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)

2023

MARKING GUIDELINES/*NASIENRIGLYNE*

MARKS/*PUNTE*: 150

These marking guidelines consist of 20 pages.
Hierdie nasienriglyne bestaan uit 20 bladsye.

 Please turn over/Blaai om asseblief

QUESTION/*VRAAG 1*

1.1 A ✓✓ (2)

1.2 D ✓✓ (2)

1.3 B ✓✓ (2)

1.4 C ✓✓ (2)

1.5 C ✓✓ (2)

1.6 B ✓✓ (2)

1.7 C ✓✓ (2)

1.8 D ✓✓ (2)

1.9 A ✓✓ (2)

1.10 D ✓✓ (2)
[20]

QUESTION/*VRAAG 2*

2.1 Compounds with one or more <u>multiple bonds between C atoms</u> in the hydrocarbon chain. ✓✓ (2 or 0)
Verbindings met een of meer <u>meervoudige bindings tussen C-atome</u> in die koolwaterstofkettings. (2 of 0)
OR/*OF*
A hydrocarbon with <u>two or more bonds between the C-atoms</u>.
'n Koolwaterstof met <u>twee of meer bindings tussen die C-atome.</u>
OR/*OF*
Hydrocarbons containing not only single bonds between C atoms.
Koolwaterstowwe wat nie slegs enkelbindings tussen die C-atome bevat nie.
<u>ACCEPT/*AANVAAR:*</u>
Compounds with one or more <u>double/triple bonds between C atoms</u> in the hydrocarbon chain.
Verbindings met een of meer <u>dubbel/trippelbindings tussen C-atome</u> in die koolwaterstofkettings. (2)

2.2.1 D ✓ (1)

2.2.2 2,4-dimethylhexane ✓✓✓
2,4-dimetielheksaan

Marking criteria:
- Correct stem i.e. hexane. ✓
- Substituents (dimethyl) correctly identified. ✓
- IUPAC name completely correct including numbering, sequence, hyphens and commas. ✓

Nasienkriteria:
- *Korrekte stam d.i. heksaan.* ✓
- *Substituente (dimetiel) korrek geïdentifiseer.* ✓
- *IUPAC-naam heeltemal korrek insluitende nommering, volgorde, koppeltekens en kommas.* ✓

(3)

2.2.3 Propan-2-ol /2-propanol ✓✓

Marking criteria:
- Correct stem i.e. propanol. ✓
- IUPAC name completely correct including numbering and hyphens. ✓

Nasienkriteria:
- *Korrekte stam d.i. propanol.* ✓
- *IUPAC-naam heeltemal korrek insluitende nommering en koppeltekens.* ✓

(2)

2.2.4 hept-1-ene/1-heptene ✓✓
hept-1-een/1-hepteen

Marking criteria:
- Correct stem i.e. heptene. ✓
- IUPAC name completely correct including numbering and hyphens. ✓

Nasienkriteria:
- *Korrekte stam d.i. hepteen.* ✓
- *IUPAC-naam heeltemal korrek insluitende nommering en koppeltekens.* ✓

(2)

2.2.5 **Marking criteria/*Nasienkriteria***
- Correct molecular formula: C_8H_{18} ✓
  Korrekte molekulêre formula: C_8H_{18}
- Correct molecular formula of inorganic reactant and products. ✓
  Korrekte molekulêre formule vir die anorganiese reaktant en produkte.
- Balancing/*Balansering* ✓

$2C_8H_{18}$ ✓ + $\underline{25O_2 \rightarrow 16CO_2 + 18H_2O}$ ✓ Bal ✓

Notes/*Aantekeninge:*
- 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)

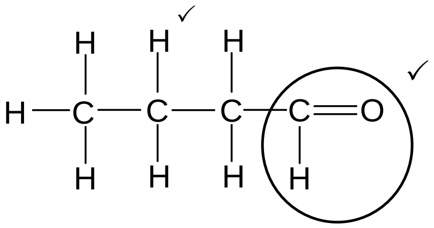
2.3.1 **Marking criteria/*Nasienkriteria***
If any one of the underlined key phrases in the correct context is omitted, deduct 1 mark./*Indien enige van die onderstreepte frases in die korrekte konteks uitgelaat is, trek 1 punt af.*

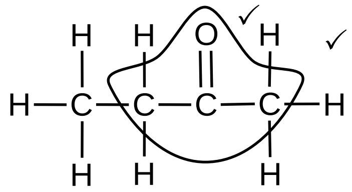
Compounds with the same molecular formula but different functional groups/homologous series. ✓✓
Verbindings met dieselfde molekulêre formule maar verskillende funksionele groepe/homoloë reekse. (2)

2.3.2

Marking criteria/*Nasienkriteria*:

• Functional group for aldehyde correct ✓ *Funksionele groep van aldehied korrek* • Whole structure of aldehyde correct ✓ *Hele struktuur van aldehied korrek*	• Functional group for ketone correct ✓ *Funksionele groep van ketoon korrek* • Whole structure of ketone correct ✓ *Hele struktuur van ketoon korrek*





(4)

2.4

Marking criteria

- Calculate the mass/percentage of oxygen. ✓
- Substitute correct mass and molar mass for both C and H into $n = \frac{m}{M}$. ✓
- Substitute correct mass and molar mass for O into $n = \frac{m}{M}$. ✓
- Simplify ratio. (Accept correct empirical formula if no ratio is given.) ✓
- Correct molecular formula. ✓✓

Nasienkriteria:

- *Bereken die massa/persentasie suurstof.* ✓
- *Vervang korrekte massa en molêre massa vir beide C en H in* $n = \frac{m}{M}$. ✓
- *Vervang korrekte massa en molêre massa vir O in* $n = \frac{m}{M}$. ✓
- *Vereenvoudig verhouding.* (Aanvaar korrekte empiriese formule indien geen verhouding nie) ✓
- *Korrekte molekulêre formule*. ✓✓

OPTION 1/*OPSIE 1*

	C	H	O
Mass / *Massa*	1,09	0,18	2 – (1,09 + 0,18) ✓ = 0,73
Moles /*mol*	$n = \frac{m}{M}$ $= \frac{1,09}{12}$ = 0,0908	$n = \frac{m}{M}$ $= \frac{0,18}{1}$ ✓ = 0,18	$n = \frac{m}{M}$ $= \frac{0,73}{16}$ ✓ = 0,046
Simplest ratio *Eenvoudigste verhouding*	2	4	1 ✓
Empirical formula *Empiriese formule*	C_2H_4O		

$M(C_2H_4O) \times n = 88\ (g \cdot mol^{-1})$
$44n = 88$
$n = 2$

Molecular formula of compound **X**/
Molekulêre formule van verbinding **X**: $C_4H_8O_2$ ✓✓

OPTION 2/*OPTION 2*

	C	H	O
Percentage/Persentasie	54,5	9	36,5 ✓
Moles /*mol*	$n = \frac{m}{M}$ $= \frac{54,5}{12}$ = 4,5417	$n = \frac{m}{M}$ $= \frac{9}{1}$ ✓ = 9	$n = \frac{m}{M}$ $= \frac{36,5}{16}$ ✓ = 2,28
Simplest ratio *Eenvoudigste verhouding*	2	4	1 ✓
Empirical formula *Empiriese formule*	C_2H_4O		

$M(C_2H_4O)$ x n= 88 ($g{\cdot}mol^{-1}$)
44n = 88
n = 2

Molecular formula of compound **X**/
Molekulêre formule van verbinding **X**: $C_4H_8O_2$ ✓✓ (6)

[25]

QUESTION/*VRAAG* 3

3.1

Marking criteria/*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 temperature at which the vapour pressure (of a compound) equals atmospheric pressure. ✓✓
Die temperatuur waarby die dampdruk (van 'n verbinding) gelyk is aan die atmosferiese druk. (2)

3.2

Marking criteria/*Nasienkriteria*
- Compare compounds in terms of branches/chain lengths/surface area. ✓
  Vergelyk verbindings in terme van vertakkings/kettinglengte/oppervlakarea.
- Compare strengths of IMF's/*Vergelyk sterkte van IMK'e*.✓
- Compare energy/*Vergelyk energie* ✓

Butan-1-ol ✓
- Has a longer chain length./is less branched./has a larger surface area/ contact area. ✓
- Strength of the intermolecular forces is greater./There are more sites for London forces. ✓
- More energy is needed to overcome/break intermolecular forces. ✓

- *Het 'n langer kettinglengte./is minder vertak./het 'n groter kontakoppervlak/reaksieoppervlak.* ✓
- *Sterkte van die intermolekulêre kragte verhoog./Daar is meer plekke vir Londonkragte.* ✓
- *Meer energie word benodig om die intermolekulêre kragte te oorkom/breek.* ✓

OR/*OF*
- 2-methylpropan-1-ol has a shorter chain length./is more branched./ has a smaller surface area/contact area.
- Strength of the intermolecular forces is weaker./There are fewer sites for London forces.
- Lesser energy is needed to overcome/break intermolecular forces.

- *2-metielpropan-1-ol het 'n korter kettinglengte./is meer vertak./het 'n kleiner kontakoppervlak/reaksieoppervlak.*
- *Sterkte van die intermolekulêre kragte is swakker./Daar is minder plekke vir Londonkragte.*
- *Minder energie word benodig om intermolekulêre kragte te oorkom/breek.* (4)

3.3 Boiling point/*Kookpunt* ✓ (1)

3.4

3.4.1 S ✓ (1)

3.4.2 P ✓ (1)

3.4.3 R ✓ (1)

3.5 Propanoic acid/P has the strongest intermolecular forces. ✓
OR
Two sites for hydrogen bonding (which is stronger than other intermolecular forces).
OR
Most energy needed to separate the chains.

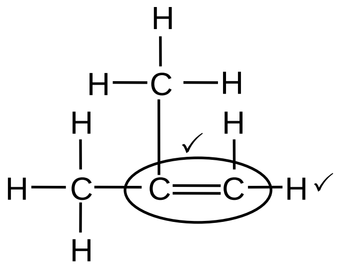
Propanoësuur/P het die sterkste intermolekulêre kragte.
OF
Twee plekke vir waterstofbindings (wat sterker is as die ander intermolekulêre kragte).
OF
Meeste energie benodig om kettings te skei. (1)
[11]

QUESTION/*VRAAG 4*

4.1
4.1.1 Halogenation/Bromination ✓
Halogenering/Brominering (1)

4.1.2 The bromine water/Br_2/solution <u>decolourises</u>./Brown <u>colour disappears</u>. ✓
Die broomwater/Br_2/oplossing <u>ontkleur</u>./Bruin <u>kleur verdwyn</u>.

OR/*OF*
Bromine water/Br_2/solution changes from <u>brown/reddish to colourless</u>.
Broomwater/Br_2/oplossing verander van <u>bruin/rooierig na kleurloos</u>. (1)

4.1.3


<u>Marking criteria/*Nasienkriteria*</u>
• Functional group correct ✓ *Funksionele groep korrek*
• Whole structure correct ✓ *Hele struktuur korrek*

(2)

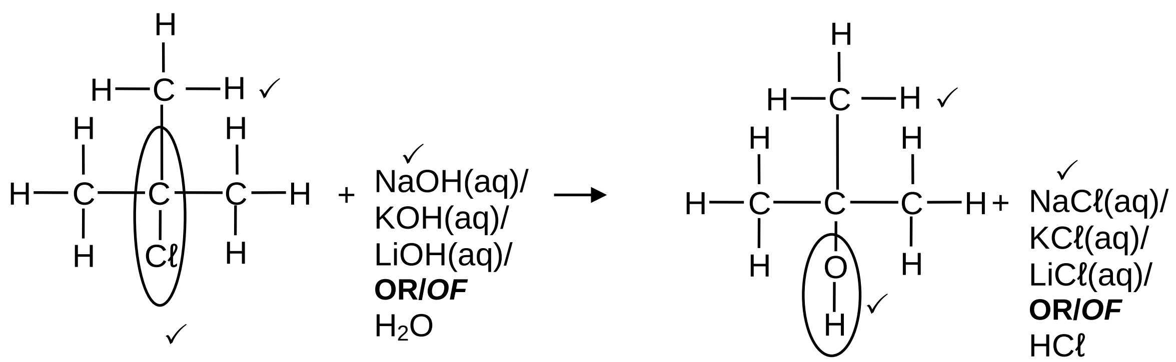
4.1.4 <u>2-chloro-2-methyl</u>✓<u>propane</u>✓ /<u>*2-chloro-2-metielpropaan*</u>

<u>**ACCEPT/*AANVAAR***</u>***:***
2-chloromethylpropane / 2-*chlorometielpropaan* (2)

4.1.5

Marking criteria:
- Cℓ atom on second C atom on compound R ✓
- Whole structure of compound R correct ✓
- React compound R with NaOH(aq)/ KOH(aq)/LiOH(aq) **OR** H_2O ✓
- OH-group replaces Cℓ atom at the same position. ✓
- Whole structure of alcohol correct. ✓
- NaCℓ(aq)/KCℓ(aq)/LiCℓ(aq) **OR** HCℓ(aq) ✓
  (must correspond to the inorganic reactant used)

Nasienkriteria:
- *Cℓ-atoom op tweede C-atoom van verbinding R* ✓
- *Hele struktuur van verbinding R korrek* ✓
- *Reageer verbinding R met NaOH*(aq)/ *KOH*(aq)/*LiOH*(aq) ***OF*** H_2O ✓
- *OH-groep vervang Cℓ-atoom by dieselfde posisie.* ✓
- *Hele struktuur van alkohol korrek.* ✓
- *NaCℓ(aq)/KCℓ(aq)/LiCℓ(aq)* ***OF*** *HCℓ(aq)* ✓
  (moet ooreenstem met die anorganiese reaktans gebruik)



Notes/*Aantekeninge*:
- Ignore/*Ignoreer* ⇌
- Accept all inorganic reagents as condensed./*Aanvaar alle anorganiese reagense as gekondenseerd.*
- Accept coefficients that are multiples.
  Aanvaar koëffisiënte wat veelvoude is.
- Any additional reactants and/or products
  Enige addisionele reaktanse en/of produkte: Max./*Maks.* $^5/_6$
- Incorrect balancing/*Verkeerde balansering*: Max./*Maks.* $^5/_6$
- Molecular formulae/M*olekulêre formule*: Max./*Maks.* $^3/_6$
- Condensed formulae/G*ekondenseerde formule:* Max./*Maks.* $^4/_6$

Accept/*Aanvaar*:
-OH as condensed / *-OH as gekondenseerd*

Condensed formulae/*Gekondenseerde formule:*

$CH_3C(CH_3)C\ell CH_3$ ✓ + ✓ NaOH(aq)/ KOH(aq)/ LiOH(aq)/ **OR**/***OF*** H_2O → $CH_3C(CH_3)OHCH_3$ ✓ + ✓ NaCℓ(aq)/ KCℓ(aq)/ LiCℓ(aq)/ **OR**/***OF*** HCℓ

(6)

4.1.6 2-methyl✓propan-2-ol✓/2-methyl-2-propanol
2-metielpropan-2-ol/2-metiel-2-propanol
ACCEPT/AANVAAR:
Methylpropan-2-ol/ *Metielpropan-2-ol* (2)

4.1.7 Dehydration/*Dehidrasie/Dehidratering* ✓ (1)

4.2.1 Esterfication/Condensation ✓
Verestering/Esterfikasie/Kondensasie (1)

4.2.2 Butyl✓propanoate ✓
Butielpropanoaat (2)
[18]

QUESTION/*VRAAG 5*

5.1 Initial concentration is 0 (of NO_2)./Concentration increases./
Curve starts at 0. ✓
Beginkonsentrasie is 0 (van NO_2)./Konsentrasie verhoog./Kurwe begin by 0.

OR/*OF*
Curve B has an initial concentration and is the reactant as its concentration decreases.
Kurwe B het 'n beginkonsentrasie en is die reaktant aangesien sy konsentrasie afneem. (1)

5.2 True/*Waar* ✓
n mol of N_2O_5 forms 2n mol of NO_2 per unit time. ✓
n mol N_2O_5 vorm 2n mol NO_2 per eenheidstyd.

OR/*OF*
Gradient of graph for NO_2 is twice the gradient of graph for N_2O_5.
Gradiënt van grafiek vir NO_2 is twee keer die gradiënt van grafiek vir N_2O_5.
NOTE/*LET WEL*:
If gradients calculated correctly award mark.
Indien gradiënte korrek bereken word punt toegeken. (2)

5.3.1

Marking criteria/*Nasienkriteria:*

- Formula: $c = \frac{m}{MV}$ / $n(NO_2) = cV$ / $n(NO_2) = \frac{m}{M}$ ✓
- Substitute change in concentration. ✓
  Vervang verandering in konsentrasie .
- Substitute M (46) and V (2)./*Vervang M (46) en V (2).* ✓
- Final correct answer/ *Finale korrekte antwoord:* 1,84 g ✓

OPTION 1/*OPSIE 1*

$c(NO_2) = \frac{m}{MV}$ ✓

200×10^{-4} ✓ $= \frac{m}{(46)(2)}$ ✓

$m = 1,84\ g$ ✓

OPTION 2/*OPSIE 2*

$n(NO_2) = cV$ ✓

$= (200 \times 10^{-4})$ ✓ $\times 2$

$= 4 \times 10^{-2}$ mol

$n(NO_2) = \frac{m}{M}$

$4 \times 10^{-2} = \frac{m}{46}$

$m = 1,84\ g$ ✓

✓ either/*enige een*

✓ both/*beide*

(4)

5.3.2

Marking criteria/*Nasienkriteria:*

- Substitute the change in concentration into rate formula. ✓
  Vervang verandering in konsentrasie in tempo formule.
- Substitute time into the rate formula./ *Vervang tyd in tempo formule.* ✓
- Use mol ratio/*Gebruik molverhouding:* rate/*tempo*(O_2) = ½ rate/*tempo*(N_2O_5)/ rate/*tempo*(O_2) = ¼ rate/*tempo*(NO_2) ✓
- Final correct answer/*Finale korrekte antwoord:* 1×10^{-5} $(mol{\cdot}dm^{-3}{\cdot}s^{-1})$ ✓

NOTE/LET WEL

If concentration is converted to moles, final moles per s $(mol{\cdot}s^{-1})$ must be converted back to concentration $(mol{\cdot}dm^{-3}{\cdot}s^{-1})$. i.e. there must be multiplication and division by 2. If one of these is omitted: Max. $^2/_4$

Indien konsentrasie omgeskakel is na mol, moet die finale mol per s $(mol{\cdot}s^{-1})$ omgeskakel word na konsentrasie $(mol{\cdot}dm^{-3}{\cdot}s^{-1})$ d.w.s daar moet vermenigvuldig en gedeel word deur 2. Indien een van hierdie uitgelaat word: *Maks.* $^2/_4$

OPTION 1/*OPSIE 1*

Ave rate/*gem tempo* $= -\frac{\Delta c(N_2O_5)}{\Delta t}$

$= -\frac{(60 \times 10^{-4} - 200 \times 10^{-4})}{700\ (-\ 0)}$ ✓ ✓

$= 2 \times 10^{-5}$ $(mol{\cdot}dm^{-3}{\cdot}s^{-1})$

$rate(O_2) = ½\ rate(N_2O_5) = ½(2 \times 10^{-5})$ ✓

$= 1 \times 10^{-5}$ $(mol{\cdot}dm^{-3}{\cdot}s^{-1})$ ✓

OPTION 2/*OPSIE 2*

Ave rate/*gem tempo* $= \frac{\Delta c(NO_2)}{\Delta t}$

$= \frac{(280 \times 10^{-4}\ (-\ 0))}{700\ (-\ 0)}$ ✓ ✓

$= 4 \times 10^{-5}$ $(mol{\cdot}dm^{-3}{\cdot}s^{-1})$

$rate(O_2) = ¼\ rate(NO_2) = ¼(4 \times 10^{-5})$ ✓

$= 1 \times 10^{-5}$ $(mol{\cdot}dm^{-3}{\cdot}s^{-1})$ ✓

OPTION 3/*OPSIE 3*

$\Delta c(O_2) = \frac{1}{2}\Delta c(N_2O_5)$
$= \frac{1}{2}(60 \times 10^{-4} - 200 \times 10^{-4})$ ✓
$= \frac{1}{2}(140 \times 10^{-4})$
$= 7 \times 10^{-3}\ mol\cdot dm^{-3}$

OR/*OF*

$\Delta c(O_2) = \frac{1}{4}\Delta c(NO_2)$
$= \frac{1}{4}(280 \times 10^{-4}$ ✓$(-0))$
$= 7 \times 10^{-3}\ mol\cdot dm^{-3}$
$= 7 \times 10^{-3}\ mol\cdot dm^{-3}$

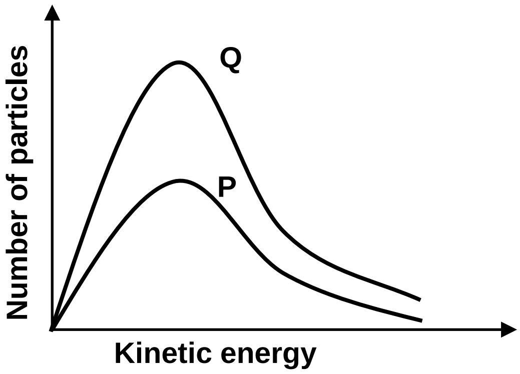
Ave rate/*gem tempo* $= \frac{\Delta c(O_2)}{\Delta t}$

$= \frac{(7 \times 10^{-3})}{700\ (-0)}$ ✓ ✓

$= 1 \times 10^{-5}\ (mol\cdot dm^{-3}\cdot s^{-1})$ ✓ (4)

5.4

5.4.1



Marking criteria/*Nasienkriteria*

- Curve Q must be above the given curve P and have the same shape as the given curve P and the peaks have to correspond. ✓
  Kurwe Q moet bo die gegewe kurwe P wees en moet dieselfde vorm hê as die gegewe kurwe P en die maksimums moet ooreenstem
- Starts at origin and not crossing curve P. ✓
  Begin by oorsprong en nie kruis met kurwe P nie.

(2)

5.4.2 Higher than/*Hoër as* ✓

- When the concentration of N_2O_5 is higher there are more N_2O_5 particles per unit volume. ✓
- More effective collisions per unit time/second. ✓
  OR
  Higher frequency of effective collisions.

- *'n Hoër konsentrasie van* N_2O_5 *bevat meer* N_2O_5*-deeltjies per eenheidsvolume.* ✓
- *Meer effektiewe botsings per eenheidstyd/sekonde.* ✓
  OF
  Hoër frekwensie van effektiewe botsings.

(3)
[16]

QUESTION/*VRAAG 6*

6.1

Marking criteria/*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.*

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

6.2.1 $n[H_2(g)] = 0{,}11$ (mol) ✓ (1)

6.2.2

OPTION 1/*OPSIE 1*	**OPTION 2/*OPSIE 2***
$n(HI)_{used/gebruik} = 2n(I_2)$ $= 2(0{,}11)$ $n(HI)_{eq} = 1 - 0{,}22$ $= 0{,}78$ (mol) ✓	$K_c = \frac{[H_2][I_2]}{[HI]^2}$ $0{,}02 = \frac{(0{,}11)(0{,}11)}{[HI]^2}$ $[HI] = 0{,}78\ mol{\cdot}dm^{-3}$ $n(HI) = 0{,}78$ (mol) ✓

(1)

6.3

6.3.1 Endothermic/*Endotermies* ✓ (1)

6.3.2 K_c increased:

- The concentration of the product/$H_2(g)$ and $I_2(g)$ is increased. ✓
  OR: The concentration of the reactant/HI decreases.
- The increase in temperature favoures the forward reaction. ✓
- (According to Le Chatelier's principle) an increase in temperature favours the endothermic reaction. ✓

K_c het verhoog:

- *Die konsentrasie van die produkte/$H_2(g)$ en $I_2(g)$* verhoog. ✓
  OF: Die *konsentrasie van die reaktanse/HI verlaag.*
- *'n Toename in temperatuur bevoordeel die voorwaartse reaksie.* ✓
- *(Volgens Le Chatelier se beginsel) sal 'n toename in temperatuur die endotermiese reaksie bevoordeel.* ✓

(3)

6.3.3

POSITIVE MARKING FROM Q6.2/*POSITIEWE NASIEN VANAF V6.2*	
Marking criteria: (a) Correct K_c expression (formulae in square brackets). ✓ (b) Substitution of 0,09 in Kc expression. ✓ (c) Correct initial moles from 6.2.1 and 6.2.2. ✓ (d) USING ratio: $nHI(g) : 2nI_2(g) = 1:2$ ✓ (e) Substitution of concentrations into correct K_c expression. ✓ (f) Subtraction $[HI]_{ini} – \Delta[HI]$ ✓ (g) Substitution of 128 in m = nM. ✓ (h) Final answer: 80,64 g ✓ (range: 79,36 - 80,64 g)	***Nasienkriteria:*** *(a) Korrekte K_c uitdrukking (formules in vierkantige hakies).* ✓ *(b) Vervang 0,09 in Kc uitdrukking.* ✓ *(c) Aanvanklike mol korrek vanaf 6.2.1 en 6.2.2.* ✓ *(d) GEBRUIK verhouding: $nHI(g) : 2nI_2(g) = 1:2$* ✓ *(e) Vervang konsentrasies in korrekte K_c uitdrukking.* ✓ *(f) Verskil: $[HI]_{aanv} – \Delta[HI]$* ✓ *(g) Vervang 128 in m = nM.* ✓ *(h) Finale antwoord*: 80,64 g ✓ *(gebied*: 79,36 - 80,64 g)

OPTION 1/*OPSIE 1*

$$K_c = \frac{[H_2][I_2]}{[HI]^2} \checkmark \textbf{(a)}$$

✓ **(c)** (0,11 and/*en* 0,78 from 6.2.1 and/*en* 6.2.2)

(b) ✓

$$0,09 = \frac{(0,11 + x)(0,11 + x)}{(0,78 - 2x)^2} \checkmark \textbf{(e)} \quad \checkmark \textbf{(d)}$$

$$x = 0,0775$$

$[HI]_{equilibrium/ewewig} = [HI]_{ini/aanv} – \Delta[HI]$

$= \underline{0,78 – 2(0,0775)}$ ✓**(f)**

$= 0,63 \text{ mol·dm}^{-3}$ (0,625)

$n(HI) = cV$

$= (0,63)(1)$

$= 0,63$ mol (0,625)

$m(HI) = nM$

$= (0,63)(128)$ ✓ **(g)**

$= 80,64$ g ✓ **(h)**

OR/*OF*

$m(HI) = cVM$

$= (0,63)(1)(128)$ ✓ **(g)**

$= 80,64$ g ✓ **(h)**

OPTION 2/*OPSIE 2*

	HI	I_2	H_2
Initial quantity (mol) *Aanvanklike hoeveelheid (mol)*	0,78	0,11	0,11
Change (mol) *Verandering (mol)*	2x	x	x
Quantity at equilibrium (mol) *Hoeveelheid by ewewig (mol)*	0,78 - 2x	0,11 + x	0,11 + x
Equilibrium concentration *Ewewigskonsentrasie* ($mol{\cdot}dm^{-3}$)	$\frac{0,78 - 2x}{1}$	$\frac{0,11 + x}{1}$	$\frac{0,11 + x}{1}$

Ratio 1:2 ✓

$K_c = \frac{[H_2][I_2]}{[HI]^2}$ ✓ **(a)**

(b)

$0,09 = \frac{(0,11 + x)(0,11 + x)}{(0,78 - 2x)^2}$ ✓ **(e)**

$x = 0,0775$

(f)

$[HI]_{\text{equilibrium/}\textit{ewewig}} = \underline{0,78 - 2(0,0775)}$ ✓
$= 0,63\ mol{\cdot}dm^{-3}\ (0,625)$

$n(HI) = cV$
$= (0,63)(1)$
$= 0,63\ mol\ (0,625\ mol)$

$m(HI) = nM$
$= (0,63)(128)$ ✓ **(g)**
$= 80,64\ g$ ✓ **(h)**

OR/*OF*
$m(HI) = cVM$
$= (0,63)(1)(128)$ ✓ **(g)**
$= 80,64\ g$ ✓ **(h)**

(8)
[16]

QUESTION/*VRAAG 7*

7.1

7.1.1 **ANY ONE***:*

- A substance whose aqueous <u>solution contains ions</u>. ✓✓ **(2 or 0)**
- Substance that dissolves in water to give a <u>solution that conducts electricity.</u>
- A substance that <u>forms ions in water</u>/<u>forms ions when molten</u>.

***ENIGE EEN**:*

- *'n Stof waarvan die <u>oplossing ione bevat</u>.* ✓✓ ***(2 of 0)***
- *'n Stof wat in water oplos om 'n <u>oplossing</u> te vorm <u>wat elektrisiteit gelei</u>.*
- *'n Stof wat <u>ione vorm in water</u>/<u>ione vorm wanneer gesmelt</u>.* (2)

7.1.2 A ✓

H_2SO_4 is diprotic./Donates more than one mole of H^+ ions per mole of acid ✓ (and both acids are of the same concentration)./H_2SO_4 has a higher K_a value.
H_2SO_4 is diproties./Skenk meer as een mol H^+ ione per mol suur (en beide sure het dieselfde konsentrasie)/ H_2SO_4 het 'n hoër K_a-waarde.

OR/*OF*

It ionises to produce more than one mole of protons/H^+ ions for each mole of H_2SO_4./H_2SO_4 has a higher K_a value.
Dit ioniseer om meer as een mol protone/ H^+-ione vir elke mol H_2SO_4 te vorm./H_2SO_4 het 'n hoër K_a-waarde. (2)

7.1.3 B ✓

Stronger acid/ionises completely ✓(and both acids are of the same concentration)./HNO_3 has a higher K_a value.
Sterker suur/ioniseer volledig (en beide sure het dieselfde konsentrasie)./ HNO_3 het 'n hoër K_a-waarde.

OR/*OF*

C/CH_3COOH is a weaker acid/ionises incompletely.
C/CH_3COOH is 'n swak suur/ioniseer onvolledig. (2)

7.2

7.2.1

Marking criteria/*Nasienkriteria:*

- Substitute/*Vervang* 0,04 mol·dm^{-3} and 25 x 10^{-3} dm^3 (25 cm^3) and 19,5 x 10^{-3} dm^3 (19,5 cm^3). ✓
- USE mol ratio:/*GEBRUIK molverhouding:* $n(Na_2CO_3) : n(HC\ell) = 1 : 2$ ✓
- Final answer/*Finale antwoord:* 0,10 to/*tot* 0,103 mol·dm^{-3} ✓

OPTION 1/*OPSIE 1*	**OPTION 2/*OPSIE 2***
$\frac{c_aV_a}{c_bV_b} = \frac{n_a}{n_b}$ $\frac{c_a(19,5)}{(0,04)(25)}$ ✓ $= \frac{2}{1}$ ✓ c_a = 0,10 mol·dm^{-3} ✓ (0,103)	$n(Na_2CO_3) = cV$ $= \underline{0,04 \times 0,025}$ = 0,001 mol $n(HC\ell) = 2n(Na_2CO_3)$ = 0,002 mol ✓ $[HC\ell] = \frac{n}{V}$ $= \frac{0,002}{0,0195}$ ✓ = 0,10 mol·dm^{-3} ✓ (0,103)

(3)

7.2.2 Greater than/*Groter as* ✓

The few drops of water will <u>dilute the HCℓ</u>, ✓therefore greater volume of acid will be needed to neutralise the base.
'n Paar druppels water sal die <u>HCℓ verdun</u>, daarom sal 'n groter volume suur benodig word om die basis te neutraliseer. (2)

7.2.3

POSITIVE MARKING FROM Q7.2.1/*POSITIEWE NASIEN VANAF V7.2.1*

Marking criteria:	*Nasienkriteria:*
(a) Substitute 0,1 mol·dm^{-3} & 18,7 x 10^{-3} dm^3 (18,7 cm^3). ✓ (b) Use mole ratio: 1:1 ✓ (c) Calculate n(NH_3) / m(NH_3) in 250 cm^3: Substitute 0,25 dm^3 (250 cm^3) ✓ (d) Substitute 0,022 dm^3 (22 cm^3). ✓ (e) Substitute 0,02 dm^3 (20 cm^3) to calculate mole/mass in initial solution. ✓ (f) Use 17 g·mol^{-1} in $n = \frac{m}{M}$. ✓ (g) Final answer: 18,06 g ✓ Range: 17 to 19,13 g	(a) *Vervang 0,1 mol·dm^{-3} & 18,7 x 10^{-3} dm^3 (18,7 cm^3).* ✓ (b) *Gebruik molverhouding: 1:1* ✓ (c) *Bereken n(NH_3) / m(NH_3) in 250 cm^3: Vervang 0,25 dm^3 (250 cm^3).* ✓ (d) *Vervang 0,022 dm^3 (22 cm^3).* ✓ (e) *Vervang 0,02 dm^3 (20 cm^3) om mol/massa van oorspronklike oplossing te bereken.* ✓ (f) *Gebruik 17 g·mol^{-1} in* $n = \frac{m}{M}$. ✓ (g) *Finale antwoord:* 18,06 g ✓ *Gebied*: 17 *tot* 19,13 g

OPTION 1/*OPSIE 1*

n(HCℓ) = cV
$= \underline{(0,1)(18,7 \times 10^{-3})}$ ✓ **(a)**
$= 1,87 \times 10^{-3}$ mol

n(NH_3)$_{reacted/reageer}$ = n(HCℓ)$_{reacted/reageer}$
$= 1,87 \times 10^{-3}$ mol ✓**(b)**

n(NH_3) in 22 cm^3 = $1,87 \times 10^{-3}$ mol

n(NH_3) in 250 cm^3 = $\frac{(1,87 \times 10^{-3})(250)}{22}$ ✓**(c)** ✓**(d)**
= 0,021 mol
($2,13 \times 10^{-2}$)

n(NH_3) in initial 20 cm^3 = 0,021 mol

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

$0,021 = \frac{m}{17}$ ✓ **(f)**

m(NH_3) = 0,357 g in 20 cm^3

m(NH_3) = $\frac{(0,357)(1000)}{20}$ ✓**(e)**
= 17,85 g ✓**(g)** (18,06)

OPTION 2/*OPSIE 2*

n(HCℓ) = cV
$= \underline{(0,1)(18,7 \times 10^{-3})}$ ✓**(a)**
$= 1,87 \times 10^{-3}$ mol

(NH_3)$_{reacted/reageer}$ = n(HCℓ)$_{reacted/reageer}$
$= 1,87 \times 10^{-3}$ mol ✓**(b)**

n(NH_3) in 22 cm^3 = $1,87 \times 10^{-3}$ mol

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

$1,87 \times 10^{-3} = \frac{m}{17}$ ✓ **(f)**

m(NH_3) = $3,72 \times 10^{-3}$ g in 22 cm^3

m(NH_3) in 250 cm^3 = $\frac{(3,72 \times 10^{-3})(250)}{22}$ ✓**(c)** ✓**(d)**
= 0,361 g

m(NH_3) in initial 20 cm^3 = 0,361 g

m(NH_3) in 1 000 cm^3 = $\frac{(0,361)(1000)}{20}$ ✓**(e)**
= 18,06 g ✓**(g)**

(7)

OPTION 3/*OPSIE 3*

$$\frac{c_bV_b}{c_aV_a} = \frac{n_b}{n_a}$$

$$\frac{c_b(22)\ \checkmark\textbf{(d)}}{(0,1)(18,7)\ \checkmark\textbf{(a)}} = \frac{1}{1}\ \checkmark\ \textbf{(b)}$$

$c_1 = 0,085\ mol{\cdot}dm^{-3}$

$[NH_3]$ in 22 cm^3 = $0,085\ mol{\cdot}dm^{-3}$

$[NH_3]$ in 250 cm^3 = $0,085\ mol{\cdot}dm^{-3}$

$c_1V_1 = c_2V_2$

$c_1(0,02)\ \checkmark\ \textbf{(e)} = \underline{(0,085)(0,25)}\ \checkmark\ \textbf{(c)}$

$c_1 = 1,06\ mol{\cdot}dm^{-3}$

$m = cVM$ **(f)**

$= (1,06)(1)(17\checkmark)$

$= 18,06\ g\ \checkmark\ \textbf{(g)}$

OPTION 4/*OPSIE 4*

$n(HC\ell) = cV$

$= \underline{(0,1)(18,7 \times 10^{-3})}\ \checkmark\ \textbf{(a)}$

$= 1,87 \times 10^{-3}\ mol$

$(NH_3)_{reacted/reageer} = n(HC\ell)_{reacted/reageer}$

$= 1,87 \times 10^{-3}\ mol\ \checkmark\textbf{(b)}$

$n(NH_3)$ in 22 cm^3 = $1,87 \times 10^{-3}$ mol

$$n(NH_3)\text{ in 250 } cm^3 = \frac{(1,87 \times 10^{-3})(250)}{22}\ \checkmark\textbf{(c)}\ \checkmark\textbf{(d)}$$

$= 0,021\ mol$

$c(20\ cm^3) = c(1\ dm^3)$

$$\frac{n_1}{V_1} = \frac{n_2}{V_2}$$

$$n(NH_3)\text{ in 1 000 } cm^3 = \frac{0,021 \times 1000}{20}\ \checkmark\ \textbf{(e)}$$

$= 1,06\ mol$

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

$$1,06 = \frac{m}{17}\ \checkmark\textbf{(f)}$$

$m(NH_3) = 18,06\ g\ \checkmark\textbf{(g)}$

7.2.4 Less than 7/*Minder as 7* ✓

$NH_4^+(aq) + H_2O(\ell)\ \checkmark \rightleftharpoons NH_3(aq) + H_3O^+(aq)\ \checkmark$

Notes/*Aantekeninge:*
- Ignore single arrow/*Ignoreer* enkelpyl: →

(3)
[21]

QUESTION/*VRAAG 8*

8.1
- Pressure: <u>1 atmosphere</u> /101,3 kPa /1,01 x 10^5 Pa ✓
  Druk: <u>1 atmosfeer</u> /101,3 kPa /1,01 x 10^5 Pa
- Temperature/*Temperatuur*: <u>25 °C</u> /298 K ✓
- Concentration of electrolytes: <u>1 $mol{\cdot}dm^{-3}$</u> ✓
  Konsentrasie van elektroliete: <u>1 $mol{\cdot}dm^{-3}$</u> (3)

8.2 To maintain electrical neutrality/To complete the circuit/To allow movement of ions between electrolytes ✓
Om elektriese neutraliteit te verseker/Om die stroombaan te voltooi/Laat ione toe om tussen elektroliete te beweeg (1)

8.3

OPTION 1/*OPTION 1*	**Notes/*Aantekeninge***
$E^\theta_{cell} = E^\theta_{cathode} - E^\theta_{anode}$ ✓ $1{,}20$✓ $= E^\theta_{cathode} - 0$ ✓ $E^\theta_{cathode} = 1{,}20$ (V) ✓ X is Pt/platinum ✓	• 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:* Max./*Maks.* $\frac{4}{5}$

OPTION 2/*OPSIE 2*

✓ $\left\{\begin{array}{ll} X^{2+} + 2e^- \rightarrow X & E^\theta = 1{,}20\ V ✓ \\ H_2 \rightarrow 2H^+ + 2e^- & E^\theta = 0{,}00\ V ✓ \end{array}\right.$

$H_2 + X^{2+} \rightarrow X + 2H^+$ $E^\theta = 1{,}20$ V ✓

X is Pt/Platinum ✓ (5)

8.4 $H_2(g) \rightarrow 2H^+(aq) + 2e^-$ ✓✓

Marking criteria/*Nasienkriteria:*

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

(2)

8.5 H^+, X^{2+} (Pt^{2+}), Au^{3+} ✓

- H_2 loses/donates electrons to both Au and X/Pt. ✓
  OR
  H_2 is the anode/is oxidised in both cells.
  Therefore H^+ is the weakest oxidising agent.

- The reduction potential of X│X^{2+} is 1,2 V and that of Au│Au^{3+} is 1,5 V. ✓
  OR
  The reduction potential of X│X^{2+} is smaller than that of Au│Au^{3+}.
  OR
  According to the Table of Standard Reduction Potentials Au^{3+} is stronger oxidation agent than Pt^{2+}.
  OR
  The cell containing Au produces a higher emf than cell containing X.

- *H_2 verloor/skenk elektrone aan beide Au en X/Pt.* ✓
  OF
  H_2 is die anode/word geoksideer in beide selle.
  Daarom is H^+ die swakste oksideermiddel

- *Die reduksiepotensiaal van X│X^{2+} is 1,2 V en die van Au│Au^{3+} is 1,5 V.* ✓
  OF
  Die reduksiepotensiaal van X│X^{2+} is kleiner as dié van Au│Au^{3+}.
  OF
  Volgens *die Tabel van Standaardreduksiepotensiale is Au^{3+} 'n sterker oksideermiddel as* Pt^{2+}
  OF
  Die sel wat Au bevat het 'n hoër emk as die sel wat X bevat. (3)

[14]

QUESTION/*VRAAG 9*

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

9.2 R ✓
Oxidation takes place./R loses electrons./R decreases in mass. ✓
Oksidasie vind plaas./R verloor elektrone./R se massa sal afneem. (2)

9.3

9.3.1 $Zn^{2+}(aq) + 2e^- \rightarrow Zn(s)$ ✓✓
Ignore phases/*Ignoreer fases*

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

(2)

9.3.2 Zinc/Zn/*Sink* ✓ (1)

9.4 <u>Zn^{2+} ions are reduced/[Zn^{2+}] decreases.</u> ✓
Zn^{2+} ions must be replaced by oxidation of the Zn electrode. ✓
<u>Zn^{2+} ione word gereduseer/[Zn^{2+}] neem af.</u>
Zn^{2+} ione moet vervang word deur oksidasie van Zn-elektrode. (2)
[9]

TOTAL/*TOTAAL:* **150**