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.

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

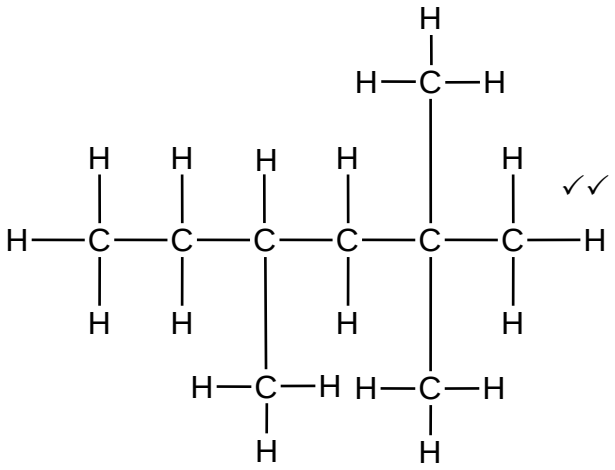
2.2.1 2-bromo-3-chloro-4-methylpentane
2-bromo-3-chloro-4-metielpentaan / 2-broom-3-chloor-4-metielpentaan

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)

2.3
2.3.1



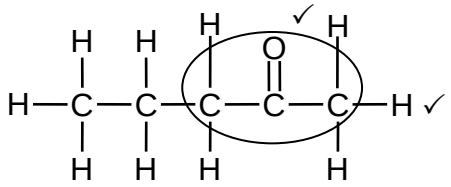
✓✓

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, but H atoms omitted / *Indien korrekte struktuur, 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:*
- If two or more functional groups/Indien *twee of meer funksionele groepe:* $\frac{0}{2}$
- 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]

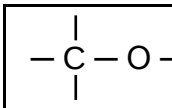
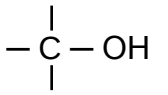
QUESTION 3 / *VRAAG 3*

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)

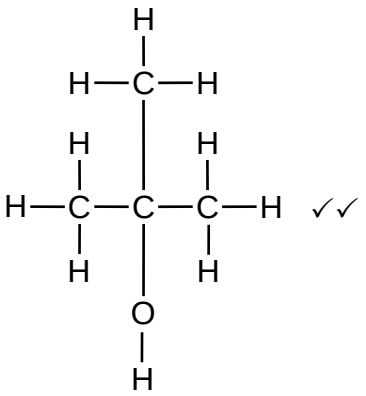
3.2

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 or more functional groups / *Indien twee of 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 <u>London forces</u> / <u>dispersion forces / induced dipole forces</u>. ✓
  Tussen <u>propaan</u>molekule is <u>Londonkragte / dispersiekragte / geïnduseerde dipoolkragte</u>.
- Between <u>propan-1-ol</u> molecules are London forces / dispersion forces / induced dipole forces and <u>hydrogen bonds</u>. ✓
  Tussen <u>propan-1-</u>ol molekule is Londonkragte / dispersiekragte / geïnduseerde dipoolkragte en <u>waterstofbindings.</u>
- Hydrogen bonds / Forces between alcohol molecules are <u>stronger or need more energy than</u> 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*

Between <u>propane molecules are weak London forces</u> / dispersion forces / induced dipole forces ✓ and between <u>propan-1-ol molecules are strong hydrogen bonds</u>. ✓✓
Tussen propaanmolekule is swak Londonkragte / dispersiekragte / geïnduseerde dipoolkragte en tussen propan-1-olmolekule is sterk waterstofbindings. (3) **[12]**

QUESTION 4 / *VRAAG 4*

4.1

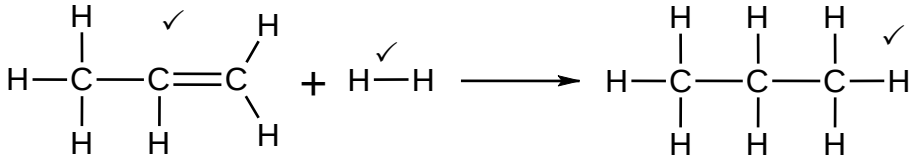
4.1.1 Substitution / chlorination / halogenation ✓
Substitusie / chlorering / halogenering / halogenasie (1)

4.1.2 Substitution / hydrolysis ✓
Substitusie / hidrolise (1)

4.2

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

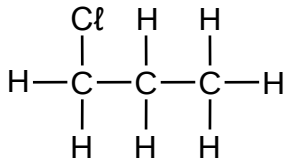
4.2.2



<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:* 2/2
- Only ONE Cℓ atom as functional group. / *Slegs EEN Cℓ-atoom as funksionele groep.* 1/2

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

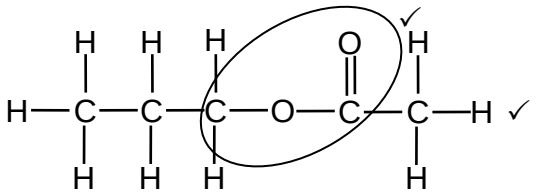
(2)

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:* 2/2
- Only functional group correct / *Slegs funksionele groep korrek:* 1/2

Notes / *Aantekeninge:*
- If two or more functional groups/Indien *twee of meer funksionele groepe:* 0/2
- Condensed or semi-structural formula:
  Gekondenseerde of semistruktuurformule: Max./*Maks.* 1/2
- Molecular formula / *Molekulêre formule*: 0/2
- If functional group is incorrect/*Indien funksionele groep verkeerd is:* 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/INDIEN:** No reference to mass / amount / surface area in answer: Geen verwysing na mas*sa / 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 in $n = \frac{m}{M}$. ✓
- Subtraction / *Aftrekking.* ✓
- Final answer / *Finale antwoord:* 7,00 g to*/tot* 7,5 g ✓

OPTION 1 / *OPSIE 1*

$$n(CO_2) = \frac{V}{V_m}$$
$$= \frac{4,5}{25,7} \checkmark$$
$$= 0,18 \text{ mol } (0,175 \text{ mol})$$

$n(CaCO_3) = n(CO_2) = 0,18$ mol ✓

$$n(CaCO_3) = \frac{m}{M}$$
$$0,18 = \frac{m}{100} \checkmark$$
$$\therefore m = 18 \text{ g } (17,5 \text{ g})$$

$m(CaCO_3)$ not reacted/*nie gereageer nie):*
25 – 18 ✓ = 7,00 g ✓ (7,49 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:

$$n(CO_2) = \frac{V}{V_m}$$
$$= \frac{4,5}{25,7} \checkmark$$
$$= 0,18 \text{ mol } (0,175 \text{ mol})$$

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

Ratio/ verhouding ✓

$$m(CaCO_3 \text{ needed / } benodig) = \frac{7,92}{44} \times 100 \checkmark$$
$$= 18 \text{ g } (17,5 \text{ g})$$

$m(CaCO_3$ not reacted/*nie gereageer nie):*
25 – 18,00 ✓ = 7,00 g ✓ (7,49 g)

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

OPTION 3 / *OPSIE 3*

25,7 dm^3 : 1 mol
4,5 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 $CaCO_3 \rightarrow 25,7$ dm^3 CO_2 ✓✓
x g $\rightarrow 4,5$ 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)

(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) ✓
  Accept range/*Aanvaar gebied:* 1,11 – 1,12 (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.* $\frac{7}{8}$

Wrong K_C expression/*Verkeerde K_c-uitdrukking*: Max./M*aks.* $\frac{5}{8}$

$\therefore$ x = 0,5472

$\therefore$ n(initial/*aanvanklik*) = 2(0,5472) + 0,016
= 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 – 0,016	$\frac{x-0,016}{2}$ ✓	ratio ✓ *verhouding*
Quantity at equilibrium (mol)/ *Hoeveelheid by ewewig (mol)*	0,016	$\frac{x-0,016}{2}$	
Equilibrium concentration ($mol \cdot dm^{-3}$) *Ewewigskonsentrasie ($mol \cdot dm^{-3}$)*	0,2	$\frac{x-0,016}{0,16}$	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.* $\frac{7}{8}$

Wrong K_C expression/*Verkeerde K_c-uitdrukking*: Max./M*aks.* $\frac{5}{8}$

(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 $[N_2O_4]$ = equilibrium $[N_2O_4]$ – initial $[N_2O_4]$. ✓
  Verandering in $[N_2O_4]$ = ewewig $[N_2O_4]$ – aanvanklike $[N_2O_4]$.
- **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) ✓
  Accept range/*Aanvaar gebied:* 1,11 – 1,12 (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./*Maks.* $^5/_8$

	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 ✓	ratio ✓ *verhouding*
Equilibrium concentration (mol·dm^{-3}) *Ewewigskonsentrasie (mol·dm^{-3})*	0,2	6,84	

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

OPTION 6 / *OPSIE 6*

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

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.* $\frac{5}{8}$

$n(NO_2) = cV = (13,88)(0,08)$ ✓ = 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]

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 $c = \frac{n}{V}$ ✓
$2 = \frac{n}{0,1}$ ✓
$\therefore$ n(HCℓ) = 0,2 mol ✓ (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(HCℓ) = n(NaOH)
$= 4,2 \times 10^{-3}$ mol (3)

7.2.6 **POSITIVE MARKING FROM QUESTION 7.2.1 AND 7.2.5.**
POSITIEWE 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 = 2 : 1. ✓
  Gebruik molverhouding suur : basis = 2 : 1.
- 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)
[21]

QUESTION 8 / *VRAAG 8*

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

- $2H^+ + 2e^- \rightleftharpoons H_2$ $\frac{1}{2}$ $H_2 \rightleftharpoons 2H^+ + 2e^-$ $\frac{0}{2}$
  $H_2 \leftarrow 2H^+ + 2e^-$ $\frac{2}{2}$ $H_2 \rightarrow 2H^+ + 2e^-$ $\frac{0}{2}$ (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. ✓

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

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 ✓

Thus/*Dus:* $E^\theta_{reduction}$ = - 2,36 (V) ✓
M is magnesium/ Mg. ✓

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. $E^\phi_{sel} = E^\phi_{OM} - E^\phi_{RM}$
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 ✓ & 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 Cu is a stronger reducing agent ✓ than $C\ell^-$ (ions) ✓ and Cu will be oxidised ✓ (to Cu^{2+}).
Cu is 'n sterker reduseermiddel as Cℓ^-(-ione) en Cu sal geoksideer word (na Cu^{2+}).

OR/*OF*

$C\ell^-$ (ions) is a weaker reducing agent ✓ than Cu ✓ and Cu will be oxidised ✓ (to Cu^{2+}).
Cℓ^-(-ione) is 'n swakker reduseermiddel as Cu 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 $NH_3 + HNO_3$ ✓ $\rightarrow NH_4NO_3$ ✓ 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*:	**OPTION 2 / *OPSIE 2:***	**OPTION 3 / *OPSIE 3*:**
% N = $\frac{3}{9}$ ✓ (x 36) ✓ = 12 % $\therefore$ m(N) : $\frac{12}{100}$ (× 20 ✓ kg) = 2,4 kg ✓	m(nutrients/*voedingstowwe*): $\frac{36}{100}$ ✓ (x 20 ✓) = 7,2 kg $\therefore$ m(N) = $\frac{3}{9}$ ✓ x 7,2 = 2,4 kg ✓	m(N): $\frac{3}{9}$ ✓ × (× 20 ✓) (× $\frac{36}{100}$ ✓) = 2,4 kg ✓

(4)
[9]

TOTAL/*TOTAAL*: 150