education

Department of Education
FREE STATE PROVINCE

PREPARATORY EXAMINATION
VOORBEREIDENDE EKSAMEN

GRADE/GRAAD 12

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

SEPTEMBER 2016

MARKS/*PUNTE*: 150

MEMORANDUM

This memorandum consists of 13 pages.
Hierdie memorandum bestaan uit 13 bladsye.

QUESTION 1/*VRAAG 1*

1.1 B ✓✓ (2)

1.2 B ✓✓ (2)

1.3 D ✓✓ (2)

1.4 B ✓✓ (2)

1.5 D ✓✓ (2)

1.6 B ✓✓ (2)

1.7 B ✓✓ (2)

1.8 D ✓✓ (2)

1.9 C ✓✓ (2)

1.10 C ✓✓ (2)

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QUESTION 2/*VRAAG 2*

2.1.1 E ✓ (1)

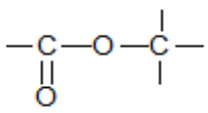
2.1.2 C ✓ (1)

2.1.3 A ✓ (1)

2.1.4 B ✓ (1)

2.2.1 (2)

✓✓



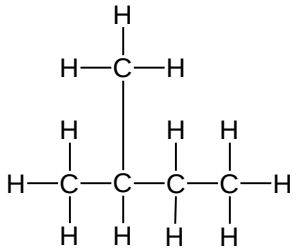
2.2.2 Ethanoic acid/*etanoësuur* ✓ and/*en* ethanol/*etanol*✓ (2)

2.3.1 Butan✓-2-one✓/Butanone/*Butan-2-oon/Butanoon* ✓✓ (2)

2.3.2 1,2-dibromo✓ butane/*Butaan* ✓ (2)

2.4 $CH_3CH_2\overset{O}{\overset{\|}{C}}CH_3$ /$C_2H_5CCH_3$ ✓✓ (2)

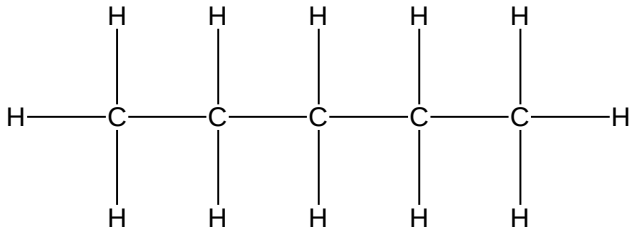
2.5.1 ✓✓



(2)

Marking criteria/*Nasienriglyne:*	
• Whole structure correct/*Hele struktuur korrek:*	$^2/_2$
• Only functional group correct/single bonds between carbon atoms*:* *Slegs funksionele groep korrek/enkel bindings tussen koolstofatome*	½

OR/OF

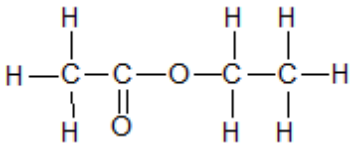


Notes/*Aantekeninge*:	
• If correct but hydrogens omitted/*Indien korrek maar waterstowwwe weggelaat*	Max./*Maks* ½
• Condensed formulae or semi structural formula/ *Gekondenseerde of semistrukturele formule*	Max./*Maks.* ½
• Molecular formula/*Molekulêre formule*	$^0/_2$

2.5.2

Marking criteria/*Nasienriglyne:*	
• Whole structure correct/*Hele struktuur korrek:*	$^2/_2$
• Only functional group correct/*Slegs funksionele groep korrek:*	½

✓✓



(2)
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QUESTION 3/*VRAAG 3*

3.1.1 Chain length/Molecular mass/Number of carbon atoms ✓
Kettinglengte/Molekulêre massa/Aantal koolstofatome (1)

3.1.2 Boiling point/*Kookpunt* ✓ (1)

3.1.3

Criteria for investigative question/*Riglyne vir ondersoekende vraag:*	
The dependent and independent variables are stated. *Die afhanklike en onafhanklike veranderlikes is genoem.*	✓
Gives the relationship between the independent and dependent variables./*Vra 'n vraag oor die verwantskap tussen die onafhanklike en afhanklike veranderlikes.*	✓

Examples/*Voorbeelde*:

- What is the relationship between chain length/molecular mass/number of carbon atoms and the boiling points of the organic compounds?
  Wat is die verwantskap tussen kettinglengte/molekulêre massa/aantal koolstofatome en die kookpunt van die organiese verbindings? (2)

3.2 Decreases/*Neem af* ✓

- **Structure/*Strukture:***
  The branching increases/surface area decreases. ✓
  Die vertakking neem toe/oppervlakte neem af
- **Intermolecular forces/*Intermolekulêre kragte:***
  Decrease in strength of intermolecular forces/or less intermolecular forces/Van der Waals forces/dispersion forces/London forces. ✓
  Afname in sterkte van intermolekulêre kragte/of minder intermolekulêre kragte/Van der Waalskragte/dispersiekragte/Londonkragte
- **Energy/*Energie:***
  Less energy needed to overcome or break intermolecular forces/Van der. Waals forces/dispersion forces /London forces. ✓
  Minder kragte nodig om intermolekulêre kragte te oorkom/Van der Waalskragte/dispersiekragte/Londonkragte (4)

*3.3.*1 Alkanes/Alkane✓ (1)

3.3.2 2,2-dimethyl✓ propane/2,2-dimetielpropaan✓ (2)

Marking criteria/*Nasienriglyne:*
• Correct stem i.e. propane./*Korrekte stam d.i. pentaan.* ✓ • All substituents correctly identified and correctly numbered/*Alle substituente korrek geïdentifiseer en korrek genommer* ✓

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QUESTION 4/*VRAAG 4*

4.1.1 Substitution/halogenation/*Substitusie/halogenering* ✓ (1)

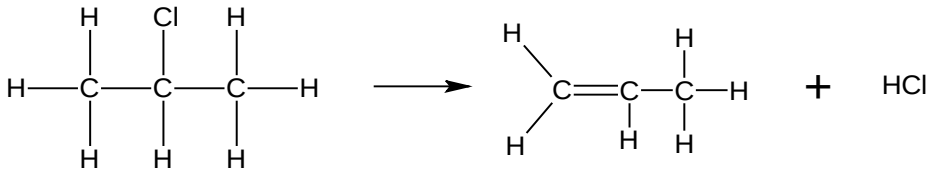
4.1.2 Elimination/dehydrohalogenation/*Eliminasie/dehidrohalogenering* ✓ (1)

4.1.3 Addition/Hydrogenation/*Addisie/Hidrogenering/Hidrogenasie*✓ (1)

4.2

4.2.1 2-chloro✓propane✓/*2-chloro✓propaan*✓/2-chloor✓propaan (2)

4.2.2 ✓✓ ✓ ✓



(4)

Notes/*Aantekeninge*:
- Ignore/*Ignoreer* ⇌
- Accept HCℓ if condensed/*Aanvaar HCℓ indien gekondenseer*
- Any additional reactants and/or products/*Enige addisionele reaktanse en/of ander produkte* Max./*Maks.* $^{3}/_{4}$
- Accept coefficients that are multiples/*Aanvaar koëffisiënte wat veelvoude is*
- Molecular/condensed formulae/*Molekulêre/gekondenseerde formules* Max./*Maks.* $^{3}/_{4}$

4.3.1 A compound in which a hydroxyl group is attached to a carbon atom which has two other carbon atoms attached to it. ✓✓
'n Verbinding waarin 'n hidroksielgroep aan 'n koolstofatoom verbind is, waaraan twee ander koolstofatome verbind is. (2)

4.3.2 Propan-2-ol/*Propaan-2-ol*✓✓ **OR/*OF*** 2-propanol/*2-propanol*✓✓ (2)
[13]

QUESTION 5/*VRAAG 5*

5.1 A reaction which does not need (activation) energy to start. ✓✓
'n Reaksie wat nie (aktiverings-) energie benodig om te begin nie. (2)

5.2 Hydrochloric acid/HCℓ/*Soutsuur/ HCℓ* ✓ (1)

5.3.1 Decreases/*Neem af* ✓ (1)

5.3.2 Increases/*Neem toe* ✓ (1)

5.3.3 Increases/*Neem toe*✓ (1)

5.3.4

- At higher temperature more molecules have enough ✓✓/sufficient kinetic energy/more molecules have kinetic energy greater than activation energy.
  Teen 'n hoër temperatuur het meer molekule genoeg *kinetiese energie/ meer molekule het kenetiese energie goter as die aktiveringsenergie*
- More effective collisions per unit time/second. ✓
  Meer effektiewe botsings per eenheid tyd/sekonde (3)

[9]

QUESTION 6/ *VRAAG 6*

6.1 Haber (process)/*Haberproses*✓ (1)

6.2 Iron/ Fe/*Yster/ Fe* ✓ (1)

6.3

- The forward and reverse reactions take place simultaneously at the same rate.✓
  Die voorwaartse en terugwaartse reaksies vind gelyktydig teen dieselfde tempo plaas.
- The amount of energy given off by exothermic reaction is taken up by the endothermic reaction. ✓
  Die hoeveelheid energie wat deur die eksotermiese reaksie vrygestel word, word deur die endotermiese reaksie opgeneem. (2)

6.4

CALCULATIONS USING NUMBER OF MOLES/
BEREKENINGE WAT GETAL MOL GEBRUIK
Mark allocation/*Puntetoekenning:*

- Correct K_c expression (formulae in square brackets) ✓
  Korrekte K_c –uitdrukking (formules in vierkanthakies)
- Substitution of concentrations into K_C expression ✓
  Vervanging van konsentrasies in K_c-waardes
- Substitution of K_c 0,1/*Vervanging van K_c 0,1*✓
- Equilibrium/*Ewewig*: n(N_2) ✓ n(NH_3) ✓
- Equilibrium/*Ewewig*: n(NH_3) = n : Change/*Verandering* ✓
- **USING** ratio*:* $N_2 : 3H_2 : 2NH_3 = 1 : 3 : 2$ ✓
  GEBRUIK *verhouding: $N_2 : 3H_2 : 2NH_3 = 1 : 3 : 2$*
- Initial mole of N_2 = Equilibrium + Change ✓
  Aanvangsmol van N_2 = Ewewig + Verandering
- Substitution of n & M into formula $n(\mathrm{N_2}) = \frac{\mathrm{m}}{\mathrm{M}}$ ✓
  Vervanging van n & M in formule $n(\mathrm{N_2}) = \frac{\mathrm{m}}{\mathrm{M}}$
- Final answer: 0,58g/*Finale antwoord*✓

$$K_C = \frac{[NH_3]^2}{[N_2][H_2]^3}$$ ✓

✓ $0,1 = \frac{(2,7x10^{-3})^2}{(N_2)(1,221 \times 10^{-1})^3}$ ✓

$[N_2] = 4x10^{-2}\ mol.dm^{-3}$

	N_2	H_2	NH_3
Initial quantity (mol) *Aanvangshoeveelheid (mol)*	2,07 x 10^{-2} ✓	2,936 x 10^{-3}	0
Change (mol) *Verandering (mol)*	6,75 x 10^{-4}	2,025 x 10^{-3}	1,35 x 10^{-3} ✓ ratio ✓
Quantity at equilibrium (mol) n = cv *Hoeveelheid by ewewig (mol)*	0,02 ✓	6,105 x 10^{-2}	1,35 x 10^{-3} ✓
Equilibrium concentration (mol·dm^{-3}) *Ewewigskonsentrasie (mol·dm^{-3})*	4 x 10^{-2}	1,221 x 10^{-1}	2,7 x 10^{-3}

Mass/massa (N_2)
m = nM ✓
= (2,07 x 10^{-2}) x (28)
= 5,79 x 10^{-1}g/ 0,58g ✓

OR/OF

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

2,07 x $10^{-2} = \frac{m}{28}$

m = 5,79 x 10^{-1}g/0,58g (10)

6.5 A <u>decrease in temperature will increase the yield</u> ✓, but the <u>reaction will be slow</u> ✓ and the profit margins will be low. ✓
<u>'n Afname in temperatuur sal tot 'n toename in opbrengs lei</u>, maar die <u>reaksie sal stadig wees</u> en die winsgrens laag.

OR/OF

<u>Increase in temperature favours the reverse reaction</u> ✓, but <u>reaction takes place much quicker</u> ✓ and the process is <u>less expensive</u> ✓.
<u>'n Toename in temperatuur is voordelig vir die terugwaartse reaksie</u>, <u>maar reaksies sal baie vinniger</u> wees en die proses <u>goedkoper</u>. (3)

[17]

QUESTION 7/*VRAAG 7*

7.1.1 An acid that dissociates/ionises completely in water ✓✓
'n Suur wat heeltemal in water ioniseer/dissosieer (2)

7.1.2 $HC\ell(aq) + H_2O(\ell)$ ✓ $\rightarrow H_3O^+(aq) + C\ell^-(aq)$ ✓ ✓ balancing/*balansering*

OR/OF

$HC\ell + H_2O$ ✓ $\rightarrow H_3O^+ + C\ell^-$ ✓ ✓ balancing/*balansering* (3)

7.1.3 Acid✓ pH below (<)7 ✓/*Suur pH onder* (<)*7* (2)

7.1.4 $pH = -\log[H_3O^+]$ **OR/OF** $pH = -\log[H^+]$✓

$4 = -\log[H_30^+]$✓

$[H_30^+] = 1 \times 10^{-4}$ mol.dm^{-3}✓ (3)

7.1.5

POSITIVE MARKING FROM QUESTION 7.1.4/*POSITIEWE NASIEN VANAF VRAAG 7.1.4*

Marking criteria/*Nasienriglyne:*

- Final/*Finale* n(HCℓ): Multiplying/ *Vermenigvuldig1* x 10^{-4}mol.dm^{-3} by/ met 0,17 dm^3 ✓
- Initial/*Aanvanklike* n(HCℓ):Multiplying/*Vermenigvuldig* 0,03 mol.dm^{-3} by/met 0,15 dm^3 ✓
- n(HCℓ reacted/*reageer*) = initial/ *Aanvanklike* – final/ *finale* .✓
- *Use mol ratio of acid:base/Molverhouding suur:basis= 1 : 1.* ✓
- Substitute/*Vervang*: n(NaOH) in $c = \frac{n}{V}$ ✓
- Final answer /*Finale antwoord:* 0,22 mol.dm^{-3} ✓

n(HCℓ in excess/ *in oormaat*):

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

$n(HC\ell) = (1 \times 10^4)(0,17)$ ✓

$= 1,7 \times 10^{-5}$ mol

n(HCℓ initial/ a*anvanklik*):

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

$n(HC\ell) = (0,03)(0,15)$ ✓

$= 4,5 \times 10^{-3}$ mol

n(HCℓ reacted/reageer) = $4,5 \times 10^{-3} - 1,7 \times 10^{-5}$ ✓

$= 4,48 \times 10^{-3}$ mol

Ratio/*Verhouding* n(HCℓ) = n(NaOH) = $4,48 \times 10^{-3}$ ✓

c(NaOH) initial/ a*anvanklik* :

$c = 4,483 \times 10^{-3} / 2 \times 10^{-2}$ ✓

$= 0,22$ mol.dm^{-3} ✓ (6)

[22]

7.2

Marking criteria/*Nasienriglyne:*

- Divide volume by/*Deel volume deur*: 22,4 ✓
- Use ratio/Gebruik v*erhouding*: $n(CO_2) = n(CaCO_3) = 1:1$ ✓
- Substitute/*Vervang* 100 in $n = \frac{m}{M}$. ✓
- Mass/*Massa* (4g – 4,46g) ✓
- Divide by/*Deel deur* 5 x 100 ✓
- Final answer/*Finale antwoord:* 80% to 90% ✓

$$n(CO_2) = \frac{V}{V_m}$$
$$= \frac{1,06}{22,4} \quad ✓$$
$$= 0,04 \text{ mol} \quad (0,0446 \text{ mol})$$

$n(CaCO_3) = n(CO_2) = 0,04$ mol ✓ (0, 0446 mol)

$$n(CaCO_3) = \frac{m}{M}$$
$$0,04 = \frac{m}{100} \quad ✓$$
$\therefore$ m = 4 g (4,46 g) ✓

$$\% \ CaCO_3 = \frac{4}{5} \times 100\%$$
= 80 % ✓ (6)

(Accept range/*Anvaar variasie:* 80% – 90%)

[22]

QUESTION 8/*VRAAG 8*

8.1 To complete the circuit/to maintain electrical neutrality ✓
Om die stroombaan te voltooi/om elektriese neutraliteit te handhaaf (1)

8.2 Ni ✓ (1)

8.3 (5)

$E^{\theta}_{cell} = E^{\theta}_{reduction} - E^{\theta}_{oxidation}$ ✓
1,07 ✓ = E°x – (-0,27) ✓
E°x = 0,8 (V) ✓

X is silver/ Ag. ✓

Option 2/ *Opsie 2*

$Ni \rightarrow Ni^{2+} + 2e^-$ E° = 0,27(V) ✓
$X^+ + e^- \rightarrow X$ E° = 0,8 (V) ✓
E° = 1,07 V ✓

Thus/*Dus:* $E^{\theta}_{reduction}$ = 0,8 (V) ✓
X is silver/ Ag. ✓

Notes/*Aantekeninge:*
Accept any other correct formula from the data sheet.
Aanvaar enige ander korrekte formule vanaf gegewensblad.

Any other formula using unconventional abbreviations, e.g. $E^{\theta}_{cell} = E^{\theta}_{OA} - E^{\theta}_{RA}$ followed by correct substitutions: $^4/_5$
Enige ander formule wat onkonvensionele afkortings gebruik bv. $E^{\theta}_{sel} = E^{\theta}_{OM} - E^{\theta}_{RM}$ *gevolg deur korrekte vervangings:* $^4/_5$

8.4 $Ni + 2Ag^+$ ✓ $\rightarrow Ni^+ + 2Ag$ ✓ ✓ balancing/*balansering*
OR/OF
$Ni + 2X^+$ ✓ $\rightarrow Ni+ + 2X^+$ ✓ ✓ balancing/*balansering* (3)

8.5.1 Nickel ions/ Ni^{2+}/*Nikkelione/ Ni*$^{2+}$ ✓ (1)

8.5.2 $Zn \rightarrow Zn^{2+} + 2e^-$ ✓✓ (2)

Marking guidelines/*Nasienriglyne:*
- $Zn \rightleftharpoons Zn^{2+} + 2e^-$ $^1/_2$ $Zn^{2+} + 2e^- \rightleftharpoons Zn$ $^0/_2$
  $Zn^{2+} + 2e^- \leftarrow Zn$ $^2/_2$ $Zn^{2+} + 2e^- \rightarrow Zn$ $^0/_2$

8.5.3 $Zn(s) \mid Zn^{2+}(aq)$ (1 mol.dm^{-3})✓ ||✓ $Ni^{2+}(aq)$ (1 mol.dm^{-3}) | Ni(s) ✓
OR/OF
$Zn(s) \mid Zn^{2+}(aq)$ ✓ ||✓ $Ni^{2+}(aq)$ | Ni(s) ✓
OR/OF
$Zn \mid Zn^{2+}$ ✓ ||✓ $Ni^{2+} \mid Ni$ ✓ (3)
[16]

QUESTION 9/*VRAAG 9*

9.1 Electrical (energy) to chemical (energy) ✓
Elektriese (energie) na chemiese (energie) (1)

9.2 Bauxite ✓ (1)

9.3 Decreases melting point of aluminium oxide✓
Laat smeltpunt van aluminiumoksied afneem (1)

9.4 $C(s) + O_2(g) \rightarrow CO_2(g)$ ✓ ✓ balancing/*balansering* (2)

9.5 $A\ell^{3+} + 3e^- \rightarrow A\ell$ ✓ (1)

9.6 **ANY TWO**

- The cell produces red mud waste, which can result in the alkali seeping through the soil and contaminating water supplies. ✓
- Consumes large quantities of energy, which leads to load-shedding/ increased emission of green house gases. ✓
- Carbon dioxide from the burning of the anodes contributes to the (enhanced) greenhouse effect (air pollution/global warming). ✓
- Carbon dioxide is poisonous. ✓
- Fluorine (and fluorine compounds) lost from the cryolite during the electrolysis process is poisonous. ✓
- Loss of landscape due to the size of the chemical plant needed. ✓
- Pollution caused by power generation (for electrolytic process) using coal-fired plants leads to acid rain/enhanced (greenhouse effect). ✓
- Noise pollution✓

ENIGE TWEE

- *Die sel produseer rooi modderafval wat kan lei tot alkali wat deur die grond sypel en die watertoevoer besoedel.*
- *Groot hoeveelhede energie word gebruik, wat tot beurtkrag aanleiding kan gee/die vrystelling van kweekhuisgasse laat toeneem.*
- *Koolstofdioksied vrygestel deur die brand van anodes dra by tot die kweekhuiseffek (lugbesoedeling/aardverwarming).*
- *Koolstofdioksied is giftig.*
- *Fluoor (en fluoor verbindings) vrygestel deur die krioliet tydens die elektroliseproses is giftig.*
- *Landskap word vernietig deur groot chemiese aanleg wat benodig word.*
- *Besoedeling veroorsaak deur kragopwekking (vir elektrolitiese proses) deur die gebruik van steenkoolaanlegte lei tot suurreën/kweekhuiseffek neem toe.*
- *Geraasbesoedeling* (2)

9.7 The extraction cell uses too much electrical energy, recycling saves energy. ✓✓
Die ontrekkingselle gebruik te veel elektriese energie, herwinning spaar energie
Clean environment from littering.
Voorkom omgewingsbesoedeling. (2)
[10]

QUESTION 10/*VRAAG 10*

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

10.1.2 Catalytic oxidation of SO_2 /*Katalitiese oksidasie van SO_2* ✓ (1)

10.1.3 Vanadium pentoxide (V_2O_5)/*Vanadium pentoksied (V_2O_5)*✓ (1)

10.1.4 $H_2S_2O_7$ ✓✓ (2)

10.1.5 NH_3 ✓ + H_2SO_4 ✓ → $(NH_4)_2SO_4$ ✓ ✓balancing/*balansering*
(4)

10.2 **ANY ONE /*ENIGE EEN***

- Fertilisers in water leads to eutrophication which can result in less drinking water/starvation due to dying of fish/less water recreation areas.✓✓
  Kunsmis in water lei tot eutrofikasie wat beteken dat minder drinkwater beskikbaar sal wees/hongersnood a.g.v. vrektes van die vispopulasie/minder waterbronne vir ontspanning.

- Fertilisers in water leads to excess of nitrates in water resulting in blue baby syndrome/cancer. /✓✓
  Kunsmis in water lei tot oormaat nitraat in water wat aanleiding gee tot bloubabasindroom/kanker. (2)

10.3.1 Nitrogen/*Stikstof* ✓ (1)

10.3.2 Potassium/*Kalium* ✓ (1)

10.4 Phosphorus/*Fosfor* ✓ (1)
[14]

GRAND TOTAL/*GROOTTOTAAL*: 150