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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.***

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## 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]**

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## 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)

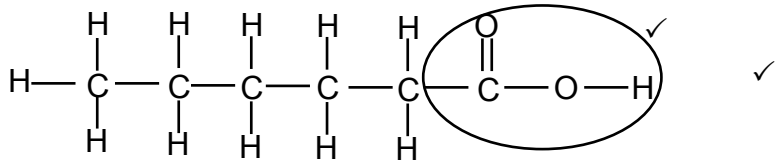
2.3 $$\frac{M(ester)}{M(C_4H_8O)} = \frac{144}{72\checkmark} = 2$$
$\therefore$ 2 x $C_4H_8O = C_8H_{16}O_2$ ✓

**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)



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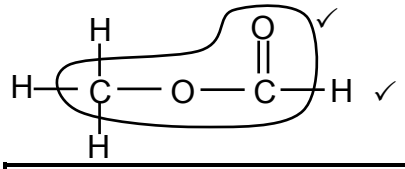
3.2.3



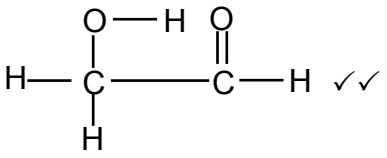
**Marking criteria/*Nasienriglyne***

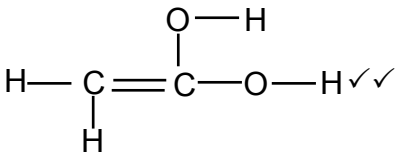
- Whole structure correct:
  *Hele struktuur korrek:* 2/2
- Only functional group correct:
  *Slegs funksionele groep korrek:* Max/*Maks*: 1/2

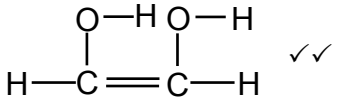
**IF/*INDIEN***

- 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]**

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## QUESTION 4/*VRAAG 4*

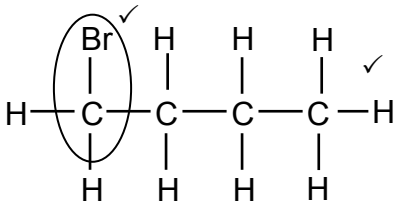
4.1

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:* ½
- Whole structure correct/*Hele struktuur korrek:* 2/2

**IF/INDIEN:**
$Br_2$ but rest of structure correct/$Br_2$ maar res van struktuur korrek: ½

(2)

4.1.5 $C_5H_{12} + 8O_2$ ✓ → $5CO_2 + 6H_2O$ ✓ Bal ✓

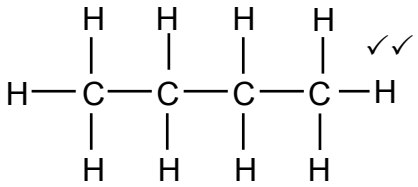
**Marking guidelines/*Nasienriglyne***
- Reactants ✓ *Reaktanse* Products ✓ *Produkte* Balancing ✓ *Balansering*
- Ignore double arrows and phases./*Ignoreer dubbelpyle en fases.*
- Marking rule 6.3.10/*Nasienreël 6.3.10.*
- If condensed structural formulae used/*Indien gekondenseerde struktuurformules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

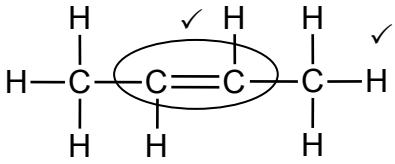
4.2

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)

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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)



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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

$$n(Zn) = \frac{m}{M}$$
$$= \frac{1,5}{65} \checkmark$$
$$= 0,023 \text{ mol}$$
$$\text{rate/}tempo = -\frac{\Delta n}{\Delta t} \checkmark$$
$$= -\left(\frac{0 - 0,023}{14 \checkmark - 0}\right)$$
$$= 1,65 \times 10^{-3} \text{ (mol·min}^{-1}\text{)}$$
✓

**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)

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## 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·dm$^{-3}$) *Ewewigskonsentrasie (mol·dm$^{-3}$)* | 0,4**x** | 0,2**x** | Divide by 2 $dm^3$ ✓ |

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

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

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

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***

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

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

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

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

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

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

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

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

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

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## 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 ($mol \cdot dm^{-3}$)<br>*Aanvanklike konsentrasie ($mol \cdot dm^{-3}$)* | $\frac{x}{2} = 0,5\mathbf{x}$ | 0 | Divide by 2 $dm^3$ ✓ |
| Change ($mol \cdot dm^{-3}$)<br>*Verandering ($mol \cdot dm^{-3}$)* | $0,1\mathbf{x}$ ✓ | $0,2\mathbf{x}$ | ratio ✓<br>*verhouding* |
| Equilibrium concentration ($mol \cdot dm^{-3}$)<br>*Ewewigskonsentrasie ($mol \cdot dm^{-3}$)* | $0,4\mathbf{x}$ | $0,2\mathbf{x}$ | ✓ |

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

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

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

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]**



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## 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·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: $\frac{6}{7}$

**OPTION 1/*OPSIE 1***

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

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

$n_a$ = 4 x $10^4$ mol

$n(H_3O^+)_{react/reag}$ = 4 x $10^4$ – 1,26 x $10^3$ ✓✓
= 3,87 x $10^4$ mol

n(CaO) = ½$n(H_3O^+)$
= ½ x 3,87 x $10^4$ ✓
= 1,94 x $10^4$ mol

**OPTION 2/*OPSIE 2***

$c(H_3O^+)_{fin} = \frac{n}{V}$ ✓

= $\frac{1{,}26 \times 10^3}{4 \times 10^9}$ ✓
= 3,15 x $10^{-7}$ $mol \cdot dm^{-3}$

$c(H_3O^+)_{rea}$ = 1 x $10^{-5}$ – 3,15 x $10^{-7}$ ✓✓
= 9,69 x $10^{-6}$ $mol \cdot dm^{-3}$

$n(H_3O^+)_{rea}$ = cV
= (9,65 x $10^{-6}$)(4 x $10^9$)
= 3,87 x $10^4$ mol

n(CaO) = ½$n(H_3O^+)$
= ½ x 3,87 x $10^4$ ✓
= 1,94 x $10^4$ mol

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**OR/*OF***

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

1,94 x $10^4$ = $\frac{m}{56}$ ✓

∴ m = 1,09 x $10^6$ g ✓

1 mol : 56 g ✓

1,94 x $10^4$ mol : m

∴ 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 x $10^{-7}$ $mol \cdot dm^{-3}$

$c(H_3O^+)_{rea}$ = 1 x $10^{-5}$ – 3,15 x $10^{-7}$ ✓✓
= 9,69 x $10^{-6}$ $mol \cdot dm^{-3}$

c(CaO) = ½$c(H_3O^+)$ ✓ = 4,845 x $10^{-6}$ $mol \cdot dm^{-3}$

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

(7)
**[20]**



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## 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 ✓ Products ✓ Balancing ✓
  *Reaktanse* *Produkte* *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*** |
|---|---|
| $E^{\theta}_{cell} = E^{\theta}_{reduction} - E^{\theta}_{oxidation}$ ✓<br>= 0,34 ✓ – (-0,06) ✓<br>= 0,40 V ✓ | • Accept any other correct formula from the data sheet./*Aanvaar enige ander korrekte formule vanaf gegewensblad.*<br>• 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]**



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## 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 $2NH_3 + H_2SO_4$ ✓ → $(NH_4)_2SO_4$ ✓ Bal ✓ (3)

**Marking guidelines/*Nasienriglyne***
- Reactants ✓ Products ✓ Balancing ✓
  *Reaktanse* *Produkte* *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 ✓

$n(KCℓ) = \frac{18\,000}{74,5}$ = 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 ✓

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

(5)
**[12]**

**TOTAL/*TOTAAL*: 150**

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