education

Department of Education
FREE STATE PROVINCE

PREPARATORY EXAMINATION
VOORBEREIDENDE EKSAMEN



GRADE/*GRAAD* 12

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



SEPTEMBER 2025

MARKS/*PUNTE*: 150

MARKING GUIDELINES/*NASIENRIGLYNE*

These marking guidelines consist of 14 pages.
Hierdie nasienriglyne bestaan uit 14 bladsye.

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QUESTION 1/*VRAAG 1*

1.1 B ✓✓ (2)

1.2 B ✓✓ (2)

1.3 B ✓✓ (2)

1.4 C ✓✓ (2)

1.5 D ✓✓ (2)

1.6 C ✓✓ (2)

1.7 D ✓✓ (2)

1.8 C ✓✓ (2)

1.9 A ✓✓ (2)

1.10 A ✓✓ (2)
[20]

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QUESTION 2/*VRAAG 2*

2.1.1 D ✓ (1)

2.1.2 A & D ✓ (1)

2.1.3 E ✓ (1)

2.2 C_nH_{2n+2} ✓✓ (2)

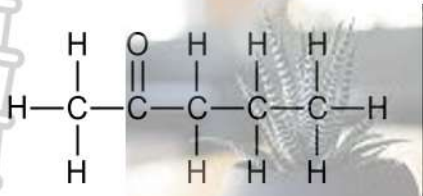
2.3.1 B ✓ (1)

2.3.2 Chain (isomers)/*Ketting (isomere)* ✓ (1)

2.3.3 2,2,4-trimethylpentane/*trimetielpentaan* ✓✓✓ (3)

Marking criteria/*Nasienkriteria*:
- Correct stem, i.e. pentane ✓
  Korrekte stam, d.w.s. pentaan
- Correct substituents (methyl) identified. ✓
  Korrekte substituente (metiel) geïdentifiseer.
- IUPAC name entirely correct including numbering, sequence, hyphens and commas. ✓
  IUPAC-naam heeltemal korrek insluitend nommering, volgorde, koppeltekens en kommas.

2.4



Marking criteria/*Nasienkriteria:*
- Functional group/*Funksionele groep* ✓
- 5 C-atoms in the longest chain ✓
  5 C-atome in die langste ketting
- Whole structure correct ✓
  Hele struktuur korrek

(3)

2.5.1 Esterification/condensation / *Verestering/kondensasie* ✓ (1)

2.5.2 H_2SO_4/sulphuric acid / *swaelsuur* ✓ (1)

2.5.3 Propyl ✓ ethanoate ✓ / *Propyl etanoaat* (2)

[17]

QUESTION 3/*VRAAG 3*

3.1

Marking criteria/*Nasienkriteria*:
If any of the underlined key phrases in the correct context is omitted, deduct 1 mark.
Indien enige van die onderstreepte sleutelfrases in die korrekte konteks weggelaat is, trek 1 punt af.

The temperature at which the vapour pressure of a liquid is equal to the atmospheric pressure. ✓✓
Die temperatuur waarby die dampdruk van 'n vloeistof gelyk is aan die atmosferiese druk. (2)

3.2 **Compound C**
- Is more branched/compact/spherical/smaller surface area ✓
- Weaker intermolecular forces ✓
- Less energy needed to break/overcome intermolecular forces ✓

Verbinding C
- *Is meer vertak/kompak/sferies/kleiner oppervlakte*
- *Swakker intermolekulêre kragte*
- *Minder energie benodig om intermolekulêre kragte te breek/oorkom*

OR/*OF*

Compound B
- Is less branched/compact/spherical/larger surface area
- Stronger intermolecular forces
- More energy is needed to break/overcome intermolecular forces

Verbinding B
- *Is minder vertak/kompak/sferies/groter oppervlakte*
- *Sterker intermolekulêre kragte*
- *Meer energie benodig om intermolekulêre kragte te breek/oorkom* (3)

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3.3.1 117,7 (°C) ✓ (1)

3.3.2
- Between molecules of compound A are 2 sites of hydrogen bonds (in addition to London and dipole-dipole forces) ✓
- Between molecules of compound B is 1 site of hydrogen bonds (in addition to London and dipole-dipole forces) ✓
- Between compound D are dipole-dipole forces (in addition to London forces) ✓
- Intermolecular forces between molecules of B are weaker than those between molecules of A ✓ but stronger than those between molecules of D ✓
- Less energy needed to overcome intermolecular forces of B compared to that of A ✓/ More energy needed to overcome intermolecular forces of B compared to that of D

- *Tussen molekules van verbinding A is 2 plekke van waterstofbindings (bykomend tot Londen en dipool-dipoolkragte)*
- *Tussen molekules van verbinding B is 1 plek van waterstofbindings (bykomend tot Londen en dipool-dipoolkragte)*
- *Tussen verbinding D is dipool-dipoolkragte (bykomend tot Londen-kragte)*
- *Intermolekulêre kragte tussen molekules van B is swakker as dié tussen molekules van A, maar sterker as dié tussen molekules van D*
- *Minder energie benodig om intermolekulêre kragte van B te oorkom in vergelyking met dié van A / Meer energie benodig om intermolekulêre kragte van B te oorkom in vergelyking met dié van D* (6)

3.4.1 Butane/*Butaan* ✓✓ (2)

3.4.2 **From compound E to G**:
- Chain length increases ✓
- Strength of intermolecular forces increases ✓
- More energy needed to break the intermolecular forces ✓

Vanaf verbinding E na G:
- *Kettinglengte neem toe*
- *Sterkte van intermolekulêre kragte neem toe*
- *Meer energie benodig om die intermolekulêre kragte te breek*

OR/*OF*

From compound G to E
- Chain length decreases
- Strength of intermolecular forces decreases
- Less energy needed to break the intermolecular forces

Van verbinding G na E
- *Kettinglengte neem af*
- *Sterkte van intermolekulêre kragte neem af*
- *Minder energie benodig om die intermolekulêre kragte te breek* (3)

[17]

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QUESTION 4/*VRAAG 4*

4.1

Marking criteria/*Nasienkriteria*:
If any of the underlined key phrases in the correct context is omitted, deduct 1 mark.
Indien enige van die onderstreepte sleutelfrases in die korrekte konteks weggelaat is, trek 1 punt af.

A chemical process in which longer chain hydrocarbon molecules are broken down to shorter, more useful molecules. ✓✓
'n Chemiese proses waarin langerketting koolwaterstofmolekules in korter, meer bruikbare molekules afgebreek word. (2)

4.2.1 Exothermic/*Eksotermies* ✓ (1)

4.2.2 $C_3H_8 + 5O_2$ ✓ $\rightarrow 3CO_2$ ✓ $+ 4H_2O$ ✓

Marking criteria/*Nasienkriteria:*
- Reactants ✓ *Reaktanse* Products ✓ *Produkte* Balancing ✓ *Balansering*
- Ignore ⇌ and phases
  Ignoreer ⇌ en fases
- Marking rule 6.3.10/*Nasienreël 6.3.10*

(3)

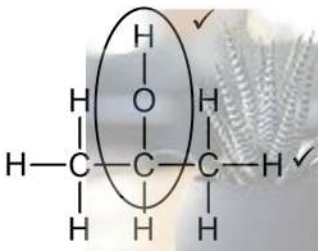
4.2.3 Carbon dioxide/*Koolstofdioksied* ✓ (1)

4.3.1 Addition/hydrohalogenation/hydrobromination ✓
Addisie/hidrohalogenering/hidrobromering (1)

4.3.2 No water/use unreactive solvent ✓
Geen water/gebruik onreaktiewe oplosmiddel (1)

4.3.3 2-bromo ✓propane ✓ /*2-broom propaan* (2)

4.4.1



✓ ✓

Marking criteria:
- Functional group correct. ✓
- Whole structural formula correct. ✓

Nasienkriteria:
- *Funksionele groep korrek.*
- *Hele struktuurformule korrek.*

(2)

4.4.2 Substitution/hydrolysis / *Substitusie/hidrolise* ✓ (1)

4.5.1 Dehydration / *Dehidrasie* ✓ (1)

4.5.2 Propene/prop-1-ene/1-propene / *Propeen/prop-1-een/1-propeen* ✓✓ (2)
[17]

QUESTION 5/*VRAAG 5*

5.1 Gas syringe/measuring cylinder / *Gasspuit/maatsilinder* ✓ (1)

5.2
- Change in concentration/mass/volume/amount of reactants/ products per unit time ✓✓
- Mass/volume/amount/concentration of reactants used/products formed per unit time
- Rate of change in concentration/mass/volume/amount of reactants or products **(2 or/*of* 0)**

- *Verandering in konsentrasie/massa/volume/hoeveelheid reaktanse/ produkte per tydseenheid*
- *Massa/volume/hoeveelheid/konsentrasie van reaktanse gebruik/ produkte gevorm per tydseenheid*
- *Tempo van verandering in konsentrasie/massa/volume/hoeveelheid van reaktanse of produkte* (2)

5.3

Marking criteria/*Nasienriglyne:*   (a) Substitute 0,05 in rate formula /*Vervang 0,05 in tempoformule* ✓   (b) Substitute 40 in rate formula / *Vervang 40 in tempoformule* ✓   (c) Final answer/*Finale antwoord:* 1,25 x 10^{-3} $dm^3 \cdot s^{-1}$ ✓
Rate/*Tempo* $= \frac{\Delta V}{\Delta t}$ ✓ $= \frac{0,05}{40}$ ✓ $= 1,25 \times 10^{-3}$ $(dm^3 \cdot s^{-1})$ ✓

(3)

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5.4

Marking criteria/*Nasienriglyne:*

(a) Formula/*Formule*: $n = \frac{V}{V_m}$/ $n = \frac{m}{M}$ ✓
(b) Substitute/*Vervang* 22,4 in $n = \frac{V}{V_m}$ ✓
(c) Using ratio/*Gebruik verhouding* n(Mg): $n(H_2) = 1:1$ ✓
(d) Substitute/*Vervang* 24 in $n = \frac{m}{M}$ ✓
(e) Divide/*Deel* $m(Mg)_{reacted/gereageer}$ by $m(Mg)_{initial/begin}$/divide/*deel* $n(Mg)_{reacted/gereageer}$ by $n(Mg)_{initial/begin}$
(f) Multiply by/*Vermenigvuldig met* 100 ✓
(g) Final answer/*Finale antwooord:* 2,5 % ✓
RANGE/*GEBEID*: 2,5 % to 2,79 %

OPTION/*OPSIE* 1

$n(H_2) = \frac{V}{Vm}$ ✓

$= \frac{0,05}{22,4}$ ✓

$= 2,232 \times 10^{-3}$ mol

$n(Mg) = n(H_2)$
$= 2,232 \times 10^{-3}$ mol ✓

$m(Mg)_{reacted} = n \times M$
$= (2,232 \times 10^{-3})(24)$ ✓
$= 0,054$ g

% purity/*suiwerheid* $= \frac{0,054}{2}$ ✓ $\times 100$ ✓
$= 2,5$ % ✓

OPTION/*OPSIE* 2

$n(H_2) = \frac{V}{Vm}$ ✓

$= \frac{0,05}{22,4}$ ✓

$= 2,232 \times 10^{-3}$ mol

$n(Mg)_{reacted/gereageer} = n(H_2)$
$= 2,232 \times 10^{-3}$ mol ✓

$n(Mg)_{initial/begin} = \frac{m}{M}$
$= \frac{2}{24}$ ✓
$= 0,083$ mol

% purity/*suiwerheid* $= \frac{2,232 \times 10^{-3}}{0,083}$ ✓ $\times 100$ ✓
$= 2,69$ % ✓

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5.5.1 Temperature/*Temperatuur* ✓ (1)

5.5.2 A ✓ (1)

5.5.3 **Curve A:**

- Fewer particles with enough/sufficient kinetic energy ✓
  OR
  Fewer particles with $E_k \geq E_a$
- Less effective collisions per unit time ✓

Kromme A:

- *Minder deeltjies met genoeg/voldoende kinetiese energie*
  OF
  Minder deeltjies met $E_k \geq E_a$
- *Minder effektiewe botsings per tydseenheid* (2)

[17]

QUESTION 6/ *VRAAG 6*

6.1 Yes/*Ja* ✓ (1)

6.2 The system doesn't exchange matter with the surroundings/sealed container. ✓✓
Die stelsel ruil nie materie uit met die omgewing nie/verseëlde houer. (2)

6.3

CALCULATIONS USING NUMBER OF MOLES
Marking criteria:
(a) Multiplying [CO] and dividing [CO_2] by 2. ✓
(b) Change moles CO = equilibrium moles CO ✓
(c) **USING** ratio CO_2 : CO = 1 : 2 ✓
(d) Equilibrium moles CO_2 = initial moles CO_2 - change moles CO_2 ✓
(e) Correct K_c expression (formulae in square brackets) ✓
(f) Substituting K_c value into K_c expression ✓
(g) Substituting concentrations into the correct K_c expression ✓
(h) Final answer = 0,056 ✓

BEREKENINGE MET GEBRUIK VAN AANTAL MOL
Nasienkriteria:
(a) Vermenigvuldig [CO] en deel [CO_2] deur 2. ✓
(b) Verander mol CO = ekwilibrium mol CO ✓
*(c) **GEBRUIK** verhouding CO_2 : CO = 1 : 2* ✓
(d) Ekwilibrium mol CO_2 = aanvanklike mol CO_2 - verander mol CO_2 ✓
(e) Korrekte K_c-uitdrukking (formules tussen vierkantige hakies) ✓
(f) Vervanging van K_c-waarde in K_c-uitdrukking ✓
(g) Vervang konsentrasies in die korrekte K_c-uitdrukking ✓
(h) Finale antwoord = 0,056 ✓

OPTION/*OPSIE* 1	CO_2	CO	
Initial quantity/*Aanvanklike hoeveelheid* (mol)/	0,056✓	0	
Change/*Verandering* (mol)	0,04	0,08 ✓	Ratio/ *Verhouding* ✓
Quantity at equilibrium/*Hoeveelheid by ewewig* (mol)	0,016 ✓	0,08	
Equilibrium concentration/*Ewewigs-konsentrasie* (mol·dm^{-3})	8×10^{3}	0,04	÷ & × 2 ✓

$$K_c = \frac{[CO]^2}{[CO_2]} \checkmark$$

$$0,2 \checkmark = \frac{0,04^2}{[CO_2]} \checkmark$$

$$[CO_2] = 8 \times 10^{3}$$

Wrong K_c expression *Verkeerde K_c-uitdrukking*	Max/*Maks*: $^5/_8$
No K_c expression *Geen K_c-uitdrukking*	Max/*Maks*: $^7/_8$

(8)

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OPTION/*OPSIE* 2	CO_2	CO	
Initial quantity/*Aanvanklike hoeveelheid* (mol)	x	0	
Change/*Verandering* (mol)	0,04	0,08 ✓	Ratio/ *Verhouding* ✓
Quantity at equilibrium/*Hoeveelheid by ewewig* (mol)	x – 0,04 ✓	0,08	
Equilibrium concentration/*Ewewigs-konsentrasie* ($mol \cdot dm^{-3}$)	$\frac{x - 0,04}{2}$	0,04	÷ & × 2 ✓

$$K_c = \frac{[CO]^2}{[CO_2]} \checkmark$$

$$0,2 \checkmark = \frac{0,04^2}{\frac{x-0,04}{2}} \checkmark$$

$$x = 0,056 \text{ (mol)} \checkmark$$

Wrong K_c expression *Verkeerde K_c-uitdrukking*	Max/*Maks*: $^5/_8$
No K_c expression *Geen K_c-uitdrukking*	Max/*Maks*: $^7/_8$

6.4 Low/*Laag* ✓ (1)

6.5 Low K_c value/*Lae K_c-waarde* ✓✓ (2)

6.6.1 Endothermic/*Endotermies* ✓ (1)

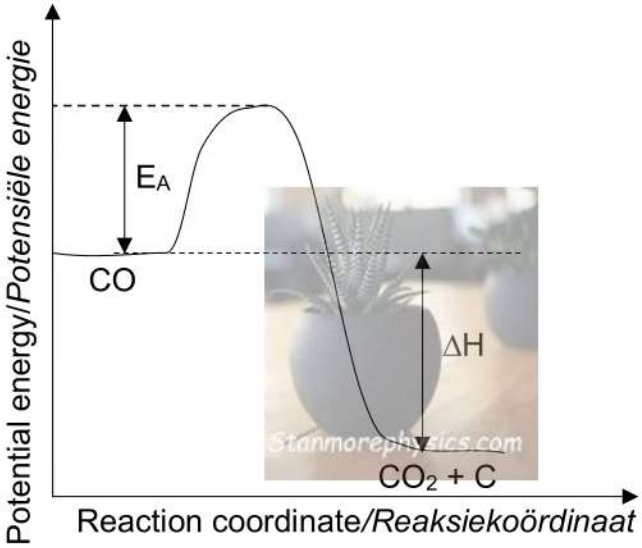
6.6.2 Decrease in temperature favours exothermic reaction ✓
Reverse reaction is favoured/concentration of products decreases/ concentration of reactants increases ✓

Verlaging in temperatuur bevoordeel eksotermiese reaksie
Omgekeerde reaksie word bevoordeel/konsentrasie van produkte neem af/ konsentrasie van reaktanse neem toe (2)

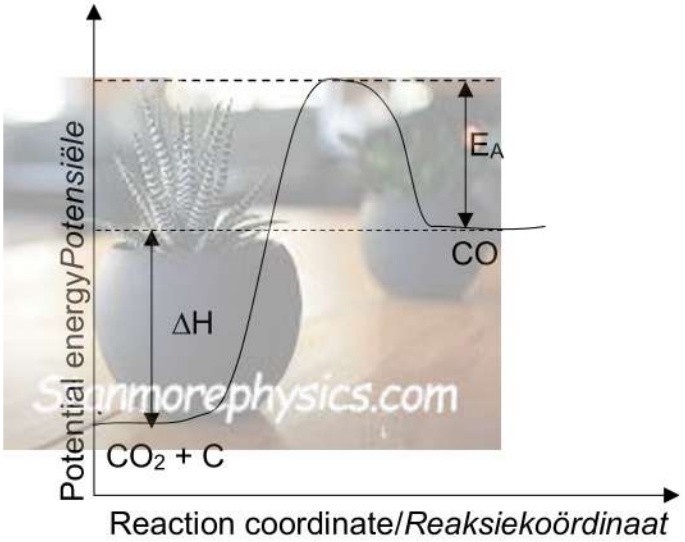
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6.7

Marking criteria/*Nasienkriteria*:
(a) Correct shape of the graph/*Korrekte vorm van die grafiek* ✓
(b) E_A (reactants = CO) correctly indicated/*E_A (reaktanse = CO) korek aangedui* ✓
(c) ΔH correctly indicated/*Korrek aangedui* ✓
(d) Energy of reactants with label CO and energy of products with label CO_2 + C indicated/*Energie met reaktanse met byskrif CO en energie van produkte met byskrif CO_2 + C aangedui* ✓



OR/*OF*



(4)
[21]

QUESTION 7/*VRAAG 7*

7.1.1 A solution of known concentration ✓✓
'n Oplossing met 'n bekende konsentrasie (2)

7.1.2 Strong/*Sterk* ✓ (1)

7.1.3 Dissociates/ionises completely in water to form a high concentration of hydroxide/OH^-ions ✓✓
Dissosieer/ioniseer heeltemal in water om 'n hoë konsentrasie van hidroksied/ OH-ione te vorm (2)

7.1.4

Marking criteria/*Nasienriglyne:*
(a) Formula/*Formule* pH = -log$[H_3O^+]$/Kw = $[H_3O^+][OH^-]$ ✓
(b) Correctly substituting 13,4 in pH formular ✓
Korrekte vervanging 13,4 in pH formule
(c) Substituting 10^{-14} in formula Kw = $[H_3O^+][OH^-]$✓
Vervang 10^{-14} in formule Kw = $[H_3O^+][OH^-]$
(d) Substitute 3,98 x10^{-14} in formula Kw = $[H_3O^+][OH^-]$ ✓
Vervang 3,98 x10^{-14} in formule Kw = $[H_3O^+][OH^-]$
(e) Final answer/*Finale antwoord:* 0,25 mol·dm^{-3} ✓

pH = -log$[H_3O^+]$ ✓
13,4 ✓ = -log$[H_3O^+]$
$[H_3O^+]$ = 3,981 x 10^{-14} mol·dm^{-3}

$K_w = [H_3O^+][OH^-]$
10^{-14} ✓ = 3,981 x 10^{-14} ✓ $[OH^-]$
$[OH^-]$ = 0,25 mol·dm^{-3} ✓

(5)

7.1.5

Marking criteria/*Nasienriglyne:*
(a) Formula/*Formule* $\frac{CaVa}{CbVb} = \frac{n_a}{n_b}$ /n = cV ✓
(b) Multliply/*Vermenigvuldig* 0,4 by/*met* 3,125 in $\frac{CaVa}{CbVb} = \frac{n_a}{n_b}$ **OR/*OF***
0,4 by 3,125 x 10^{-3} in n = cV✓
(c) Using ratio/*Gebruik verhouding*: n(H_2SO_4) : n(NaOH) = 1:2 ✓
(d) Multiply/*Vermenigvuldig* V by 0,25 ✓
(e) Final answer/*Finale antwoord:* 0,01 dm^3/10 cm^3 ✓

OPTION/*OPSIE* 1

$\frac{CaVa}{CbVb} = \frac{n_a}{n_b}$ ✓

$\frac{(0,4)(3,125)}{(0,25)(Vb)} = \frac{1}{2}$ ✓

V_b = 10cm^3 ✓

OPTION/*OPSIE* 2

n(H_2SO_4) = cV ✓
= (0,4093,05 x 10^{-3}) ✓
= 1,25 x 10^{-3} mol

n(NaOH) = 2n(H_2SO_4)
= 2 x 1,25 x 10^{-3} ✓
= 2,5 x 10^{-3}

n(NaOH) = cV
2,5 x 10^{-3} = 0,25 V ✓
V = 0,01 dm^3 ✓

(5)

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7.2

Marking criteria*:*

(a) Substituting 5 & 84 in Formula $n = \frac{m}{M}$ ✓
(b) Multiplying 1,6 by 0,05 ✓
(c) Using ratio: $n(HC\ell) : n(NaHCO_3) = 1:1$ ✓
(d) Subtracting n(HCℓ) reacted from n(HCℓ)initial ✓
(e) Dividing n(HCℓ)left by 0,05 ✓
(f) Substituting c(HCℓ) in pH formular ✓
(g) Final answer = 0,4 ✓

Nasienkriteria:

(a) Vervang 5 & 84 in Formule $n = \frac{m}{M}$ ✓
(b) Vermenigvuldiging 1,6 met 0,05 ✓
(c) Gebruik verhouding: $n(HC\ell) : n(NaHCO_3) = 1:1$ ✓
(d) Trek n(HCℓ) gereageer van n(HCℓ) begin ✓
(e) Deel n(HCℓ) links deur 0,05 ✓
(f) Vervanging van c(HCℓ) in pH-formule ✓
(g) Finale antwoord = 0,4 ✓

$n(NaHCO_3)_{initial/begin} = \frac{m}{M}$

$= \frac{5}{84}$ ✓

$= 0,06$ mol

$n(HC\ell)_{reacted/gereageer} = n(NaHCO_3)$ ✓
$= 0,06$ mol

$n(HC\ell)_{initial/begin} = cV$
$= (1,6)(0,05)$ ✓
$= 0,08$ mol

$n(HC\ell)_{unreacted/ongereageerde} = 0,08 - 0,06$ ✓
$= 0,02$ mol

$c(HC\ell) = \frac{n}{V}$

$= \frac{0,02}{0,05}$ ✓

$= 0,4$ mol·dm^{-3}

$[H_3O^+] = c(HC\ell) = 0,4$ mol·dm^{-3}

$pH = -\log [H_3O^+]$
$= -\log 0,4$ ✓
$= 0,4$ ✓

RANGE/*GEBIED*: 0,39 – 0,4

(7)
[22]

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QUESTION 8/*VRAAG 8*

8.1 A solution that conducts electricity through the movement of ions ✓✓
'n Oplossing wat elektrisiteit gelei deur die beweging van ione (2)

8.2 $Pb(s) \mid Pb^{2+}(aq)$ ✓ ✓ $\| Ag^{+}(aq) \mid Ag(s)$ ✓ (3)

8.3 Potassium chloride/KCℓ ✓✓
Any other soluble salt, excluding lead and silver salts

Kaliumchloried/KCℓ
Enige ander oplosbare sout behalwe lood- en silwersoute (2)

8.4

OPTION/*OPSIE* 1	**Notes/*Aantekeninge:***
$E^{\theta}_{cell/sel} = E^{\theta}_{reduction/reduksie} - E^{\theta}_{oxidation/oksidasie}$ ✓ $= 0{,}80$ ✓ $- (-0{,}13)$ ✓ $= 0{,}93$ V ✓	Accept any other correct formula from the data sheet. *Aanvaar enige ander korrekte formule uit die datablad.* Any other formula using unconventional abbreviations, e.g. $E^{\theta}_{cell} = E^{\theta}_{OA} - E^{\theta}_{R}$, followed by correct substitutions: Max: $^{3}/_{4}$ *Enige ander formule wat onkonvensionele afkortings gebruik, bv.* $E^{\theta}_{sel} = E^{\theta}_{OA} - E^{\theta}_{R}$. *gevolg deur korrekte vervangings:* *Maks:* $^{3}/_{4}$

OPTION/*OPSIE* 2	
$Ag^{+} + e^{-} \rightarrow Ag$] ✓ $Pb \rightarrow Pb^{2+} + 2e^{-}$]	$E^{\theta} = +0{,}80$ (V) ✓ $E^{\theta} = +0{,}13$ (V) ✓
$2Ag^{+} + Pb \rightarrow 2Ag + Pb^{2+}$	$E^{\theta} = +0{,}93$ V ✓

(4)
[11]

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QUESTION 9/*VRAAG 9*

9.1 (Gas) mask/*work in fume cupboard* ✓
(Gas)-masker/werk in dampkas (1)

9.2 Chlorine gas is poisonous/*Chloorgas is giftig* ✓✓ (2)

9.3 Q to/*tot* P ✓ (1)

9.4 Copper/*Koper* ✓ (1)

9.5 $2C\ell^-(aq) + Cu^{2+}(aq)$ ✓ → $C\ell_2(g) + Cu(s)$ ✓ Balancing/*Balansering* ✓

Marking criteria/*Nasienkriteria:*
- Reactants ✓ Products ✓ Balancing ✓
  Reaktanse *Produkte* *Balansering*
- Ignore ⇌ and phases
  Ignoreer ⇌ en fases
- Marking rule 6.3.10/*Nasienreël 6.3.10*

(3)
[8]

TOTAL/*TOTAAL*: 150

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