basic education

Department:
Basic Education
REPUBLIC OF SOUTH AFRICA

SENIOR CERTIFICATE EXAMINATIONS/
NATIONAL SENIOR CERTIFICATE EXAMINATIONS
SENIORSERTIFIKAAT-EKSAMEN/
NASIONALE SENIORSERTIFIKAAT-EKSAMEN

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

2021

MARKING GUIDELINES/*NASIENRIGLYNE*

MARKS/*PUNTE*: 150

These marking guidelines consist of 19 pages./
Hierdie nasienriglyne bestaan uit 19 bladsye.

QUESTION 1/*VRAAG 1*

1.1 C ✓✓ (2)

1.2 D ✓✓ (2)

1.3 C ✓✓ (2)

1.4 B ✓✓ (2)

1.5 D ✓✓ (2)

1.6 C ✓✓ (2)

1.7 B ✓✓ (2)

1.8 B ✓✓ (2)

1.9 A ✓✓ (2)

1.10 B ✓✓ (2)

[20]

QUESTION 2/*VRAAG 2*

2.1

2.1.1 F ✓ (1)

2.1.2 B & F ✓ (1)

2.1.3 C ✓ (1)

2.2

2.2.1 Haloalkane / alkyl halide ✓
Haloalkaan/alkielhalied (1)

2.2.2 3,5-dibromooctane ✓✓✓
3,5-dibroomoktaan

Marking criteria/*Nasienkriteria:*
- Octane/*Oktaan* ✓
- Dibromo/*Dibroom* ✓
- Substituents (dibromo) correctly numbered, hyphens, commas correctly used./ *Substituente (dibroom) korrek genommer, koppeltekens en kommas korrek gebruik.* ✓

(3)

2.3

2.3.1 Pentan-3-one ✓✓
Pentan-3-oon
OR/*OF*
3-pentanone✓✓
3-pentanoon

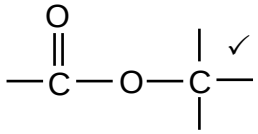
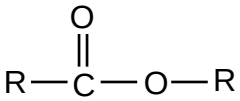
Marking criteria/*Nasienkriteria:*
- Pentanone/*pentanoon* ✓
- Correct position of functional group. ✓ *Korrekte posisie van funksionele groep.*

(2)

2.3.2 3-methyl✓butan-2-one✓/*3-metielbutan-2-oon*
OR/*OF*
3-methyl✓butanone✓/*3-metielbutanoon*
OR/*OF*
methyl✓butanone✓/*metielbutanoon*
OR/*OF*
3-methyl✓- 2-butanone✓/*3-metiel-2-butanoon* (2)

2.4

2.4.1 Hexyl✓ methanoate ✓
Heksielmetanoaat (2)

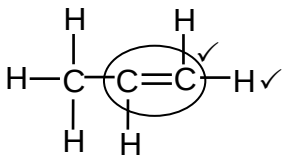
2.4.2  **OR/*OF***  (1)

2.5

2.5.1 Cracking/Elimination ✓
Kraking/eliminasie (1)

2.5.2 C_7H_{16} ✓✓ (2)

2.5.3



Notes/*Aantekeninge*
- Functional group/*Funksionele groep*: ✓
- Whole structure correct/*Hele struktuur korrek*: ✓

(2)
[19]

QUESTION 3/*VRAAG 3*

3.1

Marking guidelines/*Nasienkriteria:*
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 pressure exerted by a vapour at equilibrium with its liquid in a closed system. ✓✓
Die druk uitgeoefen deur 'n damp in ewewig met sy vloeistoffase in 'n geslote sisteem. (2)

3.2 Functional group/Type of intermolecular forces/Homologous series ✓
Funksionele groep/Tipe intermolekulêre kragte/Homoloë reeks (1)

3.3 B ✓ (1)

3.4

Marking criteria/*Nasienkriteria*
- State hydrogen bonding in **A**./*Noem waterstofbinding in **A**.* ✓
- State dipole-dipole forces in **B**./*Noem dipool-dipoolkragte in **B**.*✓
- Compare strengths of IMFs./*Vergelyk sterktes van IMKe.* ✓
- Compare energies required./*Vergelyk energieë benodig.* ✓

- Compound **A**/butan-1-ol has hydrogen bonding (dipole-dipole and London forces) between molecules. ✓
- Compound **B**/butan-2-one has dipole-dipole forces (and London forces) between molecules. ✓
- Intermolecular forces in compound **A**/butan-1-ol are stronger than intermolecular forces in compound B/butan-2-one. ✓
  OR
  Intermolecular forces in compound **B**/butan-2-one are weaker than intermolecular forces in compound **A**/butan-1-ol. ✓
- More energy is needed to overcome/break intermolecular forces in compound **A**/*butan-ol* than in compound **B**/butan-2-one. ✓

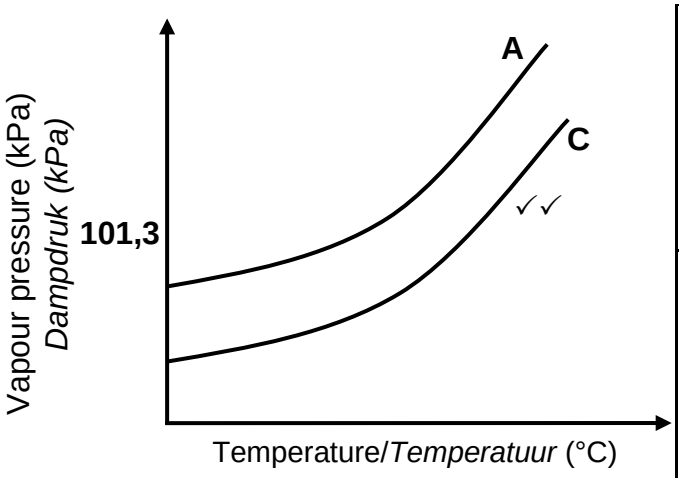
- *Verbinding **A**/butan-1-ol het waterstofbindings (dipool-dipoolkragte en Londonkragte) tussen molekule.*
- *Verbinding **B**/butan-2-oon het dipool-dipoolkragte (en London kragte) tussen molekule.* ✓
- *Intermolekulêre kragte in verbinding **A**/butan-1-ol is sterker as intermolekulêre kragte in verbinding **B**/butan-2-oon.*
  OF
  *Intermolekulêre kragte in verbinding **B**/butan-2-oon is swakker as intermolekulêre kragte in verbinding **A**/butan-1-ol.*
- *Meer energie is nodig om intermolekulêre kragte te oorkom/breek in verbinding **A**/butan-1-ol as in verbinding **B**/butan-2-oon.* (4)

3.5

3.5.1 Boiling point (of compound **A**/butan-1-ol) ✓
*Kookpunt (van verbinding **A**/butan-1-ol)* (1)

3.5.2 Gas ✓ (1)

3.5.3



Marking criteria/*Nasienkriteria*:
- Curve **C** starts below curve **A**/*Kurwe **C** begin onder kurwe **A***. ✓
- Curve **C** remains below curve **A**/ *Kurwe **C** bly onder kurwe **A***. ✓

Accept/*Aanvaar*
- If **C** is labelled as **B** / *Indien **C** as **B** benoem is*
- If graph below graph **A** is unlabelled /*Indien grafiek onder grafiek **A** nie benoemis nie*

Note/*Let Wel*
If both graphs unlabelled / *Indien beide grafiek nie benoem is nie:*
0 marks / *0 punte*

(2)
[12]

QUESTION 4/*VRAAG 4*

4.1

4.1.1 Heat/sunlight/ultraviolet light/radiation/light ✓
Hitte/sonlig/ultravioletlig/straling/lig (1)

4.1.2 HBr/hydrogen bromide/*waterstofbromied* ✓ (1)

4.1.3 Hydrolysis/*hidrolise* ✓ (1)

4.1.4 H_2O/water✓
Accept/*Aanvaar*
hydrogen oxide/*waterstofoksied*

OR/*OF*
NaOH/KOH/LiOH/sodium hydroxide/potassium hydroxide/lithium hydroxide
NaOH/KOH/LiOH/Natriumhidroksied/kaliumhidroksied/litiumhidroksied (1)

4.1.5 2-bromo✓propane ✓
2-bromopropaan (2)

4.2

Marking criteria/*Nasienkriteria*:
(Mark bullets independently. / Sien *kolpunte onafhanklik na.)*
- React chloroethane with (conc) NaOH or NaOH in ethanol. ✓
- Indicate heat/Δ (on the arrow) or as a reactant in the reaction of chloroethane. ✓
- Correct condensed formula for ethene as product.✓
- Product NaCℓ in the reaction of chloroethane. ✓
- Product H_2O in the reaction of chloroethane. ✓
- React ethene with H_2.✓
- Indicate Pt on the arrow of / at the reaction of ethene with H_2. ✓
- Correct condensed formula of ethane as product. ✓

.
- *Reageer chloroetaan met (gekons) NaOH of NaOH in etanol.*✓
- *Dui hitte/Δ (op die pyl) of as 'n reaktant in die reaksie van chloroetaan.* ✓
- *Korrekte gekondenseerde formule vir eteen as produk.* ✓
- *Produk NaCℓ in die reaksie van chloroetaan.*✓
- *Produk H_2O in die reaksie van chloroetaan.*✓
- *Reageer eteen met H_2* ✓
- *Dui Pt aan op die pyl / by die reaksie van eteen met H_2.* ✓
- *Korrekte gekondenseerde formule vir etaan as produk.* ✓

$$CH_3CH_2Cl + (\text{conc/}gekons)\ NaOH \xrightarrow{\Delta} CH_2CH_2 + NaCl + H_2O$$
(+ NaOH (in ethanol/*etanol*) ✓; NaOH ✓; Δ ✓; CH_2CH_2 ✓; NaCℓ ✓; H_2O ✓)

$$CH_2CH_2 + H_2 \xrightarrow{Pt} CH_3CH_3$$
(H_2 ✓; Pt ✓; CH_3CH_3 ✓)

Note/*Let wel*
Any additional reactants or products: *Deduct one mark per reaction*
Enige addisionele reaktanse of produkte: Trek een punt af per reaksie

(8)
[14]

QUESTION 5/*VRAAG 5*

5.1

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)

5.2

- Time/*tyd* ✓
- Volume of gas/CO_2/carbon dioxide (in gas syringe)✓
  Volume gas/CO_2/koolstofdioksied (in gasspuit)

OR/*OF*

- Time taken for $A\ell_2(CO_3)_3$ to be used up. ✓✓
  Tyd geneem vir die $A\ell_2(CO_3)_3$ om opgebruik te word.

Accept/*Aanvaar*
Measure volume of gas/CO_2 at regular time intervals. ✓✓
Meet volume van gas/CO_2 met gereelde tydintervalle. (2)

5.3 **Experiment II/*Eksperiment II:***

- More (HCℓ) particles per unit volume./More particles with correct orientation. ✓
- More effective collisions per unit time./Higher frequency of effective collisions. ✓
- Higher reaction rate. ✓
- *Meer (*HCℓ)-*deeltjies per eenheid volume./Meer deeltjies met korrekte oriëntasie.*
- *Meer effektiewe botsings per eenheid tyd./Hoër frekwensie van effektiewe botsings.*
- *Hoër reaksietempo.* (3)

OR/*OF*

Experiment I/*Eksperiment I:*

- Less (HCℓ) particles per unit volume. ✓
- Less effective collisions per unit time./Lower frequency of effective collisions. ✓
- Lower reaction rate. ✓

- *Minder (*HCℓ) *deeltjies per eenheidvolume.*
- *Minder effektiewe botsings per eenheidtyd./ Laer frekwensie van effektiewe botsings.*
- *Laer reaksietempo.*

5.4

OPTION 1/*OPSIE* 1

ave rate/*gem tempo* = $-\frac{\Delta n}{\Delta t}$

$4,4 \times 10^{-3} = -\frac{n_f - 0,016}{2,5\,(-0)}$ ✓ ✓

$n[A\ell_2(CO_3)_3] = 0,005$ (mol) ✓

OPTION 2/*OPSIE* 2

ave rate/*gem tempo* = $\frac{\Delta n}{\Delta t}$

$4,4 \times 10^{-3} = \frac{\Delta n}{2,5}$ ✓

$\Delta n[A\ell_2(CO_3)_3] = 0,016 - 0,011$ ✓
$= 0,005$ mol ✓

Marking criteria/*Nasienkriteria*

- Substitute average rate and Δt./ *Vervang gemiddelde tempo en* Δt. ✓
- Substitute/*Vervang* Δn. ✓
- Final answer/*Finale antwoord:* 0,005 (mol) ✓

NOTE/*LET WEL*

- Accept negative answers when the negative sign in front of the formula is omitted./*Aanvaar negatiewe antwoord wanneer die negatiewe teken voor die formule uitgelaat is.*
- Do not penalise if initial and final mole values or time values are swopped. / *Moenie penaliseer indien aanvanklike en finale molwaardes omgeruil is nie.*

OPTION 3/*OPSIE* 3

With reference to CO_2/*Met verwysing na* CO_2

ave. rate/*gem tempo* = $\frac{\Delta n}{\Delta t}$

$4,4 \times 10^{-3} = \frac{\Delta n}{2,5}$ ✓

$\Delta n(CO_2) = 0,011$ mol

$n(CO_2) : n(A\ell_2(CO_3)_3$
3 : 1
$0,011 : 3,67 \times 10^{-3}$ mol ✓

$n(A\ell_2(CO_3)_3$ left/*oor* $= 0,016 - 3,67 \times 10^{-3} = 1,23 \times 10^{-2}$ mol ✓

OPTION 4/*OPSIE 4*
With reference to HCℓ/*Met verwysing na HCℓ*

ave. rate/*gem tempo* = $\frac{\Delta n}{\Delta t}$

$4,4 \times 10^{-3} = \frac{\Delta n}{2,5}$ ✓

$\Delta n(HC\ell) = 0,011$ mol

$n[A\ell_2(CO_3)_3] = \frac{0,011}{6} = 0,0018$ mol ✓

$n[A\ell_2(CO_3)_3]$ left/*oor* = 0,016 – 0,0018 = 0,0142 mol ✓

OPTION 5/*OPSIE 5*
With reference to $A\ell C\ell_3$/*Met verwysing na $A\ell C\ell_3$*

ave. rate/*gem tempo* = $\frac{\Delta n}{\Delta t}$

$4,4 \times 10^{-3} = \frac{\Delta n}{2,5}$ ✓

$\Delta n(A\ell C\ell_3) = 0,011$ mol

$n[A\ell_2(CO_3)_3] = 0,0055$ mol ✓

$n[A\ell_2(CO_3)_3]$ left/*oor* = 0,016 – 0,0055 = 0,0105 mol ✓ (3)

5.5

Marking criteria/*Nasienkriteria:*
- Use mol ratio/*Gebruik molverhouding*: $n(CO_2) : n(A\ell_2(CO_3)_3) = 3 : 1$ ✓
- Substitute 24 000 $cm^3 \cdot mol^{-1}$/24 $dm^3 \cdot mol^{-1}$ in $n = \frac{V}{V_M}$ or in ratio. ✓

  Vervang 24 000 $cm^3 \cdot mol^{-1}$/24 $dm^3 \cdot mol^{-1}$ in $n = \frac{V}{V_M}$ of in verhouding.
- Final answer/*Finale antwoord:* 1 152 cm^3 / 1,152 dm^3 ✓

OPTION 1/*OPSIE 1*

$n(CO_2) = 3n[A\ell_2(CO_3)_3]$
$= 3(0,016)$ ✓
$= 0,048$ mol

$n(CO_2) = \frac{V}{V_M}$

$\therefore 0,048 = \frac{V}{24000}$ ✓

$V(CO_2) = 1\ 152\ cm^3$ (1,152 dm^3) ✓

OPTION 2/*OPSIE 2*

$n(CO_2) = 3n[A\ell_2(CO_3)_3]$
$= 3(0,016)$ ✓
$= 0,048$ mol

1 mol ……24 000 cm^3
0,048 mol ……V

$V(CO_2) = \frac{0,048 \times 24000}{1}$ ✓
$= 1\ 152\ cm^3$ (1,152 dm^3) ✓ (3)

[13]

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. **(2 or/*of* 0)**

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

6.2

6.2.1 X ✓
ANY ONE/*ENIGE EEN*
- The concentration of products increases (from 0 – 6 min.).
  Die konsentrasie van die produkte neem toe (van 0 - 6 min.).
- The concentration of reactants decreases (from 0 – 6 min.).
  Die konsentrasie van die reaktanse neem af (van 0 – 6 min.).
- No products were present initially. ✓
  Geen produkte was aanvanklik teenwoordig nie.
- The curve begins at zero./*Die kurwe begin by nul.* (2)

6.2.2 Higher than/*Hoër as* ✓ (1)

6.3 **CALCULATIONS USING NUMBER OF MOLES**
BEREKENINGE WAT AANTAL MOL GEBRUIK

Marking criteria/*Nasienkriteria*
- Calculate/*Bereken* mol HI: $n(HI)_{ini/aanv.}$ = 1(0,5). ✓
- Use mol ratio/*Gebruik molverhouding:* 2:1:1 / n(HI) = $2n(H_2)$ = $2n(I_2)$. ✓
- $n(H_2)_{equilibrium/ewewig}$ = $n(H_2)_{formed/gevorm}$
  $n(I_2)_{equilibrium/ewewig}$ = $n(I_2)_{formed/gevorm}$ ✓
  Note: If Δn not shown award mark for equal $n_{equilibrium}$
  ***Let wel**: Indien Δn nie aangedui is nie, ken punt toe vir gelyke n_{ewewig}*
- $n((HI)_{equilibrium/ewewig}$ = $n(HI)_{initial/aanvanklik}$ - $n(HI)_{change/verandering}$. ✓
- Divide $n(HI)_{equil}$ & $n(H_2)_{equil}$ & $n(H_2)_{equil}$ by 0,5 dm^3. ✓
  Deel $n(HI)_{ewewig}$ & $n(H_2)_{ewewig}$ & $n(H_2)_{ewewig}$ deur 0,5 dm^3.
- Correct K_c expression (formulae in square brackets). ✓
  Korrekte K_c-uitdrukking (formules in vierkanthakies).
- Substitute 0,04 into K_c expression. ✓
  Vervang 0,04 in K_c-uitdrukking.
- Substitute equilibrium concentrations in K_c expression. ✓
  Vervang ewewigskonsentrasies in K_c-uitdrukking.
- Final answer/*Finale antwoord*: 0,07 mol ✓
  Range/*Gebied*: 0,07 – 0,072 mol

OPTION 1/*OPSIE 1*

n(HI) = 1(0,5) = 0,5 mol

	HI	H_2	I_2	
Initial quantity (mol) *Aanvangshoeveelheid (mol)*	0,5 ✓	0	0	
Change (mol) *Verandering (mol)*	2x	x	x	ratio ✓ *verhouding*
Quantity at equilibrium (mol)/ *Hoeveelheid by ewewig (mol)*	0,5-2x ✓	x	x ✓	
Equilibrium concentration ($mol \cdot dm^{-3}$) *Ewewigskonsentrasie ($mol \cdot dm^{-3}$)*	$\frac{0,5-2x}{0,5}$	$\frac{x}{0,5}$	$\frac{x}{0,5}$	divide by 0,5 ✓ *deel deur 0,5*

$K_c = \frac{[H_2][I_2]}{[HI]^2}$ ✓

$0,04 \overset{\checkmark}{=} \frac{(\frac{x}{0,5})(\frac{x}{0,5})}{(\frac{0,5-2x}{0,5})^2}$ ✓

x = 0,071 mol ✓

No K_C expression, correct substitution/*Geen K_c-uitdrukking*, *korrekte substitusie*: Max./*Maks.* $\frac{8}{9}$

Wrong K_C expression /*Verkeerde K_c-uitdrukking*: Max./M*aks.* $\frac{6}{9}$

CALCULATIONS USING CONCENTRATION
BEREKENINGE WAT KONSENTRASIE GEBRUIK

Marking criteria/*Nasienkriteria:*

- Use initial/*Gebruik aanvanklike* c(HI) = 1 $mol \cdot dm^{-3}$. ✓
- Use mol ratio/*Gebruik molverhouding:* 2 : 1: 1 / n(HI) = $2n(H_2)$ = $2n(I_2)$. ✓
- $c(H_2)_{equilibrium/ewewig} = c(H_2)_{formed/gevorm}$
$c(I_2)_{equilibrium/ewewig} = c(I_2)_{formed/gevorm}$ } ✓
  Note: If Δc not shown award mark for equal $c_{equilibrium}$
  ***Let wel**: Indien Δc nie aangedui is nie, ken punt toe vir gelyke c_{ewewig}*
- $c(HI)_{equilibrium/ewewig} = c(HI)_{initial} - c(HI)_{change}$. ✓
- Correct K_c expression (formulae in square brackets). ✓
  Korrekte K_c-uitdrukking (formules in vierkanthakies).
- Substitution of 0,04 into K_c expression. ✓
  Vervang 0,04 in K_c-uitdrukking.
- Substitution of equilibrium concentrations into K_c expression. ✓
  Vervanging van ewewigskonsentrasies in K_c-uitdrukking.
- Multiply concentration by 0,5 dm^3. ✓
  Vermenigvuldig konsentrasie met 0,5 dm^3.
- Final answer/*Finale antwoord*: 0,07 mol ✓
  Range/*Gebied*: 0,07 to/*tot* 0,072 mol

OPTION 2/*OPSIE 2*

	HI	H_2	I_2
Initial concentration (mol·dm^{-3}) *Aanvangskonsentrasie (mol·dm^{-3})*	1 ✓	0	0
Change (mol·dm^{-3}) *Verandering* (mol·dm^{-3})	2x	x	x
Equilibrium concentration (mol·dm^{-3}) *Ewewigskonsentrasie* (mol·dm^{-3})	1-2x ✓	x	x ✓

$K_c = \frac{[H_2][I_2]}{[HI]^2}$ ✓

$0,04 \overset{✓}{=} \frac{(x)(x)}{(1-2x)^2}$ ✓

$x = 0,143$ mol·dm^{-3}

$n(I_2) = cV$
$= 0,143 \times 0,5$ ✓
$= 0,072$ mol ✓

No K_C expression, correct substitution/*Geen K_c-uitdrukking*, *korrekte substitusie*: Max./*Maks.* $\frac{8}{9}$

Wrong K_C expression /*Verkeerde K_c-uitdrukking*: Max./M*aks.* $\frac{6}{9}$

(9)

6.4

6.4.1 Both forward and reverse/*Beide voorwaartse en terugwaartse* ✓ (1)

6.4.2 Positive/*Positief* ✓

- The forward reaction is favoured. ✓
  Die voorwaartse reaksie word bevoordeel.
- An increase in temperature favours the endothermic reaction. ✓
  'n Toename in temperatuur bevoordeel die endotermiese reaksie.
- The forward reaction is endothermic. ✓
  Die voorwaartse reaksie is endotermies.

(4)
[19]

QUESTION 7/VRAAG 7

7.1 Standard solution/*Standaardoplossing* ✓ (1)

7.2

7.2.1

Marking criteria/*Nasienkriteria*:

- Any one of the formulae/*Enige een van die formules*: $c = \frac{m}{MV}$ / $n = \frac{m}{M}$ / $c = \frac{n}{V}$ ✓
- Substitution of 40 g·mol^{-1} into correct formula. ✓
  Vervanging van 40 g·mol^{-1} in korrekte formule.
- Substitution of 0,25 dm^3 into correct formula. ✓
  Vervanging van 0,25 dm^3 in korrekte formule.
- Final answer/*Finale antwoord*: 0,2 mol·dm^{-3} ✓

OPTION 1/*OPSIE 1*

$c = \frac{m}{MV}$ ✓

$= \frac{2}{40 \times 0,25}$ ✓

= 0,20 mol·dm^{-3} ✓

OPTION 2/*OPSIE 2*

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

$= \frac{2}{40}$ ✓

= 0,05 mol

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

$= \frac{0,05}{0,25}$ ✓

= 0,20 mol·dm^{-3} ✓

Any one formula/ *enige formule* ✓

(4)

7.2.2 **POSITIVE MARKING FROM 7.2.1./*POSITIEWE NASIEN VAN 7.2.1.***

OPTION 1/*OPSIE 1*

$[H_3O^+][OH^-] = 1 \times 10^{-14}$

$[H_3O^+](0,2) = 1 \times 10^{-14}$ ✓

$[H_3O^+] = 5 \times 10^{-14}$ mol·dm^{-3}

↓

pH = -log$[H_3O^+]$ ✓

= -log(5×10^{-14}) ✓

= 13,30 ✓

OPTION 2/*OPSIE 2*

pOH = -log$[OH^-]$ ✓

= -log(0,2) ✓

= 0,6989 (0,7)

↓

pH + pOH = 14

pH = 14 – 0,6989 ✓

= 13,30 ✓

(4)

7.3 **POSITIVE MARKING FROM QUESTION 7.2.**
POSITIEWE NASIEN VANAF VRAAG 7.2.

Marking criteria/*Nasienkriteria*:

- Substitution to calculate n(NaOH)./*Vervanging om* n(NaOH) *te bereken*. ✓
- Use mol ratio/*Gebruik molverhouding*: $n(HC\ell)_{excess/oormaat}$: n(NaOH) = 1 : 1. ✓
- Substitute/*Vervang* 100 g·mol^{-1} in $n = \frac{m}{M}$ ✓
- Use mol ratio *Gebruik molverhouding*: $n(HC\ell)_{reacted/oormaat}$: $n(CaCO_3)$ = 2 : 1. ✓
- $n(HC\ell)_{initial/aanvanklik} = n(HC\ell)_{excess/oormaat} + n(HC\ell)_{reacted/reageer}$ ✓✓
- Substitute 0,05 dm^3 to calculate either $c(HC\ell)_{initial}$ or $c(HC\ell)_{reacted}$ ✓
  Vervang 0,05 dm^3 om $c(HC\ell)_{aanvanklik}$ of $c(HC\ell)_{reageer}$ te bereken.
- Final answer/*Finale antwoord*: 0,7 mol·dm^{-3} ✓
  Range/*Gebied:* 0,70 to/*tot* 0,90 mol·dm^{-3}

OPTION 1/*OPSIE 1*

$n(NaOH)_{used/gebruik} = c_bV_b$
$= 0,2 \times 0,025$ ✓
$= 5 \times 10^{-3}$ mol

OPTION 2/*OPSIE 2*

$n(NaOH)_{used/gebruik} = \frac{25}{250} \times \frac{2}{40}$ ✓
$= 5 \times 10^{-3}$ mol

$n(HC\ell)_{excess/oormaat} = n(NaOH) = 5 \times 10^{-3}$ mol ✓

$n(CaCO_3) = \frac{m}{M}$
$= \frac{1,5}{100}$ ✓
$= 0,015$ mol (0,02 mol)

$n(HC\ell)_{reacted/reageer} = 2n(CaCO_3) = 0,03$ mol ✓ (0,04 mol)

$n(HC\ell)_{ini/aanv.} = 5 \times 10^{-3} + 0,03$ ✓✓
$= 0,035$ mol (0,045 mol)

$c(HC\ell)_{ini/aanv} = \frac{n}{V}$
$= \frac{0,035}{0,05}$ ✓
$= 0,70$ mol·dm^{-3} ✓ (0,90 mol·dm^{-3})

OPTION 3/*OPSIE 3*

$\frac{c_a V_a}{c_b V_b} = \frac{n_a}{n_b}$

$\frac{c_a(0,05)}{(0,2)(0,025)\checkmark} = \frac{1}{1}\checkmark$

$c_a = c(HC\ell)_{excess/oormaat}$

$= 0,1 \text{ mol·dm}^{-3}$

OPTION/*OPSIE 4*

$(NaOH)_{used/gebruik} = c_b V_b$

$= (0,2)(0,025)\checkmark$

$= 0,005 \text{ mol}$

$n(HC\ell)_{excess/oormaat} = n(NaOH)\checkmark$

$= 0,005 \text{ mol}$

$c(HC\ell)_{excess/oormaat} = \frac{0,005}{0,05}$

$= 0,1 \text{ mol·dm}^{-3}$

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

$= \frac{1,5}{100}\checkmark$

$= 0,015 \text{ mol}$

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

$n(HC\ell)_{reacted/reageer} = 2(0,015)\ \checkmark$

$= 0,03 \text{ mol}$

$c(HC\ell)_{reacted/reageer} = \frac{n}{V}$

$= \frac{0,03}{0,05}\checkmark$

$= 0,6 \text{ mol·dm}^{-3}$

$c(HC\ell)_{initial/aanvanklik} = c(HC\ell)_{reacted/reageer} + c(HC\ell)_{excess/oormaat}$

$= 0,6 + 0,1\ \checkmark\checkmark$

$= 0,7 \text{ mol·dm}^{-3}\ \checkmark$

(8)
[17]

QUESTION 8/*VRAAG 8*

8.1

8.1.1 Gain of electrons./*Opneem van elektrone*. ✓✓ **(2 or/*of* 0)** (2)

8.1.2 $2H_2O(\ell) + 2e^- \rightarrow H_2(g) + 2OH^-(aq)$ ✓✓

Ignore phases/*Ignoreer fases.*

Marking criteria /*Nasienkriteria:*

- $H_2(g) + 2OH^-(aq) \leftarrow 2H_2O(\ell) + 2e^-$ ($^2/_2$)
  $2H_2O(\ell) + 2e^- \rightleftharpoons H_2(g) + 2OH^-(aq)$ ($^1/_2$)
  $H_2(g) + 2OH^-(aq) \rightleftharpoons 2H_2O(\ell) + 2e^-$ ($^0/_2$)
  $2H_2O(\ell) + 2e^- \leftarrow H_2(g) + 2OH^-(aq)$ ($^0/_2$)
- Ignore if charge omitted on electron./*Ignoreer indien lading weggelaat op elektron.*
- If charge (-) omitted on OH^-/*Indien lading (-) weggelaat op* OH^-:
  Example/*Voorbeeld:* $2H_2O(\ell) + 2e^- \rightarrow H_2(g) + 2OH(aq)$ ✓ Max./*Maks:* $^1/_2$

(2)

8.1.3 $2Na(s) + 2H_2O(\ell)$ ✓ $\rightarrow H_2(g) + 2OH^-(aq) + 2Na^+(aq)$ ✓ Bal ✓

OR/*OF*

$2Na(s) + 2H_2O(\ell)$ ✓ $\rightarrow H_2(g) + 2NaOH(aq)$ ✓ Bal ✓

Ignore phases/*Ignoreer fases.*

Marking criteria/*Nasienkriteria:*

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

(3)

8.1.4 Formation of hydroxide ions / OH^- / sodium hydroxide/base/ alkaline/ pH > 7 ✓
Vorming van hidroksied / OH^- / natriumhidroksied / basis / alkalies / pH > 7 (1)

8.1.5 Cu is a weaker reducing agent ✓ than H_2 (and OH^-) ✓ and H_2O will not be reduced ✓ (to H_2 and OH^-).
Cu is 'n swakker reduseermiddel as H_2 (and OH^-) *en H_2O sal nie gereduseer word nie na H_2 (en OH^-).*

OR/*OF*

H_2 (and OH^-) are stronger reducing agent ✓ than Cu and H_2O ✓ will not be reduced✓ (to H_2 and OH^-).
H_2 (en OH^-) is 'n sterker reduseermiddel as Cu en H_2O sal nie gereduseer word (na H_2 en OH^-).

(3)

8.2

8.2.1 Phase separator/boundary/difference ✓
Fase skeiding/grens/verskil (1)

8.2.2 Chemical (energy) to electrical (energy) ✓
Chemiese (energie) na elektriese (energie) (1)

8.2.3

OPTION/*OPSIE 1*	**Notes/*Aantekeninge***
$E^{\theta}_{cell} = E^{\theta}_{reduction} - E^{\theta}_{oxidation}$ ✓ = 0,77 ✓ - (-0,13) ✓ E^{θ}_{cell} = 0,90 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. $E^{\theta}_{cell} = E^{\theta}_{OA} - E^{\theta}_{RA}$ followed by correct substitutions:/*Enige ander formule wat onkonvensionele afkortings gebruik bv.* $E^{\theta}_{sel} = E^{\theta}_{OM} - E^{\theta}_{RM}$ *gevolg deur korrekte vervangings: Max/Maks:* $\frac{3}{4}$

OPTION/*OPSIE 2*

✓ $Pb(s) \rightarrow Pb^{2+}(aq) + 2e^-$ 0,13 (V) ✓
$2Fe^{3+}(aq) + 2e^- \rightarrow 2Fe^{2+}(aq)$ 0,77 (V) ✓
$Pb^{2+}(aq) + 2Fe^{3+}(aq) \rightarrow Pb(s) + 2Fe^{2+}(aq)$ 0,90 V ✓ (4)

[17]

QUESTION 9/*VRAAG 9*

9.1 Electrolytic (cell)/*Elektrolitiese (sel)* ✓

Cells have a battery/DC power source/ /Electrical energy is converted to chemical energy. ✓
Selle het batterye/GS kragbron/ Elektriese energie is omgeskakel na chemiese energie. (2)

9.2

9.2.1 $2C\ell^- \rightarrow C\ell_2 + 2e^-$ ✓✓

Notes/*Aantekeninge*

$2C\ell^- \rightleftharpoons C\ell_2 + 2e^-$ ($\frac{1}{2}$) $C\ell_2 + 2e^- \leftarrow 2C\ell^-$ ($\frac{2}{2}$)
$C\ell_2 + 2e^- \rightleftharpoons 2C\ell^-$ ($\frac{0}{2}$) $2C\ell^- \leftarrow C\ell_2 + 2e^-$ ($\frac{0}{2}$)

- Ignore if charge omitted on electron./*Ignoreer indien lading weggelaat op elektron.*
- If charge (-) omitted on $C\ell^-$/*Indien lading (-) weggelaat op* $C\ell^-$:
  Example/*Voorbeeld:* $2C\ell(aq) \rightarrow C\ell_2(g) + 2e^-$ Max./*Maks:* $\frac{1}{2}$

(2)

9.2.2 $A\ell^{3+} + 3e^- \rightarrow A\ell$ ✓✓

Notes/*Aantekeninge*

$A\ell^{3+} + 3e^- \rightleftharpoons A\ell$ $(\frac{1}{2})$ $A\ell \leftarrow A\ell^{3+} + 3e^-$ $(\frac{2}{2})$

$A\ell \rightleftharpoons A\ell^{3+} + 3e^-$ $(\frac{0}{2})$ $A\ell^{3+} + 3e \leftarrow A\ell$ $(\frac{0}{2})$

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

9.2.3 Cu/copper/*koper* ✓ (1)

9.3 **ANY ONE/*ENIGE EEN***

- The electrode/carbon/C reacts with oxygen. ✓
  Die elektrode/koolstof/C reageer met suurstof.
- $C + O_2 \rightarrow CO_2$
- Oxidation takes place./Electrons are lost.
  Oksidasie vind plaas./Elektrone word verloor.
- Oxygen corrodes the carbon electrode.
  Suurstof roes die koolstof elektrode. (1)

[8]

QUESTION 10/*VRAAG 10*

10.1

10.1.1 Sulphur dioxide/SO_2/*swaweldioksied* ✓ (1)

10.1.2 Sulphur trioxide/SO_3/*swaweltrioksied* ✓ (1)

10.1.3 Vanadium pentoxide/V_2O_5/ Vanadium(V) oxide ✓
Vanadiumpentoksied/*Vanadium(V) oksied* (1)

10.1.4 $H_2SO_4 + 2NH_3$ ✓ → $(NH_4)_2SO_4$ ✓ bal ✓

Marking guidelines/*Nasienkriteria:*

- Reactants ✓ Products ✓ Balancing ✓
  Reaktanse ✓ *Produkte* ✓ *Balansering* ✓
- Ignore/*Ignoreer* → and phases / *en fases*
- Marking rule 6.3.10/*Nasienreël 6.3.10* (3)

10.2

10.2.1 The ratio of nitrogen (N), phosphorous (P) and potassium (K) in a fertiliser./The ratio of the primary nutrients ✓
Die verhouding van stikstof (N), fosfor (P) en kalium (K) in die kunsmis. / Die verhouding van primêre nutriënte. (1)

10.2.2

OPTION 1/OPSIE 1

Mass N in 4 kg NH_4NO_3 / Massa N in 4 kg NH_4NO_3

m**(**N) = $\frac{28}{80}$ x 4 ✓

= 1,4 kg

m(K) = 2m(N) ✓

= 2,8 kg

m(P) = 3m(N) ✓

= 4,2 kg

m(fertiliser/kunsmis) = 1,4 + 2,8 + 4,2

= 8,4 kg ✓

OPTION 2/*OPSIE 2*

Mass N in 4 kg NH_4NO_3/*Massa N in 4 kg* NH_4NO_3:

m(N) = $\frac{28}{80}$ x 4 ✓

= 1,4 kg

N : P : K

1 : 3 : 2

∴ m(fertiliser/*kunsmis*) = (6)✓(1,4)✓

= 8,4 kg ✓

OPTION 3/*OPSIE 3*

% N = $\frac{(2)(14)}{80}$ x 100 = 35%

Nitrogen in 4 kg = 35% of/*van* 4 = 1,4 kg ✓

N : P : K

1 : 3 : 2

1,4 : 4,2✓ : 2,8 ✓

Total mass of fertiliser /*Totale massa kunsmis* = 1,4 + 4,2 + 2,8

= 8,4 kg ✓

(4)

[11]

TOTAL/*TOTAAL*: 150