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 2018

MARKING GUIDELINE/*NASIENRIGLYN*

MARKS/*PUNTE*: 150

These marking guidelines consist of 18 pages.
Hierdie nasienriglyne bestaan uit 18 bladsye.

QUESTION 1/*VRAAG 1*

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

[20]

QUESTION 2/*VRAAG 2*

2.1 **ANY ONE/*ENIGE EEN*:**

- (Alcohol/ethanol) is flammable/catches fire easily.
  (Alkohol/etanol) is vlambaar/slaan maklik aan die brand.
- To heat it evenly./*Om dit eweredig te verhit.*
- Water bath is used for low heat/low temperature./*Waterbad word gebruik vir lae hitte/lae temperatuur.*
- Alcohol/ethanol will evaporate too quickly./*(Alkohol/etanol) sal te vinnig verdamp.*

Accept/*Aanvaar*:
(Alcohol/ethanol) is volatile./*(Alkohol/etanol) is vlugtig.* (1)

2.2

2.2.1 Esterification/condensation
Verestering/esterifikasie/kondensasie (1)

2.2.2 H_2SO_4 (1)

2.2.3 Esters (1)

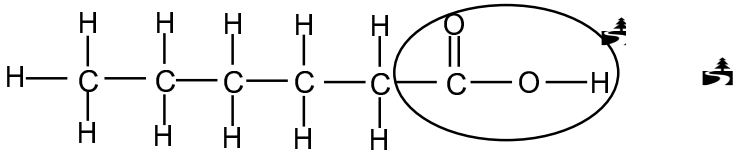
2.3 $$\frac{M(ester)}{M(C_4H_8O)} = \frac{144}{72} = 2$$
$\therefore$ 2 x $C_4H_8O = C_8H_{16}O_2$

Marking guidelines/*Nasienriglyne*
- If only answer given, award 2 marks on final answer./*Indien slegs antwoord gegee, ken 2 punte toe vir finale antwoord.*
- If 72 $g \cdot mol^{-1}$ calculated without substituting, no mark is awarded./*Indien 72 $g \cdot mol^{-1}$ bereken is sonder om te vervang word geen punt toegeken nie.* (2)

2.4 Ethyl hexanoate
Etielheksanoaat

Note/*Aantekening*
Accept any other ethyl ESTER from QUESTION 2.3.
Aanvaar enige ander etiel ESTER vanaf VRAAG 2.3. (2)

2.5 **POSITIVE MARKING FROM QUESTION 2.4.**
POSITIEWE NASIEN VANAF VRAAG 2.4.



Marking criteria/*Nasienriglyne*

- Whole structure correct/*Hele struktuur korrek:* $^{2}/_{2}$
- Only functional group correct/*Slegs funksionele groep korrek:* Max/*Maks.*: $^{1}/_{2}$
- Accept/*Aanvaar* -OH as condensed/*gekondenseerd.*

IF/*INDIEN*

- More than one functional group/wrong functional group/*Meer as een funksionele groep/foutiewe funksionele groep:* $^{0}/_{2}$
- If condensed structural formulae used/*Indien gekondenseerde struktuur-formules gebruik:* Max/*Maks.*: $^{1}/_{2}$

(2)
[10]

QUESTION 3/*VRAAG 3*

3.1

Marking guidelines/*Nasienriglyne*
If any one of the underlined key phrases in the **correct context** is omitted, deduct 1 mark./*Indien enige van die onderstreepte frases in die **korrekte konteks** uitgelaat is, trek 1 punt af.*

The temperature at which the vapour pressure of a substance equals atmospheric/external pressure.
Die temperatuur waar die dampdruk van 'n stof gelyk is aan atmosferiese/ eksterne druk. (2)

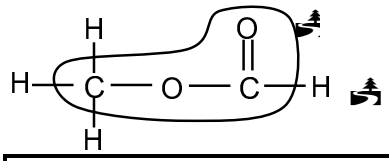
3.2

3.2.1 Carboxyl (group)/*karboksiel(groep)*

Accept/*Aanvaar*
Carboxylic/*Karboksiel* (1)

3.2.2 Propanoic acid/*propanoësuur* (1)

3.2.3



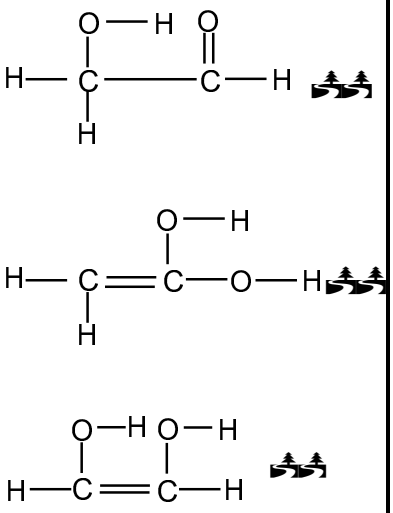
Marking criteria/*Nasienriglyne*

- Whole structure correct:
  Hele struktuur korrek: 2/2
- Only functional group correct:
  Slegs funksionele groep korrek: Max/*Maks*: 1/2

IF/*INDIEN*

- More than one functional group/wrong functional group/*Meer as een funksionele groep/foutiewe funksionele groep:* 0/2
- If condensed structural formulae used/*Indien gekondenseerde struktuur-formules gebruik:*
  Max/*Maks*: 1/2

ACCEPT/*AANVAAR*
(2 or/of 0)



(2)

3.3 A

Lowest boiling point./Shortest chain length.
Laagste kookpunt./Kortste kettinglengte. (2)

3.4

3.4.1 The same molecular mass/molecular size.
Dieselfde molekulêre massa/molekulêre grootte. (1)

3.4.2 Primary/*Primêre*
-OH group is bonded to a C atom bonded to one other C atom.
-OH-groep is gebind aan 'n C-atoom wat aan een ander C-atoom gebind is.
OR/*OF*
-OH group is bonded to a C atom that has two H atoms.
-OH-groep is gebind aan 'n C-atoom wat twee H-atome bevat. (2)

3.4.3

Marking guidelines/Nasienriglyne

- BOTH have hydrogen bonding./*BEIDE het waterstofbindings*.
- Compare number of sites for hydrogen bonding./*Vergelyk aantal punte vir waterstofbinding.*
- Compare strength of IMFs./*Vergelyk sterkte van IMKe.*
- Compare energy required./*Vergelyk energie benodig.*

- Both compounds/**X** and **B** have (in addition to London forces and dipole-dipole forces) hydrogen bonding./*Beide verbindings/**X** en **B** het waterstofbindings (behalwe Londonkragte en dipool-dipoolkragte).*
- Compound **X**/$CH_3CH_2CH_2OH$/propan-1-ol/alcohol has one site for hydrogen bonding and compound **B**/ethanoic acid/carboxylic acid has two/more sites for hydrogen bonding **OR** **B**/ethanoic acid/carboxylic acid has two/more sites for hydrogen bonding.
  Verbinding **X**/$CH_3CH_2CH_2OH$/propan-1-ol/alkohol *het een punt vir waterstofbindings en verbinding **B**/etanoësuu/karboksielsuur het twee/meer punte vir waterstofbindings **OF** **B**/etanoësuu/karboksielsuur het twee/meer punte vir waterstofbindings.*
- Intermolecular forces in compound **B**/ethanoic acid/carboxylic acid are stronger than intermolecular forces in compound **X**/$CH_3CH_2CH_2OH$/ propan-1-ol/alcohol.
  *Intermolekulêre kragte in verbinding **B**/etanoësuur/karboksielsuur is sterker as die intermolekulêre kragte in* verbinding **X**/$CH_3CH_2CH_2OH$/ *propan-1-ol/alkohol.*
  OR/*OF*
  Intermolecular forces in compound **X**/$CH_3CH_2CH_2OH$/ propan-1-ol/alcohol are weaker than intermolecular forces in compound **B**/ethanoic acid/*carboxylic acid*./*Intermolekulêre kragte in* verbinding **X**/*$CH_3CH_2CH_2OH$/propan-1-ol/alkohol is swakker as intermolekulêre kragte in verbinding **B**/etanoësuur/karboksielsuur.*
- More energy is needed to overcome/break intermolecular forces in compound **B**/ethanoic acid/carboxylic acid than in compound **X**/$CH_3CH_2CH_2OH$/ propan-1-ol/alcohol.
  *Meer energie word benodig om intermolekulêre kragte in verbinding **B**/etanoësuur as in verbinding **X**/$CH_3CH_2CH_2OH$/ propan-1-ol/alkohol te oorkom/breek.*
  OR/*OF*
  Less energy is needed to overcome/break intermolecular forces in compound **X**/$CH_3CH_2CH_2OH$/propan-1-ol/alcohol than in compound **B**/ethanoic acid/*carboxylic acid*.
  *Minder energie word benodig om intermolekulêre kragte in verbinding **X**/ $CH_3CH_2CH_2OH$/propan-1-ol/alkohol te oorkom/breek as in verbinding **B**/etanoësuur/karboksielsuur.* (4)

[15]

QUESTION 4/*VRAAG 4*

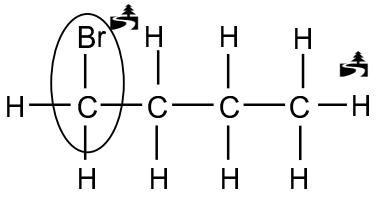
4.1

4.1.1 (A series of organic) compounds that can be described by the same general formula/functional group. **(2 or 0)**
('n Reeks organiese) verbindings wat deur dieselfde algemene formule/ funksionele groep beskryf kan word. ***(2 of 0)***
OR/*OF*
(A series of organic) compounds in which one member differs from the next by a CH_2 group./*('n Reeks organiese) verbindings waarin een lid van die volgende verskil met 'n CH_2-groep.* **(2 or/*of* 0)** (2)

4.1.2 Substitution/halogenation/bromination
Substitusie/halogenasie/halogenering/brominasie/brominering (1)

4.1.3 HBr (1)

4.1.4



Marking criteria/*Nasienriglyne*
- Br on first C atom/*Br op eerste C-atoom:* Max/*Maks:* $\frac{1}{2}$
- Whole structure correct/*Hele struktuur korrek:* $\frac{2}{2}$

IF/INDIEN:
Br_2 but rest of structure correct/Br_2 maar res van struktuur korrek: $\frac{1}{2}$ (2)

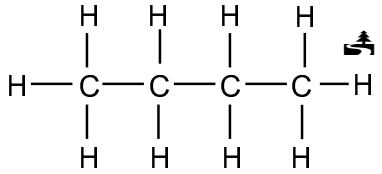
4.1.5 $C_5H_{12} + 8O_2 \rightarrow 5CO_2 + 6H_2O$ Bal

Marking guidelines/*Nasienriglyne*
- Reactants / *Reaktanse* Products / *Produkte* Balancing / *Balansering*
- Ignore double arrows and phases./*Ignoreer dubbelpyle en fases.*
- Marking rule 6.3.10/*Nasienreël 6.3.10.*
- If condensed structural formulae used/*Indien gekondenseerde struktuurformules gebruik:* Max/*Maks:* $\frac{2}{3}$ (3)

4.1.6 **Marking guidelines/*Nasienriglyne***
If any one of the underlined key phrases in the **correct context** is omitted, deduct 1 mark./*Indien enige van die onderstreepte frases in die **korrekte konteks** uitgelaat is, trek 1 punt af.*

The (chemical) process in which longer chain hydrocarbons/longer chain alkanes are broken down to shorter/more useful hydrocarbons/molecules/ chains/alkanes and alkenes.
Die (chemiese) proses waarin langketting koolwaterstowwe/langketting-alkane afgebreek word in korter/meer bruikbare koolwaterstowwe/molekule/ kettings/alkane en alkene. (2)

4.1.7



Marking guidelines/*Nasienriglyne*
- One or more H atoms omitted/*Een of meer H-atome uitgelaat:* Max/*Maks*: ½
- Condensed or semi-structural formula: *Gekondenseerde of semi-struktuur-formule:* Max/*Maks*: ½

(2)

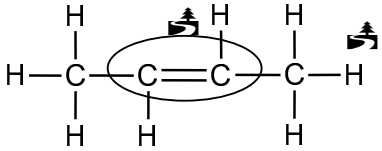
4.2

4.2.1 Butan-2-ol **OR/*OF*** 2-butanol

IF/*INDIEN:*
Butanol or/*of* butan-1-ol ½

(2)

4.2.2



Marking criteria/*Nasienriglyne*
- Only functional group correct/*Slegs funksionele groep korrek:* Max/Maks: ½
- Whole structure correct: *Hele struktuur korrek:* 2/2

(2)
[17]

QUESTION 5/*VRAAG 5*

5.1 Temperature/*Temperatuur* (1)

5. 2

NOTE/*LET WEL*
Give the mark for per unit time only if in context of reaction rate.
Gee die punt vir per eenheidtyd slegs indien in konteks met reaksietempo.

ANY ONE/*ENIGE EEN*
- Change in concentration of products/reactants per (unit) time.
  Verandering in konsentrasie van produkte/reaktanse per (eenheid) tyd.
- 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 (eenheid) tyd.
- Amount/number of moles/volume/mass of products formed/reactants used per (unit) time.
  Hoeveelheid/getal mol/volume/massa van produkte gevorm/reaktanse gebruik per (eenheid) tyd.
- Rate of change in concentration/amount/number of moles/volume/mass.
  Tempo van verandering in konsentrasie/ hoeveelheid/getal mol/ volume/massa. **(2 or/*of* 0)**

(2)

5.3 14 (min) (2)

5.4

5.4.1 Graph/*grafiek* **B**
(Experiment **3)** has the highest (acid) concentration/more particles/higher number of moles.
(*Eksperiment **3)** het die hoogste (suur)konsentrasie/meer deeltjies/groter aantal mol.* (2)

5.4.2 (Graph/*grafiek*) **C**
(Experiment 5) is at highest temperature/more particles with sufficient kinetic energy/HCℓ is at 35°C
(*Eksperiment 5) is by die hoogste temperatuur/meer deeltjies met genoeg kinetiese energie/HCℓ is by 35°C*. (2)

5.5

5.5.1 Speeds up the reaction./Increases the reaction rate./Provides alternate pathway./Lowers the (net) activation energy.
Versnel die reaksie./Verhoog die reaksietempo./Verskaf alternatiewe roete./Verlaag die (netto) aktiveringsenergie. (1)

5.5.2 Equal to/*Gelyk aan* (1)

5.6

$$n(Zn) = \frac{m}{M}$$
$$= \frac{1,5}{65}$$
$$= 0,023 \text{ mol}$$
$$\text{rate/}tempo = -\frac{\Delta n}{\Delta t}$$
$$= -\left(\frac{0 - 0,023}{140}\right)$$
$$= 1,65 \times 10^{-3} \text{ (mol·min}^{-1}\text{)}$$

Marking guidelines/*Nasienriglyne*
- Substitute/*vervang* 65 g·mol^{-1} in $n = \frac{m}{M}$
- Substitute change in mol to calculate rate./*Vervang verandering in mol om tempo te bereken.*
- Substitute change in time to calculate rate./*Vervang verandering in tyd om tempo te bereken.*
- Final answer/*Finale antwoord*: 1,65 x 10^{-3} mol·min^{-1}
  Range/*Gebied:*
  1,43 x 10^{-3} to/*tot* 1,65 x 10^{-3} (mol·min^{-1})

Notes/*Aantekeninge*
- Ignore if zeros omitted in calculation of reaction rate./*Ignoreer indien nulle uitgelaat in berekening van reaksietempo.*
- Accept negative answer i.e. -1,65 x 10^{-3} mol·min^{-1}/*Aanvaar negatiewe antwoord d.i. -1,65 x 10^{-3} mol·min^{-1}.*

(4)
[15]

QUESTION 6/*VRAAG 6*

6.1 When the equilibrium in a closed system is disturbed, the system will re-instate a (new) equilibrium by favouring the reaction that will cancel/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 kanselleer/teenwerk. (2)

6.2 Endothermic/*Endotermies*

- Decrease in temperature favours the exothermic reaction.
Afname in temperatuur bevoordeel die eksotermiese reaksie.
- The reverse reaction is favoured./*Die terugwaartse reaksie word bevoordeel.*
OR/*OF*
Number of moles/amount/concentration of N_2O_4/colourless gas increases.
Aantal mol/hoeveelheid/konsentrasie van 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)

6.3

6.3.1 Increases/*Verhoog* (1)

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

6.3.3 Increases/*Verhoog* (1)

6.4 CALCULATIONS USING NUMBER OF MOLES / *BEREKENINGE WAT GETAL MOL GEBRUIK*

Marking guidelines/*Nasienriglyne*

- $\Delta n(N_2O_4)$ = 20% of/*van* **x**/0,2**x**.
- **USE** ratio/***GEBRUIK*** *verhouding:* $N_2O_4 : NO_2 : = 1 : 2$.
- $n(N_2O_4)_{eq/ewe} = n(N_2O_4)_{initial/begin} - \Delta n(N_2O_4)$.
  $n(NO_2)_{eq/ewe} = n(NO_2)_{initial/begin} + \Delta n(NO_2)$.
- Divide equilibrium moles by 2 dm^3/*Deel ewewigsmol deur 2 dm³*.
- Correct K_c expression (formulae in square brackets).
  Korrekte K_c uitdrukking (formules in vierkanthakies).
- Substitution of K_c value/*Vervanging van K_c-waarde*.
- Substitution of concentrations into correct K_c expression.
  Vervanging van konsentrasies in korrekte K_c-uitdrukking.
- Final answer/*Finale antwoord*: 1,6 (mol)

OPTION 1/*OPSIE 1*

	N_2O_4	NO_2	
Initial amount (moles) *Aanvangshoeveelheid (mol)*	**x**	0	
Change in amount (moles) *Verandering in hoeveelheid* (mol)	0,2**x** ✓	0,4**x**	ratio ✓ *verhouding*
Equilibrium amount (moles) *hoeveelheid* (mol)	0,8**x**	0,4**x**	
Equilibrium concentration ($mol \cdot dm^{-3}$) *Ewewigskonsentrasie ($mol \cdot dm^{-3}$)*	0,4**x**	0,2**x**	Divide by 2 dm^3 ✓

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

$$0{,}16 \quad \frac{(0{,}2\mathbf{x})^2}{(0{,}4\mathbf{x})}$$

$\mathbf{x}$ = 1,6 (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./*Maks.* 5/8

OPTION 2/*OPSIE 2*

$$\Delta n(N_2O_4) = \frac{20}{100}\mathbf{x} = 0{,}2\mathbf{x}$$

$$\Delta n(NO_2) = 2\Delta n(N_2O_4) = 0{,}4\,\mathbf{x}$$

$$n(N_2O_4)_{eq/ewe} = \mathbf{x} - 0{,}2\mathbf{x} = 0{,}8\mathbf{x} \quad \textbf{AND} \quad n(NO_2)_{eq/ewe} = 0 + 0{,}4\mathbf{x}$$

$$c(N_2O_4)_{eq/ewe} = \frac{0{,}8\mathbf{x}}{2} = 0{,}4\mathbf{x}$$

$$c(NO_2)_{eq/ewe} = \frac{0{,}4\mathbf{x}}{2} = 0{,}2\mathbf{x}$$

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

$$0{,}16 \quad \frac{(0{,}2\mathbf{x})^2}{(0{,}4\mathbf{x})}$$

$\mathbf{x}$ = 1,6 (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./*Maks.* 5/8

CALCULATIONS USING CONCENTRATION
BEREKENINGE WAT KONSENTRASIE GEBRUIK

Marking guidelines/*Nasienriglyne*

- Initial $n(N_2O_4)$/**x** divide by 2 dm^3.
  *Aanvanklike $n(N_2O_4)$/**x** gedeel deur 2 dm^3.*
- $\Delta c(N_2O_4)$ = 20% of initial concentration/0,1x.
- **USE** ratio/***GEBRUIK*** *verhouding:* $c(N_2O_4) : c(NO_2) = 1 : 2$.
- $c(N_2O_4)_{eq/ewe} = c(N_2O_4)_{initial/begin} - \Delta c(N_2O_4)$.
  $c(NO_2)_{eq/ewe} = c(NO_2)_{initial/begin} + \Delta c(NO_2)$.
- Correct K_c expression (formulae in square brackets).
  Korrekte K_c uitdrukking (formules in vierkanthakies).
- Substitution of K_c value/*Vervanging van K_c-waarde.*
- Substitution of concentrations into K_c expression.
  Vervanging van konsentrasies in K_c-uitdrukking.
- Final answer/*Finale antwoord*: 1,6 (mol)

OPTION 3/*OPSIE 3*

	N_2O_4	NO_2	
Initial concentration ($mol \cdot dm^{-3}$) *Aanvanklike konsentrasie ($mol \cdot dm^{-3}$)*	$\frac{x}{2} = 0,5x$	0	Divide by 2 dm^3 ✓
Change ($mol \cdot dm^{-3}$) *Verandering ($mol \cdot dm^{-3}$)*	0,1**x**	0,2**x**	ratio *verhouding*
Equilibrium concentration ($mol \cdot dm^{-3}$) *Ewewigskonsentrasie ($mol \cdot dm^{-3}$)*	0,4**x**	0,2**x**	

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

$$0,16 = \frac{(0,2x)^2}{0,4x}$$

$$x = 1,6 \text{ (mol)}$$

No K_c expression, correct substitution/*Geen K_c-uitdrukking, korrekte substitusie:* Max./*Maks.* $\frac{6}{8}$

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

(8)

[16]

QUESTION 7/*VRAAG 7*

7.1

7.1.1 An acid is a proton donor. ✓✓
'n Suur is 'n protondonor/skenker. (2)

7.1.2 H_2O ✓ (1)

7.1.3 HSO_4^- ✓✓ (2)

7.2

7.2.1 Reaction of a salt with water/H_2O. ✓✓
Reaksie van 'n sout met water/H_2O.

Accept/*Aanvaar*
Reaction of cations or anions with water
Reaksie van katione of anione met water (2)

7.2.2 • $CO_3^{2-}(aq) + 2H_2O(\ell) \rightleftharpoons H_2CO_3(aq) + 2OH^-(aq)$ ✓✓
OR/*OF*
$CO_3^{2-}(aq) + H_2O(\ell) \rightleftharpoons HCO_3^-(aq) + OH^-(aq)$
Accept/*Aanvaar:*
$CaCO_3(aq) + 2H_2O(\ell) \rightleftharpoons H_2CO_3(aq) + Ca(OH)_2(aq)$

• The formation of $OH^-(aq)$ neutralises the excess acid. ✓
Die vorming van $OH^-(aq)$ neutraliseer die oormaat suur.

Marking guidelines/*Nasienriglyne*
- Reactants ✓ Products ✓
  Reaktanse *Produkte*
- The formation of $OH^-(aq)$ neutralises the excess acid. ✓
  Die vorming van $OH^-(aq)$ neutraliseer die oormaat suur.
- Ignore single arrows and phases./*Ignoreer enkelpyle en fases.*
- Marking rule 6.3.10/*Nasienreël 6.3.10.*
- Ignore balancing./*Ignoreer balansering.* (3)

7.3

7.3.1 $pH = -\log[H_3O^+]$ ✓
5 ✓ $= -\log[H_3O^+]$
$[H_3O^+] = 1 \times 10^{-5}\ mol \cdot dm^{-3}$ ✓ (3)

7.3.2 **POSITIVE MARKING FROM QUESTION 7.3.1.**
POSITIEWE NASIEN VAN VRAAG 7.3.1.

Marking guidelines/*Nasienriglyne*

- Any formula/*Enige formule*: $c = \frac{n}{V} / n = \frac{m}{M} / \frac{c_a \times V_a}{c_b \times V_b} = \frac{n_a}{n_b} / c = \frac{m}{MV}$
- Substitute/*vervang* V = 4 x 10^9 dm^3
- Calculate n_a(reacted) = n_a(initial) – n_a(final)
  Bereken n_a(reageer) = n_a(begin) – n_a(finaal)
- Use/*Gebruik* $n(CaO) : n(H_3O^+) = 1:2$
- Substitution of/*Vervanging van* 56 $g \cdot mol^{-1}$
- Final answer/*Finale antwoord*: m = 1,08 x 10^6 g to/*tot* 1,09 x 10^6 g

IF final answer is negative:/***INDIEN*** finale antwoord negatief is Max/Maks: 6/7

OPTION 1/*OPSIE 1*

$c(H_3O^+)_{ini/aanv.} = \frac{n}{V}$

$1 \times 10^{-5} = \frac{n}{4 \times 10^9}$

$n_a = 4 \times 10^4$ mol

$n(H_3O^+)_{react/rea} = 4 \times 10^4 - 1{,}26 \times 10^3$

$= 3{,}87 \times 10^4$ mol

$n(CaO) = \frac{1}{2} n(H_3O^+)$

$= \frac{1}{2} \times 3{,}87 \times 10^4$

$= 1{,}94 \times 10^4$ mol

OR/*OF*

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

$1{,}94 \times 10^4 = \frac{m}{56}$

$\therefore$ m = 1,09 x 10^6 g

OPTION 2/*OPSIE 2*

$c(H_3O^+)_{fin} = \frac{n}{V}$

$= \frac{1{,}26 \times 10^3}{4 \times 10^9}$

$= 3{,}15 \times 10^{-7}$ $mol \cdot dm^{-3}$

$c(H_3O^+)_{rea} = 1 \times 10^{-5} - 3{,}15 \times 10^{-7}$

$= 9{,}69 \times 10^{-6}$ $mol \cdot dm^{-3}$

$n(H_3O^+)_{rea} = cV$

$= (9{,}65 \times 10^{-6})(4 \times 10^9)$

$= 3{,}87 \times 10^4$ mol

$n(CaO) = \frac{1}{2} n(H_3O^+)$

$= \frac{1}{2} \times 3{,}87 \times 10^4$

$= 1{,}94 \times 10^4$ mol

1 mol : 56 g

$1{,}94 \times 10^4$ mol : m

$\therefore$ m = 1,09 x 10^6 g

OPTION 3/*OPSIE 3*

$c(H_3O^+)_{fin} = \frac{n}{V}$

$= \frac{1{,}26 \times 10^3}{4 \times 10^9}$

$= 3{,}15 \times 10^{-7}$ $mol \cdot dm^{-3}$

$c(H_3O^+)_{rea} = 1 \times 10^{-5} - 3{,}15 \times 10^{-7}$

$= 9{,}69 \times 10^{-6}$ $mol \cdot dm^{-3}$

$c(CaO) = \frac{1}{2} c(H_3O^+) = 4{,}845 \times 10^{-6}$ $mol \cdot dm^{-3}$

$c = \frac{m}{MV}$ $\therefore$ $4{,}845 \times 10^{-6} = \frac{m}{56(4 \times 10^9)}$ $\therefore$ m = 1,09 x 10^6 g

(7)
[20]

QUESTION 8/*VRAAG 8*

8.1

8.1.1 Loss of electrons./*Verlies aan elektrone*. **(2 or/*of* 0)** (2)

8.1.2 $Fe \rightarrow Fe^{3+} + 3e^-$

Marking guidelines/*Nasienriglyne*

- $Fe \rightleftharpoons Fe^{3+} + 3e^-$ $\frac{1}{2}$ $Fe^{3+} + 3e^- \rightleftharpoons Fe$ $\frac{0}{2}$
  $Fe^{3+} + 3e^- \leftarrow Fe$ $\frac{2}{2}$ $Fe^{3+} + 3e^- \rightarrow Fe$ $\frac{0}{2}$
- Ignore if charge omitted on electron./*Ignoreer indien lading weggelaat op elektron.*
- If charge (+) omitted on Fe^{3+}/*Indien lading (+) weggelaat op* Fe^{3+}*:*
  Example/*Voorbeeld:* $Fe \rightarrow Fe^3 + 3e^-$ Max./*Maks:* $\frac{1}{2}$

(2)

8.1.3 Reducing agent/*Reduseermiddel* (1)

8.1.4 Fe is a stronger reducing agent than Cu and (Fe) will be oxidised (to Fe^{3+})./*Fe is 'n sterker reduseermiddel as Cu en (Fe) sal geoksideer word (na* Fe^{3+}*).*

OR/*OF*

Cu is a weaker reducing agent than Fe and (Cu) will not be oxidised (to Cu^{2+})./*Cu is 'n swakker reduseermiddel as Fe en (Cu) sal nie geoksideer word nie (na* Cu^{2+}*).* (3)

8.1.5 Zinc/Zn
Stronger reducing agent (than Fe)./*Sterker reduseermiddel (as Fe).*

OR/*OF*

Zn will undergo oxidation (before Fe)./*Zn sal oksidasie (voor Fe) ondergaan.*

OR/*OF*

Cu is a weaker reducing agent (than Fe)./*Cu is 'n swakker reduseermiddel (as Fe).* (2)

8.2

8.2.1 $3Cu^{2+} + 2Fe \rightarrow 3Cu + 2Fe^{3+}$ Bal.

Marking guidelines/*Nasienriglyne*

- Reactants / *Reaktanse* Products / *Produkte* Balancing / *Balansering*
- Ignore double arrows./*Ignoreer dubbelpyle.*
- Marking rule 6.3.10/*Nasienreël 6.3.10.*

(3)

8.2.2

OPTION 1/*OPSIE 1*	**Notes/*Aantekeninge***
$E^{\theta}_{cell} = E^{\theta}_{reduction} - E^{\theta}_{oxidation}$ ✓ = 0,34 ✓ – (-0,06) ✓ = 0,40 V ✓	• Accept any other correct formula from the data sheet./*Aanvaar enige ander korrekte formule vanaf gegewensblad.* • Any other formula using unconventional abbreviations, e.g. $E°_{cell} = E°_{OA} - E°_{RA}$ followed by correct substitutions:/*Enige ander formule wat onkonvensionele afkortings gebruik bv.* $E°_{sel} = E°_{OM} - E°_{RM}$ *gevolg deur korrekte vervangings*: $\frac{3}{4}$

OPTION 2/*OPSIE 2*

$Cu^{2+} + 2e^- \rightarrow Cu$ ✓ $E^{\theta} = 0,34$ V ✓

$Fe \rightarrow Fe^{3+} + 3e^-$ $E^{\theta} = 0,06$ V ✓

$3Cu^{2+} + 2Fe \rightarrow 3Cu + 2Fe^{3+}$ $E^{\theta} = +0,40$ V ✓ (4)

[17]

QUESTION 9/*VRAAG 9*

9.1 A cell in which electrical energy is converted to chemical energy. ✓✓ **(2 or 0)**
'n Sel waarin elektriese energie omgeskakel word na chemiese energie.
(2 of 0)

OR/*OF*

A cell in which electrical energy/electricity is used to obtain a chemical change/reaction. **(2 or 0)**
*'n Sel waarin elektriese energie/elektrisiteit gebruik word om 'n chemiese verandering/reaksie te veroorsaak. (**2 of 0**)* (2)

9.2 Any soluble copper(II) salt e.g./*Enige oplosbare koper(II)-sout bv.*
$CuSO_4/Cu(NO_3)_2/CuC\ell_2$ ✓ (1)

9.3 B ✓

$Cu^{2+} + 2e^- \rightarrow Cu$ ✓✓

Marking guidelines/*Nasienriglyne*

- $Cu \leftarrow Cu^{2+} + 2e^-$ $(\frac{2}{2})$ $Cu \rightleftharpoons Cu^{2+} + 2e^-$ $(\frac{0}{2})$
  $Cu^{2+} + 2e^- \rightleftharpoons Cu$ $(\frac{1}{2})$ $Cu \rightarrow Cu^{2+} + 2e^-$ $(\frac{0}{2})$
- Ignore if charge on electron is omitted./*Ignoreer indien lading op elektron uitgelaat is.*
- If a charge of an ion is omitted e.g. $Cu^2 + 2e^- \rightarrow Cu$ /*Indien lading op ioon uitgelaat is bv.* $Cu^2 + 2e^- \rightarrow Cu$ Max./*Maks*: $\frac{1}{2}$ (3)

9.4 Platinum/Pt ✓ **AND/*EN*** silver/Ag/*silwer* ✓ (2)

[8]

QUESTION 10/*VRAAG 10*

10.1

10.1.1 Haber (process)/*Haber(proses)* (1)

10.1.2 Ostwald (process)/*Ostwald(proses)* (1)

10.2

10.2.1 Ammonium nitrate/*Ammoniumnitraat*/NH_4NO_3 (1)

10.2.2 Iron/iron oxide/Fe/FeO
Yster/ysteroksied/Fe/FeO (1)

10.3 $2NH_3 + H_2SO_4 \rightarrow (NH_4)_2SO_4$ Bal (3)

Marking guidelines/*Nasienriglyne*
- Reactants / *Reaktanse* Products / *Produkte* Balancing / *Balansering*
- Ignore double arrows./*Ignoreer dubbelpyle.*
- Marking rule 6.3.10./*Nasienreël 6.3.10.*

10.4

Marking guidelines/*Nasienriglyne*
- Any ONE molar mass correct/*Enige EEN molêre massa korrek:*
  80 g·mol^{-1}/164 g·mol^{-1}/74,5 g·mol^{-1}
- m(N) = 7 (kg) **OR/*OF*** 0,14
- m(P) = 2,27 (kg) **OR/*OF*** 0,045
- m(K) = 9,42 (kg) **OR/*OF*** 0,188
- Final answer/*Finale antwoord*: 3 : 1 : 4
  ACCEPT/*AANVAAR*: 3,08 : 1 : 4,15 **OR/*OF*** 7 : 2,27 : 9,42

OPTION 1/*OPSIE 1*

NH_4NO_3:
80 g → 28 g N
20 kg → $\frac{28}{80}$ x 20
∴ m(N) = 7 kg

Na_3PO_4:
164 g → 31 g P
12 kg → $\frac{31}{164}$ x 12
∴ m(P) = 2,27 kg

KCℓ:
74,5 g → 39 g K
18 kg → $\frac{39}{74,5}$ x 18
∴ m(K) = 9,42 kg

∴ N : P : K
7 : 2,27 : 9,42
3 : 1 : 4

OPTION 2/*OPSIE 2*

$n(NH_4NO_3) = \frac{m}{M}$
$= \frac{20\,000}{80} = 250$ mol
$n(N) = 2n(NH_4NO_3) = 500$ mol
m(N) = 500 x 14
= 7 000 g = 7 kg

$n(Na_3PO_4) = \frac{12\,000}{164} = 73,17$ mol
m(P) = 73,17 x 31
= 2 268 g = 2,27 kg

$n(KC\ell) = \frac{18\,000}{74,5} = 241,61$ mol
m(K) = 241,61 x 39
= 9 423 g = 9,42 kg
∴ N : P : K
7 : 2,27 : 9,42
3 : 1 : 4

OPTION 3/*OPSIE 3*	**OPTION 4/*OPSIE 4***
NH_4NO_3: %N = $\frac{28}{80}$ x 100 = 35%	NH_4NO_3:
m(N) = $\frac{35}{100} \times 20 = 7$ kg	%N = $\frac{28}{80}$ x 100 = 35%
Na_3PO_4:	Na_3PO_4:
%P = $\frac{31}{164}$ x 100 = 18,9%	%P = $\frac{31}{164}$ x 100 = 18,9%
m(N) = $\frac{18,9}{100} \times 12$ = 2,27 kg	KCℓ:
KCℓ:	%K = $\frac{39}{74,5}$ x 100 = 52,34%
%K = $\frac{39}{74,5}$ x 100 = 52,34%	N: $\frac{20}{50}$ x 35 = 0,14
m(K) = $\frac{52,34}{100} \times 18 = 9,42$ kg	P: $\frac{12}{50}$ x 18,9 = 0,045
∴ N : P : K = 7 : 2,27 : 9,42	K: $\frac{18}{50}$ x 52,34 = 0,188
= 3 : 1 : 4	N : P : K = 0,14 : 0,045 : 0,188
	= 3 : 1 : 4

(5)
[12]

TOTAL/*TOTAAL*: 150