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# 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 2019**

**MARKING GUIDELINES/NASIENRIGLYNE**

**MARKS/PUNTE: 150**

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

### QUESTION 1/VRAAG 1

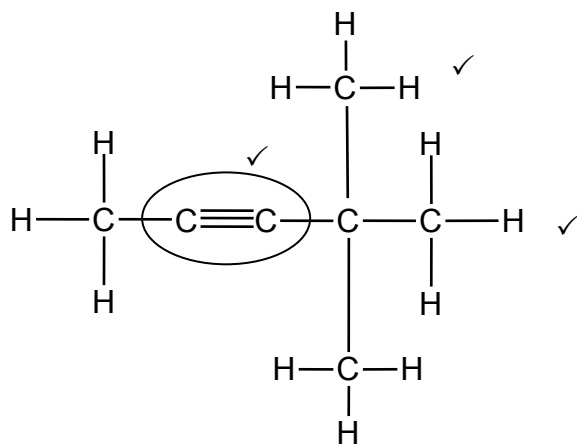
- 1.1 D ✓✓ (2)
- 1.2 C ✓✓ (2)
- 1.3 B ✓✓ (2)
- 1.4 D ✓✓ (2)
- 1.5 C ✓✓ (2)
- 1.6 B ✓✓ (2)
- 1.7 B ✓✓ (2)
- 1.8 A ✓✓ (2)
- 1.9 A ✓✓ (2)
- 1.10 C ✓✓ (2)
- [20]**

### QUESTION 2/VRAAG 2

2.1

2.1.1  $C_nH_{2n-2}$  ✓ (1)

2.1.2



#### Marking criteria/Nasienriglyne

- Functional group correct. ✓  
*Funksionele groep korrek.*
- 2 methyl substituents. ✓  
*2 metielsubstituente.*
- Whole structure correct: /Hele  
*struktuur korrek:*  $\frac{3}{3}$

(3)

2.2

- 2.2.1 Compounds with the same molecular formula, ✓ but different positions of the side chain/substituents/functional groups ✓ on the parent chain.

*Verbindings met dieselfde molekulêre formule, maar verskillende posisies van die syketting/substituente/funksionele groepe op die stamketting.*

(2)

- 2.2.2 Pentan-3-one/3-pentanone ✓✓

*Pentan-3-oon/3-pentanoon*

**Marking criteria/Nasienriglyne**

- Functional group and correct position i.e. 3 /Funksionele groep en korrekte posisie nl. 3. ✓
- Whole name correct/Hele naam korrek. ✓

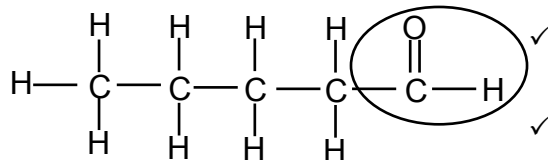
**Accept for ONE mark/Aanvaar vir EEN punt**

Pentanone with the 3 in incorrect place, e.g. penta-3-none.

*Pentanoon met die 3 in foutiewe plek, bv. penta-3-noon.*

(2)

2.2.3

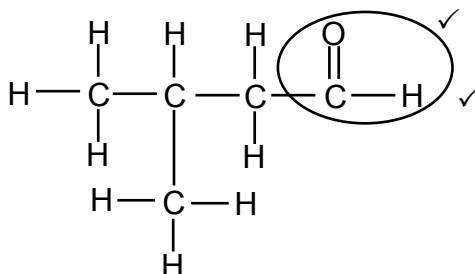


**Marking criteria/Nasienriglyne**

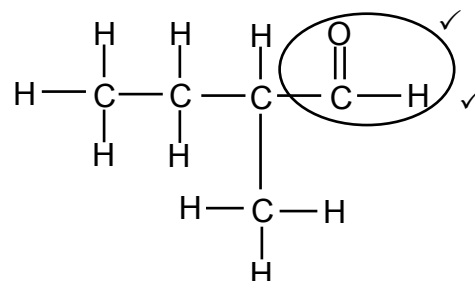
- Whole structure correct:/Hele struktuur korrek:  $\frac{2}{2}$
- Only functional group correct/Slegs funksionele groep korrek Max:  $\frac{1}{2}$

**OR: Any correct structure of an aldehyde with five carbon atoms.**

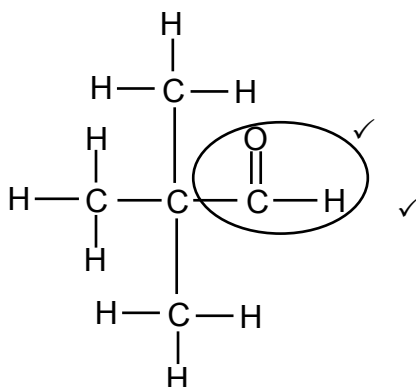
**OF: Enige korrekte struktuur van 'n aldehied met vyf koolstofatome.**



OR/OF



OR/OF



(2)

2.3

2.3.1 Tertiary (alcohol)/Tersiêre (alkohol) ✓

The C atom bonded to the functional group/hydroxyl (group)/-OH is bonded to three other C atoms. /The C-atom bonded to the hydroxyl (group) has no hydrogen atoms. ✓

*Die C-atoom gebind aan die funksionele groep/hidroksiel(groep)/-OH is gebind aan drie ander C-atome./ Die C-atoom gebind aan die hidroksiel (groep) het geen waterstofatome nie.*

(2)

2.3.2 2-methylbutan-2-ol/2-methyl-2-butanol/2-metielbutan-2-ol/2-metiel-2-butanol

**Marking criteria/Nasienriglyne**

- 2-methyl/2-metiel ✓
- Butan-2-ol/2-butanol ✓
- Any error e.g. hyphens omitted and/or incorrect sequence:

*Enige fout, bv. koppeltekens weggelaat en/of verkeerde volgorde: Max./Maks:  $\frac{1}{2}$*

(2)

2.3.3 2-methylbut-2-ene/2-methyl-2-butene/2-metielbut-2-ene/2-metiel-2-buteen

**Marking criteria/Nasienriglyne**

- 2-methyl/2-metiel ✓
- But-2-ene/2-butene/But-2-ene/2-buteen ✓
- Any error e.g. hyphens omitted and/or incorrect sequence:

*Enige fout, bv. koppeltekens weggelaat en/of verkeerde volgorde: Max./Maks:  $\frac{1}{2}$*

(2)

**[16]****QUESTION 3/VRAAG 3**

3.1

**Marking guidelines/Nasienriglyne**

The underlined key phrases must be used in the **CORRECT CONTEXT (pressure/boiling)**. /Die onderstreepte frases moet gebruik word in die **KORREKTE KONTEKS (druk/kook)**.

The temperature ✓ at which the vapour pressure of a substance equals atmospheric/external pressure. ✓

*Die temperatuur waar die dampdruk van 'n stof gelyk is aan atmosferiese/eksterne druk.*

(2)

3.2

(Q, R and S) have same molecular mass/formulae/number of carbon and hydrogen atoms/are (chain) isomers. ✓

*(Q, R en S) het dieselfde molekulêre massa/formule/aantal koolstof en waterstofatome/ is (ketting)isomere.*

**OR/OF**

The compounds are all alkanes /same homologous series and have the same number of carbon atoms.

*Die verbindings is almal alkane /dieselfde homologe reeks en het die dieselfde aantal koolstofatome.*

(1)

**Marking guidelines/Nasienriglyne**

- 55 (°C) ✓
- Compare all three compounds or Q and S in terms of branches/chain lengths / surface area. ✓  
*Vergelyk al drie verbindings of Q en S in terme van vertakkings/kettinglengte/ oppervlakarea.*
- Compare strengths of all three or Q and S's IMF's / *Vergelyk sterkte van al drie of Q en S se IMK'e.* ✓
- Compare energy of all three / *Vergelyk energie van al drie.* ✓

3.3

55 (°C) ✓

**Compare compound R with compounds Q and S:**

- Compound **R** is less branched/compact/spherical/surface area than compound **Q** and more branched/compact/spherical/surface area than compound **S**. ✓  
**OR**  
**Q** is the most branched/compact /spherical/surface area and **S** is least branched/compact/spherical/surface area.
- Intermolecular forces in compound R are stronger than in compound Q and weaker than in compound S. ✓
- More energy needed to overcome intermolecular forces in compound R than in compound Q and less energy needed to overcome (break) intermolecular forces in compound R than in compound S. ✓

**OR**

- Compound **R** has a longer chain length than compound **Q** and a shorter chain length than compound **S**. ✓  
**OR**  
**S** has the longest chain length and **Q** the shortest.
- Intermolecular forces increase with increase in chain length. ✓
- More energy needed to overcome intermolecular forces as chain length increases. ✓

**Vergelyk verbinding R met verbindings Q en S:**

- Verbinding R is minder vertak/kompak/sferieseoppervlak as verbinding Q en meer vertak as verbinding S.

**OF****Q** is die meeste vertak/kompak en **S** is die minste vertak/kompak/series/oppervlak.

- Intermolekulêre kragte in verbinding R is sterker as in verbinding Q en swakker as in verbinding S.
- Meer energie word benodig om intermolekulêre kragte in verbinding R te oorkom as in verbinding Q, en minder energie word benodig om intermolekulêre kragte in verbinding R te oorkom / breek as in verbinding S.

**OF**

- Verbinding R het 'n langer kettinglengte as verbinding Q en 'n korter kettinglengte as S.

**OF****S** het die langste ketting en **Q** die kortste.

- Intermolekulêre kragte neem toe met toename in kettinglengte.
- Meer energie word benodig om intermolekulêre kragte te oorkom wanneer kettinglengte toeneem.

(4)

3.4

3.4.1 P ✓✓

(2)

3.4.2

**Marking guidelines/Nasienriglyne**

- Name type of IMFs in **P/pentanal**. ✓  
*Noem tipe IMK'e in **P/pentanaal**.*
- Name type of IMFs in/*Noem tipe IMK'e in **T/pentan-1-ol**.* ✓
- Compare strength of IMFs. /*Vergelyk sterkte van IMK'e.* ✓

**OR/OF**Compare energy needed to overcome IMFs. /*Vergelyk energie benodig om IMK'e te oorkom.*

- In **P/ pentanal**/aldehydes: dipole-dipole forces ✓ (in addition to London forces/dispersion forces/induced dipole forces).
- In **T/pentan-1-ol**: Hydrogen bonding. ✓ (in addition to London forces/dispersion forces/induced dipole forces).
- Intermolecular forces in **P/pentanal** are weaker ✓ than in **T/pentan-1-ol**  
**OR** dipole-dipole forces are weaker than hydrogen bonds **OR**  
intermolecular forces in **T/pentan-1-ol** are stronger than in **P/pentanal**.  
**OR**  
More energy needed to overcome/break intermolecular forces in **T**.
- In **P/pentanaal**/aldehyede: dipool-dipoolkragte (tesame met Londonkragte/dispersiekragte/geïnduseerde dipoolkragte).*
- In **T/pentan-1-ol**: Waterstofbinding. (tesame met Londonkragte/dispersiekragte/geïnduseerde dipoolkragte).*
- Intermolekulêre kragte in **P** swakker as in **T/pentan-1-ol** **OF**  
intermolekulêre kragte in **T/pentan-1-ol** sterker as in **P/pentanaal** **OF**  
dipool-dipoolkragte is swakker as waterstofbindings.*

**OF**Meer energie benodig om intermolekulêre kragte te oorkom/breek in **T**.

(3)

**[12]**

**QUESTION 4/VRAAG 4**

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

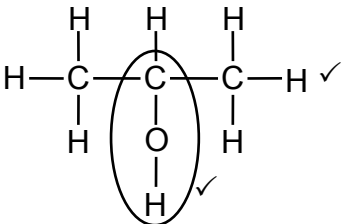
4.2  
4.2.1 Elimination/dehydrohalogenation ✓  
Eliminasie/dehidrohalogenering (1)

4.2.2 Substitution/hydrolysis ✓  
Substitusie/hidrolise (1)

4.2.3 Esterification/condensation ✓  
Esterifikasie/kondensasie/verestering (1)

4.3  
4.3.1 • (Mild) heat/Heating/(matige) hitte/ verhitting ✓  
• Dilute (strong base)/Verdunde (sterk basis)/(NaOH/KOH/LiOH) ✓  
**OR/OR**  
Add water/H<sub>2</sub>O/Voeg water/H<sub>2</sub>O by (2)

4.3.2 Propan-1-ol/1-propanol ✓✓  
**Marking criteria/Nasienriglyne:**  
• Correct stem and functional group i.e. propanol/Korrekte stam en funksionele groep, d.i. propanol. ✓  
• Whole name correct:/Hele naam korrek: propan-1-ol ✓ (2)

4.4  ✓  
**Marking criteria/Nasienriglyne**  
• Whole structure correct:/Hele struktuur korrek: 2/2  
• Only functional group correct/Slegs funksionele groep korrek: 1/2

**Notes/Aantekeninge**

- Accept –OH as condensed. /Aanvaar –OH as gekondenseerd.
- Condensed or semi-structural formula:  
Gekondenseerde of semi-struktuurformule: Max./Maks. 1/2
- Molecular formula/Molekulêre formule: 0/2
- If functional group is incorrect/Indien funksionele groep verkeerd is: 0/2
- If more than one functional group:  
Indien meer as een funksionele groep: 0/2

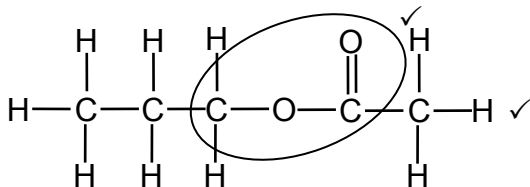
(2)



4.5

**POSITIVE MARKING FROM Q4.3.2 ONLY IF THE COMPOUND IN Q4.3.2 IS AN ALCOHOL. /POSITIEWE NASIEN VANAF V4.3.2 SLEGS INDIEN DIE VERBINDING IN Q4.3.2 'N ALKOHOL IS.**

4.5.1

**Marking criteria/Nasienriglyne**

- Whole structure correct:/Hele struktuur korrek:  $\frac{2}{2}$
- Only functional group correct/Slegs funksionele groep korrek:  $\frac{1}{2}$

**Notes/Aantekeninge**

- Condensed or semi-structural formula:

Gekondenseerde of semistruktuurformule: Max./Maks.  $\frac{1}{2}$

- Molecular formula/Molekulêre formule:  $\frac{0}{2}$

- If functional group is incorrect/Indien funksionele groep verkeerd is:  $\frac{0}{2}$

(2)

4.5.2 (Concentrated) sulphuric acid/(Gekonsentreerde) swawelsuur/ $\text{H}_2\text{SO}_4$  ✓

(1)

**[13]****QUESTION 5/VRAAG 5**

5.1 Exothermic/Eksotermies ✓



$\Delta H < 0$ /Energy is released/Energie word vrygestel ✓

(2)

5.2

$$\begin{aligned} \text{rate/tempo} &= -\frac{\Delta m}{\Delta t} \\ &= -\frac{0,25 - 2}{30} \checkmark \\ &= 0,06 \text{ (g} \cdot \text{s}^{-1}) \checkmark \\ &\quad (0,0583 \text{ g} \cdot \text{s}^{-1}) \end{aligned}$$

**OR/OF**

$$\begin{aligned} \text{rate/tempo} &= -\frac{\Delta m}{\Delta t} \\ &= -\frac{-1,75}{30} \checkmark \\ &= 0,06 \text{ (g} \cdot \text{s}^{-1}) \checkmark \\ &\quad (0,0583 \text{ g} \cdot \text{s}^{-1}) \end{aligned}$$

(3)

**Notes/Aantekeninge**

**Accept** negative answer i.e./Aanvaar negatiewe antwoord d.i.  $-0,06 \text{ g} \cdot \text{s}^{-1}$ .

5.3

**Marking guidelines**

- Calculate/Bereken:  $m(\text{CaCO}_3)$  reacted/reageer or / of  $V(\text{CO}_2)$  produced/gevorm. ✓
- Substitute/Vervang:  $100 \text{ g} \cdot \text{mol}^{-1}$ . ✓
- USE mol ratio/GEbruik molverhouding:  $n(\text{CO}_2) : n(\text{CaCO}_3) = 1 : 1$  ✓
- Use of/ /Gebruik van  $22,4 \text{ dm}^3 \cdot \text{mol}^{-1}$ . ✓
- Final answer/Finale antwoord:  $0,18 \text{ dm}^3$  ( $0,1792 \text{ dm}^3$ ) ✓

**OPTION 1/OPSIE 1**

$$\begin{aligned}
 m(\text{CaCO}_3) &= \frac{40}{100} \times 2 \quad \checkmark \\
 &= 0,8 \text{ g} \\
 n(\text{CaCO}_3)_{\text{reacted}} &= \frac{m}{M} \\
 &= \frac{0,8}{100} \quad \checkmark \\
 &= 8 \times 10^{-3} \text{ mol} \\
 n(\text{CO}_2) &= n(\text{CaCO}_3) \quad \checkmark \\
 &= 8 \times 10^{-3} \text{ mol} \\
 V(\text{CO}_2) &= 8 \times 10^{-3} \times 22,4 \quad \checkmark \\
 &= 0,18 \text{ dm}^3 \quad \checkmark
 \end{aligned}$$

**OPTION 2/OPSIE 2**

For 2 g antacid/teensuurtablet:

100 g ✓  $\text{CaCO}_3$  .....  $22,4 \text{ dm}^3$  ✓  $\text{CO}_2$ 2 g  $\text{CaCO}_3$  .....  $0,448 \text{ dm}^3$  ✓100%  $\text{CO}_2$  .....  $0,448 \text{ dm}^3$  ✓40%  $\text{CO}_2$  .....  $0,18 \text{ dm}^3$  ✓**OPTION 3/OPSIE 3**100%  $\text{CaCO}_3$  ..... 2 g

40% ..... 0,8 g ✓

100 g ✓ ..... 1 mol

0,8 g .....  $8 \times 10^{-3} \text{ mol}$  ✓1 mol .....  $22,4 \text{ dm}^3$  ✓ $8 \times 10^{-3} \text{ mol}$  .....  $0,18 \text{ dm}^3$  ✓

(5)

5.4

**ANY ONE/ENIGE EEN:**

- Concentration (of acid)/Konsentrasie (van suur) ✓
- Size/mass of tablet/Identical tablet /Type of tablet.  
Grootte/massa van tablet/Identiese tablet./Tipe tablet.
- State of division / Surface area / Toestand van verdeeldheid /  
reaksieoppervlak.

(1)

5.5

**Criteria for conclusion/Riglyne vir gevolgtrekking:**

Dependent [(reaction) rate/time] and independent (temperature) variables correctly identified.

Afhanklike [(reaksie)tempo/tyd] en onafhanklike (temperatuur) veranderlikes korrek geïdentifiseer.

Relationship between the independent and dependent variables correctly stated./Verwantskap tussen die afhanklike en onafhanklike veranderlikes korrek genoem.

✓

✓

**Examples/Voorbeelde:**

- Reaction rate ( $\frac{1}{\text{time}}$ ) increases with increase in temperature.  
*Reaksietempo ( $\frac{1}{\text{time}}$ ) neem toe met toename in temperatuur.*
- Reaction rate ( $\frac{1}{\text{time}}$ ) decreases with decrease in temperature.  
*Reaksietempo ( $\frac{1}{\text{time}}$ ) neem af met afname in temperatuur.*
- Time taken for reaction decreases when temperature increases.  
*Tyd vir die reaksie neem af wanneer temperatuur toeneem.*
- Time taken for reaction increases when temperature decreases.  
*Tyd vir die reaksie neem toe as temperatuur afneem.*

**IF/INDIEN**Reaction rate is DIRECTLY proportional to temperature: Max.  $\frac{1}{2}$ *Reaksietempo is DIREK eweredig aan temperatuur: Maks.  $\frac{1}{2}$* 

(2)

5.6

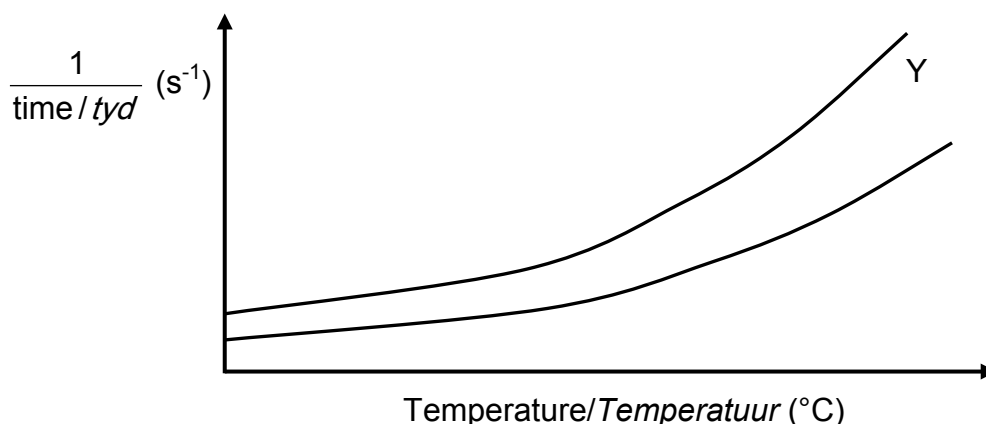
- Increase in temperature increases the average kinetic energy/molecules move faster. /*Toename in temperatuur verhoog die gemiddelde kinetiese energie/molekule beweeg vinniger.* ✓
- More molecules have enough/sufficient kinetic energy/More molecules have  $E_k > E_a$ . ✓  
*Meer molekule het genoeg/voldoende kinetiese energie/Meer molekule het  $E_k > E_a$ .*
- More effective collisions per unit time/second. /Frequency of effective collisions increases. ✓  
*Meer effektiewe botsings per eenheidtyd/sekonde./Frekwensie van effektiewe botsings neem toe.*

(3)

5.7

**Marking guidelines/Nasienriglyne**

- For each value of temperature, the CURVE Y must be above the given CURVE. /*Vir elke waarde van temperatuur, moet kurwe Y bo die gegewe kurwe wees.* ✓
- CURVE Y must have an increasing rate with an increase in temperature. /*KURWE Y moet 'n toenemende tempo het soos die temperatuur toeneem.* ✓



(2)

**[18]**

**QUESTION 6/VRAAG 6**

- 6.1 (The stage in a chemical reaction when the) rate of forward reaction equals the rate of reverse reaction. ✓✓  
 (Die stadium in 'n chemiese reaksie wanneer die) tempo van die voorwaartse reaksie gelyk is aan die tempo van die terugwaartse reaksie. (2 or/of 0)

**OR/OF**

- (The stage in a chemical reaction when the) concentrations of reactants and products remain constant.  
 (Die stadium in 'n chemiese reaksie wanneer die) konsentrasies van reaktanse en produkte konstant bly. (2 or/of 0) (2)

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

6.2.1 **Marking guidelines/Nasienriglyne**

- Substitute/Vervang:  $44 \text{ g} \cdot \text{mol}^{-1}$ . ✓
- Equilibrium concentration of  $\text{CO}_2$  multiply by  $3 \text{ dm}^3$   
 Ewewigskonsentrasie van  $\text{CO}_2$  vermenigvuldig met  $3 \text{ dm}^3$  } ✓  
**AND/EN**  $n(\text{CO})_{\text{eq}}$  divide by /deel deur  $3 \text{ dm}^3$
- Use mole ratio/Gebruik molverhouding:  $1:2$  /  $n(\text{CO}) = 2n(\text{CO}_2)$ . ✓
- $n(\text{CO}_2)_{\text{change}} = n(\text{CO}_2)_{\text{initial}} - n(\text{CO}_2)_{\text{final}}$  } ✓  
 $n(\text{CO})_{\text{eq/ewe}} = n(\text{CO})_{\text{initial/begin}} + \Delta n(\text{CO})$  }
- 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  $K_c$ -uitdrukking.
- Final answer/Finale antwoord: 12,24 (range/gebied: 11,85 – 12,66) ✓

**OPTION 1/OPSIE 1**

$$n(\text{CO}_2) = \frac{m}{M}$$

$$= \frac{60,8}{44} \checkmark$$

$$= 1,382 \text{ mol}$$

	CO <sub>2</sub>	CO
Initial quantity (mol) <i>Aanvangshoeveelheid (mol)</i>	1,382	0
Change (mol) <i>Verandering (mol)</i>	1,22	2,44
Quantity at equilibrium (mol)/ <i>Hoeveelheid by ewewig (mol)</i>	0,162	2,44
Equilibrium concentration (mol·dm <sup>-3</sup> ) <i>Ewewigskonsentrasie (mol·dm<sup>-3</sup>)</i>	0,054	0,813

Use ratio/*Gebruik verhouding* ✓Divide/multiply by 3/*Deel/ vermenigvuldig met 3* ✓

$$K_c = \frac{[\text{CO}]^2}{[\text{CO}_2]} \checkmark$$

$$= \frac{(0,813)^2}{0,054} \checkmark$$

$$= 12,24 \checkmark$$

No K<sub>c</sub> expression, correct substitution/*Geen K<sub>c</sub>-uitdrukking, korrekte substitusie*: Max./Maks.  $\frac{6}{7}$ Wrong K<sub>c</sub> expression/*Verkeerde K<sub>c</sub>-uitdrukking*: Max./Maks.  $\frac{4}{7}$ **OPTION 2/OPSIE 2**

$$n(\text{CO}_2) = \frac{m}{M}$$

$$= \frac{60,8}{44} \checkmark$$

$$= 1,382 \text{ mol}$$

$$n(\text{CO}_2)_{\text{change}} = n(\text{CO}_2)_{\text{initial/begin}} - n(\text{CO}_2)_{\text{final/finaal}}$$

$$= 1,382 - 0,162$$

$$= 1,22 \text{ mol}$$

$$n(\text{CO})_{\text{change}} = 2(\text{CO}_2) \checkmark$$

$$= 2(1,22) \checkmark$$

$$= 2,44 \text{ mol}$$

$$n(\text{CO})_{\text{eq}} = n(\text{CO})_{\text{change}} = 2,44 \text{ mol}$$

$$c(\text{CO}) = \frac{n}{V}$$

$$= \frac{2,44}{3} \checkmark$$

$$= 0,813 \text{ mol·dm}^{-3}$$

$$K_c = \frac{[\text{CO}]^2}{[\text{CO}_2]} \checkmark$$

$$= \frac{(0,813)^2}{0,054} \checkmark$$

$$= 12,24 \checkmark$$

(Accept range/*Aanvaar gebied*: 11,85 – 12,66).

### **CALCULATIONS USING CONCENTRATION** **BEREKENINGE WAT KONSENTRASIE GEBRUIK**

#### **Marking guidelines/Nasienriglyne**

- Substitute  $44 \text{ g}\cdot\text{mol}^{-1}$ . ✓
- Initial  $n(\text{CO}_2)$  divide by  $3 \text{ dm}^3$ . ✓  
*Aanvanklike  $n(\text{CO}_2)$  gedeel deur  $3 \text{ dm}^3$ .*
- **USE** ratio/**GEBRUIK** verhouding:  $c(\text{CO}_2) : c(\text{CO}) = 1 : 2$  ✓
- $\Delta c(\text{CO}_2) = c(\text{CO}_2)_{\text{initial/begin}} - c(\text{CO}_2)_{\text{eq/ewe}}$ . ✓  
 $c(\text{CO})_{\text{eq/ewe}} = c(\text{CO})_{\text{initial/begin}} + \Delta c(\text{CO})$ . ✓
- 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  $K_c$ -uitdrukking.*
- Final answer/*Finale antwoord*: 12,15 (range/gebied: 11,85 – 12,66) ✓

#### **OPTION 3/OPSIE 3**

$$n(\text{CO}_2) = \frac{m}{M}$$

$$= \frac{60,8}{44} \checkmark$$

$$= 1,382 \text{ mol}$$

	$\text{CO}_2$	$\text{CO}$
Initial concentration ( $\text{mol}\cdot\text{dm}^{-3}$ ) <i>Aanvanklike konsentrasie (<math>\text{mol}\cdot\text{dm}^{-3}</math>)</i>	0,4607	0
Change ( $\text{mol}\cdot\text{dm}^{-3}$ ) <i>Verandering (<math>\text{mol}\cdot\text{dm}^{-3}</math>)</i>	0,4067	0,813
Equilibrium concentration ( $\text{mol}\cdot\text{dm}^{-3}$ ) <i>Ewewigskonsentrasie (<math>\text{mol}\cdot\text{dm}^{-3}</math>)</i>	0,054	0,813

Divide by /Deel deur  $3 \text{ dm}^3$  ✓  
ratio ✓  
verhouding

$$K_c = \frac{[\text{CO}]^2}{[\text{CO}_2]} \checkmark$$

$$= \frac{(0,813)^2}{0,054} \checkmark$$

$$= 12,15 \checkmark$$

No  $K_c$  expression, correct substitution/Geen  $K_c$ -uitdrukking, korrekte substitusie: Max./Maks.  $\frac{6}{7}$

Wrong  $K_c$  expression/Verkeerde  $K_c$ -uitdrukking:  
Max./Maks.  $\frac{4}{7}$

(7)

#### 6.2.2 **POSITIVE MARKING FROM Q6.2.1/POSITIEWE NASIEN VANAF V6.2.1**

$$n(\text{C})_{\text{reacted/reageer}} =$$

$$n(\text{CO}_2)_{\text{reacted/reageer}} = 1,22 \text{ mol} \checkmark$$

$$m(\text{C}) = nM \checkmark$$

$$= 1,22(12) \checkmark$$

$$= 14,64 \text{ g} \checkmark$$

#### **Marking guidelines**

- **USE** mol ratio/ **GEBRUIK** molverhouding:  
 $n(\text{C}) = n(\text{CO}_2)$ . ✓
- Substitute/Vervang:  $12 \text{ g}\cdot\text{mol}^{-1}$ . ✓
- Final answer/*Finale antwoord*: 14,64 g. ✓

(3)

6.3

6.3.1 Remains the same/*Bly dieselfde* ✓

(1)

6.3.2 Decreases/*Afneem* ✓



- (When pressure is increased) the reaction that leads to the smaller amount/number of moles/volume of gas is favoured. ✓  
(*Wanneer die druk verhoog word, word die reaksie wat tot die kleiner hoeveelheid/aantal mol/volume gas lei, bevoordeel.*)
- The reverse reaction is favoured. / More CO<sub>2</sub> is formed. ✓  
(*Die terugwaartse reaksie word bevoordeel./ meer CO<sub>2</sub> word gevorm.*)

(3)

6.4

6.4.1 Endothermic/*Endotermies* ✓



- When the temperature increases the mol/percentage CO(g)/product increases/forward reaction is favoured./*Wanneer die temperatuur toeneem, neem die mol/persentasie CO(g)/produk toe/voorwaartse reaksie word bevoordeel.* ✓
- An increase in temperature favours the endothermic reaction/*Toename in temperatuur bevoordeel die endotermiese reaksie.* ✓

(3)

6.4.2

**POSITIVE MARKING FROM Q6.2.1./POSITIEWE NASIEN VANAF V6.2.1.**

**Marking guidelines/Nasienriglyne**

- Calculate total volume/mol of gas at equilibrium/*Bereken totale volume/mol gas by ewewig*:  $0,162 + 2,44 = 2,606 \text{ dm}^3 / \text{mol}$  ✓  
**OR/OF**  
Calculate the total concentration at equilibrium/*Bereken die totale konsentrasie by ewewig*:  $0,054 + 0,813 = 0,867 \text{ mol} \cdot \text{dm}^{-3}$
- Calculate percentage of ANY one gas/*Bereken persentasie van ENIGE een gas (CO<sub>2</sub> or/of CO).* ✓
- Final answer/*Finale antwoord*:  $T = 827 \text{ }^{\circ}\text{C}$  ✓

**OPTION 1/OPSIE 1**

$$V_{\text{total eq}} = 0,162 + 2,44 \checkmark$$

$$= 2,606 \text{ dm}^3$$

$$\% \text{ CO}_2 = \frac{0,162}{2,606} \times 100 \checkmark$$

$$= 6,225 \%$$

**OR/OF**

$$\% \text{ CO} = \frac{2,44}{2,606} \times 100 \checkmark$$

$$= 93,63 \%$$

**OPTION 2/OPSIE 2**

$$C_{\text{total eq}} = 0,054 + 0,813$$

$$= 0,867 \text{ mol} \cdot \text{dm}^{-3}$$

$$\% \text{ CO}_2 = \frac{0,054}{0,867} \times 100 \checkmark$$

$$= 6,228 \%$$

**OR/OF**

$$\% \text{ CO} = \frac{0,813}{0,867} \times 100 \checkmark$$

$$= 93,77 \%$$

$\therefore T = 827 \text{ }^{\circ}\text{C}$  ✓

(3)

[22]

**QUESTION 7/VRAAG 7**7.1  Strong (acid)/Sterk (suur) ✓Large/Groot  $K_a$  value/waarde/  $K_a > 1$  / (HBr) ionises completely/ioniseer volledig ✓

(2)

7.2  $H_2O$  ✓ $Br^-$  ✓

(2)

7.3

7.3.1

**Marking guidelines/Nasienriglyne**

- Formula/Formule:  $c = \frac{n}{V} / n = cV / \frac{c_a \times V_a}{c_b \times V_b} = \frac{n_a}{n_b}$  ✓
- Substitution of/Vervanging van:  $(0,5)(0,0165)/(0,5)(16,5)$  ✓
- Use mol ratio/Gebruik molverhouding:  $1:1/n(HBr) = n(NaOH)$  ✓
- Substitute/Vervang:  $V = 0,09 \text{ dm}^3 / 90 \text{ cm}^3$  ✓
- Formula/Formule:  $pH = -\log[H_3O^+]$  ✓
- Substitute  $[H_3O^+]$  in pH formula. ✓
- Final answer/Finale antwoord:  $pH = 1,04$  (range/gebied:  $1,036 - 1,05$ ) ✓

**OPTION 1/OPSIE 1**

$$n(NaOH)_{\text{reacted/reageer}} = cV \checkmark$$

$$= 0,5(0,0165) \checkmark$$

$$= 0,00825 \text{ mol}$$

$$n(HBr)_{\text{excess/oormaat}} = n(NaOH) = 0,00825 \text{ mol} \checkmark$$

$$c(H_3O^+) = \frac{n}{V}$$

$$= \frac{0,00825}{0,09} \checkmark$$

$$= 0,092 \text{ mol} \cdot \text{dm}^{-3}$$

$$pH = -\log[H_3O^+] \checkmark$$

$$= -\log(0,092) \checkmark$$

$$= 1,04 \checkmark$$

**OPTION 2/OPSIE 2**

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

$$\frac{c_a (90)}{(0,5)(16,5)} = \frac{1}{1} \checkmark$$

$$c_a = 0,092 \text{ mol} \cdot \text{dm}^{-3}$$

$$pH = -\log[H_3O^+] \checkmark$$

$$= -\log(0,092) \checkmark$$

$$= 1,04 \checkmark$$

(7)



## 7.3.2

**Marking guidelines/Nasienriglyne**

- Calculate/Bereken  $n(\text{HBr})_{\text{initial/aanvanklik}}$ : substitute/vervang  $(0,45)(0,09)$  in  $n = cV$  ✓
- Subtraction/Aftrekking:  
 $n(\text{HBr})_{\text{reacted/reageer}} = n(\text{HBr})_{\text{initial/aanvanklik}} - n(\text{HBr})_{\text{reacted with/reageer met NaOH}}$  ✓✓  
**OR/OF:**  $c(\text{HBr})_{\text{reacted/reageer}} = c(\text{HBr})_{\text{initial/aanvanklik}} - c(\text{H}_3\text{O}^+)_{\text{excess/oormaat}}$
- Use mol ratio/Gebruik molverhouding:  $n(\text{Zn}(\text{OH})_2) : n(\text{HBr}) = 1 : 2$  ✓
- Substitution of/Vervanging van:  $99 \text{ g} \cdot \text{mol}^{-1}$  ✓
- Final answer/Finale antwoord:  $1,5964 \text{ g}$  (range/gebied:  $1,58 - 1,68$ ) ✓

**POSITIVE MARKING FROM Q7.3.1/POSITIEWE NASIEN VANAF V7.3.1****OPTION 1/OPSIE 1**

$$\begin{aligned}
 n(\text{HBr})_{\text{initial/begin}} &= cV \\
 &= (0,45)(0,09) \checkmark \\
 &= 0,0405 \text{ mol} \\
 n(\text{HBr reacted with/reageer met Zn}(\text{OH})_2) &= \underline{0,0405 - 0,00825} \checkmark \checkmark \\
 &= 0,03224 \text{ mol} \\
 n(\text{Zn}(\text{OH})_2) &= \frac{1}{2}n(\text{HBr}) = \frac{1}{2}(0,03224) \checkmark = 0,016125 \text{ mol} \\
 m(\text{Zn}(\text{OH})_2) &= nM \\
 &= (0,016125)(99) \checkmark \\
 &= 1,596 \text{ g} \checkmark
 \end{aligned}$$

**OPTION 2/OPSIE 2**

$$\begin{aligned}
 c(\text{HBr}) &= 0,45 - 0,092 \checkmark \checkmark \\
 &= 0,358 \text{ mol} \cdot \text{dm}^{-3} \\
 n(\text{HBr reacted/reageer}) &= cV \\
 &= 0,358 \times 0,09 \checkmark \\
 &= 0,0322 \text{ mol} \\
 n(\text{Zn}(\text{OH})_2) &= \frac{1}{2}n(\text{HBr}) = \frac{1}{2}(0,0322) \checkmark = 0,01611 \text{ mol} \\
 m(\text{Zn}(\text{OH})_2) &= nM \\
 &= 0,01611 \times 99 \checkmark \\
 &= 1,595 \text{ g} \checkmark \quad (1,60 \text{ g})
 \end{aligned}$$

(6)  
[17]

**QUESTION 8/VRAAG 8**

8.1 Chemical to electrical/*Chemies na elektries* ✓ (1)

8.2 Provides path for movement of ions./ Completes the circuit./Ensures electrical neutrality in the cell./Restore charge balance. ✓  
*Verskaf pad vir beweging van ione./Voltooi die stroombaan./Verseker elektriese neutraliteit in die sel./Herstel balans van lading.* (1)

8.3 **OPTION 1/OPTION 1**

$$E_{\text{cell}}^{\ominus} = E_{\text{cathode}}^{\ominus} - E_{\text{anode}}^{\ominus} \checkmark$$

$$1,49 = 1,36 - E_{\text{anode}}^{\ominus}$$

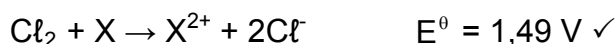
$$E_{\text{anode}}^{\ominus} = 1,36 - 1,49$$

$$= -0,13 \text{ (V)} \checkmark$$

X is Pb/Lead/Lood ✓

**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.  $E_{\text{cell}}^{\ominus} = E_{\text{OA}}^{\ominus} - E_{\text{RA}}^{\ominus}$  followed by correct substitutions: /Enige ander formule wat onkonvensionele afkortings gebruik, bv.  $E_{\text{sel}}^{\ominus} = E_{\text{OM}}^{\ominus} - E_{\text{RM}}^{\ominus}$  gevolg deur korrekte vervangings:  $\frac{4}{5}$

**OPTION 2/OPSIE 2**

X is Pb/Lead/Lood ✓

(5)

**POSITIVE MARKING FROM Q8.3/POSITIEWE NASIEN VANAF V8.3**

8.4 X/Pb/Lead/Lood ✓ (1)

8.5

8.5.1 Reaction reached equilibrium./ (In each half cell) the rate of oxidation is equal to rate of reduction./Rate of the forward reaction is equal to the rate of the reverse reaction. ✓  
*Reaksie bereik ewewig./ (In elke halfsel) die tempo van oksidasie is gelyk aan tempo van reduksie./Tempo van die voorwaartse reaksie is gelyk aan die tempo van die terugwaartse reaksie.* (1)

8.5.2 Increases/Toeneem ✓ (1)

8.5.3 • [Cl<sup>-</sup>] decreases/neem af. ✓  
• Forward reaction is favoured./Voorwaartse reaksie word bevoordeel. ✓ (2)

**[12]**

## QUESTION 9/VRAAG 9

9.1

**Marking guidelines/Nasienriglyne**

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 chemical process in which electrical energy is converted to chemical energy. ✓✓

Die chemiese proses waarin elektriese energie omgeskakel word na chemiese energie.

**OR/OF**

The use of electrical energy to produce a chemical change.

Die gebruik van elektriese energie om 'n chemiese verandering teweeg te bring.

**OR/OF**

The process during which an electrical current passes through a solution/molten ionic compound.

Die proses waar 'n elektriese stroom deur 'n oplossing/gesmelte ioniese verbinding gestuur word.

(2)

9.2

9.2.1  $2\text{H}_2\text{O}(\text{l}) + 2\text{e}^- \rightarrow \text{H}_2(\text{g}) + 2\text{OH}^-(\text{aq})$  ✓✓

Ignore phases/Ignoreer fases

**Marking guidelines/Nasienriglyne**

•  $\text{H}_2(\text{g}) + 2\text{OH}^-(\text{aq}) \leftarrow 2\text{H}_2\text{O}(\text{l}) + 2\text{e}^-$  ( $\frac{2}{2}$ )  $2\text{H}_2\text{O}(\text{l}) + 2\text{e}^- \rightleftharpoons \text{H}_2(\text{g}) + 2\text{OH}^-(\text{aq})$  ( $\frac{1}{2}$ )

$\text{H}_2(\text{g}) + 2\text{OH}^-(\text{aq}) \rightleftharpoons 2\text{H}_2\text{O}(\text{l}) + 2\text{e}^-$  ( $\frac{0}{2}$ )  $2\text{H}_2\text{O}(\text{l}) + 2\text{e}^- \leftarrow \text{H}_2(\text{g}) + 2\text{OH}^-(\text{aq})$  ( $\frac{0}{2}$ )

• Ignore if charge omitted on electron./Ignoreer indien lading weggelaat op elektron.

• If charge (-) omitted on  $\text{OH}^-$  /Indien lading (-) weggelaat op  $\text{OH}^-$ :

Example/Voorbeeld:  $2\text{H}_2\text{O}(\text{l}) + 2\text{e}^- \rightarrow \text{H}_2(\text{g}) + 2\text{OH}(\text{aq})$  ✓

Max./Maks:  $\frac{1}{2}$

(2)

9.2.2 Water/  $\text{H}_2\text{O}$  ✓

9.3  $\text{H}_2\text{O}$  is a stronger oxidising agent ✓ than  $\text{Na}^+$  ✓ and will be reduced ✓ (to  $\text{H}_2$ ).  
 $\text{H}_2\text{O}$  is 'n sterker oksideermiddel as  $\text{Na}^+$  en sal gereduseer word (na  $\text{H}_2$ ).

**OR/OF**

$\text{Na}^+$  is a weaker oxidizing agent ✓ than  $\text{H}_2\text{O}$  ✓ and therefore  $\text{H}_2\text{O}$  will be reduced ✓ (to  $\text{H}_2$ )

$\text{Na}^+$  is 'n swakker oksideermiddel as  $\text{H}_2\text{O}$  en daarom sal  $\text{H}_2\text{O}$  gereduseer word (na  $\text{H}_2$ )

**OR/OF**

The half-reaction that produces  $\text{H}_2(\text{g})$  has a more positive reduction potential (-0,83 V) ✓ than the half-reaction that produces Na (-2,71 V). ✓

Therefore water/ $\text{H}_2\text{O}$  will be reduced ✓ to  $\text{H}_2$ ./ $\text{Na}^+$  will not be reduced to Na.

Die halfreaksie wat  $\text{H}_2(\text{g})$  vorm, het 'n meer positiewe reduksiepotensiaal (-0,83 V) as die halfreaksie wat Na vorm (-2,71 V).

Daarom word water/ $\text{H}_2\text{O}$  na  $\text{H}_2$  gereduseer./ $\text{Na}^+$  sal nie gereduseer word na

(3)

*Na nie.*

**[8]**

**QUESTION 10/VRAAG 10**

10.1

10.1.1 Hydrogen/*Waterstof*/H<sub>2</sub> ✓ (1)10.1.2 Nitrogen monoxide/*Stikstofmonoksied*/NO ✓ (1)10.1.3 Nitric acid/*Salpetersuur*/HNO<sub>3</sub> ✓ (1)

10.2

10.2.1 (Catalytic) oxidation/Redox/*(Katalitiese) oksidasie/Redoks* ✓ (1)10.2.2 NH<sub>3</sub> + HNO<sub>3</sub> ✓ → NH<sub>4</sub>NO<sub>3</sub> ✓ Bal ✓**Notes/Aantekeninge**

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

(3)

10.3

10.3.1 (Total) percentage of nutrients/fertiliser/N,P,K. ✓  
(Totale) persentasie nutriente/ kunsmis/N,P, K. (1)

10.3.2 **Marking guidelines/Nasienriglyne**

- Calculate mass fertiliser in A./Bereken massa kunsmis in A ✓
- Calculate mass fertiliser in B./ Bereken massa kunsmis in B ✓
- Calculate mass P in A and B ./Bereken massa P in A en B✓
- Final answer/Finale antwoord:  
B has more phosphorous than/het meer fosfor as A. ✓

**OPTION 1/OPSIE 1**

Mass fertiliser in A:

*Massa kunsmis in A:*

$$m = \frac{21}{100} \times 50 \checkmark = 10,5 \text{ kg}$$

Mass fertiliser in B:

*/Massa kunsmis in B:*

$$m = \frac{27}{100} \times 40 \checkmark = 10,8 \text{ kg}$$

Mass phosphorous in A/

*Massa fosfor in A:*

$$\frac{3}{8} \times 10,5 = 3,94 \text{ kg}$$

Mass phosphorous in B/ ✓

*Massa fosfor in B:*

$$\frac{3}{8} \times 10,8 = 4,05 \text{ kg}$$

Fertiliser B has more phosphorous than fertiliser A. ✓

**OPTION 2/OPSIE 2**

Mass phosphorous in A/

*Massa fosfor in A:*

$$m = \frac{3}{8} \times \frac{21}{100} \times 50 \checkmark = 3,94 \text{ kg}$$

Mass(P) in B

*Massa (P) in B:*

$$m = \frac{3}{8} \times \frac{27}{100} \times 40 \checkmark = 4,05 \text{ kg}$$

Fertiliser B has more phosphorous than fertiliser A. /Kunsmis B het meer fosfor as kunsmis A. ✓

**OPTION 3/OPSIE 3**

Mass phosphorous in A/

*Massa fosfor in A:*

$$\%P = \frac{3}{8} \times 21 = 7,88\%$$

$$m(P) = \frac{7,88}{100} \times 50 \checkmark = 3,94 \text{ kg}$$

Mass(P) in B

*Massa (P) in B:*

$$\%(P) = \frac{3}{8} \times 27 = 10,13\%$$

$$m = \frac{10,13}{100} \times 40 \checkmark = 4,05 \text{ kg}$$

Fertiliser B has more phosphorous than fertiliser A. /Kunsmis B het meer fosfor as kunsmis A ✓

**OPTION 4/OPSIE 4**

Mass fertiliser in A:

*Massa kunsmis in A:*

$$m = \frac{21}{100} \times 50 \checkmark = 10,5 \text{ kg}$$

Mass fertiliser in B:

*/Massa kunsmis in B:*

$$m = \frac{27}{100} \times 40 \checkmark = 10,8 \text{ kg}$$

For the same NPK ratio ✓

the bag with more fertiliser will have

more phosphorous ∴ bag B ✓

*Vir dieselfde NPK verhouding, die sake met meer kunsmis sal meer fosfor het**∴ sak B*

(4)

[12]

**TOTAL/TOTAAL:****150**