basic education

Department:
Basic Education
REPUBLIC OF SOUTH AFRICA

NATIONAL SENIOR CERTIFICATE *NASIONALE SENIOR SERTIFIKAAT*

GRADE/*GRAAD* 12

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

NOVEMBER 2021

MARKING GUIDELINES/*NASIENRIGLYNE*

MARKS/*PUNTE*: 150

These marking guidelines consist of 21 pages.
Hierdie nasienriglyne bestaan uit 21 bladsye.

QUESTION 1/*VRAAG 1*

1.1 D ✓✓ (2)

1.2 D ✓✓ (2)

1.3 A ✓✓ (2)

1.4 B ✓✓ (2)

1.5 D ✓✓ (2)

1.6 D ✓✓ (2)

1.7 C ✓✓ (2)

1.8 B ✓✓ (2)

1.9 A ✓✓ (2)

1.10 B ✓✓ (2)

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QUESTION 2/*VRAAG 2*

2.1 A compound that contains a double bond/multiple bond/does NOT contain only single bonds (between C atoms). ✓✓ **(2 or 0)**
'n Verbinding wat dubbelbindings/meervoudige bindings/NIE net enkel-bindings (tussen C-atome) bevat NIE. ***(2 of 0)*** (2)

2.2
2.2.1 B / E ✓ (1)

2.2.2 Carbonyl (group bonded to two C atoms) ✓
Karboniel(groep gebind aan twee C-atome)

ACCEPT/*AANVAAR*
Ketone/*Ketoon* (1)

2.2.3 F ✓✓ (2)

2.2.4 2,5-dichloro-3-methylhexane/*2,5-dichloro-3-metielheksaan*

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

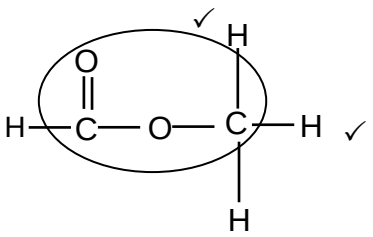
Nasienkriteria:
- *Korrekte stam d.i. heksaan.* ✓
- *Alle substituente (dichloro en metiel) korrek geïdentifiseer.* ✓
- *IUPAC-naam heeltemal korrek insluitende nommering, volgorde, koppeltekens en kommas.* ✓ (3)

2.2.5 C_nH_{2n} ✓ (1)

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

2.4
2.4.1 Carboxylic acids/*Karboksielsure* ✓ (1)

2.4.2



✓ ✓

Marking criteria/*Nasienkriteria*:
- Whole structure correct/
  Hele struktuur korrek: $\frac{2}{2}$
- Only functional group correct/*Slegs funksionele groep korrek:* Max/*Maks.*: $\frac{1}{2}$

IF/*INDIEN*
More than one functional group:
Meer as een funksionele groep: $\frac{0}{2}$

IF/*INDIEN*
- Molecular formula/*Molekulêre formule* $\frac{0}{2}$
- Condensed structural formula /*Gekondenseerde struktuurformule* $\frac{1}{2}$

(2)

2.5
2.5.1 Ethanol/*Etanol* ✓ (1)

2.5.2 E ✓ **ACCEPT/*AANVAAR*:** C_2H_4 (1)

2.5.3 (Concentrated) sulphuric acid/H_2SO_4/(concentrated) phosphoric acid/H_3PO_4 ✓
(Gekonsentreerde) swawelsuur/ H_2SO_4/(gekonsentreerde) fosforsuur/ H_3PO_4 (1)
[18]

QUESTION 3/*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 solid and liquid phases are in equilibrium. ✓✓
Die temperatuur waarby die vastestof- en vloeistoffases van 'n stof in ewewig is. (2)

3.2

Marking criteria
- Identification of independent variable. ✓
- Stating the relationship between dependent and independent variable. ✓

Nasienkriteria
- *Identifikasie van onafhanklike veranderlike.* ✓
- *Stel verwantskap tussen afhanklike en onafhanklike veranderlikes*. ✓

- As the chain length/number of C atoms/molecular mass/surface area/strength of the intermolecular forces ✓ increases, the melting points increase. ✓
  OR
- As the chain length/ number of C atoms/molecular mass/surface area/strength of the intermolecular forces ✓ decreases, the melting points decrease. ✓

- *Wanneer die kettinglengte/aantal C-atome/molekulêre massa/oppervlak-area/sterkte van intermolekulêre kragte ✓ toeneem, neem die smeltpunte toe.*
  OF
- *Wanneer die kettinglengte/aantal C-atome/molekulêre massa/oppervlak-area/sterkte van intermolekulêre kragte afneem, neem die smeltpunte af.* (2)

3.3 London forces ✓
Londonkragte (1)

ACCEPT/*AANVAAR*
Dispersion forces/induced dipole forces
Dispersiekragte/geïnduseerde dipoolkragte

3.4

3.4.1 Liquid/*Vloeistof* ✓ (1)

3.4.2 Solid/*Vaste stof* ✓ (1)

3.5

3.5.1 Equal to/*Gelyk aan* ✓

Same molecular formula/Isomers/same number and types of atoms/same number of C and H atoms ✓
Dieselfde molekulêre formule/Isomere/dieselfde aantal en soort atome/ dieselfde aantal C- en H-atome (2)

3.5.2 Lower than/*Laer as* ✓ (1)

3.5.3

Marking criteria:
- Compare structures. ✓
- Compare the strength of intermolecular forces.✓
- Compare the energy required to overcome intermolecular forces. ✓

2,2-dimethylbutane:
- **Structure:**
  More branched/more compact/more spherical/smaller surface area (over which intermolecular forces act).✓
- **Intermolecular forces*:***
  Weaker/less intermolecular forces/Van der Waals forces/London forces/dispersion forces. ✓
- **Energy:**
  Lesser energy needed to overcome or break intermolecular forces/Van der Waals forces. ✓

OR

Hexane
- **Structure:**
  Longer chain length/unbranched/less compact/less spherical/larger surface area (over which intermolecular forces act). ✓
- **Intermolecular forces*:***
  Stronger/more intermolecular forces/Van der Waals forces/London forces/dispersion forces. ✓
- **Energy:**
  More energy needed to overcome or break intermolecular forces/Van der Waals forces. ✓

Nasienkriteria:
- *Vergelyk strukture* ✓
- *Vergelyk die sterkte van intermolekulêre kragte.* ✓
- Vergelyk die energie benodig om intermolekulêre kragte te oorkom. ✓

***2,2-dimetielbutaan*:**
- ***Struktuur*:**
  Meer vertak/meer kompak/meer sferies/kleiner oppervlak (waaroor intermolekulêre kragte werk). ✓
- ***Intermolekulêre kragte:***
  Swakker/minder intermolekulêre kragte/Van der Waalskragte/London-kragte/dispersiekragte. ✓
- ***Energie*:**
  Minder energie benodig om intermolekulêre kragte/Van der Waalskragte/ dispersiekragte/Londonkragte te oorkom/breek. ✓

OF

Heksaan
- ***Struktuur*:**
  Langer kettinglengte/onvertak/minder kompak/minder sferies/groter oppervlak (waaroor intermolekulêre kragte werk). ✓
- ***Intermolekulêre kragte:***
  Sterker/meer intermolekulêre kragte/Van der Waalskragte/Londonkragte/ dispersiekragte. ✓
- ***Energie*:**
  Meer energie benodig om intermolekulêre kragte/Van der Waalskragte/ dispersiekragte/Londonkragte te oorkom/breek. ✓

(3)
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QUESTION 4/*VRAAG 4*

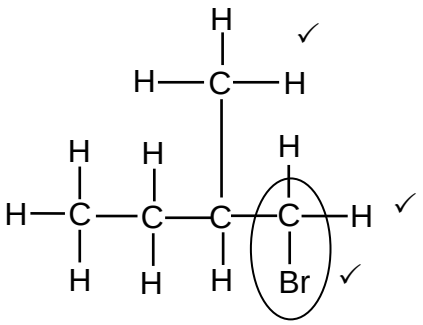
4.1

4.1.1 Substitution/Hydrolysis ✓
Substitusie/Hidrolise (1)

4.1.2 Primary (alcohol) ✓
ANY ONE:
- The C atom of the functional group is the terminal C atom.
- The C-atom bonded to the hydroxyl/-OH is bonded to (only) one other C-atom. ✓
- The hydroxyl/-OH is bonded to a C-atom which is bonded to two hydrogen atoms.
- The hydroxyl/-OH is bonded to a primary C atom/terminal C atom/first C atom.

Primêre (alkohol) ✓
ENIGE EEN:
- *Die C-atoom van die funksionele groep is die terminale C-atoom.*
- *Die C-atoom wat aan die hidroksiel/-OH gebind is, is aan (slegs) een ander C-atoom gebind.* ✓
- *Die hidroksiel/-OH is gebind aan 'n C-atoom wat aan twee waterstofatome gebind is.*
- *Die hidroksiel/-OH is aan 'n primêre C-atoom/*terminale C-atoom/eerste C-atoom gebind. (2)

4.1.3



✓ ✓ ✓

Marking criteria:
- Four C atoms in longest chain. ✓
- One methyl substituent on C2. ✓
- Bromo substituent on C1. ✓

Nasienkriteria:
- *Vier C-atome in langste ketting.* ✓
- *Een metielsubstituent op C2.* ✓
- *Broomsubstituent op C1.* ✓

IF/*INDIEN*
Any error e.g. omission of H atoms, condensed or semi structural formula/*Enige fout bv. weglating van H-atome, gekondenseerde of semi-struktuurformule.* Max/*Maks.*: 2/3 (3)

4.1.4 Elimination/dehydrohalogenation/dehydrobromination ✓
Eliminasie/dehidrohalogenering/dehidrohalogenasie/dehidrobrominasie/dehidrobromonering (1)

4.1.5 Alkenes/*Alkene* ✓ (1)

4.1.6 Addition/*Addisie* ✓ (1)

4.1.7 2-bromo-2-methyl✓butane ✓
2-bromo-2-metiel✓butaan ✓ (2)

4.2 **NOTE/*LET WEL*:**
- Penalise only once for the use of structural formulae or molecular formulae.
- *Penaliseer slegs een keer vir die gebruik van struktuurformules of molekulêre formules.*

4.2.1 **Marking criteria:**
- Correct condensed structure for but-2-ene. ✓
- React but-2-ene with H_2/H — H. ✓
- Indicate the catalyst Pt/Ni/Pd on arrow/at the equation. ✓
- Correct condensed formula for butane as product. ✓

IF: Any additional products or reactants - minus 1 mark

Nasienkriteria:
- *Korrekte gekondenseerde struktuur vir but-2-een.* ✓
- *Reageer but-2-een met H_2*/H — H. ✓
- *Dui die katalisator Pt/Ni/Pd op die pyl/by die vergelyking aan*. ✓
- *Korrekte gekondenseerde formule vir butaan as produk.* ✓

***INDIEN:** Enige addisionele reaktanse of produkte – minus 1 punt*

$$CH_3CHCHCH_3 \checkmark + H_2 \checkmark \xrightarrow{Pt/Ni/Pd \checkmark} CH_3CH_2CH_2CH_3 \checkmark$$

ACCEPT/*AANVAAR*
As reactant/*reaktans*: $CH_3(CH)_2CH_3$ / $CH_3CH = CHCH_3$ / $CH_3 — CH = CH — CH_3$
As product/*produk*: $CH_3(CH_2)_2CH_3$ / $CH_3 — CH_2 — CH_2 — CH_3$ /$CH_3 — (CH_2)_2 — CH_3$ (4)

4.2.2 Elimination/Cracking ✓
Eliminasie/Kraking (1)

4.2.3 Propene/1-propene/prop-1-ene ✓✓
Propeen/1-propeen/prop-1-een (2)

4.2.4 **Marking criteria:**
- Correct condensed formula for propene as reactant. ✓
- React (propene) with Br_2/Br — Br ✓
- Correct condensed formula for 1,2-dibromopropane as product. ✓

IF: Any additional products or reactants - minus 1 mark

Nasienkriteria:
- *Korrekte gekondenseerde formule vir propeen as reaktans.* ✓
- *Reageer* (propeen) met *Br_2*/Br — Br. ✓
- *Korrekte gekondenseerde formule vir 1,2-dibromopropaan as produk.* ✓

***INDIEN:** Enige addisionele reaktanse of produkte – minus 1 punt*

$$CH_3CHCH_2 \checkmark + Br_2 \checkmark \longrightarrow CH_3CHBrCH_2Br \checkmark$$

ACCEPT/*AANVAAR:*
As reactant/*reaktans*: $CH_3CH = CH_2$ / $CH_2 = CHCH_3$
As product/*produk*: $CH_3CHBrCH_2Br$ / $CH_3 — \underset{\displaystyle Br}{\underset{|}{CH}} — \underset{\displaystyle Br}{\underset{|}{CH_2}}$ /

$BrCH_2CHBrCH_3$ / $\underset{\displaystyle Br}{\underset{|}{CH_2}} — \underset{\displaystyle Br}{\underset{|}{CH}} — CH_3$

(3)
[21]

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 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 of moles/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 mol/getal mol/ volume/ massa.* ✓✓ **(2 *of* 0)** (2)

5.2 Reaction rate decreases./Concentration of HCℓ decreases./Concentration of reactant decreases./Reactants are used up/Mass of $CaCO_3$ decreases or is used up. ✓
Reaksietempo neem af./Konsentrasie van HCℓ neem af./Konsentrasie van reaktans neem af./Reaktanse word opgebruik./Massa van $CaCO_3$ neem af of word opgebruik. ✓ (1)

5.3

5.3.1 Exothermic/*Eksotermies* ✓ (1)

5.3.2

- Gradient increases/becomes steeper. / Curve becomes steeper. ✓
- Reaction rate increases/More (or larger volume) of CO_2 is produced per unit time. ✓
- Temperature increases./Energy is released/Average kinetic energy of the molecules increases. ✓

- *Gradiënt neem toe/word steiler. / Kurwe word steiler*. ✓
- *Reaksietempo neem toe./Meer (of groter volume) CO_2 word produseer per eenheidtyd.* ✓
- *Temperatuur neem toe./Energie word vrygestel./Gemiddelde kinetiese energie van molekule neem toe.* ✓ (3)

5.4

Marking criteria

- m(pure $CaCO_3$) = $\frac{82,5}{100}$ x 15 ✓ / $V(CO_2)$ = $\frac{82,5}{100}$ x $V(CO_2)$ from/*uit* 15 g $CaCO_3$
- Divide by 100 $g \cdot mol^{-1}$. ✓
- Use mol ratio: $n(CO_2) = n(CaCO_3)$. ✓
- Multiply $n(CO_2)$ by 24 000 cm^3/24 dm^3. ✓
- Final answer: 2 976 cm^3 ✓
- **Range*:*** 2880 to 2970 cm^3 / 2,88 to 2,97 dm^3

Nasienkriteria

- m(*suiwer* $CaCO_3$) = $\frac{82,5}{100}$ *x 15* ✓ */ V(CO_2)* = $\frac{82,5}{100}$ *x V(CO_2) uit 15 g $CaCO_3$*
- *Deel deur 100 $g \cdot mol^{-1}$.* ✓
- *Gebruik molverhouding*: $n(CO_2) = n(CaCO_3)$. ✓
- *Vermenigvuldig* $n(CO_2)$ *met* 24 000 cm^3/24 dm^3. ✓
- *Finale antwoord*: 2 976 cm^3 ✓
  Gebied: 2880 *tot* 2970 cm^3 / 2,88 tot 2,97 dm^3

OPTION 1/*OPSIE 1*

m(pure/*suiwer* $CaCO_3$) = $\frac{82,5}{100}$ x 15 ✓
= 12,375 g

n(pure/*suiwer* $CaCO_3$) = $\frac{m}{M}$
= $\frac{12,375}{100}$ ✓
= 0,124 mol

$n(CO_2) = n(CaCO_3)$
= 0,124 mol ✓

$V(CO_2)$ = 0,124 x 24 000 ✓
= 2 976 cm^3 ✓

OR/*OF*

$V(CO_2)$ = 0,124 x 24 ✓
= 2,98 dm^3 ✓

OPTION 2/*OPSIE 2*

IF 15 g **PURE** $CaCO_3$ reacts:
INDIEN *15 g* ***SUIWER*** *$CaCO_3$ reageer:*

$n(CaCO_3) = \frac{m}{M}$
= $\frac{15}{100}$ ✓
= 0,15 mol

$n(CO_2) = n(CaCO_3)$ ✓
= 0,15 mol

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

0,15 = $\frac{V}{24\ 000}$ ✓ / 0,15 = $\frac{V}{24}$

V = 3 600 cm^3 / V = 3,6 dm^3

Actual CO_2 formed:
W*erklike CO_2 gevorm:*

$V(CO_2)$ = $\frac{82,5}{100}$ x 3 600 / 3,6 ✓
= 2 976 cm^3 / 2,976 dm^3 ✓ (5)

OPTION 3/*OPSIE 3*

IF 15 g **PURE** $CaCO_3$ reacts:/***INDIEN*** *15 g* ***SUIWER*** *$CaCO_3$ reageer:*

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

$= \frac{15}{100}$ ✓

$= 0,15$ mol

$n(CO_2) = n(CaCO_3)$ ✓

$= 0,15$ mol

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

$m(CO_2) = 0,15 \times 44$

$= 6,6$ g

$82,5 = \frac{m_{actual/\ werklik}}{6,6} \times 100$ ✓

$m_{(actual/werklik)} = 5,445$ g

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

$= \frac{5,445}{44}$

$= 0,12375$ mol

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

$0,12375 = \frac{V}{24\ 000}$ ✓ / $0,12375 = \frac{V}{24}$

$V = 2\ 976\ cm^3 / 2,976\ dm^3$ ✓ (5)

5.5 Increases/*Toeneem* ✓ (1)

5.6
- More ($CaCO_3$) particles with correct orientation/exposed./ Greater (exposed) surface area. ✓
- More effective collisions per unit time./Higher frequency of effective collisions. ✓

- *Meer ($CaCO_3$)-deeltjies met korrekte oriëntasie/blootgestel./ Groter (blootgestelde) reaksieoppervlakte.* ✓
- *Meer effektiewe botsings per eenheid tyd./Hoër frekwensie van effektiewe botsings.*✓

NOTE/*LET WEL*
- If explanation in terms of CONCENTRATION: No mark for bullet 1.
  Indien verduideliking in terme van KONSENTRASIE: Geen punt vir kolpunt 1.
- Bullets are marked independently./*Kolpunte word onafhanklik nagesien.*

(2)

[15]

QUESTION 6/*VRAAG 6*

6.1 (The stage in a chemical reaction when the) rate of forward reaction equals the rate of reverse reaction. ✓✓ **(2 or 0*)***
OR
(The stage in a chemical reaction when the) concentrations of reactants and products remain constant. **(2 or 0*)***

(Die stadium in 'n chemiese reaksie wanneer die) tempo van die voorwaartse reaksie gelyk is aan die tempo van die terugwaartse reaksie. **(2 *of* 0*)***
OF
(Die stadium in 'n chemiese reaksie wanneer die) konsentrasies van reaktanse en produkte konstant bly. **(2 *of* 0*)*** (2)

6.2
6.2.1 Negative/*Negatief* ✓ (1)

6.2.2
- Increase in temperature favours an endothermic reaction. **Accept:** Decrease in temperature favours an exothermic. ✓
- Reverse reaction is favoured./Concentration of reactants increases./ Concentration of products decreases. ✓
- (Forward) reaction is exothermic. **Accept:** Reverse reaction is endothermic. ✓

- *Toename in temperatuur bevoordeel 'n endotermiese reaksie.* ✓ ***Aanvaar:*** *Afname in temperatuur bevoordeel die eksotermiese reaksie.*
- *Terugwaartse reaksie word bevoordeel./Konsentrasie van reaktanse neem toe./Konsentrasie van produkte neem af.* ✓
- *(Voorwaartse) reaksie is eksotermies.* ***Aanvaar:*** *Terugwaartse reaksie is endotermies.* ✓ (3)

6.2.3

CALCULATIONS USING NUMBER OF MOLES
BEREKENINGE WAT GETAL MOL GEBRUIK

Marking criteria*:*
a) Initial n(P) and n(Q_2) and n(PQ) from table. ✓
b) Change in n(P) = equilibrium n(P) – initial n(P).✓
c) **USING** ratio: P : Q_2 : PQ = 2 : 1 : 2 ✓
d) Equilibrium n(Q_2) = initial n(Q_2) + change in n(Q_2)
Equilibrium n(PQ) = initial n(PQ) - change in n(PQ) } ✓
e) Divide **equilibrium** amounts of P and Q_2 and PQ by 2 dm^3. ✓
f) Correct K_c expression (formulae in square brackets). ✓
g) Substitution of equilibrium concentrations into K_c expression. ✓
h) Final answer: 10,889 ✓

Nasienkriteria*:
a) Aanvanklike n(P) en n(Q_2) en n(PQ) uit tabel.✓
b) Verandering in n(P) = ewewigs n(P) – aanvanklike n(P).✓
c) ***GEBRUIK*** *verhouding:* P : Q_2 : PQ = 2 : 1 : 2 ✓
d) Ewewig n(Q_2) = aanvanklike n(Q_2) + verandering in n(Q_2)
Ewewig n(PQ) *= aanvanklike n(PQ) - verandering in n(PQ)* } ✓
e) Deel ***ewewigs****hoeveelhede van P en Q_2 en PQ deur 2 dm^3.* ✓
f) Korrekte K_c-uitdrukking (formules in vierkanthakies). ✓
g) Vervanging van ewewigskonsentrasies in K_c-uitdrukking. ✓
h) Finale antwoord: 10,89 / 10,889 ✓

(3)

OPTION 1/*OPSIE 1*

	P	Q_2	PQ	
Initial quantity (mol) *Aanvangshoeveelheid (mol)*	0,8	0,8	3,2	✓(a)
Change (mol) *Verandering (mol)*	0,4 ✓(b)	0,2	0,4	✓(c)
Quantity at equilibrium (mol)/ *Hoeveelheid by ewewig (mol)*	1,2	1,0	2,8	✓(d)
Equilibrium concentration ($mol \cdot dm^{-3}$) *Ewewigskonsentrasie ($mol \cdot dm^{-3}$)*	0,6	0,5	1,4	✓(e)

$$K_c = \frac{[PQ]^2}{[Q_2][P]^2} \checkmark(f)$$

$$= \frac{1{,}4^2}{(0{,}5)(0{,}6)^2} \checkmark(g)$$

$$= 10{,}89 \checkmark(h)$$

No K_c expression, correct substitution/*Geen K_c-uitdrukking*, *korrekte substitusie*: Max./*Maks.* $\frac{7}{8}$

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

OPTION 2/*OPSIE 2*

	PQ	P	Q_2
Initial quantity (mol) *Aanvangshoeveelheid (mol)*	3,2	0,8	0,8 ✓(a)
Change (mol) *Verandering (mol)*	0,4	0,4 ✓(b)	0,2 ✓(c)
Quantity at equilibrium (mol)/ *Hoeveelheid by ewewig (mol)*	2,8	1,2 ✓(d)	1,0
Equilibrium concentration ($mol \cdot dm^{-3}$) *Ewewigskonsentrasie ($mol \cdot dm^{-3}$)*	1,4	0,6	0,5 ✓(e)

Reverse reaction
Terugwaartse reaksie:

$K_c = \frac{[P]^2[Q_2]}{[PQ]^2}$ ✓(f)

$= \frac{(0,6)^2(0,5)}{(1,4)^2}$ ✓(g)

$K_c = 0,09$

No K_c expression, correct substitution/*Geen K_c-uitdrukking*, *korrekte substitusie*: Max./*Maks.* $\frac{7}{8}$
Wrong K_c expression/*Verkeerde K_c-uitdrukking*: Max./M*aks.* $\frac{5}{8}$

Forward reaction/*Voorwaartse reaksie:*

$K_c = \frac{1}{0,09}$

$= 10,89$ ✓ (h)

CALCULATIONS USING NUMBER OF MOLES
BEREKENINGE WAT GETAL MOL GEBRUIK

Marking criteria:

a) Initial n(P) = 4 mol and n(Q_2) = 2,4 mol and n(PQ) = 0 ✓
b) Change in n(P) = equilibrium n(P) – initial n(P) = 2,8 mol.✓
c) USING ratio: P : Q_2 : PQ = 2 : 1 : 2 ✓
d) Equilibrium n(Q_2) = initial n(Q_2) + change in n(Q_2)
Equilibrium n(PQ) = initial n(PQ) - change in n(PQ) } ✓
e) Divide equilibrium amounts of P and Q2 and PQ by 2 dm^3. ✓
f) Correct Kc expression (formulae in square brackets). ✓
g) Substitution of equilibrium concentrations into K_c expression. ✓
h) Final answer: 10,89 / 10,889 ✓

Nasienkriteria:

a) Aanvanklike n(P) = 4 mol en n(Q_2) = 2,4 mol en n(PQ) = 0.✓
b) Verandering in n(P) = ewewigs n(P) – aanvanklike n(P) = 2,8 mol.✓
c) GEBRUIK verhouding: P : Q_2 : PQ = 2 : 1 : 2 ✓
d) Ewewig n(Q_2) = aanvanklike n(Q_2) + verandering in n(Q_2)
Ewewig n(PQ) = aanvanklike n(PQ) - verandering in n(PQ) } ✓
e) Deel ewewigshoeveelhede van P en Q_2 en PQ deur 2 dm^3. ✓
f) Korrekte K_c-uitdrukking (formules in vierkanthakies). ✓
g) Vervanging van ewewigskonsentrasies in K_c-uitdrukking. ✓
h) Finale antwoord: 10,89 / 10,889 ✓

OPTION 3/*OPSIE 3*

	P	Q_2	PQ	
Initial quantity (mol) *Aanvangshoeveelheid (mol)*	4	2,4	0	✓(a)
Change (mol) *Verandering (mol)*	2,8 ✓(b)	1,4	2,8	✓(c)
Quantity at equilibrium (mol)/ *Hoeveelheid by ewewig (mol)*	1,2	1,0	2,8	✓(d)
Equilibrium concentration ($mol \cdot dm^{-3}$) *Ewewigskonsentrasie ($mol \cdot dm^{-3}$)*	0,6	0,5	1,4	✓(e)

$$K_c = \frac{[PQ]^2}{[Q_2][P]^2} \checkmark(f)$$

$$= \frac{1,4^2}{(0,5)(0,6)^2} \checkmark(g)$$

= 10,89 ✓ (h)

No K_c expression, correct substitution/*Geen K_c-uitdrukking*, *korrekte substitusie*: Max./*Maks.* $\frac{7}{8}$

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

CALCULATIONS USING CONCENTRATION
BEREKENINGE WAT KONSENTRASIE GEBRUIK

Marking criteria*:*
a) Initial c(P) and c(Q_2) and c(PQ) from table. ✓
b) Change in c(P) = equilibrium c(P) – initial c(P). ✓
c) **USING** ratio*:* P : Q_2 : PQ = 2 : 1 : 2 ✓
d) Equilibrium c(Q_2) = initial c(Q_2) + change in c(Q_2)
Equilibrium c(PQ) = initial c(PQ) - change in c(PQ) } ✓
e) Divide **initial** amounts of P and Q_2 and PQ by 2 dm^3. ✓
f) Correct K_c expression (formulae in square brackets). ✓
g) Substitution of equilibrium concentrations into K_c expression. ✓
h) Final answer: 10,89 / 10,889 ✓

***Nasienriglyne*:**
a) Aanvanklike c(P) en c(Q_2) en c(PQ) uit tabel.✓
b) Verandering in c(P) = ewewigs c(P) – aanvanklike c(P).
c) ***GEBRUIK*** *verhouding:* P : Q_2 : PQ = 2 : 1 : 2 ✓
d) Ewewig c(Q_2) = aanvanklike c(Q_2) + verandering in c(Q_2)
Ewewig c(PQ) *= aanvanklike c(PQ) - verandering in c(PQ)* } ✓
e) Deel ***aanvangs****hoeveelhede van P en Q_2 en PQ deur 2 dm^3.* ✓
f) Korrekte K_c-uitdrukking (formules in vierkanthakies). ✓
g) Vervanging van ewewigskonsentrasies in K_c-uitdrukking. ✓
h) Finale antwoord: 10,89 / 10,889 ✓

OPTION 4/*OPSIE 4*

	P	Q_2	PQ	
Initial concentration (mol·dm^{-3}) Aanvangskonsentrasie (mol·dm^{-3})	0,4	0,4	1,6 ✓(a)	✓(e)
Change in concentration (mol·dm^{-3}) *Verandering in* konsentrasie (mol·dm^{-3})	0,2 ✓(b)	0,1	0,2	✓(c)
Equilibrium concentration (mol·dm^{-3}) *Ewewigskonsentrasie (mol·dm^{-3})*	0,6	0,5	1,4	✓ (d)

$$K_c = \frac{[PQ]^2}{[Q_2][P]^2}$$ ✓ (f)

$$= \frac{1{,}4^2}{(0{,}5)(0{,}6)^2}$$ ✓ (g)

= 10,89 ✓ (h)

No K_c expression, correct substitution/*Geen K_c-uitdrukking*, *korrekte substitusie*: Max./*Maks.* $\frac{7}{8}$

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

(8)

6.2.4 Remains the same/*Bly dieselfde* ✓

Only temperature can change K_c./Temperature remains constant. ✓
Slegs temperatuur kan K_c verander./Temperatuur bly konstant. (2)

6.3
6.3.1 Increases/*Toeneem* ✓ (1)

6.3.2 Decreases/*Afneem* ✓ (1)
[18]

QUESTION 7/VRAAG 7

7.1

7.1.1 (It is a) proton/H_3O^+ (ion)/H^+ (ion) donor. ✓✓
(Dit is 'n) proton/H_3O^+-(ioon)/H^+-(ioon)skenker. (2)

7.1.2 HSO_4^-/hydrogen sulphate ion/*waterstofsulfaatioon* ✓

ANY ONE:
- It acts as base in reaction **I** and as acid in reaction **II**. ✓
- Acts as acid and base.

ENIGE EEN:
- *Dit reageer as basis in reaksie **I** en as suur in reaksie **II**.*
- *Reageer as suur en basis.* (2)

7.1.3 HSO_4^-/Reaction (solution) II/*Reaksie (oplossing) II* ✓

Smaller K_a value/weaker acid ✓
Lower ion concentration/Incompletely ionised. ✓

Kleiner K_a-waarde/swakker suur ✓
Laer ioonkonsentrasie/Onvolledig geïoniseer. ✓ (3)

7.2

7.2.1

OPTION 1/*OPSIE 1*	**OPTION 2/*OPSIE 2***
$pH = -\log[H_3O^+]$ ✓ 1,02 ✓$= -\log[H_3O^+]$ $[H_3O^+] = 0{,}0955$ mol·dm^{-3} ✓ Therefore/*Dus* [HCℓ] = 0,0955 mol·dm^{-3} (0,096/0,1 mol·dm^{-3})	$pH = -\log[H_3O^+]$ $[H_3O^+] = 10^{-pH}$ ✓Any one/*Enige* $= 10^{-1,02}$ ✓ = 0,0955 mol·dm^{-3} ✓ Therefore/*Dus* [HCℓ] = 0,0955 mol·dm^{-3} (0,096/0,1 mol·dm^{-3})

(3)

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

Marking citeria:

- Formula: $c = \frac{n}{V} / \frac{c_a V_a}{c_b V_b} = \frac{n_a}{n_b}$ ✓
- Calculate $n(Na_2CO_3)$: 0,075 x 0,025 ✓
- Calculate n(HCℓ): 0,0955 x 0,05 / 0,096 x 0,05 ✓
- Use ratios: $n(HC\ell) = 2n(Na_2CO_3)$ ✓
- $n(HC\ell)_{excess} = n(HC\ell)_{initial} - n(HC\ell)_{used}$ = 0,00475 – 0,0038 ✓✓
- Substitute 0,075 dm^3 in $c = \frac{n}{V}$ ✓
- Final answer: 0,013 mol·dm^{-3} ✓ (1,3 x 10^{-2} mol·dm^{-3})

  Range: 0,01 to 0,02 mol·dm^{-3}

Nasienkriteria:

- *Formule*: $c = \frac{n}{V} / \frac{c_a V_a}{c_b V_b} = \frac{n_a}{n_b}$ ✓
- *Bereken* $n(Na_2CO_3)$: 0,075 x 0,025 ✓
- *Bereken* n(HCℓ): 0,0955 x 0,05 / 0,096 x 0,05 ✓
- *Gebruik molverhouding*: $n(HC\ell) = 2n(Na_2CO_3)$ ✓
- $n(HC\ell)_{oormaat} = n(HC\ell)_{aanvanklik} - n(HC\ell)_{gebruik}$ = 0,00475 – 0,0038 ✓✓
- *Vervang* 0,075 dm^3 in $c = \frac{n}{V}$ ✓
- *Finale antwoord*: 0,013 mol·dm^{-3} ✓ (1,3 x 10^{-2} mol·dm^{-3})

  ***Gebied:** 0,01 tot 0,02 mol·dm^{-3}*

OPTION 1/*OPSIE 1*

$n(Na_2CO_3) = cV$ ✓
= 0,075 x 0,025 ✓
= 0,001875 mol (1,875 x 10^{-3}/0,002 mol)

$n(HC\ell)_{initial/aanvanklik} = cV$
= 0,096 x 0,05 ✓
= 0,00475 mol (4,75 x 10^{-3}/0,005 mol)

$n(HC\ell)_{used/gebruik} = 2n(Na_2CO_3)$ ✓
= 2(0,001875)
= 0,0038 mol (3,75 x 10^{-3}/0,004 mol)

$n(HC\ell)_{excess/oormaat}$ = 0,00475 – 0,0038 ✓✓
= 0,00095mol (9,5 x 10^{-4}/1 x 10^{-3} mol)

$c(HC\ell) = \frac{n}{V}$
$= \frac{0,00095}{0,075}$ ✓
= 0,013 mol·dm^{-3} ✓ (1,3 x 10^{-2} mol·dm^{-3})

OPTION 2/*OPSIE 2*

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

$\frac{c_a(50)✓}{(0,075)(25)✓} = \frac{2}{1}$ ✓

$c(HCℓ)_{rea} = 0,075 \text{ mol·dm}^{-3}$

$c(HCℓ)_{excess/oormaat} = 0,0955 - 0,075$ ✓✓
$= 0,0205 \text{ mol·dm}^{-3}$

$c_1V_1 = c_2V_2$
$(0,0205)(50) = c_2(75)$ ✓
$c_2 = 0,014 \text{ mol·dm}^{-3}$ ✓ (8)

[18]

QUESTION 8/*VRAAG 8*

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

8.2

Marking criteria:

- Any formula: $c = \frac{m}{MV} / c = \frac{n}{V} / n = \frac{m}{M}$ ✓
- Substitute 1 mol·dm^{-3}.✓
- Substitute 170 g·mol^{-1} [or 108 + 14 + 3(16)] and 0,15 dm^3 in correct formulae. ✓
- Final answer: 25,50 g ✓

Nasienkriteria:

- *Enige formule*: $c = \frac{m}{MV} / c = \frac{n}{V} / n = \frac{m}{M}$ ✓
- *Vervang 1* mol·dm^{-3}.✓
- *Vervang 170 g·mol^{-1} [of 108 + 14 + 3(16)] en 0,15 dm^3 in korrekte formules*. ✓
- *Finale antwoord*: 25,50 g ✓

OPTION 1/*OPSIE 1*

$c = \frac{m}{MV}$ ✓

✓
$1 = \frac{m}{170 \times 0,15}$ ✓

$m = 25,50$ g ✓

OPTION 2/*OPSIE 2*

$n = cV$ ✓
$= 1$ ✓ x 0,15
$= 0,15$ mol ✓

$m = nM$
$= (0,15)(170)$
$= 25,50$ g ✓ (4)

8.3 **ANY ONE:**

- A substance that loses/donates electrons. ✓✓
- A substance that is oxidised.
- A substance whose oxidation number increases.

ENIGE EEN:

- *'n Stof wat elektrone verloor/skenk.* ✓✓
- *'n Stof wat geoksideer word.*
- *'n Stof wat waarvan die oksidasiegetal toeneem.* (2)

8.4

8.4.1 Copper/Cu/*Koper* ✓ (1)

8.4.2

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.*

$Cu(s) + 2Ag^+(aq)$ ✓ → $Cu^{2+}(aq) + 2Ag(s)$ ✓ Bal ✓

ACCEPT/*AANVAAR:*

$Cu(s) + 2AgNO_3(aq)$ ✓ → $Cu(NO_3)_2(aq) + 2Ag(s)$ ✓ Bal ✓

NOTE/*LET WEL*

- **IF** electrons are not cancelled – minus 1 mark
- ***INDIEN*** *elektrone nie gekanselleer is nie – minus 1 punt* (3)

8.5

OPTION 1/*OPSIE 1*	**Notes/*Aantekeninge***
$E^\theta_{cell} = E^\theta_{reduction} - E^\theta_{oxidation}$ ✓ = 0,80 ✓ – (0,34) ✓ = 0,46 V ✓	• Accept any other correct formula from the data sheet./*Aanvaar enige ander korrekte formule vanaf gegewensblad.* • Any other formula using unconventional abbreviations, e.g. $E°_{cell} = E°_{OA} - E°_{RA}$ followed by correct substitutions:/*Enige ander formule wat onkonvensionele afkortings gebruik bv.* $E°_{sel} = E°_{OM} - E°_{RM}$ *gevolg deur korrekte vervangings:* $^3/_4$
OPTION 2/*OPSIE 2*	
$2Ag^+ + 2e^- \rightarrow 2Ag$ ✓ E^θ = 0,80 V ✓ $Cu \rightarrow Cu^{2+} + 2e^-$ E^θ = - 0,34 V ✓ $2Ag^+ + Cu \rightarrow 2Ag + Cu^{2+}$ E^θ = +0,46 V ✓	

(4)

8.6 Decreases/*Afneem* ✓ (1)

[16]

QUESTION 9/*VRAAG 9*

9.1 **ANY ONE*:* (2 or 0)**

- A substance whose (aqueous) solution contains ions. ✓✓
- Substance that dissolves in water to give a solution that conducts electricity.
- A substance that forms ions in water / when melted.
- A solution that conducts electricity through the movement of ions.

ENIGE EEN*: *(2 of 0)

- *'n Stof waarvan die oplossing ione bevat.* ✓✓
- *'n Stof wat in water oplos om 'n oplossing te vorm wat elektrisiteit gelei.*
- *'n Stof wat ione in water vorm/ wanneer dit gesmelt word.*
- *'n Oplossing wat elektrisiteit gelei deur die beweging van ione.* (2)

9.2 Anode ✓

Chromium is oxidised./Oxidation takes place (at the anode)./Chromium (it) loses electrons./Mass decreases./$Cr \rightarrow Cr^{3+} + 3e^-$ ✓
Chroom word geoksideer./Oksidasie vind (by die anode) plaas./Chroom (dit) verloor elektrone./Massa neem af./$Cr \rightarrow Cr^{3+} + 3e^-$

NOTE/*LET WEL*:
If half-reaction is used, it must be correct/*Indien halfreaksie gebruik word, moet dit korrek wees*: $Cr \rightarrow Cr^{3+} + 3e^-$ (2)

9.3 $Cr^{3+}(aq) + 3e^- \rightarrow Cr(s)$ ✓✓

Ignore phases./*Ignoreer fases*.

Marking guidelines/*Nasienkriteria*

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

9.4

Marking criteria:

- Substitute 52 g·mol^{-1} in $n = \frac{m}{M}$ /ratio ✓
- Use mol ratio: n(electrons): n(Cr) = 3 : 1. ✓
- Number of electrons = n x 6,02 x 10^{23}/No of *Cr atoms = n x 6,02 x 10^{23}*/ratio. ✓
- Total charge = number of electrons x 1,6 x 10^{-19}/ratio. ✓
- Final answer: 11 113,85 C ✓
  Range*: 11 076,8 to 11 580 C*

Nasienkriteria:

- *Vervang 52 g·mol^{-1} in $n = \frac{m}{M}$ /verhouding* ✓
- *Gebruik molverhouding: n(elektrone) : n(Cr^{3+}) = 3 : 1.* ✓
- *Aantal elektrone = n x 6,02 x 10^{23}/Aantal Cr-atome = n x 6,02 x 10^{23}/verhouding.*✓
- *Totale lading = aantal elektrone x 1,6 x 10^{-19}/verhouding.* ✓
- *Finale antwoord: 11 113,85 C* ✓
  Gebied: *11 076,8 tot 11 580 C*

OPTION 1/*OPSIE 1*

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

$= \frac{2}{52}$✓

= 0,038 mol (0,04 mol)

n(e$^-$) = 3n(Cr) ✓
= 3(0,038)
= 0,115 mol (0,12 mol)

Number (e$^-$) = 0,115 x 6,02 x 10^{23} ✓
= 6,946 x 10^{22}

Q = 6,95 x 10^{22} x 1,6 x 10^{-19} ✓
= 11 113,85 C ✓

OPTION 2/*OPSIE 2*

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

$= \frac{2}{52}$✓

= 0,038 mol (0,04 mol)

Number Cr atoms
= 0,038 x 6,02 x 10^{23} ✓
= 2,315 x 10^{22}

Number (e$^-$) = 3N(Cr) ✓
= 3(2,315 x 10^{22})
= 6,946 x 10^{22}

Q = 6,95 x 10^{22} x 1,6 x 10^{-19} ✓
= 11 113,85 C ✓

OPTION 3/*OPSIE 3*

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

$= \frac{2}{52}$✓

= 0,038 mol

n(e$^-$) = 3n(Cr) ✓
= 3(0,038)
= 0,115 mol

1 mol …. 96 500 C ✓
0,115 mol 11 134,62 C ✓✓

(5)
[11]

TOTAL/*TOTAAL*: 150