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# basic education

Department:  
Basic Education  
**REPUBLIC OF SOUTH AFRICA**

**SENIOR CERTIFICATE EXAMINATIONS/  
NATIONAL SENIOR CERTIFICATE EXAMINATIONS  
*SENIORSERTIFIKAAT-EKSAMEN/  
NASIONALE SENIORSERTIFIKAAT-EKSAMEN***

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

**2023**

**MARKING GUIDELINES/*NASIENRIGLYNE***

**MARKS/*PUNTE*: 150**

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

**QUESTION/VRAAG 1**

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

**QUESTION/VRAAG 2**

- 2.1 Compounds with one or more 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)
- 2.2.1 D ✓ (1)

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

**Marking criteria:**

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

**Nasienkriteria:**

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

(3)

2.2.3 Propan-2-ol /2-propanol ✓✓

**Marking criteria:**

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

**Nasienkriteria:**

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

(2)

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

**Marking criteria:**

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

**Nasienkriteria:**

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

(2)

2.2.5 **Marking criteria/Nasienkriteria**

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

**Notes/Aantekeninge:**

- Ignore double arrows and phases./Ignoreer dubbelpyle en fases.
- Marking rule 6.3.10/Nasienreël 6.3.10.
- If condensed structural formulae used:/Indien gekondenseerde struktuurformules gebruik:  $\text{Max/Maks. } \frac{2}{3}$

(3)

2.3.1 **Marking criteria/Nasienkriteria**

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

Compounds with the same molecular formula but different functional groups/homologous series. ✓✓

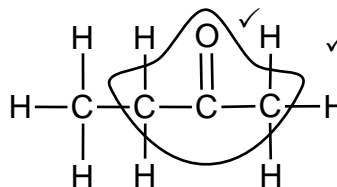
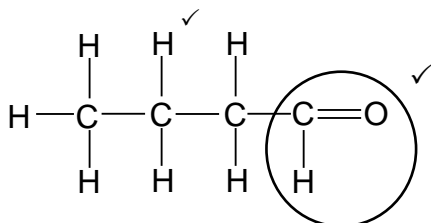
Verbindings met dieselfde molekulêre formule maar verskillende funksionele groepe/homoloë reekse.

(2)

2.3.2

**Marking criteria/Nasienkriteria:**

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



(4)

2.4

**Marking criteria**

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

**Nasienkriteria:**

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

**OPTION 1/OPSIE 1**

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

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

$$44n = 88$$

$$n = 2$$

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



**OPTION 2/OPTION 2**

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

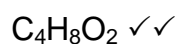
$$M(C_2H_4O) \times n = 88 \text{ (g} \cdot \text{mol}^{-1})$$

$$44n = 88$$

$$n = 2$$

Molecular formula of compound X/

Molekulêre formule van verbinding X:

(6)  
[25]

**QUESTION/VRAAG 3**

3.1

**Marking criteria/Nasienkriteria**

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

The temperature at which the vapour pressure (of a compound) equals atmospheric pressure. ✓✓

Die temperatuur waarby die dampdruk (van 'n verbinding) gelyk is aan die atmosferiese druk.

(2)

3.2

**Marking criteria/Nasienkriteria**

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

Butan-1-ol ✓

- Has a longer chain length./is less branched./has a larger surface area/contact area. ✓
- Strength of the intermolecular forces is greater./There are more sites for London forces. ✓
- More energy is needed to overcome/break intermolecular forces. ✓
- Het 'n langer kettinglengte./is minder vertak./het 'n groter kontakoppervlak/reaksieoppervlak. ✓
- Sterkte van die intermolekulêre kragte verhoog./Daar is meer plekke vir Londonkragte. ✓
- Meer energie word benodig om die intermolekulêre kragte te oorkom/breek. ✓

**OR/OF**

- 2-methylpropan-1-ol has a shorter chain length./is more branched./ has a smaller surface area/contact area.
- Strength of the intermolecular forces is weaker./There are fewer sites for London forces.
- Lesser energy is needed to overcome/break intermolecular forces.
- 2-metielpropan-1-ol het 'n korter kettinglengte./is meer vertak./het 'n kleiner kontakoppervlak/reaksieoppervlak.
- Sterkte van die intermolekulêre kragte is swakker./Daar is minder plekke vir Londonkragte.
- Minder energie word benodig om intermolekulêre kragte te oorkom/breek.

(4)

3.3

Boiling point/Kookpunt ✓

(1)

3.4

3.4.1

S ✓

(1)

3.4.2

P ✓

(1)

3.4.3 R ✓ (1)

3.5 Propanoic acid/P has the strongest intermolecular forces. ✓

**OR**

Two sites for hydrogen bonding (which is stronger than other intermolecular forces).

**OR**

Most energy needed to separate the chains.

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

(1)

**[11]****QUESTION/VRAAG 4**

4.1

4.1.1 Halogenation/Bromination ✓

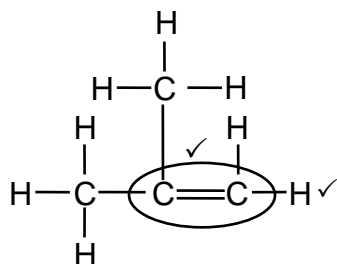
*Halogenering/Brominerig*

(1)

4.1.2 The bromine water/Br<sub>2</sub>/solution decolourises./Brown colour disappears. ✓*Die broomwater/Br<sub>2</sub>/oplossing ontkleur./Bruin kleur verdwyn.***OR/OF**Bromine water/Br<sub>2</sub>/solution changes from brown/reddish to colourless.*Broomwater/Br<sub>2</sub>/oplossing verander van bruin/rooierig na kleurloos.*

(1)

4.1.3

**Marking criteria/Nasienkriteria**

- Functional group correct ✓  
*Funksionele groep korrek*
- Whole structure correct ✓  
*Hele struktuur korrek*

(2)

4.1.4 2-chloro-2-methyl✓ propane✓ / 2-chloro-2-metielpropan**ACCEPT/AANVAAR:**2-chloromethylpropane / 2-chlorometielpropan

(2)



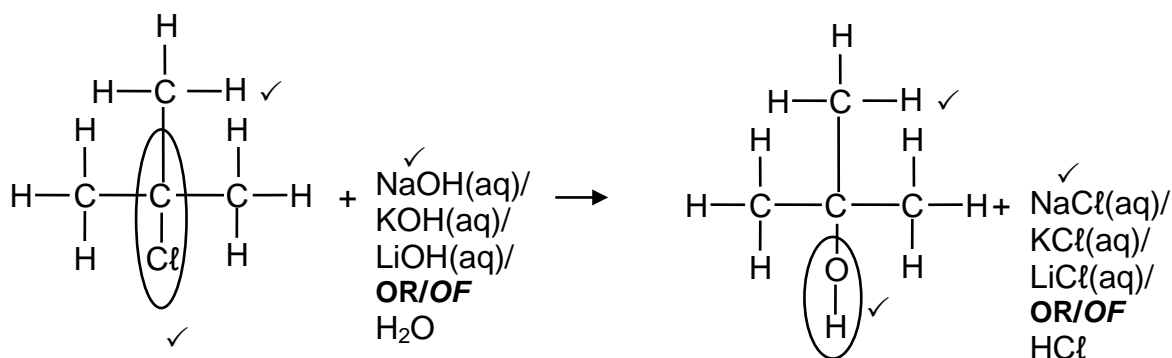
## 4.1.5

**Marking criteria:**

- Cl atom on second C atom on compound R ✓
- Whole structure of compound R correct ✓
- React compound R with NaOH(aq)/ KOH(aq)/LiOH(aq) **OR** H<sub>2</sub>O ✓
- OH-group replaces Cl atom at the same position. ✓
- Whole structure of alcohol correct. ✓
- NaCl(aq)/KCl(aq)/LiCl(aq) **OR** HCl(aq) ✓  
(must correspond to the inorganic reactant used)

**Nasienkriteria:**

- Cl-atoom op tweede C-atoom van verbinding R ✓
- Hele struktuur van verbinding R korrek ✓
- Reageer verbinding R met NaOH(aq)/ KOH(aq)/LiOH(aq) **OF** H<sub>2</sub>O ✓
- OH-groep vervang Cl-atoom by dieselfde posisie. ✓
- Hele struktuur van alkohol korrek. ✓
- NaCl(aq)/KCl(aq)/LiCl(aq) **OF** HCl(aq) ✓  
(moet ooreenstem met die anorganiese reaktans gebruik)

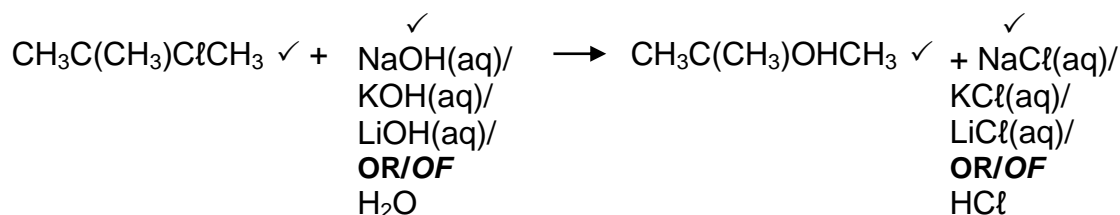
**Notes/Aantekeninge:**

- Ignore/Ignoreer ⇌
- Accept all inorganic reagents as condensed./Aanvaar alle anorganiese reagense as gekondenseerd.
- Accept coefficients that are multiples.  
Aanvaar koëffisiënte wat veelvoude is.
- Any additional reactants and/or products  
Enige addisionele reaktanse en/of produkte: Max./Maks.  $\frac{5}{6}$
- Incorrect balancing/Verkeerde balansering: Max./Maks.  $\frac{5}{6}$
- Molecular formulae/Molekulêre formule: Max./Maks.  $\frac{3}{6}$
- Condensed formulae/Gekondenseerde formule: Max./Maks.  $\frac{4}{6}$

**Accept/Aanvaar:**

-OH as condensed / -OH as gekondenseerd

Condensed formulae/Gekondenseerde formule:



(6)

- 4.1.6 2-methyl✓propan-2-ol✓/2-methyl-2-propanol  
2-metielpropan-2-ol/2-metiel-2-propanol  
**ACCEPT/AANVAAR:**  
Methylpropan-2-ol/ Metielpropan-2-ol (2)
- 4.1.7 Dehydration/Dehidrasie/Dehidratering ✓ (1)
- 4.2.1 Esterfication/Condensation ✓  
 Verestering/Esterfikasie/Kondensasie (1)
- 4.2.2 Butyl✓propanoate ✓  
 Butielpropanoat (2)
- [18]**

**QUESTION/VRAAG 5**

- 5.1 Initial concentration is 0 (of  $\text{NO}_2$ )/Concentration increases./  
 Curve starts at 0. ✓  
Beginkonsentrasie is 0 (van  $\text{NO}_2$ )/Konsentrasie verhoog./Kurwe begin by 0.
- OR/OF**  
 Curve B has an initial concentration and is the reactant as its concentration decreases.  
Kurwe B het 'n beginkonsentrasie en is die reaktant aangesien sy konsentrasie afneem. (1)
- 5.2 True/Waar ✓  
 $n$  mol of  $\text{N}_2\text{O}_5$  forms  $2n$  mol of  $\text{NO}_2$  per unit time. ✓  
 $n$  mol  $\text{N}_2\text{O}_5$  vorm  $2n$  mol  $\text{NO}_2$  per eenheidstyd.
- OR/OF**  
 Gradient of graph for  $\text{NO}_2$  is twice the gradient of graph for  $\text{N}_2\text{O}_5$ .  
 Gradiënt van grafiek vir  $\text{NO}_2$  is twee keer die gradiënt van grafiek vir  $\text{N}_2\text{O}_5$ .
- NOTE/LET WEL:**  
 If gradients calculated correctly award mark.  
 Indien gradiënte korrek bereken word punt toegeken. (2)

5.3.1

<b>Marking criteria/Nasienkriteria:</b>	
<ul style="list-style-type: none"> <li>Formula: <math>c = \frac{m}{MV}</math> / <math>n(\text{NO}_2) = cV</math> / <math>n(\text{NO}_2) = \frac{m}{M}</math> ✓</li> <li>Substitute change in concentration. ✓ <i>Vervang verandering in konsentrasie.</i></li> <li>Substitute M (46) and V (2). / <i>Vervang M (46) en V (2).</i> ✓</li> <li>Final correct answer/ <i>Finale korrekte antwoord:</i> 1,84 g ✓</li> </ul>	
<b>OPTION 1/OPSIE 1</b>	<b>OPTION 2/OPSIE 2</b>
$c(\text{NO}_2) = \frac{m}{MV}$ $200 \times 10^{-4} \checkmark = \frac{m}{(46)(2)} \checkmark$ $m = 1,84 \text{ g} \checkmark$	$n(\text{NO}_2) = cV \checkmark$ $= (200 \times 10^{-4}) \checkmark \times 2$ $= 4 \times 10^{-2} \text{ mol}$ <div style="display: flex; align-items: center; justify-content: space-around;"> <div style="text-align: center;"> <math display="block">n(\text{NO}_2) = \frac{m}{M}</math> <math display="block">4 \times 10^{-2} = \frac{m}{46}</math> <math display="block">m = 1,84 \text{ g} \checkmark</math> </div> <div style="text-align: center;"> <math display="block">m = \frac{M}{M} \times n</math> <math display="block">m = \frac{46}{1} \times 4 \times 10^{-2}</math> <math display="block">m = 1,84 \text{ g} \checkmark</math> </div> </div>

(4)

5.3.2

<b>Marking criteria/Nasienkriteria:</b>	
<ul style="list-style-type: none"> <li>Substitute the change in concentration into rate formula. ✓ <i>Vervang verandering in konsentrasie in tempo formule.</i></li> <li>Substitute time into the rate formula. / <i>Vervang tyd in tempo formule.</i> ✓</li> <li>Use mol ratio/<i>Gebruik molverhouding:</i> <math>\text{rate/tempo}(\text{O}_2) = \frac{1}{2} \text{ rate/tempo}(\text{N}_2\text{O}_5)</math> / <math>\text{rate/tempo}(\text{O}_2) = \frac{1}{4} \text{ rate/tempo}(\text{NO}_2)</math> ✓</li> <li>Final correct answer/<i>Finale korrekte antwoord:</i> <math>1 \times 10^{-5} (\text{mol} \cdot \text{dm}^{-3} \cdot \text{s}^{-1})</math> ✓</li> </ul>	
<b>NOTE/LET WEL</b> If concentration is converted to moles, final moles per s ( $\text{mol} \cdot \text{s}^{-1}$ ) must be converted back to concentration ( $\text{mol} \cdot \text{dm}^{-3} \cdot \text{s}^{-1}$ ). i.e. there must be multiplication and division by 2. If one of these is omitted: <span style="float: right;">Max. <math>\frac{2}{4}</math></span> <i>Indien konsentrasie omgeskakel is na mol, moet die finale mol per s (<math>\text{mol} \cdot \text{s}^{-1}</math>) omgeskakel word na konsentrasie (<math>\text{mol} \cdot \text{dm}^{-3} \cdot \text{s}^{-1}</math>) d.w.s daar moet vermenigvuldig en gedeel word deur 2. Indien een van hierdie uitgelaat word: <span style="float: right;">Maks. <math>\frac{2}{4}</math></span></i>	
<b>OPTION 1/OPSIE 1</b>	
$\text{Ave rate/gem tempo} = - \frac{\Delta c(\text{N}_2\text{O}_5)}{\Delta t}$ $= - \frac{(60 \times 10^{-4} - 200 \times 10^{-4}) \checkmark}{700 (-0) \checkmark}$ $= 2 \times 10^{-5} (\text{mol} \cdot \text{dm}^{-3} \cdot \text{s}^{-1})$ $\text{rate}(\text{O}_2) = \frac{1}{2} \text{ rate}(\text{N}_2\text{O}_5) = \frac{1}{2} (2 \times 10^{-5}) \checkmark$ $= 1 \times 10^{-5} (\text{mol} \cdot \text{dm}^{-3} \cdot \text{s}^{-1}) \checkmark$	
<b>OPTION 2/OPSIE 2</b>	
$\text{Ave rate/gem tempo} = \frac{\Delta c(\text{NO}_2)}{\Delta t}$ $= \frac{(280 \times 10^{-4} (-0)) \checkmark}{700 (-0) \checkmark}$ $= 4 \times 10^{-5} (\text{mol} \cdot \text{dm}^{-3} \cdot \text{s}^{-1})$ $\text{rate}(\text{O}_2) = \frac{1}{4} \text{ rate}(\text{NO}_2) = \frac{1}{4} (4 \times 10^{-5}) \checkmark$ $= 1 \times 10^{-5} (\text{mol} \cdot \text{dm}^{-3} \cdot \text{s}^{-1}) \checkmark$	

**OPTION 3/OPSIE 3**

$$\Delta c(\text{O}_2) = \frac{1}{2} \Delta c(\text{N}_2\text{O}_5)$$

$$= \frac{1}{2} (60 \times 10^{-4} - 200 \times 10^{-4}) \checkmark$$

$$= \frac{1}{2} (140 \times 10^{-4})$$

$$= 7 \times 10^{-3} \text{ mol} \cdot \text{dm}^{-3}$$

**OR/OF**

$$\Delta c(\text{O}_2) = \frac{1}{4} \Delta c(\text{NO}_2)$$

$$= \frac{1}{4} (280 \times 10^{-4} \checkmark (-0))$$

$$= 7 \times 10^{-3} \text{ mol} \cdot \text{dm}^{-3}$$

$$= 7 \times 10^{-3} \text{ mol} \cdot \text{dm}^{-3}$$

$$\text{Ave rate/gem tempo} = \frac{\Delta c(\text{O}_2)}{\Delta t}$$

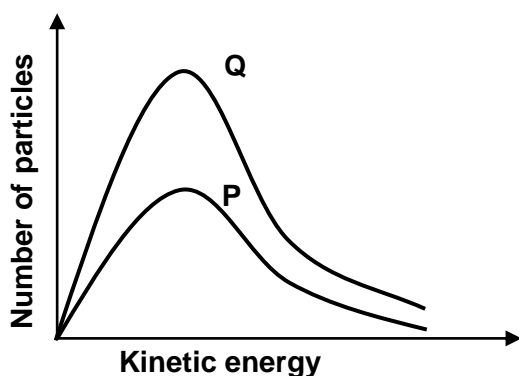
$$= \frac{(7 \times 10^{-3}) \checkmark}{700 (-0) \checkmark}$$

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

(4)

5.4

5.4.1

**Marking criteria/Nasienkriteria**

- Curve Q must be above the given curve P and have the same shape as the given curve P and the peaks have to correspond. ✓

*Kurwe Q moet bo die gegewe kurwe P wees en moet dieselfde vorm hê as die gegewe kurwe P en die maksimums moet ooreenstem*

- Starts at origin and not crossing curve P. ✓

*Begin by oorsprong en nie kruis met kurwe P nie.*

(2)

5.4.2 Higher than/Hoër as ✓

- When the concentration of  $\text{N}_2\text{O}_5$  is higher there are more  $\text{N}_2\text{O}_5$  particles per unit volume. ✓

- More effective collisions per unit time/second. ✓

**OR**

Higher frequency of effective collisions.

- 'n Hoër konsentrasie van  $\text{N}_2\text{O}_5$  bevat meer  $\text{N}_2\text{O}_5$ -deeltjies per eenheidsvolume. ✓

- Meer effektiewe botsings per eenheidstyd/sekonde. ✓

**OF**

Hoër frekwensie van effektiewe botsings.

(3)

**[16]**

## QUESTION/VRAAG 6

6.1

**Marking criteria/Nasienkriteria:**

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

When the equilibrium in a closed system is disturbed, the system will re-instate a (new) equilibrium by favouring the reaction that will cancel/oppose the disturbance. ✓✓

Wanneer die ewewig in 'n geslote sisteem versteur word, sal die sisteem 'n (nuwe) ewewig instel deur die reaksie te bevoordeel wat die versteuring kanselleer/teenwerk.

(2)

6.2

6.2.1  $n[\text{H}_2(\text{g})] = 0,11 \text{ (mol)}$  ✓

(1)

6.2.2

**OPTION 1/OPSIE 1**

$$n(\text{HI})_{\text{used/gebruik}} = 2n(\text{I}_2) \\ = 2(0,11)$$

$$n(\text{HI})_{\text{eq}} = 1 - 0,22 \\ = 0,78 \text{ (mol)} \quad \checkmark$$

**OPTION 2/OPSIE 2**

$$K_c = \frac{[\text{H}_2][\text{I}_2]}{[\text{HI}]^2}$$

$$0,02 = \frac{(0,11)(0,11)}{[\text{HI}]^2}$$

$$[\text{HI}] = 0,78 \text{ mol} \cdot \text{dm}^{-3}$$

$$n(\text{HI}) = 0,78 \text{ (mol)} \quad \checkmark$$

(1)

6.3

6.3.1 Endothermic/Endotermies ✓

(1)

6.3.2  $K_c$  increased:

- The concentration of the product/ $\text{H}_2(\text{g})$  and  $\text{I}_2(\text{g})$  is increased. ✓  
**OR:** The concentration of the reactant/HI decreases.
- The increase in temperature favours the forward reaction. ✓
- (According to Le Chatelier's principle) an increase in temperature favours the endothermic reaction. ✓

 $K_c$  het verhoog:

- Die konsentrasie van die produkte/ $\text{H}_2(\text{g})$  en  $\text{I}_2(\text{g})$  verhoog. ✓  
**OF:** Die konsentrasie van die reaktantse/HI verlaag.
- 'n Toename in temperatuur bevoordeel die voorwaartse reaksie. ✓
- (Volgens Le Chatelier se beginsel) sal 'n toename in temperatuur die endotermiese reaksie bevoordeel. ✓

(3)

6.3.3

**POSITIVE MARKING FROM Q6.2/POSITIEWE NASIEN VANAF V6.2****Marking criteria:**

- (a) Correct  $K_c$  expression (formulae in square brackets). ✓  
 (b) Substitution of 0,09 in  $K_c$  expression. ✓  
 (c) Correct initial moles from 6.2.1 and 6.2.2. ✓  
 (d) USING ratio:  $n\text{HI(g)} : 2n\text{I}_2(\text{g}) = 1:2$  ✓  
 (e) Substitution of concentrations into correct  $K_c$  expression. ✓  
 (f) Subtraction  $[\text{HI}]_{\text{ini}} - \Delta[\text{HI}]$  ✓  
 (g) Substitution of 128 in  $m = nM$ . ✓  
 (h) Final answer: 80,64 g ✓  
 (range: 79,36 - 80,64 g)

**Nasienkriteria:**

- (a) Korrekte  $K_c$  uitdrukking (formules in vierkantige hakies). ✓  
 (b) Vervang 0,09 in  $K_c$  uitdrukking. ✓  
 (c) Aanvanklike mol korrek vanaf 6.2.1 en 6.2.2. ✓  
 (d) GEBRUIK verhouding:  
 $n\text{HI(g)} : 2n\text{I}_2(\text{g}) = 1:2$  ✓  
 (e) Vervang konsentrasies in korrekte  $K_c$  uitdrukking. ✓  
 (f) Verskil:  $[\text{HI}]_{\text{aanv}} - \Delta[\text{HI}]$  ✓  
 (g) Vervang 128 in  $m = nM$ . ✓  
 (h) Finale antwoord: 80,64 g ✓  
 (gebied: 79,36 - 80,64 g)

**OPTION 1/OPSIE 1**

$$K_c = \frac{[\text{H}_2][\text{I}_2]}{[\text{HI}]^2} \quad \checkmark \text{ (a)} \quad \checkmark \text{ (c) (0,11 and/en 0,78 from 6.2.1 and/en 6.2.2)}$$

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

$$x = 0,0775$$

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

$$= 0,78 - 2(0,0775) \quad \checkmark \text{ (f)}$$

$$= 0,63 \text{ mol} \cdot \text{dm}^{-3} \quad (0,625)$$

$$n(\text{HI}) = cV$$

$$= (0,63)(1)$$

$$= 0,63 \text{ mol} \quad (0,625)$$

$$m(\text{HI}) = nM$$

$$= (0,63)(128) \quad \checkmark \text{ (g)}$$

$$= 80,64 \text{ g} \quad \checkmark \text{ (h)}$$

**OR/OF**

$$m(\text{HI}) = cVM$$

$$= (0,63)(1)(128) \quad \checkmark \text{ (g)}$$

$$= 80,64 \text{ g} \quad \checkmark \text{ (h)}$$

**OPTION 2/OPSIE 2**

	HI	I <sub>2</sub>	H <sub>2</sub>
Initial quantity (mol) <i>Aanvanklike hoeveelheid (mol)</i>	0,78	0,11	0,11
Change (mol) <i>Verandering (mol)</i>	2x	x	x
Quantity at equilibrium (mol) <i>Hoeveelheid by ewewig (mol)</i>	0,78 - 2x	0,11 + x	0,11 + x
Equilibrium concentration <i>Ewewigskonsentrasie (mol·dm<sup>-3</sup>)</i>	$\frac{0,78 - 2x}{1}$	$\frac{0,11 + x}{1}$	$\frac{0,11 + x}{1}$

Ratio 1:2  
✓

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

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

$$x = 0,0775$$

$$[HI]_{\text{equilibrium/ewewig}} = \frac{0,78 - 2(0,0775)}{1} \checkmark (f)$$

$$= 0,63 \text{ mol} \cdot \text{dm}^{-3} (0,625)$$

$$n(HI) = cV$$

$$= (0,63)(1)$$

$$= 0,63 \text{ mol } (0,625 \text{ mol})$$

$$m(HI) = nM$$

$$= (0,63)(128) \checkmark (g)$$

$$= 80,64 \text{ g } \checkmark (h)$$

**OR/OF**

$$m(HI) = cVM$$

$$= (0,63)(1)(128) \checkmark (g)$$

$$= 80,64 \text{ g } \checkmark (h)$$

(8)  
[16]**QUESTION/VRAAG 7**

7.1

7.1.1

**ANY ONE:**

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

**ENIGE EEN:**

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

(2)

7.1.2 A ✓

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

**OR/OF**

It ionises to produce more than one mole of protons/ $H^+$  ions for each mole of  $H_2SO_4$ ./ $H_2SO_4$  has a higher  $K_a$  value.

*Dit ioniseer om meer as een mol protone/  $H^+$ -ione vir elke mol  $H_2SO_4$  te vorm./ $H_2SO_4$  het 'n hoër  $K_a$ -waarde.*

(2)

7.1.3 B ✓

Stronger acid/ionises completely ✓(and both acids are of the same concentration)./ $HNO_3$  has a higher  $K_a$  value.

*Sterker suur/ioniseer volledig (en beide sure het dieselfde konsentrasie)./ $HNO_3$  het 'n hoër  $K_a$ -waarde.*

**OR/OF**

C/ $CH_3COOH$  is a weaker acid/ionises incompletely.

*C/ $CH_3COOH$  is 'n swak suur/ioniseer onvolledig.*

(2)

7.2

7.2.1

**Marking criteria/Nasienkriteria:**

- Substitute/Vervang  $0,04 \text{ mol} \cdot \text{dm}^{-3}$  and  $25 \times 10^{-3} \text{ dm}^3$  ( $25 \text{ cm}^3$ ) and  $19,5 \times 10^{-3} \text{ dm}^3$  ( $19,5 \text{ cm}^3$ ). ✓
- USE mol ratio:/GEBRUIK molverhouding:  $n(\text{Na}_2\text{CO}_3) : n(\text{HCl}) = 1 : 2$  ✓
- Final answer/Finale antwoord:  $0,10$  to/tot  $0,103 \text{ mol} \cdot \text{dm}^{-3}$  ✓

**OPTION 1/OPSIE 1**

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

$$\frac{c_a(19,5)}{(0,04)(25)} = \frac{2}{1} \checkmark$$

$$c_a = 0,10 \text{ mol} \cdot \text{dm}^{-3} \checkmark (0,103)$$

**OPTION 2/OPSIE 2**

$$n(\text{Na}_2\text{CO}_3) = cV$$

$$= 0,04 \times 0,025$$

$$= 0,001 \text{ mol}$$

$$n(\text{HCl}) = 2n(\text{Na}_2\text{CO}_3)$$

$$= 0,002 \text{ mol} \checkmark$$

$$[\text{HCl}] = \frac{n}{V}$$

$$= \frac{0,002}{0,0195}$$

$$= 0,10 \text{ mol} \cdot \text{dm}^{-3} \checkmark (0,103)$$

(3)

7.2.2 Greater than/Groter as ✓



The few drops of water will dilute the  $\text{HCl}$ , ✓ therefore greater volume of acid will be needed to neutralise the base.

*'n Paar druppels water sal die  $\text{HCl}$  verdun, daarom sal 'n groter volume suur benodig word om die basis te neutraliseer.*

(2)



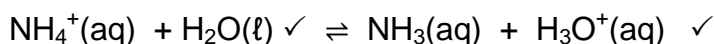
7.2.3

<b>POSITIVE MARKING FROM Q7.2.1/POSITIEWE NASIEN VANAF V7.2.1</b>	
<p><b>Marking criteria:</b></p> <p>(a) Substitute <math>0,1 \text{ mol} \cdot \text{dm}^{-3}</math> &amp; <math>18,7 \times 10^{-3} \text{ dm}^3</math> (<math>18,7 \text{ cm}^3</math>). ✓</p> <p>(b) Use mole ratio: 1:1 ✓</p> <p>(c) Calculate <math>n(\text{NH}_3) / m(\text{NH}_3)</math> in <math>250 \text{ cm}^3</math>: Substitute <math>0,25 \text{ dm}^3</math> (<math>250 \text{ cm}^3</math>) ✓</p> <p>(d) Substitute <math>0,022 \text{ dm}^3</math> (<math>22 \text{ cm}^3</math>). ✓</p> <p>(e) Substitute <math>0,02 \text{ dm}^3</math> (<math>20 \text{ cm}^3</math>) to calculate mole/mass in initial solution. ✓</p> <p>(f) Use <math>17 \text{ g} \cdot \text{mol}^{-1}</math> in <math>n = \frac{m}{M}</math>. ✓</p> <p>(g) Final answer: <math>18,06 \text{ g}</math> ✓ Range: 17 to <math>19,13 \text{ g}</math></p>	<p><b>Nasienkriteria:</b></p> <p>(a) Vervang <math>0,1 \text{ mol} \cdot \text{dm}^{-3}</math> &amp; <math>18,7 \times 10^{-3} \text{ dm}^3</math> (<math>18,7 \text{ cm}^3</math>). ✓</p> <p>(b) Gebruik molverhouding: 1:1 ✓</p> <p>(c) Bereken <math>n(\text{NH}_3) / m(\text{NH}_3)</math> in <math>250 \text{ cm}^3</math>: Vervang <math>0,25 \text{ dm}^3</math> (<math>250 \text{ cm}^3</math>). ✓</p> <p>(d) Vervang <math>0,022 \text{ dm}^3</math> (<math>22 \text{ cm}^3</math>). ✓</p> <p>(e) Vervang <math>0,02 \text{ dm}^3</math> (<math>20 \text{ cm}^3</math>) om mol/massa van oorspronklike oplossing te bereken. ✓</p> <p>(f) Gebruik <math>17 \text{ g} \cdot \text{mol}^{-1}</math> in <math>n = \frac{m}{M}</math>. ✓</p> <p>(g) Finale antwoord: <math>18,06 \text{ g}</math> ✓ Gebied: 17 tot <math>19,13 \text{ g}</math></p>
<p><b>OPTION 1/OPSIE 1</b></p> <p><math>n(\text{HCl}) = cV</math>  <math>= (0,1)(18,7 \times 10^{-3})</math> ✓ (a)  <math>= 1,87 \times 10^{-3} \text{ mol}</math></p> <p><math>n(\text{NH}_3)_{\text{reacted/reageer}} = n(\text{HCl})_{\text{reacted/reageer}}</math>  <math>= 1,87 \times 10^{-3} \text{ mol}</math> ✓ (b)</p> <p><math>n(\text{NH}_3) \text{ in } 22 \text{ cm}^3 = 1,87 \times 10^{-3} \text{ mol}</math></p> <p><math>n(\text{NH}_3) \text{ in } 250 \text{ cm}^3 = \frac{(1,87 \times 10^{-3})(250)}{22}</math> ✓ (c)  <math>= 0,021 \text{ mol}</math> (<math>2,13 \times 10^{-2}</math>)</p> <p><math>n(\text{NH}_3) \text{ in initial } 20 \text{ cm}^3 = 0,021 \text{ mol}</math></p> <p><math>n = \frac{m}{M}</math>  <math>0,021 = \frac{m}{17}</math> ✓ (f)  <math>m(\text{NH}_3) = 0,357 \text{ g in } 20 \text{ cm}^3</math></p> <p><math>m(\text{NH}_3) = \frac{(0,357)(1000)}{20}</math> ✓ (e)  <math>= 17,85 \text{ g}</math> ✓ (g) (<math>18,06</math>)</p>	<p><b>OPTION 2/OPSIE 2</b></p> <p><math>n(\text{HCl}) = cV</math>  <math>= (0,1)(18,7 \times 10^{-3})</math> ✓ (a)  <math>= 1,87 \times 10^{-3} \text{ mol}</math></p> <p><math>(\text{NH}_3)_{\text{reacted/reageer}} = n(\text{HCl})_{\text{reacted/reageer}}</math>  <math>= 1,87 \times 10^{-3} \text{ mol}</math> ✓ (b)</p> <p><math>n(\text{NH}_3) \text{ in } 22 \text{ cm}^3 = 1,87 \times 10^{-3} \text{ mol}</math></p> <p><math>n = \frac{m}{M}</math>  <math>1,87 \times 10^{-3} = \frac{m}{17}</math> ✓ (f)  <math>m(\text{NH}_3) = 3,72 \times 10^{-3} \text{ g in } 22 \text{ cm}^3</math> ✓ (c)</p> <p><math>m(\text{NH}_3) \text{ in } 250 \text{ cm}^3 = \frac{(3,72 \times 10^{-3})(250)}{22}</math> ✓ (d)  <math>= 0,361 \text{ g}</math></p> <p><math>m(\text{NH}_3) \text{ in initial } 20 \text{ cm}^3 = 0,361 \text{ g}</math></p> <p><math>m(\text{NH}_3) \text{ in } 1\,000 \text{ cm}^3 = \frac{(0,361)(1000)}{20}</math> ✓ (e)  <math>= 18,06 \text{ g}</math> ✓ (g)</p>

(7)

<p><b>OPTION 3/OPSIE 3</b></p> $\frac{c_b V_b}{c_a V_a} = \frac{n_b}{n_a}$ $\frac{c_b(22)}{(0,1)(18,7)} = \frac{1}{1} \quad \checkmark (d) \quad \checkmark (b)$ $c_1 = 0,085 \text{ mol} \cdot \text{dm}^{-3}$ $[\text{NH}_3] \text{ in } 22 \text{ cm}^3 = 0,085 \text{ mol} \cdot \text{dm}^{-3}$ $[\text{NH}_3] \text{ in } 250 \text{ cm}^3 = 0,085 \text{ mol} \cdot \text{dm}^{-3}$ $c_1 V_1 = c_2 V_2$ $c_1(0,02) = (0,085)(0,25) \quad \checkmark (c) \quad \checkmark (e)$ $c_1 = 1,06 \text{ mol} \cdot \text{dm}^{-3}$ $m = cVM \quad (f)$ $= (1,06)(1)(17) \quad \checkmark$ $= 18,06 \text{ g} \quad \checkmark (g)$	<p><b>OPTION 4/OPSIE 4</b></p> $n(\text{HCl}) = cV$ $= (0,1)(18,7 \times 10^{-3}) \quad \checkmark (a)$ $= 1,87 \times 10^{-3} \text{ mol}$ $(\text{NH}_3)_{\text{reacted/reageer}} = n(\text{HCl})_{\text{reacted/reageer}}$ $= 1,87 \times 10^{-3} \text{ mol} \quad \checkmark (b)$ $n(\text{NH}_3) \text{ in } 22 \text{ cm}^3 = 1,87 \times 10^{-3} \text{ mol}$ $n(\text{NH}_3) \text{ in } 250 \text{ cm}^3 = \frac{(1,87 \times 10^{-3})(250)}{22} \quad \checkmark (c) \quad \checkmark (d)$ $= 0,021 \text{ mol}$ $c(20 \text{ cm}^3) = c(1 \text{ dm}^3)$ $\frac{n_1}{V_1} = \frac{n_2}{V_2}$ $n(\text{NH}_3) \text{ in } 1\,000 \text{ cm}^3 = \frac{0,021 \times 1000}{20} \quad \checkmark (e)$ $= 1,06 \text{ mol}$ $n = \frac{m}{M}$ $1,06 = \frac{m}{17} \quad \checkmark (f)$ $m(\text{NH}_3) = 18,06 \text{ g} \quad \checkmark (g)$
--	---

7.2.4 Less than 7/Minder as 7 ✓



**Notes/Aantekeninge:**

- Ignore single arrow/Ignoreer enkelpyl: →

(3)  
[21]

**QUESTION/VRAAG 8**

8.1 • Pressure: 1 atmosphere /101,3 kPa/1,01 x 10<sup>5</sup> Pa ✓

*Druk:* 1 atmosfeer /101,3 kPa/1,01 x 10<sup>5</sup> Pa

• Temperature/Temperatuur: 25 °C /298 K ✓

• Concentration of electrolytes: 1 mol·dm<sup>-3</sup> ✓

*Konsentrasie van elektroliete:* 1 mol·dm<sup>-3</sup>

(3)

8.2 To maintain electrical neutrality/To complete the circuit/To allow movement of ions between electrolytes ✓

*Om elektriese neutraliteit te verseker/Om die stroombaan te voltooi/Laat ione toe om tussen elektroliete te beweeg*

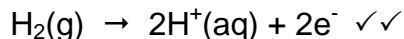
(1)

8.3

<p><b>OPTION 1/OPTION 1</b></p> <p><math>E_{\text{cell}}^{\theta} = E_{\text{cathode}}^{\theta} - E_{\text{anode}}^{\theta} \checkmark</math></p> <p><math>1,20 \checkmark = E_{\text{cathode}}^{\theta} - 0 \checkmark</math></p> <p><math>E_{\text{cathode}}^{\theta} = 1,20 \text{ (V)} \checkmark</math></p> <p>X is Pt/platinum <math>\checkmark</math></p>	<p><b>Notes/Aantekeninge</b></p> <ul style="list-style-type: none"> <li>Accept any other correct formula from the data sheet./Aanvaar enige ander korrekte formule vanaf gegewensblad.</li> <li>Any other formula using unconventional abbreviations, e.g. <math>E_{\text{cell}}^{\circ} = E_{\text{OA}}^{\circ} - E_{\text{RA}}^{\circ}</math> followed by correct substitutions./Enige ander formule wat onkonvensionele afkortings gebruik, bv. <math>E_{\text{sel}}^{\circ} = E_{\text{OM}}^{\circ} - E_{\text{RM}}^{\circ}</math> gevolg deur korrekte vervangings: Max./Maks. <math>\frac{4}{5}</math></li> </ul>
<p><b>OPTION 2/OPSIE 2</b></p> <p><math>\checkmark \begin{cases} X^{2+} + 2e^{-} \rightarrow X \\ H_2 \rightarrow 2H^{+} + 2e^{-} \end{cases}</math></p> <p><math>H_2 + X^{2+} \rightarrow X + 2H^{+}</math></p> <p>X is Pt/Platinum <math>\checkmark</math></p>	<p><math>E^{\theta} = 1,20 \text{ V} \checkmark</math></p> <p><math>E^{\theta} = 0,00 \text{ V} \checkmark</math></p> <p><math>E^{\theta} = 1,20 \text{ V} \checkmark</math></p>

(5)

8.4

**Marking criteria/Nasienkriteria:**

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

(2)

8.5  $H^+$ ,  $X^{2+}$  ( $Pt^{2+}$ ),  $Au^{3+}$  ✓

- $H_2$  loses/donates electrons to both Au and X/Pt. ✓

**OR** $H_2$  is the anode/is oxidised in both cells.Therefore  $H^+$  is the weakest oxidising agent.

- The reduction potential of  $X|X^{2+}$  is 1,2 V and that of  $Au|Au^{3+}$  is 1,5 V. ✓

**OR**The reduction potential of  $X|X^{2+}$  is smaller than that of  $Au|Au^{3+}$ .**OR**According to the Table of Standard Reduction Potentials  $Au^{3+}$  is stronger oxidation agent than  $Pt^{2+}$ .**OR**

The cell containing Au produces a higher emf than cell containing X.

- $H_2$  verloor/skenk elektrone aan beide Au en X/Pt. ✓

**OF** $H_2$  is die anode/word geoksideer in beide selle.Daarom is  $H^+$  die swakste oksideermiddel

- Die reduksiepotensiaal van  $X|X^{2+}$  is 1,2 V en die van  $Au|Au^{3+}$  is 1,5 V. ✓

**OF**Die reduksiepotensiaal van  $X|X^{2+}$  is kleiner as dié van  $Au|Au^{3+}$ .**OF**Volgens die Tabel van Standaardreduksiepotensiale is  $Au^{3+}$  'n sterker oksideermiddel as  $Pt^{2+}$ **OF**

Die sel wat Au bevat het 'n hoër emk as die sel wat X bevat.

(3)

**[14]**

**QUESTION/VRAAG 9**

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

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

9.3  
9.3.1  $\text{Zn}^{2+}(\text{aq}) + 2\text{e}^- \rightarrow \text{Zn}(\text{s})$  ✓✓  
Ignore phases./Ignoreer fases

**Marking criteria/Nasienkriteria:**

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

9.3.2 Zinc/Zn/Sink ✓ (1)

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

**TOTAL/TOTAAL: 150**