basic education

Department:
Basic Education
REPUBLIC OF SOUTH AFRICA

SENIOR CERTIFICATE EXAMINATIONS/ NATIONAL SENIOR CERTIFICATE EXAMINATIONS
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PHYSICAL SCIENCES: CHEMISTRY (P2)
FISIESE WETENSKAPPE: CHEMIE (V2)

MAY/JUNE 2025/*MEI/JUNIE 2025*

MARKING GUIDELINES/*NASIENRIGLYNE*

MARKS/*PUNTE*: 150

These marking guidelines consist of 22 pages.
Hierdie nasienriglyne bestaan uit 22 bladsye.

QUESTION 1/*VRAAG 1*

1.1 B ✓✓ ACCEPT/*AANVAAR* 2 (2)

1.2 D ✓✓ (2)

1.3 D ✓✓ (2)

1.4 A ✓✓ (2)

1.5 B ✓✓ (2)

1.6 C ✓✓ (2)

1.7 D ✓✓ (2)

1.8 B ✓✓ (2)

1.9 C ✓✓ (2)

1.10 C ✓✓ (2)
[20]

QUESTION 2/*VRAAG 2*

2.1 Compounds with one or more multiple bonds between C atoms in the hydrocarbon chain. ✓✓ (2 or 0)
Verbindings met een of meer meervoudige bindings tussen C-atome in die koolwaterstofkettings. (2 of 0)

OR/*OF*
A hydrocarbon with two or more bonds between the C-atoms.
'n Koolwaterstof met twee of meer bindings tussen die C-atome.

OR/*OF*
Hydrocarbons containing not only single bonds between C atoms.
Koolwaterstowwe wat nie slegs enkelbindings tussen die C-atome bevat nie.

ACCEPT/*AANVAAR:*
Compounds with one or more double/triple bonds between C atoms in the hydrocarbon chain.
Verbindings met een of meer dubbel/trippelbindings tussen C-atome in die koolwaterstofkettings. (2)

2.2
2.2.1 E ✓ (1)

2.2.2 F ✓ (1)

2.3 Ketones/*Ketone* ✓
Aldehydes/*Aldehiede* ✓ (2)

2.4 Tertiary/*Tersiêre* ✓

The hydroxyl group/functional group (-OH) is bonded to a C atom that is bonded to three other C atoms. ✓
Die hidroksiel/funksionele groep (-OH) is gebind aan 'n C-atoom wat aan drie ander C-atome gebind is.

OR/*OF*
The functional group ($-\overset{|}{\underset{\substack{|\\ \mathrm{OH}}}{\mathrm{C}}}-$) is bonded to three other C atoms.

Die funksionele groep ($-\overset{|}{\underset{\substack{|\\ \mathrm{OH}}}{\mathrm{C}}}-$) *is gebind aan drie ander C-atome.* (2)

2.5

2.5.1

<u>Marking criteria:</u>
- Correct stem, i.e. <u>hexane</u>. ✓
- Both substituent (ethyl and iodo) correctly identified. ✓
- IUPAC name completely correct including numbering, sequence, hyphens and commas. ✓

<u>Nasienkriteria:</u>
- *Korrekte stam, d.i. <u>heksaan</u>.* ✓
- *Beide substituent (etiel en jodo) korrek geïdentifiseer.* ✓
- *IUPAC-naam heeltemal korrek insluitende nommering, volgorde, koppeltekens en kommas.* ✓

3-ethyl-4-iodohexane/*3-etiel-4-jodoheksaan* ✓✓✓ (3)

2.5.2

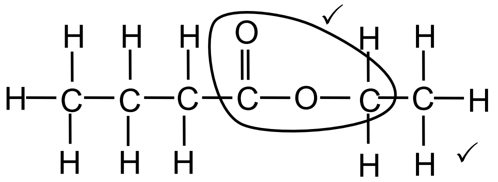
<u>Marking criteria/*Nasienkriteria:*</u>
- Correct stem and substituents: methyl and propanol ✓
  Korrekte stam en substituente: metiel en propanol
- IUPAC name completely correct including numbering, sequence, hyphens and commas. ✓
  IUPAC-naam heeltemal korrek insluitende nommering, volgorde, koppeltekens en kommas.

2-methylpropan-1-ol/ 2-methyl-1-propanol/ methylpropan-1-ol/
methyl-1-propanol ✓✓
2-metielpropan-1-ol/ 2-metiel-1-propanol / metielpropan-1-ol/
metiel-1-propanol (2)

2.6

2.6.1 Esterification/Condensation/*Verestering/Esterifikasie/Kondensasie* ✓ (1)

2.6.2



Marking criteria/*Nasienkriteria:*
- Functional group correct. ✓
  Funksionele groep korrek.
- Whole structure correct. ✓
  Hele struktuur korrek.

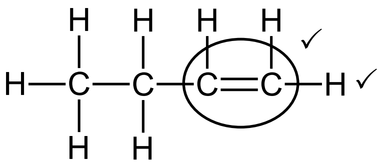
IF/*INDIEN*
- More than one functional group/wrong functional group:
  Meer as een funksionele groep/foutiewe funksionele groep: $^0/_2$
- If condensed structural formulae used/*Indien gekondenseerde struktuurformules gebruik:* Max./*Maks.* $^1/_2$

(2)

2.7

2.7.1 C_2H_4O ✓ (1)

2.7.2



Marking criteria/*Nasienkriteria*:
- Correct functional group. ✓
  Korrekte funksionele groep.
- Whole structure correct. ✓
  Hele struktuur korrek.

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 struktuurformules gebruik:* Max./*Maks.* $^1/_2$

(2)

[19]

QUESTION 3/*VRAAG 3*

3.1.1 (A series of organic) compounds that can be described by the same general formula. ✓✓ **(2 or 0)**
OR
(A series of organic) compounds in which one member differs from the next by a CH_2 group.

('n Reeks organiese) verbindings wat deur dieselfde algemene formule beskryf kan word. ✓✓ ***(2 of 0)***
OF
('n Reeks organiese) verbindings waarin die een lid van die volgende verskil met 'n CH_2-groep (2)

3.1.2
(a) Formyl (group)/*Formiel(groep)* ✓ (1)

(b)

Marking criteria*:*	***Nasienkriteria:***
• Correct chain length, i.e. Meth. ✓ • Everything else correct. ✓	• *Korrekte kettinglengte d.i. Met.* ✓ • *Alles verder reg* ✓

Methanal/*Metanaal* ✓✓ (2)

3.1.3
(a) Homologous series/Functional group/Type of intermolecular forces/Straight chain/Atmospheric pressure ✓
Homoloë reeks/Funksionele groep/Tipe intermolekulêre kragte/ Reguitketting/ Atmosferiese druk (1)

(b) The boiling points of the carboxylic acids increase with an increase in the chain length/the number of carbon atoms/surface area/molecular mass./
OR
The boiling points of the carboxylic acids decrease with a decrease in the chain length/number of carbon atoms/surface area/molecular mass. ✓

Die kookpunte van die karboksielsure neem toe met 'n toename in die kettinglengte/aantal koolstofatome/reaksieoppervlak/molekulêre massa./
OF
Die kookpunte van die karboksielsure neem af met 'n afname in die kettinglengte/aantal koolstofatome/reaksieoppervlak/molekulêre massa. (1)

(c)

<u>Marking criteria:</u>
For increasing or decreasing number of C atoms
- Compare the strength of intermolecular forces. ✓
- Compare the energy required to overcome intermolecular forces. ✓

<u>Nasienkriteria:</u>
Vir toename of afname in aantal C-atome
- *Vergelyk die sterkte van intermolekulêre kragte.* ✓
- *Vergelyk die energie benodig om intermolekulêre kragte te oorkom.* ✓

As the number of C atoms/chain length/surface area/contact area/molecular mass increases
- The strength of intermolecular/London/dispersion forces increases. ✓
- More energy is needed to overcome intermolecular forces/London/ dispersion forces. ✓

OR
As the number of C atoms/chain length/surface area/contact area/molecular mass decreases
- The strength of intermolecular/London/dispersion forces decreases. ✓
- Less energy is needed to overcome intermolecular forces/London/ dispersion forces. ✓

Met toename in aantal C-atome/kettinglengte/reaksieoppervlak/kontakarea/ molekulêre massa.
- *Die sterkte van die die intermolekulêre kragte/Londonkragte/ dispersiekragte neem toe.*
- *Meer energie word benodig om die intermolekulêre kragte/Londonkragte/ dispersiekragte te oorkom/breek.*

OF
Met afname in aantal C-atome/kettinglengte/reaksieoppervlak/kontakarea/ molekulêre massa.
- *Die sterkte van die die intermolekulêre kragte/Londonkragte/ dispersiekragte neem af.*
- *Minder energie word benodig om die intermolekulêre kragte/ Londonkragte/dispersiekragte te oorkom/breek* (2)

3.1.4 75 °C ✓ (1)

3.2

Marking criteria:

- Higher than ✓
- State that carboxylic acids have more than one (two) site for hydrogen bonding and alcohols have one site for hydrogen bonding. ✓
- Comparing the strength of IMFs. ✓
- Comparing the number of molecules in a vapour phase at a given temperature/ energy needed to overcome IMFs. ✓

Nasienkriteria:

- *Hoër as* ✓
- *Stel dat karboksielsure het meer as een (twee) plekke vir waterstofbindings en dat alkohole een plek het vir waterstofbinding.* ✓
- *Vergelyk die sterkte van die IMK's/energie benodig om IMK's te oorkom.* ✓
- *Vergelyk die hoeveelheid molekules in die dampfase by 'n gegewe temperatuur /energie nodig om die IMK te oorkom.* ✓

- Higher than ✓
- Compound B/$CH_3CH_2CH_2COOH$/Carboxylic acid/Butanoic acid has (in addition to London forces and dipole-dipole forces), more than one site (two) for hydrogen bonding between molecules and compound A/$CH_3CH_2CH_2CH_2CH_2OH$/Alcohol/Pentan-1-ol has (in addition to London forces and dipole-dipole forces) one site for hydrogen bonding between molecules. ✓
- Intermolecular forces in compound B/$CH_3CH_2CH_2COOH$/Carboxylic acids/Butanoic acid are stronger. ✓
- More energy needed to overcome/break intermolecular forces in compound B/ $CH_3CH_2CH_2COOH$/Carboxylic acid/Butanoic acid.

OR

- At a given temperature there will be fewer molecules of compound B/$CH_3CH_2CH_2COOH$/Carboxylic acids/Butanoic acid in the vapour phase. ✓

- Higher than ✓
- Compound A/$CH_3CH_2CH_2CH_2CH_2OH$/Alcohol/Pentan-1-ol has (in addition to London forces and dipole-dipole forces) one site for hydrogen bonding between molecules and compound B/$CH_3CH_2CH_2COOH$/ Carboxylic acid/Butanoic acid has, (in addition to London forces and dipole-dipole forces), more than one site (two) for hydrogen bonding between molecules. ✓
- Intermolecular forces in compound A/$CH_3CH_2CH_2CH_2CH_2OH$/Alcohol/ Pentan-1-ol are weaker. ✓
- Less energy needed to overcome/break intermolecular forces in compound A/$CH_3CH_2CH_2CH_2CH_2OH$/Pentan-1-ol/Alcohol.

OR

- At a given temperature there will be more molecules of compound A/$CH_3CH_2CH_2CH_2CH_2OH$/Alcohol/ Pentan-1-ol in the vapour phase. ✓

• *Hoër as* • *Verbinding B/$CH_3CH_2CH_2COOH$/Karboksielsure/Butanoësuur het, (in toevoeging tot Londonkragte en dipool-dipoolkragte), meer as een posisie (twee) vir waterstofbinding tussen molekule en verbinding A/ $CH_3CH_2CH_2CH_2CH_2OH$/Alkohol/Pentan-1-ol het, (in toevoeging tot Londonkragte en dipool-dipoolkragte), een posisie vir waterstofbinding tussen molekule.* • *Intermolekulêre kragte in verbinding B/$CH_3CH_2CH_2COOH$/Karboksielsure/ Butanoësuur is sterker.* • *Meer energie word benodig om intermolekulêre kragte in verbinding B/$CH_3CH_2CH_2COOH$/Karboksielsure/Butanoësuur te oorkom/breek* ***OF*** • *By 'n gegewe temperatuur sal daar minder molekules van verbinding B/$CH_3CH_2CH_2COOH$/Karboksielsure/Butanoësuur in die dampfase wees.*
• *Hoër as* • *Verbinding A/$CH_3CH_2CH_2CH_2CH_2OH$/Alkohol/Pentan-1-ol het, (in toevoeging tot Londonkragte en dipool-dipoolkragte), een posisie vir waterstofbinding tussen molekule en verbinding B/$CH_3CH_2CH_2COOH$/ Karboksielsure/Butanoësuur het, (in toevoeging tot Londonkragte en dipool-dipoolkragte), meer as een posisie (twee) vir waterstofbinding tussen molekule.* • *Intermolekulêre kragte in verbinding A/ $CH_3CH_2CH_2CH_2CH_2OH$/Alkohol/ Pentan-1-ol is swakker.* • *Minder energie word benodig om intermolekulêre kragte in A/ $CH_3CH_2CH_2CH_2CH_2OH$/Alkohol/Pentan-1-ol te oorkom/breek.* ***OF*** • *By 'n gegewe temperatuur sal daar meer molekules van verbinding A/ $CH_3CH_2CH_2CH_2CH_2OH$/Alkohol/Pentan-1-ol in die dampfase wees.*

(4)
[14]

QUESTION 4/*VRAAG 4*

4.1

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

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

4.2

Marking criteria:	***Nasienkriteria:***
• Correct chain length, i.e. But. ✓ • Everything else correct: IUPAC name completely correct including numbering. ✓	• *Korrekte kettinglengte d.i. But.*✓ • *Alles verder reg: IUPAC-naam heeltemal korrek insluitende nommering.* ✓

Butan-1-ol/1-butanol ✓✓ (2)

4.3

4.3.1

Marking criteria/*Nasienkriteria:*

- Whole condensed structural formula of alkene correct. ✓
  Hele gekondenseerde struktuurformule van die alkeen korrek.
- H_2O. ✓
- Hydroxyl group/OH. ✓
  Hidroksielgroep/OH.
- Whole condensed structural formula of alcohol correct (OH on second C-atom). ✓
  Hele gekondenseerde struktuurformule van alkohol korrek (OH op tweede C-atoom)

IF/*INDIEN*

- Any additional reactants or products /*Enige addisionele reaktanse of produkte:* Deduct 1 mark/*Trek 1 punt af*.
- Structural formulae used/S*truktuurformule gebruik.* Max./*Maks.* $^3/_4$
- Molecular formulae used/*Molekulêre formule gebruik.* Max./*Maks.* $^1/_4$
- Only reactants without arrow/*Slegs reaktanse sonder pyl* Max/*Maks.* $^2/_4$

Marking rule 6.3.10/*Nasienreël 6.3.10*

$CH_2CHCH_2CH_3$ ✓ + H_2O ✓ → $CH_3CH\overset{✓}{O}HCH_2CH_3$ ✓

OR/*OF*

$CH_2{=}CHCH_2CH_3$ ✓ + H_2O ✓ → $CH_3\overset{\overset{OH\ ✓}{|}}{C}HCH_2CH_3$ ✓ (4)

4.3.2 Sulphuric acid/H_2SO_4/Phosphoric acid/H_3PO_4/*Swawelsuur/Fosforsuur* ✓ (1)

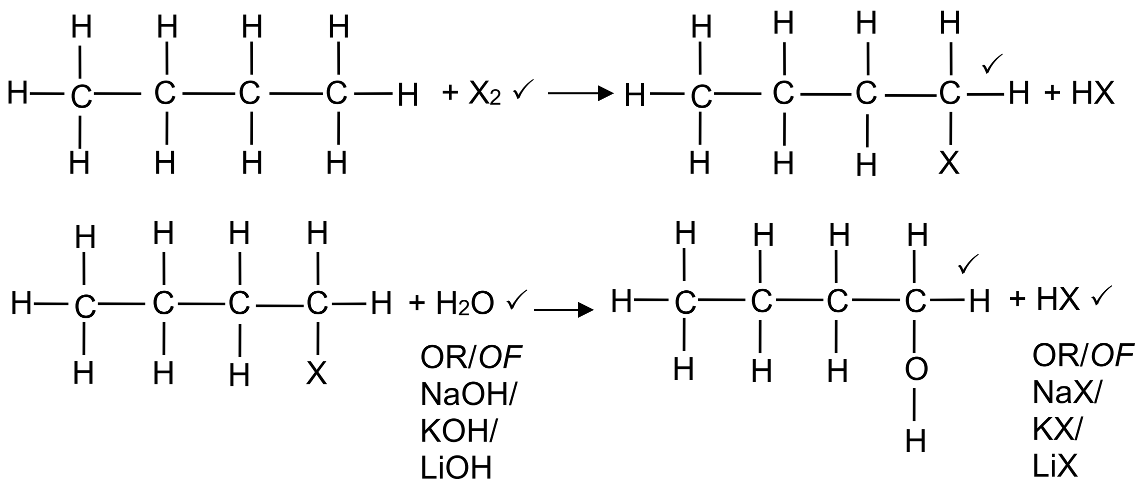
4.4

Marking criteria/*Nasienkriteria:*

- $X_2 = Br_2/C\ell_2$. ✓
- Whole structural formula of haloalkane correct. ✓
  Hele struktuurformule van haloalkaan korrek.
- H_2O/NaOH/KOH/LiOH. ✓
- Whole structural formula of alcohol correct. ✓
  Hele struktuurformule van alkohol korrek.
- HX/NaX/KX/LiX where/*waar* X = Br/Cℓ ✓

IF/*INDIEN*

- Any additional reactants or products /*Enige addisionele reaktanse of produkte:* Max./*Maks.* $^4/_5$
- Condensed structural formulae used/*Gekondenseerde struktuurformule gebruik*: deduct 1 mark/*trek 1 punt af*.
- If inorganic product does not correspond with inorganic reactant: no mark for inorganic product./*Indien anorganiese produk nie met die anorganiese reaktans ooreenstem nie, geen punt vir anorganiese produk.*
- Molecular formulae used:/*Molekulêre formule gebruik:* Max./*Maks.* $^3/_5$
- Marking rule 6.3.10/*Nasienreël 6.3.10*



(5)

4.5 $2C_4H_{10}$ ✓ + $13\underline{O_2 \rightarrow 8CO_2 + 10H_2O}$ ✓ Bal. ✓

Ignore phases./*Ignoreer fases.*

Marking criteria/*Nasienkriteria:*

- C_4H_{10} ✓ O_2, CO_2 and/*en* H_2O ✓ Balancing/*Balansering* ✓
- Ignore double arrows./*Ignoreer dubbelpyle.*
- Marking rule 6.3.10/*Nasienreël 6.3.10.*

IF/*INDIEN*:

- Structural formulae C_4H_{10} used:/*Struktuurformule C_4H_{10} gebruik:* Max./*Maks.* $^2/_3$
- Balancing mark only if everything else is correct/
  Balanseringspunt slegs indien alles korrek.

(3)

[17]

QUESTION 5/*VRAAG 5*

5.1

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

ANY ONE:

- Change in concentration ✓ of products/reactants per (unit) time. ✓
- Change in amount/number of moles/volume/mass of products or reactants per (unit) time.
- Amount/number of moles/volume/mass of products formed/reactants used per (unit) time.
- Rate of change in concentration/amount/number of moles/volume/ mass. ✓✓ **(2 or 0)**

ENIGE EEN:

- *Verandering in konsentrasie ✓ van produkte/reaktanse per (eenheid)tyd.✓*
- *Verandering in hoeveelheid/getal mol/volume/massa van produkte of reaktanse per (eenheid)tyd.*
- *Hoeveelheid/getal mol/volume/massa van produkte gevorm/reaktanse gebruik per (eenheid)tyd.*
- *Tempo van verandering in konsentrasie/ hoeveelheid/getal mol/ volume/ massa. ✓✓* **(2 *of* 0)** (2)

5.2 **ANY ONE:**
Temperature ✓/
(Initial) amount/Mass of magnesium carbonate/Surface area
***ENIGE EEN*:**
Temperatuur ✓/
(Aanvanklike) hoeveelheid/Massa van magnesiumkarbonaat/
Reaksieoppervlak (1)

5.3 CO_2/gas escapes from the reaction flask. ✓
CO_2 /gas ontsnap uit die reaksiefles. ✓ (1)

5.4

Marking criteria: **(a)** Mass subtraction ✓ **(b)** Formula: $n = \frac{m}{M}$ or $V = nV_m$ ✓ **(c)** Substitute M = 44 g·mol^{-1} in $n(CO_2) = \frac{m}{M}$ with $m(CO_2)$ from (a) ✓ **(d)** Substitute 24,5 dm^3 in $V = nV_m$ with $n(CO_2)$ ✓ **(e)** Substitute V_{CO_2} and 120 in rate formula ✓ **(f)** Final correct answer: $2,92 \times 10^{-3}$ (dm^3·s^{-1}) ✓ Range: $2,08 \times 10^{-3}$ to 3×10^{-3}	$m(CO_2) = 144,5 - 143,87$ ✓ **(a)** $= 0,63$ g $n(CO_2) = \frac{m}{M}$ ✓ **(b)** $= \boxed{\frac{0,63}{44}}$ ✓ **(c)** $= 1,43 \times 10^{-2}$ mol $V(CO_2) = nV_m$ $= (1,43 \times 10^{-2})(24,5)$ ✓ **(d)** $= 0,35$ dm^3 Ave rate/ *gem tempo* $= \frac{\Delta V(CO_2)}{\Delta t}$ $= \boxed{\frac{0,35 - (0)}{120 - (0)}}$ ✓ **(e)** $= 2,92 \times 10^{-3}$ (dm^3·s^{-1}) ✓ **(f)**
Nasienkriteria: **(a)** *Aftrek van massas.* ✓ **(b)** *Formula: $n = \frac{m}{M}$ or $V = nV_m$* ✓ **(c)** *Vervang M = 44 g·mol^{-1} in $n(CO_2) = \frac{m}{M}$ met* $m(CO_2)$ van **(a)** ✓ **(d)** *Vervang 24,5 dm^3 in $V = nV_m$ met $n(CO_2)$* ✓ **(e)** *Vervang V_{CO_2} en 120 in tempoformule* ✓ **(f)** *Finale korrekte antwoord: $2,92 \times 10^{-3}$ (dm^3·s^{-1})* ✓ *Gebied:* $2,08 \times 10^{-3}$ *tot* 3×10^{-3}	

(6)

5.5

Marking criteria: • A ✓ • Comparison of the curves of the graph ✓ • Comparison of concentration of HCℓ (from table) ✓ • Explanation of collision theory for LOWER concentration ✓✓ ***Nasienkriteria***: • *A* ✓ • *Vergelyk die kurwes van grafiek* ✓ • *Vergelyk die konsentrasie van HCℓ (vanaf tabel)* ✓ • *Verduidelik botsingsteorie vir LAER konsentrasie* ✓✓

A ✓

- Gradient is least steep/lowest reaction rate/least amount of gas produced in 120 s. ✓
- Lowest concentration of HCℓ(aq). ✓
- Least/Less particles per unit volume. ✓
- Least/Less effective collisions per unit time/second. ✓ **OR** Lowest/Lower frequency of effective collisions.

- *Gradient is die laagste/laagste reaksietempo/minste hoeveelheid gas geproduseer in 120 s.* ✓
- *Laagste konsentrasie van HCℓ(aq).* ✓
- *Minste/Minder deeltjies per eenheidsvolume.* ✓
- *Minste/Minder effektiewe botsings per eenheidstyd/sekonde.* ✓ ***OF*** *Laagste/Laer frekwensie van effektiewe botsings.* (5)

5.6 The same/ *Dieselfde* ✓
The same amount $MgCO_3$ is used in each experiment. ✓
Dieselfde hoeveelheid $MgCO_3$ is gebruik in elke eksperiment. (2)
[17]

QUESTION 6/*VRAAG 6*

6.1

6.1.1 Remains the same/*Bly dieselfde* ✓ (1)

6.1.2 Decreases/*Neem af* ✓ (1)

6.1.3 Remains the same/*Bly dieselfde* ✓ (1)

6.2
- Decrease in pressure favours the reaction that produces a greater number of moles/amount of gas. ✓
  'n Verlaging in druk bevoordeel die reaksie wat 'n groter aantal mol/hoeveelheid gas produseer.
- Forward reaction is favoured. ✓/ [CO] increases AND [CO_2] decreases
  Voorwaartse reaksie word bevoordeel./ [CO] neem toe EN [CO_2] neem af (2)

6.3

Marking criteria:	***Nasienkriteria:***
(a) Substitute 44 in $n = \frac{m}{M}$ ✓ **(b)** Change in mass of carbon: $m(C_i) - m(C_f)$/$n(C_i) - n(C_f)$ ✓ **(c)** Substitute 12 in $n = \frac{m}{M}$ ✓ **(d)** Use mole ratio 1:1 ✓ **(e)** $n(CO_2)_{eq} = n(CO_2)_{initial} - n(CO_2)_{used}$ **OR** $m(CO_2)_{eq} = m(CO_2)_{initial} - m(CO_2)_{used}$ ✓ **(f)** Final answer: 6,16 g ✓ RANGE: 6 to 6,16 g **NOTE**: If **(b)** $\Delta m(C)$ or $\Delta n(C)$ is not calculated max $^2/_6$	***(a)*** *Vervang 44 in* $n = \frac{m}{M}$ ✓ ***(b)*** *Verandering in massa:* $m(C_i) - m(C_f)$/$n(C_i) - n(C_f)$ ✓ ***(c)*** *Vervang 12 in* $n = \frac{m}{M}$ ✓ ***(d)*** *Gebruik molverhouding 1:1* ✓ ***(e)*** $n(CO_2)_{ewe} = n(CO_2)_{begin} - n(CO_2)_{gebruik}$ **OF** $m(CO_2)_{ewe} = m(CO_2)_{begin} - m(CO_2)_{gebruik}$ ✓ ***(f)*** *Finale anwtoord: 6,16 g* ✓ *GEBIED: 6 tot 6,16 g* ***NOTA**:* *Indien **(b)** $\Delta m(C)$ of $\Delta n(C)$ nie bereken maks* $^2/_6$
OPTION 1/*OPSIE 1:* $\Delta m(C) = 14 - 4{,}44$ ✓ **(b)** $= 9{,}56$ g $n(CO_2)_{initially} = \frac{m}{M}$ $= \frac{41{,}2}{44}$ ✓ **(a)** $= 0{,}94$ mol (0,936) $n(C)_{used} = \frac{m}{M}$ $n(C)_{used} = \frac{9{,}56}{12}$ ✓ **(c)** $= 0{,}80$ mol (0,797) $n(CO_2)_{used} = n(C)$ $= 0{,}80$ mol (0,797) ✓ **(d)** $n(CO_2)_{eq} = n(CO_2)_{initially} - n(CO_2)_{used}$ $= 0{,}94 – 0{,}80$ ✓ **(e)** $= 0{,}14$ mol $n(CO_2) = \frac{m}{M}$ $0{,}14 = \frac{m}{44}$ X = $m(CO_2) = 6{,}16$ (g) ✓ **(f)**	**OPTION 2/*OPSIE 2:*** $\Delta m(C) = 14 - 4{,}44$ ✓ **(b)** $= 9{,}56$ g $n(C)_{used} = \frac{m}{M}$ $n(C)_{used} = \frac{9{,}56}{12}$ ✓ **(c)** $= 0{,}80$ mol (0,797) $n(CO_2)_{used} = n(C)$ $= 0{,}80$ mol (0,797) ✓ **(d)** $n(CO_2) = \frac{m}{M}$ $0{,}80 = \frac{m}{44}$ ✓ **(a)** $m(CO_2) = 35{,}05$ g $m(CO_2)_{eq} = m(CO_2)_{initially} - m(CO_2)_{used}$ $= 41{,}2 – 35{,}05$ ✓ **(e)** X = 6,15 (g) ✓ **(f)**

<u>OPTION 3/*OPSIE 3*:</u>

$n(CO_2)_{initially} = \frac{m}{M}$

$= \frac{41,2}{44}$ ✓ **(a)**

$= 0,94$ mol (0,936)

$n(C)_{used} = \frac{9,56}{12}$ ✓ **(c)**

$= 0,80$ mol (0,797)

	C	CO_2
Ratio/*Verhouding*	1	1
Initial quantity (mol) Aanvangshoeveelheid (mol)	1,17	0,936
Change (mol) *Verandering (mol)*	0,8	0,8 ✓ **(d)**
Quantity at equilibrium (mol)/ *Hoeveelheid by ewewig (mol)*	0,37 ✓ **(b)**	0,14 ✓ **(e)**

$n(CO_2) = 0,139$ mol
$m(CO_2) = 0,139\ (44)$
X = 6,16 (g) ✓ **(f)**

(6)

6.4

POSITIVE MARKING FROM QUESTION 6.3:
POSITIEWE NASIEN VANAF VRAAG 6.3:

Marking criteria

(a) Use of ratio $n(CO_2) : n(CO) = 1 : 2$. ✓
(b) Divide by 3 dm^3 ✓
(c) Correct Kc expression (formulae in square brackets). ✓
(d) Substitute of concentration into K_C expression. ✓
(e) Final answer: 5,98 ✓
RANGE: 5,98 – 7,29

Nasienkriteria:

(a) Gebruik verhouding $n(CO_2) : n(CO) = 1 : 2$. ✓
(b) Deel deur 3 dm^3 ✓
(c) Korrekte K_c uitdrukking (formules in vierkantige hakies). ✓
(d) Vervang konsentrasies in korrekte K_c uitdrukking. ✓
(e) Finale antwoord: 5,98 ✓
GEBIED: 5,98 – 7,29

NOTE/*NOTA*:
Mark calculations of this question that may be done in QUESTION 6.3.
Merk berekeninge van hierdie vraag wat in VRAAG 6.3 gedoen is.

CALCULATIONS USING NUMBER OF MOLES
BEREKENINGE WAT AANTAL MOL GEBRUIK
OPTION 1/*OPSIE 1:*

$$n(CO_2)_{\text{initial}} = \frac{m}{M} = \frac{41,2}{44} = 0,936 \text{ mol}$$

	CO_2	CO	
Ratio/*Verhouding*	1	2	
Initial quantity (mol) Aanvangshoeveelheid (mol)	0,936	0	
Change (mol) *Verandering (mol)*	0,8	1,6	✓ **(a)**
Quantity at equilibrium (mol)/ *Hoeveelheid by ewewig (mol)*	0,14	1,6	
Equilibrium concentration ($mol \cdot dm^{-3}$) Ewewigskonsentrasie ($mol \cdot dm^{-3}$)	0,047	0,53	Divide by/deel deur 3 ✓ **(b)**

$$K_c = \frac{[CO]^2}{[CO_2]} \checkmark \textbf{(c)}$$

$$= \frac{(0,53)^2}{0,047} \checkmark \textbf{(d)}$$

$$= 5,98 \checkmark \textbf{(e)}$$

Wrong K_c expression
Verkeerde K_c-uitdrukking: Max./*Maks.* $^2/_5$
No K_c expression/*Geen K_c- uitdrukking*: $^4/_5$

CALLCULATIONS USING CONCENTRATION

BEREKENINGE WAT KONSENTRASIE GEBRUIK

OPTION 2/*OPSIE 2:*

$c(CO_2) = \frac{m}{MV}$

$= \boxed{\frac{41,2}{(44)(3)}}$

$= 0,31\ mol{\cdot}dm^{-3}$

Divide by 3 ✓ **(b)**

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

$= \frac{0,8}{3}$

$= 0,27\ mol{\cdot}dm^{-3}$ (0,267)

	CO_2	CO	
Ratio/*Verhouding*	1	2	
Initial concentration ($mol{\cdot}dm^{-3}$) *Aanvangskonsentrasie ($mol{\cdot}dm^{-3}$)*	0,31	0	
Change in concentration ($mol{\cdot}dm^{-3}$) *Verandering in konsentrasie ($mol{\cdot}dm^{-3}$)*	0,27	0,54	✓ **(a)**
Equilibrium concentration ($mol{\cdot}dm^{-3}$) Ewewigskonsentrasie ($mol{\cdot}dm^{-3}$)	0,04	0,54	

$K_c = \frac{[CO]^2}{[CO_2]}$ ✓ **(c)**

$= \boxed{\frac{(0,54)^2}{0,04}}$ ✓ **(d)**

$= 7,29$ ✓ **(e)**

Wrong K_c expression

Verkeerde K_c-uitdrukking: Max./*Maks.* $^2/_5$

No K_c expression/*Geen K_c- uitdrukking*: $^4/_5$

<u>OPTION 3/*OPSIE 3*:</u>

$n(CO_2)_{initial} = \frac{m}{M}$

$= \frac{41,2}{44}$

$= 0,936 \text{ mol}$

$\Delta n(CO_2) = 0,8 \text{ mol}$

$n(CO_2)_{eqm} = n(CO_2)_{initial} - \Delta n(CO_2)$

$= 0,936 - 0,8$

$= 0,136 \text{ mol}$

$n(CO)_{formed} = 2\Delta n(CO_2)_{used} = 1,6 \text{ mol}$ ✓ **(a)**

$n(CO)_{eqm} = \Delta n(CO)_{formed} = 1,6 \text{ mol}$

$$\left.\begin{aligned}[CO_2]_{eqm} &= \frac{0,136}{3} = 4,53 \times 10^{-2} \text{ mol·dm}^{-3} \\ [CO]_{eqm} &= \frac{1,6}{3} = 0,53 \text{ mol·dm}^{-3}\end{aligned}\right\} \checkmark \textbf{(b)}$$

$K_c = \frac{[CO]^2}{[CO_2]}$ ✓ **(c)**

$= \boxed{\frac{(0,53)^2}{4,53 \times 10^{-2}}}$ ✓ **(d**

$= 6,2$ ✓ **(e)** (5)

Wrong K_c expression *Verkeerde K_c-uitdrukking*: Max./M*aks.* $^2/_5$ No K_c expression/*Geen K_c- uitdrukking*: $^4/_5$

6.5 Y ✓✓ (2)

6.6 Remains the same/*Bly dieselfde* ✓ (1)

[19]

QUESTION 7/*VRAAG 7*

7.1 An acid produces hydrogen ions /H^+/hydronium ions/ H_3O^+ in aqueous solution/water. ✓✓ (**2 or 0**)
'n Suur is 'n stof wat waterstofione/H^+/hidroniumione/H_3O^+ vorm in waterige oplossing/water. (**2 of 0**) (2)

7.2

7.2.1 $(COOH)_2$ ✓ (1)

7.2.2 NaCℓ ✓ (1)

7.2.3 HCO_3^- ✓
OR/*OF* NH_3 (1)

7.2.4 NaOH ✓✓
OR/*OF* $Mg(OH)_2$ (2)

7.3

Marking criteria:	***Nasienkriteria:***
(a) Calculate $n(H_xY)$ ✓ **(b)** Calculate n(NaOH) ✓ **(c)** Final answer: x = 2 ✓ **(d)** Reactants ✓ Products ✓ Balancing✓ **NOTE**: Ignore ⇌ and phases Marking rule 6.3.10	**(a)** Bereken $n(H_xY)$ ✓ **(b)** Bereken n(NaOH) ✓ **(c)** Finale antwoord: x = 2 ✓ **(d)** *Reaktanse* ✓*Produkte* ✓Balansering✓ ***NOTA**: Ignoreer ⇌ en fases* *Nasienreël 6.3.10*
OPTION 1/*OPSIE 1:* $n = cV$ $n_{acid} = (0,11)(0,02364)$ ✓ **(a)** $= 2,6 \times 10^{-3}$ $n_{base} = (0,26)(0,02)$ ✓ **(b)** $= 5,2 \times 10^{-3}$ (0,0052) $\frac{n(H_xY)}{n(NaOH)} = \frac{n_a}{n_b}$ $\frac{2,6 \times 10^{-3}}{5,2 \times 10^{-3}} = \frac{1}{n_b}$ $n_b = 2$ $\therefore x = 2$ ✓ **(c)**	**OPTION 2/*OPSIE 2:*** $\frac{c_aV_a}{c_bV_b} = \frac{n_a}{n_b}$ **(a)**✓ **(b)**✓ $\frac{(23,64)(0,11)}{(20)(0,26)} = \frac{1}{n_b}$ $n_b = 2$ $\therefore x = 2$ ✓ **(c)** HxY : NaOH $2,6 \times 10^{-3} : 5,2 \times 10^{-3}$ 1 : 2
$\underline{H_2Y(aq) + 2NaOH(aq)}$ ✓→ $\underline{Na_2Y(aq) + 2H_2O(\ell)}$ ✓ Bal ✓ **(d)**	

(6)

7.4

Marking criteria:
(a) Any formula: pH = -log[H_3O^+]/pH = -log[H^+]/[H_3O^+] = 10^{-pH} ✓
(b) Substitute 1,61 in pH = -log[H_3O^+] ✓
(c) Calculate $n(HCℓ)_{unused}$ using $c = \frac{n}{V}$ ✓
(d) Calculate $n(HCℓ)_{initial}$ using $c = \frac{n}{V}$ ✓
(e) Calculate $n(HCℓ)_{used} = n(HCℓ)_{initial} - n(HCℓ)_{unused}$ ✓
(f) Using ratio 1:2 with **USED** HCℓ from of **(e)** to calculate n($CaCO_3$) ✓
(g) Substitute 100 AND n($CaCO_3$) from **(f)** in $n = \frac{m}{M}$ ✓
(h) Mass of impurity = m_{sample} – m($CaCO_3$) ✓
(i) Final answer: 0,25 g ✓ (Range: 0,2 g to 0,3 g)

Nasienkriteria:
(a) *Enige formule: pH = - log[H_3O^+]/pH = - log[H^+] /[H_3O^+] = 10^{-pH}* ✓
(b) *Vervang 1,61 in pH = -log[H_3O^+]* ✓
(c) *Bereken $n(HCℓ)_{ongebruik}$ using $c = \frac{n}{V}$* ✓
(d) *Bereken $n(HCℓ)_{begin}$ using $c = \frac{n}{V}$* ✓
(e) *Bereken $n(HCℓ)_{gebruik} = n(HCℓ)_{begin} - n(HCℓ)_{ongebruik}$* ✓
(f) *Gebruik ratio 1:2 van HCℓ **GEBRUIK** van **(e)** om n($CaCO_3$) te bereken* ✓
(g) *Vervang 100 EN n($CaCO_3$) van **(f)** in $n = \frac{m}{M}$* ✓
(h) *Massa of onsuiwerheid = $m_{monster}$ – m($CaCO_3$)* ✓
(i) *Finale antwoord: 0,25 g* ✓ (*Gebied: 0,2 g tot 0,3 g*)

pH = -log[H_3O^+] ✓ **(a)**
(b) ✓ 1,61 = -log[H_3O^+]
[H_3O^+] = $10^{-1,61}$
= $2,45 \times 10^{-2}$ mol·dm^{-3} (0,0245)

$n(HCℓ)_{unused} = n(H_3O^+) = cV$
= $(2,45 \times 10^{-2})(0,2)$ ✓ **(c)**
= $4,9 \times 10^{-3}$ mol (0,0049)

$n(HCℓ)_{initial} = cV$
= (0,15)(0,2) ✓ **(d)**
= 3×10^{-2} mol (0,03)

$n(HCℓ)_{used} = 3 \times 10^{-2} - 4,9 \times 10^{-3}$ ✓ **(e)**
= $2,51 \times 10^{-2}$ mol (0,0251)

Reaction ratio n$CaCO_3$: nHCℓ = 1:2

✓ **(f)**
n($CaCO_3$) = ½($2,51 \times 10^{-2}$) = $1,25 \times 10^{-2}$ mol

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

$\boxed{1,25 \times 10^{-2} = \frac{m}{100}}$ ✓ **(g)**

m($CaCO_3$) = 1,25 g

m of impurity in the sample = 1,5 – 1,25 ✓ **(h)**
= 0,25 g ✓ **(i)**

(9)
[22]

QUESTION 8/*VRAAG 8*

8.1 H^+/H_3O^+ ions/hydrogen ions/hydronium ions/oxonium ions ✓
Waterstofione/hidroniumione/oksoniumione (1)

8.2 0,77 V ✓ (1)

8.3 A ✓ (1)

8.4 H_2 is a stronger reducing agent ✓ than Fe^{2+}/Fe(II) ions ✓ and will reduce Fe^{3+}/Fe(III) ions ✓ (to Fe^{2+}/Fe(II) ions).

H_2 is 'n sterker reduseermiddel as Fe^{2+}/Fe(II)-ione en sal Fe^{3+}/Fe(III)-ione reduseer (na Fe^{2+}/Fe(II)-ione).

OR/*OF*

Fe^{2+}-ion is a weaker reducing agent ✓ than H_2 ✓ and therefore Fe^{3+}/Fe(III) ions (to Fe^{2+}/Fe(II) ions) will be reduced. ✓

Fe^{2+}-ioon is 'n swakker reduseermiddel as H_2 en sal Fe^{3+}/Fe(III)-ione reduseer (na Fe^{2+}/Fe(II)-ione). (3)

8.5

8.5.1 Pt/Platinum ✓ (1)

8.5.2 $H_2 \rightarrow 2H^+ + 2e^-$ ✓✓

NOTE/*NOTA*:

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

(2)

8.5.3

$\underbrace{Pt(s) \mid H_2(g) \mid H^+(aq)}_{✓} \parallel_{✓} \underbrace{Fe^{3+}(aq), Fe^{2+}(aq) \mid Pt(s)}_{✓}$

OR/*OF*

$Pt(s) \mid H_2(g) \mid H^+(1\ mol\cdot dm^{-3}) \parallel Fe^{3+}(1\ mol\cdot dm^{-3}), Fe^{2+}(1\ mol\cdot dm^{-3}) \mid Pt(s)$

ACCEPT/*AANVAAR*:

$Pt \mid H_2 \mid H^+ \parallel Fe^{3+}, Fe^{2+} \mid Pt$ (3)

8.6 The reaction reaches equilibrium/no charges/electrons flow. ✓
Die reaksie bereik ewewig/geen ladings/elektrone vloei. (1)

[13]

QUESTION 9/*VRAAG 9*

9.1 **ANY ONE:**

- The (chemical) process in which electrical energy is converted to chemical energy. ✓✓ **(2 or 0)**
- The use of electrical energy to produce a chemical change.
- Decomposition of an ionic compound by means of electrical energy.
- The process during which an electric current passes through a solution/ionic liquid/molten ionic compound.

ENIGE EEN:

- Die (*chemiese) proses waarin elektriese energie omgeskakel word na chemiese energie.* ✓✓ **(*2 of 0*)**
- *Die gebruik van elektriese energie om 'n chemiese verandering teweeg te bring.*
- *Ontbinding van 'n ioniese verbinding met behulp van elektriese energie.*
- *Die proses waardeur 'n elektriese stroom deur 'n oplossing/ioniese vloeistof/gesmelte ioniese verbinding beweeg.* (2)

9.2 $2H_2O(\ell) + 2e^- \rightarrow H_2(g) + 2OH^-(aq)$ ✓✓

NOTE/*NOTA*:

- $H_2(g) + 2OH^-(aq) \leftarrow 2H_2O(\ell) + 2e^-$ ($\frac{2}{2}$)
- $2H_2O(\ell) + 2e^- \rightleftharpoons H_2(g) + 2OH^-(aq)$ ($\frac{1}{2}$)
- $H_2(g) + 2OH^-(aq) \rightleftharpoons 2H_2O(\ell) + 2e^-$ ($\frac{0}{2}$)
- $2H_2O(\ell) + 2e^- \leftarrow H_2(g) + 2OH^-(aq)$ ($\frac{0}{2}$)
- 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:* $\frac{1}{2}$
- Ignore phases/*Ignoreer fases*

(2)

9.3 X to Y/*X tot Y* ✓ (1)

9.4

Marking criteria: **(a)** Substitute 300 x 10^{-3} and 24 dm^3 into $n = \frac{V}{V_m}$ ✓ **(b)** Using ratio 1:2 to calculate $n(e^-)$ ✓ **(c)** Substitute 6,02 x 10^{23} mol^{-1} in $n = \frac{N}{N_A}$ ✓ **(d)** Final correct answer: 1,505 x 10^{22} electrons ✓ Range: 1,505 x 10^{22} to 2,41 x 10^{22} electrons	***Nasienkriteria:*** **(a)** *Vervang 300 x 10^{-3} en 24 dm^3 in* $n = \frac{V}{V_m}$ ✓ **(b)** *Gebruik verhouding 1:2 om $n(e^-)$ te bereken* ✓ **(c)** *Vervang 6,02 x 10^{23} mol^{-1} in* $n = \frac{N}{N_A}$ ✓ **(d)** *Finale korrekte antwoord: 1,505 x 10^{22} elektrone* ✓ *Gebied: 1,505 x 10^{22} tot 2,41 x 10^{22} elektrone*
OPTION 1/*OPSIE 1*: $n(C\ell_2) = \frac{V}{V_m}$ $= \boxed{\frac{300 \times 10^{-3}}{24}}$ ✓**(a)** $= 0{,}0125$ mol (0,01) $n(e^-) = 2n(C\ell_2)$ $= 2(0{,}0125)$ ✓**(b)** $= 0{,}025$ mol $n(e^-) = \frac{N}{N_A}$ $0{,}025 = \frac{N}{6{,}02 \times 10^{23}}$ ✓**(c)** $N = 1{,}505 \times 10^{22}$ (electrons) ✓**(d)**	**OPTION 2/*OPSIE 2*:** $n(C\ell_2) = \frac{V}{V_m}$ $= \boxed{\frac{300 \times 10^{-3}}{24}}$ ✓**(a)** $= 0{,}0125$ mol (0,01) $n(C\ell_2) = \frac{N}{N_A}$ $0{,}0125 = \frac{N}{6{,}02 \times 10^{23}}$ ✓**(c)** $N = 7{,}525 \times 10^{21}$ ($C\ell_2$) $N(e^-) = 2n(C\ell_2)$ $= 2(7{,}525 \times 10^{21})$ ✓**(b)** $= 1{,}505 \times 10^{22}$ (electrons) ✓**(d)**

(4)
[9]

TOTAL/*TOTAAL*: 150