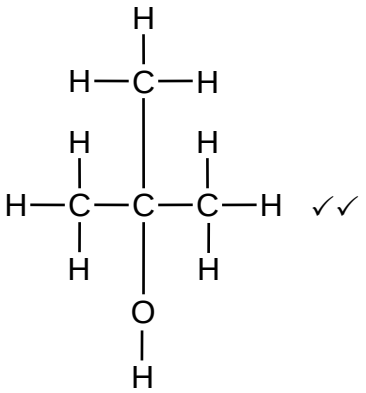
- Alkanes have ONLY single bonds. ✓
  Alkane het SLEGS enkelbindings.
- Alkanes have single bonds between C atoms.
  Alkane het enkelbindings tussen C-atome.
- Alkanes have no double OR triple bonds OR multiple bonds.
- *Alkane het geen dubbel- OF trippelbindings OF meervoudige bindings nie.*
- Alkanes contain the maximum number of H atoms bonded to C atoms.
  Alkane bevat die maksimum getal H-atome gebind aan C-atome. (1)

3.2

3.2.1 **ANY ONE / *ENIGE EEN:***

 ✓		– OH	– O – H
R ─ OH	R ─ O ─ H		

(1)

3.2.2  ✓✓

Marking criteria / *Nasienriglyne:*

- - OH group on second C atom of longest chain. ✓
  - OH-groep op tweede C-atoom van langste ketting.
- Tertiary group consisting of four C atoms with methyl group on 2nd C atom. ✓
  Tersiêre groep bestaande uit vier C-atome met metielgroep op 2de C-atoom.
- If two/more functional groups / *Indien twee/meer funksionele groepe:* $0/2$

Notes / *Aantekeninge:*

- Accept / *Aanvaar* – OH
- If correct structure and number of bonds, but H atoms omitted / *Indien korrekte struktuur en getal bindings, maar H-atome weggelaat:* Max / *Maks.* $1/2$
- Condensed or semi-structural formula / *Gekondenseerde of semistruktuurformule*: Max / *Maks.* $1/2$
- Molecular formula / *Molekulêre formule*: $0/2$

(2)

3.3
3.3.1

Criteria for investigative question / *Riglyne vir ondersoekende vraag:*	
The dependent and independent variables are stated. *Die afhanklike en onafhanklike veranderlikes is genoem.*	✓
Ask a question about the relationship between the independent and dependent variables. *Vra 'n vraag oor die verwantskap tussen die onafhanklike en afhanklike veranderlikes.*	✓

Examples / *Voorbeelde*:

- How does an increase in chain length / molecular size / molecular structure / molecular mass / surface area influence boiling point?
  Hoe beïnvloed 'n toename in kettinglengte / molekulêre grootte / molekulêre struktuur / molekulêre massa / reaksieoppervlak die kookpunt?
- What is the relationship between chain length / molecular size / molecular structure / molecular mass / surface area and boiling point?
  Wat is die verwantskap tussen kettinglengte / molekulêre grootte / molekulêre struktuur / molekulêre massa / oppervlakte en kookpunt? (2)

3.3.2

- **Structure / *Struktuur*:**
  The chain length / molecular size / molecular structure / molecular mass / surface area increases. ✓
  Die *kettinglengte / molekulêre grootte / molekulêre struktuur / molekulêre massa / oppervlakte neem toe.*
- **Intermolecular forces / *Intermolekulêre kragte*:**
  Increase in strength of intermolecular forces / induced dipole / London / dispersion / Van der Waals forces. ✓
  Toename in sterkte van intermolekulêre kragte / geïnduseerde dipoolkragte / London-kragte / dispersiekragte / Van der Waalskragte.
- **Energy / *Energie*:**
  More energy needed to overcome / break intermolecular forces. ✓
  Meer *energie benodig om intermolekulêre kragte te oorkom / breek.*

OR / *OF*

- **Structure / *Struktuur*:**
  From propane to methane the chain length / molecular size / molecular structure / molecular mass / surface area decreases. ✓
  Van propaan na metaan neem die kettinglengte / molekulêre grootte / molekulêre struktuur / molekulêre massa / oppervlakte af.
- **Intermolecular forces / *Intermolekulêre kragte:***
  Decrease in strength of intermolecular forces / induced dipole forces / London forces / dispersion forces. ✓
  Afname in sterkte van intermolekulêre kragte / geïnduseerde dipoolkragte / London-kragte / dispersiekragte.
- **Energy / *Energie*:**
  Less energy needed to overcome / break intermolecular forces. ✓
  Minder energie benodig om intermolekulêre kragte te oorkom / breek. (3)

3.4
- Between <u>propane</u> molecules are weak <u>London forces</u> / <u>dispersion forces / induced dipole forces</u>. ✓
  Tussen <u>propaan</u>molekule is swak <u>Londonkragte / dispersiekragte / geïnduseerde dipoolkragte</u>.
- Between <u>propan-1-ol</u> molecules are weak London forces / dispersion forces / induced dipole forces and strong <u>hydrogen bonds</u>. ✓
  Tussen <u>propan-1-</u>ol molekule is swak Londonkragte / dispersiekragte / geïnduseerde dipoolkragte en sterk <u>waterstofbindings.</u>
- Hydrogen bonds / Forces between alcohol molecules are <u>stronger than</u> weak London forces / dispersion forces / induced dipole forces. ✓
  Waterstofbindings / Kragte tussen alkoholmolekule is <u>sterker</u> of benodig meer energie om oorkom te word as Londonkragte / dispersiekragte / geïnduseerde dipoolkragte.
  OR / *OF*
- London forces / dispersion forces / induced dipole forces / forces between propane molecules are <u>weaker</u> than OR needed less energy to be overcome than hydrogen bonds. ✓
  Londonkragte / dispersiekragte / geïnduseerde dipoolkragte / kragte tussen propaanmolekule is <u>swakker</u> as OF benodig minder energie om oorkom te word as waterstofbindings.

(3)
[12]

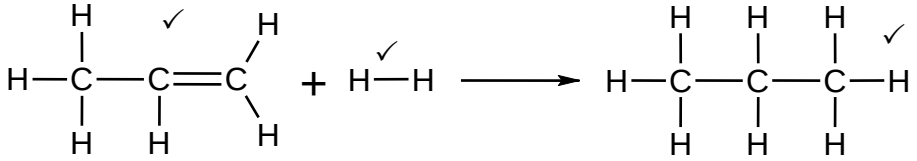
QUESTION 4 / *VRAAG 4*

4.1
4.1.1 Substitution / chlorination / halogenation ✓
Substitusie / chlorering / halogenering / halogenasie (1)

4.1.2 Substitution / hydrolysis ✓
Substitusie / hidrolise (1)

4.2
4.2.1 Hydrogenation / *Hidrogenasie / Hidrogenering* ✓ (1)

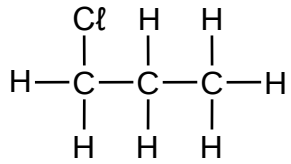
4.2.2



<u>Notes / *Aantekeninge*</u>*:*
- Ignore/*Ignoreer* ⇌
- Accept H_2 if condensed. / *Aanvaar H_2 as gekondenseerd.*
- Any additional reactants and/or products
  Enige addisionele reaktanse en / of produkte: Max./*Maks.* $\frac{2}{3}$
- Accept coefficients that are multiples.
  Aanvaar koëffisiënte wat veelvoude is.
- Molecular / condensed formulae
  Molekulêre-/ gekondenseerde formule: Max./*Maks.* $\frac{2}{3}$

(3)

4.3



Marking criteria / *Nasienriglyne:*
- Whole structure correct:/ *Hele struktuur korrek:* $\frac{2}{2}$
- Only ONE Cℓ atom as functional group. / *Slegs EEN Cℓ-atoom as funksionele groep.* $\frac{1}{2}$

Notes / *Aantekeninge:*.
- Condensed or semi-structural formula
  Gekondenseerde of semistruktuurformule: Max./*Maks.* $\frac{1}{2}$
- Molecular formula. / *Molekulêre formule*: $\frac{0}{2}$
- If functional group is incorrect. / *Indien funksionele groep verkeerd is*: $\frac{0}{2}$

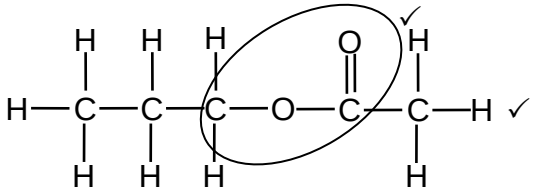
(2)

4.4

4.4.1 Esterification / Condensation ✓
Verestering / Esterifikasie / Kondensasie (1)

4.4.2 (Concentrated) H_2SO_4 / (Concentrated) sulphuric acid ✓
(Gekonsentreerde) H_2SO_4 / (Gekonsentreerde) swawelsuur of swaelsuur (1)

4.4.3



Marking criteria / *Nasienriglyne:*
- Whole structure correct / *Hele struktuur korrek:* $\frac{2}{2}$
- Only functional group correct / *Slegs funksionele groep korrek:* $\frac{1}{2}$

Notes / *Aantekeninge:*
- Condensed or semi-structural formula:
  Gekondenseerde of semistruktuurformule: Max./*Maks.* $\frac{1}{2}$
- Molecular formula / *Molekulêre formule*: $\frac{0}{2}$
- If functional group is incorrect/*Indien funksionele groep verkeerd is:* $\frac{0}{2}$

(2)

4.4.4 Propyl ✓ ethanoate ✓
Propieletanoaat (2)

4.5 Sulphuric acid / H_2SO_4 / Phosphoric acid / H_3PO_4 ✓
Swawelsuur / Swaelsuur / H_2SO_4 / Fosforsuur / H_3PO_4 (1)

[15]

QUESTION 5 / *VRAAG 5*

5.1 **ONLY ANY ONE OF/ SLEGS ENIGE EEN VAN:**

- Change in concentration of products / reactants ✓ per (unit) time. ✓
  Verandering in konsentrasie van produkte / reaktanse per (eenheids)tyd.
- Rate of change in concentration. ✓✓
  Tempo van verandering in konsentrasie.
- Change in amount / number of moles / volume / mass of products or reactants per (unit) time.
  Verandering in hoeveelheid / getal mol/volume / massa van produkte of reaktanse per (eenheids)tyd.
- Amount / number of moles / volume / mass of products formed or reactants used per (unit) time.
  Hoeveelheid / getal mol / volume / massa van produkte gevorm of reaktanse gebruik per (eenheids)tyd. (2)

5.2

5.2.1 Temperature / *Temperatuur* ✓ (1)

5.2.2 Rate of reaction / Volume of gas (formed) per (unit) time ✓
Reaksietempo / Volume gas (gevorm) per (eenheids)tyd (1)

5.3

- Larger mass / amount / surface area. ✓
  Groter massa / hoeveelheid / reaksieoppervlak.
- More effective collisions per (unit) time. / Frequency of effective collisions increase./ More particles collide with sufficient kinetic energy & correct orientation per (unit) time. ✓✓
  Meer effektiewe botsings per (eenheids)tyd. / Frekwensie van effektiewe botsings verhoog./ Meer deeltjies bots met genoeg kinetiese energie & korrekte oriëntasie per tyd(seenheid).

IF / *INDIEN*: • Larger mass / amount / surface area. ✓ *Groter massa / hoeveelheid / reaksieoppervlak.* • More particles collide. / More collisions. ✓ *Meer deeltjies bots. / Meer botsings.* *Max./Maks.* $^{2}/_{3}$
Notes / *Aantekeninge*: If no reference to mass / amount / surface area in answer: Indien geen verwysing na *massa / hoeveelheid / reaksieoppervlak in antwoord:* $^{0}/_{3}$

(3)

5.4 **Marking criteria / *Nasienriglyne:***

Compare Exp.1 with Exp. 2: *Vergelyk Eksp. 1 met Eksp. 2:*	The reaction in exp. 1 is faster in exp. 1 than in exp. 2 due to the higher acid concentration. *Die reaksie in eksp. 1 is vinniger as dié in eksp. 2 as gevolg van die hoër suurkonsentrasie.*	✓
	Therefore the gradient of the graph representing exp. 1 is greater / steeper than that of exp. 2. / Graph of Exp. 1 reaches constant volume in shorter time than exp. 2. *Dus is die gradiënt van die grafiek wat eksp. 1 voorstel, groter/steiler as dié vir eksp. 2. / Grafiek van exp. 1 bereik konstante volume in korter tyd as dié vir eksp. 2.*	✓
Compare Exp. 1 with Exp 3 & 4: *Vergelyk Eksp. 1 met Eksp. 3 & 4:*	The reaction in exp. 3 is faster than that in exp. 1 due to the higher temperature. *Die reaksie in eks. 3 is vinniger as dié in eksp. 1 as gevolg van die hoër temperatuur.*	✓
	The reaction in exp. 4 is faster than that in exp. 1 due to the higher temperature / larger surface area. *Die reaksie in eks. 4 is vinniger as dié in eksp. 1 as gevolg van die hoër temperatuur / groter reaksieoppervlak.* **OR/*OF*** *Graph A represents exp. 4 due to the greater mass of $CaCO_3$ - greater yield of CO_2 at a faster rate.* *Grafiek A stel eksp. 4 voor as gevolg van die groter massa $CaCO_3$ - groter opbrengs CO_2 teen vinniger tempo.*	✓
	Therefore the gradient of the graphs of exp. 3 & 4 are greater/steeper than that of exp. 1. / Graphs of Exp. 3 & 4 reaches constant volume in shorter time than exp. 1. *Dus is die gradiënte van die grafieke vir eksp. 3 & 4 is groter/steiler as dié in eksp. 1./ Grafieke van exp. 3 & 4 bereik konstante volume in korter tyd as dié vir eksp. 1.*	✓
Final answer *Finale antwoord*	C	✓

(6)

Notes/*Aantekeninge*

- Compare exp. 1 with exp. 2 / *Vergelyk eksp. 1 met eksp. 2*:
  - Factor & rate / *Faktor & tempo*.
  - Gradient / volume CO_2 per time / gradient / *volume CO_2 per tyd.*
- Compare exp. 1 with exp. 3 / *Vergelyk eksp. 1 met eksp. 3*:
  - Factor & rate / *Faktor & tempo.*
- Compare exp. 1 with exp. 4/ *Vergelyk eksp. 1 met eksp. 4*:
  - Factor & rate / *Faktor & tempo.*
- Compare gradient / volume CO_2 per time of exp 1 with that of exp. 3 & 4
  Vergelyk gradient/volume CO_2 per tyd van eksp 1 met die van eksp. 3 & 4
- Final answer / *finale antwoord*: C

5.5

Marking criteria / *Nasienriglyne:*

- Divide volume by / *Deel volume deur*: 25,7 ✓
- Use ratio / Gebruik v*erhouding*: $n(CO_2) = n(CaCO_3) = 1:1$ ✓
- Substitute / *Vervang* 100. ✓
- Subtraction / *Aftrekking.* ✓
- Final answer / *Finale antwoord:* 7,00 g to/*tot* 7,5 g ✓

OPTION 1 / *OPSIE 1*

$$n(CO_2) = \frac{V}{V_m}$$
$$= \frac{4,5}{25,7} \checkmark$$
$$= 0,18 \text{ mol}$$

$n(CaCO_3) = n(CO_2) = 0,18$ mol ✓

$$n(CaCO_3) = \frac{m}{M}$$
$$0,18 = \frac{m}{100} \checkmark$$
$$\therefore m = 18 \text{ g}$$

$m(CaCO_3)$ not reacted/*nie gereageer nie):*
25 – 18 ✓ = 7,00 g ✓

(Accept range*:* 7,00 g – 7,5 g)
(Aanvaar gebied: 7.00 g – 7,5 g)

OPTION 2 / *OPSIE 2*

Calculate mass of CO_2:
Bereken massa CO_2:

$$n(CO_2) = \frac{V}{V_m}$$
$$= \frac{4,5}{25,7} \checkmark$$
$$= 0,18 \text{ mol}$$

$$n(CO_2) = \frac{m}{M}$$
$$0,18 = \frac{m}{44}$$
$$\therefore m(CO_2) = 7,92 \text{ g } (7,7043 \text{ g})$$

Ratio/ verhouding ✓

$$m(CaCO_3 \text{ needed/ } benodig) = \frac{7,92}{44} \times 100 \checkmark$$
$$= 18 \text{ g}$$

$m(CaCO_3$ not reacted/*nie gereageer nie):*
25 – 18,00 ✓ = 7,00 g ✓

(Accept range*:* 7,00 g – 7,5 g)
(Aanvaar gebied: 7.00 g – 7,5 g)

(5)

OPTION 3 / *OPSIE 3*

$25,7 \text{ dm}^3$: 1 mol
$4,5 \text{ dm}^3$: 0,18 mol ✓

100 g ✓: 1 mol
x : 0,18 mol ✓
x = 18 g

$m(CaCO_3$ not reacted/*nie gereageer nie):*
25 – 18 ✓ = 7,00 g ✓

(Accept range*:* 7,00 g – 7,5 g)
(Aanvaar gebied: 7,00 g – 7,5 g)

OPTION 4 / *OPSIE 4*

100 g $CaCO_3 \rightarrow 25,7 \text{ dm}^3 CO_2$ ✓✓
x g $\rightarrow 4,5 \text{ dm}^3 CO_2$ ✓
$\therefore x = 17,51$ g

Mass not reacted/*Massa nie gereageer nie* = 25 – 17,51 ✓
= 7,49 g ✓

(Accept range*:* 7,00 g – 7,5 g)
(Aanvaar gebied: 7,00 g – 7,5 g)

(5)

QUESTION 6 / *VRAAG 6*

6.1 The stage in a chemical reaction when the rate of forward reaction equals the rate of reverse reaction. ✓✓
Die stadium in 'n chemiese reaksie wanneer die tempo van die voorwaartse reaksie gelyk is aan die tempo van die terugwaartse reaksie. ✓✓

OR / *OF*
The stage in a chemical reaction when the concentrations of reactants and products remain constant. ✓✓
Die stadium in 'n chemiese reaksie wanneer die konsentrasies van reaktanse en produkte konstant bly. ✓✓ (2)

6.2

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-uitdrukking.
- Substitution of K_C value / *Vervanging van K_C-waarde*
- Equilibrium concentration of both NO_2 & N_2O_4 multiplied by 0,08 dm^3. ✓
  Ewewigskonsentrasie van beide NO_2 & N_2O_4 vermenigvuldig met 0,08 dm^3
- Change in n(N_2O_4) = equilibrium n(N_2O_4) – initial n(N_2O_4) ✓
  Verandering in n(N_2O_4) = *ewewig* n(N_2O_4) – *aanvanklike* n(N_2O_4)
- **USING** ratio ***/ GEBRUIK*** *verhouding: NO_2 : N_2O_4 = 2 : 1* ✓
- Initial n(NO_2)= equilibrium n(NO_2) + change n(NO_2). ✓
  Aanvanklike n(NO_2)= ewewig n(NO_2) + verandering n(NO_2).
- Final answer / *Finale antwoord*: 1,11 (mol) ✓

OPTION 1 / *OPSIE 1*

$K_c = \frac{[N_2O_4]}{[NO_2]^2}$ ✓

171 ✓ = $\frac{[N_2O_4]}{(0,2)^2}$ ✓

∴ $[N_2O_4] = 171 \times (0,2)^2$
$= 6,84 \text{ mol·dm}^{-3}$

No K_C expression, correct substitution / *Geen K_c-uitdrukking*, *korrekte substitusie*: Max./*Maks.* $\frac{7}{8}$
Wrong K_C expression /*Verkeerde K_c-uitdrukking*: Max./M*aks.* $\frac{5}{8}$

(8)

	NO_2	N_2O_4	
Initial quantity (mol) *Aanvangshoeveelheid (mol)*	1,11 ✓	0	
Change (mol) *Verandering (mol)* ✓	1,094	0,55 ✓	ratio ✓ *verhouding*
Quantity at equilibrium (mol)/ *Hoeveelheid by ewewig (mol)*	0,016	0,55	
Equilibrium concentration ($mol·dm^{-3}$) *Ewewigskonsentrasie ($mol·dm^{-3}$)*	0,2	6,84	x 0,08 ✓

OPTION 2 / *OPSIE 2*

$K_c = \frac{[N_2O_4]}{[NO_2]^2}$ ✓

171 ✓ = $\frac{[N_2O_4]}{(0,2)^2}$ ✓

∴ $[N_2O_4] = 171 \times (0,2)^2$
$= 6,84 \text{ mol·dm}^{-3}$

No K_C expression, correct substitution /*Geen K_c-uitdrukking*, *korrekte substitusie:* Max./*Maks.* $\frac{7}{8}$
Wrong K_C expression /*Verkeerde K_c-uitdrukking*: Max./M*aks.* $\frac{5}{8}$

Equilibrium moles / *Ewewigsmol:*
$n(N_2O_4) = (6,84)(0,080)$
$= 0,55 \text{ mol}$
$n(NO_2) = (0,2)(0,080)$
$= 0,016 \text{ mol}$
} ✓ x 0,08 dm^3

$n(N_2O_4$ formed/*gevorm*$) = \underline{0,55 – 0} = 0,55$ mol ✓

Ratio / *Verhouding*:
$n(NO_2$ reacted / *gereageer*$) = 2n(N_2O_4$ formed/*gevorm*$) = 2(0,55) = 1,094$ mol ✓
Initial / *Aanvanklike* $n(NO_2) = 0,016 + 1,094$ ✓ $= 1,11$ (mol) ✓ (8)

OPTION 3 / *OPSIE 3*

	NO_2	N_2O_4	
Initial quantity (mol) *Aanvangshoeveelheid (mol)*	2x + 0,016	0	
Change (mol) *Verandering (mol)* ✓	2x	x ✓	ratio ✓ *verhouding*
Quantity at equilibrium (mol)/ *Hoeveelheid by ewewig (mol)*	0,016	x	
Equilibrium concentration ($mol \cdot dm^{-3}$) *Ewewigskonsentrasie ($mol \cdot dm^{-3}$)*	0,2	$\frac{x}{0,08}$	x 0,08 & ÷0,08 ✓

$K_c = \frac{[N_2O_4]}{[NO_2]^2}$ ✓

171 ✓ $= \frac{\frac{x}{0,08}}{(0,2)^2}$ ✓

No K_C expression, correct substitution/*Geen K_c-uitdrukking*, *korrekte substitusie*: Max./*Maks.* $^7/_8$

Wrong K_C expression/*Verkeerde K_c-uitdrukking*: Max./M*aks.* $^5/_8$

$\therefore$ x = 0,5472

$\therefore$ n(initial/*aanvanklik*) = 2(0,5472) + 0,16
= 1,11 mol ✓

(8)

OPTION 4 / *OPSIE 4*

	NO_2	N_2O_4	
Initial quantity (mol) *Aanvangshoeveelheid (mol)*	x	0	
Change (mol) *Verandering (mol)* ✓	x – 0,16	$\frac{x-0,16}{2}$ ✓	ratio ✓ *verhouding*
Quantity at equilibrium (mol)/ *Hoeveelheid by ewewig (mol)*	0,016	$\frac{x-0,16}{2}$	
Equilibrium concentration ($mol \cdot dm^{-3}$) *Ewewigskonsentrasie ($mol \cdot dm^{-3}$)*	0,2	$\frac{x-0,16}{0,16}$	x 0,08 & ÷0,08 ✓

$K_c = \frac{[N_2O_4]}{[NO_2]^2}$ ✓

171 ✓ $= \frac{\frac{x-0,016}{0,16}}{(0,2)^2}$ ✓

$\therefore$ x = 1,11 mol ✓

No K_C expression, correct substitution/*Geen K_c-uitdrukking*, *korrekte substitusie*: Max./*Maks.* $^7/_8$

Wrong K_C expression/*Verkeerde K_c-uitdrukking*: Max./M*aks.* $^5/_8$

(8)

CALCULATIONS USING CONCENTRATION
BEREKENINGE WAT KONSENTRASIE 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-uitdrukking*.
- Substitution of K_C value. / *Vervanging van K_C-waarde*. ✓
- Change in $[N_2O_4]$ = initial $[N_2O_4]$ – equilibrium $[N_2O_4]$. ✓
  Verandering in $[N_2O_4]$ = aanvanklike $[N_2O_4]$ – ewewig $[N_2O_4]$.
- **USING** ratio/***GEBRUIK*** *verhouding: NO_2 : N_2O_4 = 2 : 1* ✓
- Initial $[NO_2]$ = equilibrium $[NO_2]$ + change in $[NO_2]$. ✓
  Aanvanklike $[NO_2]$ = ewewigs $[NO_2]$ + verandering in $[NO_2]$.
- Equilibrium concentration of $[NO_2]$ multiplied by 0,08 dm^3. ✓
  Ewewigskonsentrasie van $[NO_2]$ vermenigvuldig met 0,08 dm^3.
- Final answer/*Finale antwoord*: 1,11 (mol) ✓

OPTION 5 / *OPSIE 5*

$$K_c = \frac{[N_2O_4]}{[NO_2]^2} \checkmark$$

$$171 \checkmark = \frac{[N_2O_4]}{(0,2)^2} \checkmark$$

$$\therefore [N_2O_4] = 171 \times (0,2)^2$$
$$= 6,84 \text{ mol·dm}^{-3}$$

No K_C expression, correct substitution/*Geen K_c-uitdrukking, korrekte substitusie*: Max./*Maks.* $^7/_8$

Wrong K_C expression/*Verkeerde K_c-uitdrukking*: Max./M*aks.* $^5/_8$

	NO_2	N_2O_4
Initial concentration (mol·dm^{-3}) *Aanvangskonsentrasie (mol·dm^{-3})*	13,88	0
Change (mol·dm^{-3}) ✓ *Verandering (*mol·dm^{-3}*)*	13,68	6,84 ✓
Equilibrium concentration (mol·dm^{-3}) *Ewewigskonsentrasie (mol·dm^{-3})*	0,2	6,84

ratio ✓ *verhouding*

$n(NO_2) = cV = (13,88)(0,08) \checkmark = 1,11$ mol ✓ (8)

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OPTION 6 / *OPSIE 6*

	NO_2	N_2O_4
Initial concentration (mol·dm^{-3}) *Aanvangskonsentrasie (mol·dm^{-3})*	x	0
Change (mol·dm^{-3}) ✓ *Verandering (*mol·dm^{-3}*)*	x – 0,2	$\frac{x-0,2}{2}$ ✓
Equilibrium concentration (mol·dm^{-3}) *Ewewigskonsentrasie (mol·dm^{-3})*	0,2	$\frac{x-0,2}{2}$

ratio ✓ *verhouding*

$K_c = \frac{[N_2O_4]}{[NO_2]^2}$ ✓

171 ✓ $= \frac{\frac{x-0,2}{2}}{(0,2)^2}$ ✓

$\therefore$ x = 13,88 mol·dm^{-3}

No K_C expression, correct substitution/*Geen K_c-uitdrukking*, *korrekte substitusie*: Max./*Maks.* 7/8

Wrong K_C expression/*Verkeerde K_c-uitdrukking*: Max./M*aks.* 5/8

$n(NO_2) = cV = (13,88)(0,08)$ ✓ = 1,11 mol ✓ (8)

6.3

6.3.1 Concentration (of the gases) increases. / Molecules become more condensed or move closer to each other. ✓
Konsentrasie (van die gasse) verhoog. / Molekule word meer saamgepers of beweeg nader aan mekaar. (1)

6.3.2
- Increase in pressure favours the reaction that leads to smaller number of moles / volume of gas. ✓
  Toename in druk bevoordeel die reaksie wat tot die kleiner getal mol / volume gas lei.
- Forward reaction is favoured. / *Voorwaartse reaksie word bevoordeel.* ✓
- Number of moles/amount of N_2O_4 / colourless gas increases.✓
  Aantal mol/hoeveelheid N_2O_4 / kleurlose gas neem toe.

OR / *OF*
Number of moles/amount of NO_2 / brown gas decreases. ✓
Aantal mol/hoeveelheid NO_2 / bruin gas neem af. (3)

6.4

6.4.1 Darker / *Donkerder* ✓ (1)

6.4.2 Decreases / *Verlaag* ✓ (1)
[16]

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QUESTION 7/ *VRAAG 7*

PENALISE ONCE FOR THE INCORRECT CONVERSION OF UNITS.
PENALISEER EENMALIG VIR VERKEERDE OMSKAKELING VAN EENHEDE.

7.1

7.1.1 Ionises / dissociates completely (in water) ✓
Ioniseer / dissosieer volledig (in water) (1)

7.1.2 NO_3^- / Nitrate ion / *Nitraatioon* ✓ (1)

7.1.3 pH = -log[H_3O^+] / -log[H^+] ✓
= -log(0,3) ✓
= 0,52 ✓ (3)

Notes/*Aantekeninge:*
- If no/incorrect formula/*Indien geen/foutiewe formule*: Max./*Maks:* $^2/_3$
- If no substitution step: 2 marks for correct answer./*Indien geen substitusie stap: 2 punte vir korrekte antwoord.*

7.2

7.2.1 $c = \frac{n}{V}$ ✓
$2 = \frac{n}{0,1}$ ✓
∴ n(HCℓ) = 0,2 mol ✓ (3)

Notes/*Aantekeninge*
If incorrect conversion of cm^3 to dm^3 / *Indien verkeerde omskakeling van cm^3 to dm^3:*
Max./*Maks:* $^1/_3$

7.2.2 Burette / *Buret* ✓ (1)

7.2.3 B ✓
Titration of strong acid and strong base. ✓✓
Titrasie van sterk suur en sterk basis.
OR/*OF*
The endpoint will be approximately at pH = 7 which is in the range of the indicator.
Die eindpunt sal ongeveer by pH = 7 wees wat in die gebied van die indikator is. (3)

7.2.4 The number of moles of acid in the flask remains constant. ✓
Die getal mol van die suur in die fles bly konstant. (1)

7.2.5

$c = \frac{n}{V}$ ✓

$0,2 = \frac{n}{0,021}$ ✓

$n = 4,2 \times 10^{-3}$ mol ✓

n(HCℓ in excess/*in oormaat*):
n = n(NaOH)
$= 4,2 \times 10^{-3}$ mol

Notes/*Aantekeninge*

- If incorrect conversion of cm^3 to dm^3
  Indien verkeerde omskakeling van cm^3 to dm^3: Max./*Maks:* $\frac{1}{3}$
- If already penalised for conversion of units in Q7.2.1, do not penalise again for substitution of incorrect unit.
  Indien reeds gepenaliseer vir omskakeling van eenhede in Q7.2.1, moenie weer penaliseer vir substitusie van verkeerde eenheid nie. Max./*Maks:* $\frac{2}{3}$

(3)

7.2.6 **POSITIVE MARKING FROM QUESTION 7.2.1 AND 7.2.5.**
POITIEWE NASIEN VAN VRAAG 7.2.1 EN 7.2.5.

Marking criteria / *Nasienriglyne:*

- n(HCℓ reacted) = Initial (from Q7.2.1) – excess (from Q7.2.5).✓
  n(HCℓ reageer) = begin (van Q7.2.1) – oormaat (van Q7.2.5).
- Use mol ratio of acid : base = 1:2. ✓
  Gebruik molverhouding suur : basis = 1:2
- Substitute / *Vervang* 40 into / *in*: $n = \frac{m}{M}$ ✓
- $\frac{m(MgO\ reacted/\ reageer)}{4,5} \times 100$. ✓
- Final answer / *Finale antwoord:* 87,11 % ✓

OPTION 1 / *OPSIE 1*

n(HCℓ reacted/*gereageer*):
0,2 – $4,2 \times 10^{-3}$ ✓ = 0,196 mol

n(MgO reacted/*gereageer*):
½n(HCℓ) = ½(0,196)
$= 9,8 \times 10^{-2}$ mol ✓

n(MgO reacted/*gereageer*) = $\frac{m}{M}$

$\therefore 0,098 = \frac{m}{40}$ ✓
$\therefore m = 3,92$ g

% purity/ *suiwerheid* = $\frac{3,92}{4,5} \times 100$ ✓
$= 87,11\%$ ✓

(Accept range*:* 87 - 87,11 %.)
(*Aanvaar gebied: 87 – 87,11 %)*

OPTION 2 / *OPSIE 2*

n(HCℓ reacted/*gereageer*):
0,2 – $4,2 \times 10^{-3}$ ✓ = 0,196 mol

n(HCℓ reacted/*gereageer*) = $\frac{m}{M}$

$0,196 = \frac{m}{36,5}$
$\therefore$ m(HCℓ reacted/*gereageer*) = 7,154 g

40 g MgO ✓ ..... 73 g HCℓ ✓
x g MgO ..... 7,154 g
$\therefore x = 3,92$ g

% purity/*suiwerheid* = $\frac{3,92}{4,5} \times 100$ ✓
$= 87,11\%$ ✓

(Accept range*:* 87 - 87,11 %.)
(*Aanvaar gebied: 87 – 87,11 %)*

(5)

7.2.6

OPTION 3 / OPSIE 3

$$\frac{c_A V_A}{c_b V_b} = \frac{n_a}{n_b}$$

$$\frac{2 \times V_a}{0{,}2 \times 21} = \frac{1}{1}$$

$$V_a = 2{,}1\,cm^3$$

V(HCℓ reacted/*gereageer*):
100 – 2,1 ✓ = 97,9 cm^3

↓

n(HCℓ) = cV
= 2 x 0.0979
= 0,196 mol ✓

n(MgO reacted/*gereageer*):
½n(HCℓ) = ½(0,196)
= 9,8 x 10^{-2} mol ✓

↙

n(MgO reacted/*gereageer*) = $\frac{m}{M}$

$\therefore$ 0,098 = $\frac{m}{40}$ ✓
$\therefore$ m = 3,92 g

→

% purity/ *suiwerheid* = $\frac{3{,}92}{4{,}5} \times 100$ ✓
= 87,11% ✓

(Accept range*:* 87 - 87,11 %.)
(*Aanvaar gebied: 87 – 87,11 %)* (5)

[21]

QUESTION 8 / *VRAAG 8*

8.1
- Pressure: 1 atmosphere (atm) / 101,3 kPa / 1,013 x 10^5 Pa ✓
  Druk: 1 atmosfeer (atm) / 101,3 kPa / 1,013 x 10^5 Pa
- Temperature/*Temperatuur*: 25 °C / 298 K ✓ (2)

8.2
- Platinum is inert / does not react with the H^+ ions OR acid. ✓
  Platinum is onaktief / reageer nie met die H^+-ione OF suur nie.
- Platinum is a conductor (of electricity). ✓
  Platinum is 'n geleier (van elektrisiteit). (2)

8.3

8.3.1 Salt bridge / *Soutbrug* ✓ (1)

8.3.2 -0,31 V ✓ (1)

8.3.3 $2H^+ + 2e^- \rightarrow H_2$ ✓✓

Marking guidelines / *Nasienriglyne:*
- $2H^+ + 2e^- \rightleftharpoons H_2$ $\frac{1}{2}$ $H_2 \rightleftharpoons 2H^+ + 2e^-$ $\frac{0}{2}$
  $H_2 \leftarrow 2H^+ + 2e^-$ $\frac{2}{2}$ $H_2 \rightarrow 2H^+ + 2e^-$ $\frac{0}{2}$
- Ignore if charge omitted on electron. / *Ignoreer indien lading weggelaat op electron.*
- If charge omitted on H^+ / Indien lading weggelaat op H^+: Max./*Maks:* $\frac{1}{2}$ (2)

8.4

8.4.1 **POSITIVE MARKING FROM QUESTION 8.3.2.**
POSITIEWE NASIEN VAN VRAAG 8.3.2.

$E^\theta_{cell} = E^\theta_{reduction} - E^\theta_{oxidation}$ ✓
2,05 ✓ = -0,31 ✓ – $E^\theta_{M/M^{2+}}$
$E^\theta_{M/M^{2+}}$ = -2,36 (V) ✓

M is magnesium/ Mg. ✓

Option 2/ *Opsie 2*

✓ { $M \rightarrow M^{2+} + 2e^-$ E° = 2,36 (V) ✓
  $X^{2+} + 2e^- \rightarrow X$ E° = -0,31 (V) ✓
  E° = 2,05 V ✓

M is magnesium/ Mg. ✓

Notes / *Aantekeninge:*
Accept any other correct formula from the data sheet.
Aanvaar enige ander korrekte formule vanaf gegewensblad.

Any other formula using unconventional abbreviations, e.g. $E^\theta_{cell} = E^\theta_{OA} - E^\theta_{RA}$ followed by correct substitutions: $\frac{4}{5}$
Enige ander formule wat onkonvensionele afkortings gebruik bv. $E^\theta_{sel} = E^\theta_{OM} - E^\theta_{RM}$
gevolg deur korrekte vervangings: $\frac{4}{5}$

Notes / *Aantekeninge*
Give mark for Mg / magnesium ONLY if concluded from -2,36 V.
Ken punt vir Mg / magnesium slegs toe indien afgelei uit -2,36 V (5)

8.4.2 Exothermic / *Eksotermies* ✓ (1)

8.5 The cell reaction reaches equilibrium. ✓
Die selreaksie bereik ewewig.

Notes / *Aantekeninge:*
Accept: One or more of reactants are used up. / The cell reaction has run to completion. ***Aanvaar:*** *Een of meer van reaktanse word opgebruik. / Die selreaksie het volledig verloop.*

(1)
[15]

QUESTION 9 / *VRAAG 9*

9.1 Electrolytic / *Elektrolities* ✓ (1)

9.2 Q ✓ AND T ✓

$Cu^{2+} + 2e \rightarrow Cu$ ✓✓

Notes / *Aantekeninge:*
IF more than TWO electrodes, mark first two ***Indien*** *meer as TWEE elektrodes, sien eerste twee na.*

Marking guidelines / *Nasienriglyne*	
$Cu^{2+} + 2e \rightleftharpoons Cu$ $(1/2)$	$Cu \rightarrow Cu^{2+} + 2e^-$ $(0/2)$
$Cu \leftarrow Cu^{2+} + 2e$ $(2/2)$	$Cu \rightleftharpoons Cu^{2+} + 2e^-$ $(0/2)$

(4)

9.3

9.3.1 $C\ell_2$ / chlorine (gas) / *chloor(gas)* ✓ (1)

9.3.2 Cu^{2+} (ions) / copper(II) ions / $CuC\ell_2$ / copper(II) chloride ✓
Cu^{2+} (ione) / k*oper(II)-ione* / $CuC\ell_2$ / *koper(II)chloried* (1)

9.4 <u>Cu is a stronger reducing agent</u> ✓ than $C\ell^-$ (ions) ✓ and Cu will be oxidised ✓ (to Cu^{2+}).
<u>Cu is 'n sterker reduseermiddel</u> as Cℓ(-ione) en Cu sal geoksideer word (na Cu^{2+}). (3)
[10]

QUESTION 10 / *VRAAG 10*

10.1

10.1.1 Nitrogen / N_2 / *Stikstof* ✓
Hydrogen / H_2 / *Waterstof* ✓ (2)

10.1.2 $NH_3 + HNO_3$ ✓ → NH_4NO_3 ✓ Bal. ✓

Notes / *Aantekeninge:*
- Reactants ✓ Products ✓ Balancing: ✓
  Reaktanse *Produkte* *Balansering*
- Ignore double arrows. / *Ignoreer dubbelpyle.*
- Marking rule 6.3.10. / *Nasienreël 6.3.10.* (3)

10.2

Marking criteria / *Nasienriglyne:*
- Use ratio / *gebruik verhouding:* $\frac{3}{9}$ ✓
- x *20 kg* ✓
- x 36 / *36 %* ✓
- Final answer / *Finale antwoord:* 2,4 kg. ✓

OPTION 1 / *OPSIE 1*:

$\%\ N = \frac{3}{9}$ ✓ (x 36) ✓
= 12 %
$\therefore m(N) : \frac{12}{100}(\times 20\ kg)$ ✓
= 2,4 kg ✓

OPTION 2 / *OPSIE 2:*

m(nutrients/*voedingstowwe*):
$\frac{36}{100}$ ✓ (x 20 ✓) = 7,2 kg
$\therefore m(N) = \frac{3}{9}$ ✓ x 7,2
= 2,4 kg ✓

OPTION 3 / *OPSIE 3*:

m(N):
$\frac{3}{9}$ ✓ × (× 20 ✓) (× $\frac{36}{100}$ ✓) = 2,4 kg ✓

(4)
[9]

TOTAL/*TOTAAL*: 150