JENN
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PHYSICAL SCIENCES

GRADE 12

SPRING CLASSES 2023

TOPIC: ELECTROCHEMICAL REACTIONS

SOLUTION BOOK

GALVANIC CELLS

ACTIV ITY 2

2.1	A✓✓	(2)
2.2	A✓✓	(2)
2.3	D✓✓	(2)
2.4	B✓✓	(2)
2.5	D✓✓	(2)
2.6	A✓✓	(2)
2.7	C✓✓	(2)
2.8	D✓✓	(2)
2.9	B✓✓	(2)
		[18]

ACTIVITY 3

3.1 A cell in which chemical energy is converted to electrical energy. ✓✓ (2)

3.2 $Cd(s) + Ni^{2+}(aq)$ ✓ $\rightarrow Cd^{2+} + Ni(s)$ ✓ bal. ✓ (3)

3.3 $Cd(s) \mid {}^{\checkmark}Cd^{2+}(aq) \parallel {}^{\checkmark}Ni^{2+}(aq) \mid {}^{\checkmark}Ni(s)$ (3)

3.4 Negative✓ (1)

3.5

$E^{\theta}_{cell} = E^{\theta}_{cathode} - E^{\theta}_{anode}$✓
$= -0,27$✓ $- (-0,40)$ ✓
$= -0,27 + 0,40$
$= + 0,13$ V✓

(4)

[13]

ACTIVITY 4

4.1

4.1.1 Zinc/Zn ✓ (1)

4.1.2 Platinum/Pt /Carbon/C/*Koolstof* ✓ (1)

4.1.3 Iron(III) ions/Fe^{3+}(aq)/Fe^{3+} ions/*Yster(III)-ione/*Fe^{3+}*-ione* ✓ (1)

4.2

4.2.1 Conductor (to complete circuit). /Provides surface area for the reaction to take place. ✓
Geleier (om die stroombaan te voltooi./Verskaf oppervlak vir die reaksie om plaas te vind. (1)

4.2.2 $Fe^{3+} + e^- \rightarrow Fe^{2+}$ ✓✓

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

(2)

4.2.3 $2Fe^{3+}(aq) + Zn$ ✓ $\rightarrow 2Fe^{2+}(aq) + Zn^{2+}(aq)$ ✓ Bal ✓

Notes/*Aantekeninge*
- Reactants ✓ Products ✓ Balancing ✓
  Reaktanse ✓ *Produkte* ✓ *Balansering* ✓
- Ignore/*Ignoreer* → and phases / *en fases*
- Marking rule 6.3.10/*Nasienreël 6.3.10*

(3)

4.3

OPTION 1/*OPSIE 1*

$E^{\theta}_{cell} = E^{\theta}_{reduction} - E^{\theta}_{oxidation}$ ✓
= 0,77 ✓– (-0,76) ✓
= 1,53 V ✓

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. $E°_{cell} = E°_{OA} - E°_{RA}$ followed by correct substitutions:/*Enige ander formule wat onkonvensionele afkortings gebruik bv.* $E°_{sel} = E°_{OM} - E°_{RM}$ *gevolg deur korrekte vervangings:* $\frac{3}{4}$

OPTION 2/*OPSIE 2*

$Fe^{3+} + e \rightarrow Fe^{2+}$ ✓ $E^{\theta} = 0,77$ V ✓
$Zn \rightarrow Zn^{2+}(aq) + 2e^-$ $E^{\theta} = 0,76$ V ✓
$Zn + 2Fe^{3+} \rightarrow Zn^{2+} + 2Fe^{2+}$ $E^{\theta} = 1,53$ V ✓

(4)

4.4 Decreases/*Verlaag* ✓ (1)

[14]

ACTIVITY 5

5.1

5.1.1 Zn/zinc/*sink* ✓ (1)

5.1.2 MnO_4^- is a stronger oxidising agent ✓ than Zn^{2+}/Zn(II) ions ✓ and will oxidise Zn ✓ (to Zn^{2+}/Zn(II) ions).

MnO_4^- is 'n sterker oksideermiddel as Zn^{2+}/Zn(II)-ione *en sal Zn oksideer (na Zn^{2+}*/Zn(II)*-ione).*

OR/*OF*

Zn^{2+}/Zn(II) ion is a weaker oxidising agent ✓ than MnO_4^- ✓ and therefore MnO_4^- will be reduced ✓ (to Mn^{2+}/Mn(II) ions).

Zn^{2+}/Zn(II) ione is 'n swakker oksideermiddel as MnO_4^- en dus word MnO_4^- gereduseer (to Mn^{2+}/Mn(II)-ione). (3)

5.2

5.2.1 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)

5.2.2 Mn to/*na* Ni ✓✓ (2)

5.2.3

OPTION 1/*OPTION 1*	**NOTE/*LET WEL***
$E^{\theta}_{cell} = E^{\theta}_{reduction} - E^{\theta}_{oxidation}$ ✓ = - 0,27✓ – (- 1,18)✓ = 0,91 V ✓	• Accept any other correct formula from the data sheet. */Aanvaar enige ander korrekte formule vanaf gegewensblad.* • Any other formula using unconventional abbreviations, e.g. $E°_{cell} = E°_{OA} - E°_{RA}$ followed by correct substitutions:/*Enige ander formule wat onkonvensionele afkortings gebruik, bv. $E°_{sel} = E°_{OM} - E°_{RM}$ gevolg deur korrekte vervangings* $^3/_4$

OPTION 2/*OPSIE 2*

✓ $Ni^{2+} + 2e^- \rightarrow Ni$ E = -0,27 ✓

$Mn \rightarrow Mn^{2+} + 2e^-$ E = 1,18 ✓

$Ni^{2+} + Mn \rightarrow Mn^{2+} + Ni$ E = 0,91 V ✓ (4)

5.2.4 Ni^{2+} + Mn ✓ → Mn^{2+} + Ni ✓ Bal. ✓

Marking criteria/*Nasienkriteria:*

- Reactants ✓ Products ✓ Balancing ✓
  Reaktanse ✓ *Produkte* ✓ *Balansering* ✓
- Ignore/*Ignoreer* ⇌ and phases/*en fases*
- Marking rule 6.3.10/*Nasienreël 6.3.10* (3)

5.2.5 Increase/*Toeneem* ✓ (1)

[15]

ACTIVITY 6

6.1 Temperature/*Temperatuur:* 298 K (25 °C) ✓
Concentration of electrolyte / *Konsentrasie van die elektroliet*: 1 mol·dm^{-3} ✓ (2)

6.2 B ✓ (1)

6.3 $Ba(s) \rightarrow Ba^{2+}(aq) + 2e^{-}$✓✓ double arrow – penalise by one mark. (2)

6.4 $Ba(s) \mid Ba^{2+}(aq)$✓ $(1mol.dm^{-3})||$✓ $Cu^{2+}(aq)$ $(1mol.dm^{-3})|Cu(s)$ ✓

(The concentration and phases can be omitted. / *Die konsentrasie en fases kan weggelaat word.*)

$Ba \mid Ba^{2+}$✓ ||✓ $Cu^{2+} \mid Cu$ ✓ (3)

6.5 $E^{\theta}_{cell} = E^{\theta}_{cathode/katode} - E^{\theta}_{anode/anode}$ ✓ (no abbreviations in formula allowed)
$= 0,34$✓$ – (-2,90)$✓
$= 3,24$ V ✓ (4)

6.6 6.6.1 Do not mark (0)

6.6.2 Decreases / *Verlaag* ✓✓ (2)
[14]

ACTIVITY 7

7.1 Substance which accepts electron/ electron acceptors✓✓/ *Stof wat elektrone opneem/ontvang*✓✓ (2)

7.2 $X^{2+} + 2e^- \rightarrow X$✓✓ (2)

7.3 $E^{\ominus}_{cell} = E^{\ominus}_{reduction} - E^{\ominus}_{oxidation}$✓
0,47✓ = $E^{\ominus}_{cathode}$ – (-0.13) ✓
$E^{\ominus}_{cathode}$ = 0,34 v✓
Metal/*Metaal* **X** = Cu/Copper✓/ Koper✓ (5)

NOTE:
- Accept any other correct formula from the data sheet.
- Any other formula using unconventional abbreviations, e.g. $E^{\ominus}_{cell} = E^{\ominus}_{OA} - E^{\ominus}_{RA}$ followed by correct substitutions: ¾

LET WEL:
- *Aanvaar enige ander korrekte formule vanaf gegewensblad.*
- *Any other formula using unconventional abbreviations, e.g. $E^{\ominus}_{cell} = E^{\ominus}_{OA} - E^{\ominus}_{RA}$ followed by correct substitutions: ¾*

7.4 $Pb(s)|Pb^{2+}(aq)$✓ ||✓ $Cu^{2+}(aq)|Cu(s)$✓ (3)

Marking criteria/*Nasienriglyne*:
- Oxidation/*Oksidasie* ✓ Double line/*Dubbellyn*(||)✓ Reduction/*Reduksie*✓
- Ignore the phases/*Ignoreer fases*

7.5 Less than 0.47 V✓/*Minder as 0.47 V*✓
As the reaction proceeds/*Soos die reaksie voortgaan*
- $[Pb^{2+}]$ increases and $[Cu^{2+}]$ decreases✓/*$[Pb^{2+}]$ verhoog en $[Cu^{2+}]$ verlaag*✓
- reverse reaction is favoured✓/*terugwaartse reaksie is bevoordeel*✓ (3)

[15]

ACTIVITY 9

9.1 Loss of electrons / *Verlies aan elektrone* ✓✓ **(2 or/*of* 0)** (2)

9.2.1 1 mol·dm^{-3} ✓ (1)

9.2.2 Platinum ✓ (1)

9.2.3 Cu ✓ (1)

9.2.4 $O_2 + 4H^+ + 4e^- \rightarrow 2\ H_2O$ ✓✓

Marking criteria / *Nasienkriteria*
- $O_2 + 4H^+ + 4e^- \rightleftharpoons 2\ H_2O$ ½
- $2\ H_2O \leftarrow O_2 + 4H^+ + 4e^-$ 2/2
- $2\ H_2O \rightleftharpoons O_2 + 4H^+ + 4e^-$ 0/2
- $2\ H_2O \rightarrow O_2 + 4H^+ + 4e^-$ 0/2

- Ignore if the charge omitted on electron / *Ignoreer indien lading op elektron weggelaat is.*

(2)

9.2.5 $2\ Cu + O_2 + 4\ H^+$ ✓→ $2\ Cu^{2+} + 2\ H_2O$ ✓ (✓ bal)

Marking criteria/*Nasienkriteria*
- Reactants/ *Reaktanse*
- Products / *Produkte*
- Balancing / *Balansering*

(3)

9.3.1 $E^{\theta}_{cell} = E^{\theta}_{cathode/reduction/oxidising\ agent} - E^{\theta}_{anode/oxidation/reducing\ agent}$ ✓

$E^{\theta}_{cell} = (1,23)$ ✓ – (0,34) ✓

$E^{\theta}_{cell} = 0,89$ V ✓

Notes/*Aantekeninge*
- Any other formula using unconventional abbreviation , e.g. $E^{o}_{cell} = E^{o}_{OA} - E^{o}_{RA}$ followed by the correct substitution : ¾
- *Enige ander formule wat onkonvensionele afkortings gebruik bv.*
- *$E^{o}_{sel} = E^{o}_{OM} - E^{o}_{RM}$ gevolg met korrekte vervangings: ¾*

(4)

9.3.2 Concentration of the reactants decreases ✓
Rate of the forward reaction decreases ✓

Konsentrasie van reaktanse verlaag
Tempo van voortwaartse reaksie verlaag (2)

9.3.3 Equilibrium / *Ewewig* ✓ (1)

[17]

ACTIVITY 10

10.1

10.1.1 Gain of electrons./*Opneem van elektrone*. ✓✓ **(2 or/*of* 0)** (2)

10.1.2. $2H_2O(\ell) + 2e^- \rightarrow H_2(g) + 2OH^-(aq)$ ✓✓

Ignore phases/*Ignoreer fases.*

Marking criteria /*Nasienkriteria:*

- $H_2(g) + 2OH^-(aq) \leftarrow 2H_2O(\ell) + 2e^-$ ($^2/_2$)

  $2H_2O(\ell) + 2e^- \rightleftharpoons H_2(g) + 2OH^-(aq)$ ($^1/_2$)

  $H_2(g) + 2OH^-(aq) \rightleftharpoons 2H_2O(\ell) + 2e^-$ ($^0/_2$)

  $2H_2O(\ell) + 2e^- \leftarrow H_2(g) + 2OH^-(aq)$ ($^0/_2$)
- Ignore if charge omitted on electron./*Ignoreer indien lading weggelaat op elektron.*
- If charge (-) omitted on OH^-/*Indien lading (-) weggelaat op* OH^-:

  Example/*Voorbeeld:* $2H_2O(\ell) + 2e^- \rightarrow H_2(g) + 2OH(aq)$ ✓ Max./*Maks:* $^1/_2$

(2)

10.1.3 $2Na(s) + 2H_2O(\ell)$ ✓ $\rightarrow H_2(g) + 2OH^-(aq) + 2Na^+(aq)$ ✓ Bal ✓

OR/*OF*

$2Na(s) + 2H_2O(\ell)$ ✓ $\rightarrow H_2(g) + 2NaOH(aq)$ ✓ Bal ✓

Ignore phases/*Ignoreer fases.*

Marking criteria/*Nasienkriteria:*

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

(3)

10.1.4 Formation of hydroxide ions / OH^- / sodium hydroxide/base/ alkaline/ pH > 7 ✓
Vorming van hidroksied / OH^- / natriumhidroksied / basis / alkalies / pH > 7 (1)

10.1.5 Cu is a weaker reducing agent ✓ than H_2 (and OH^-) ✓ and H_2O will not be reduced ✓ (to H_2 and OH^-).
Cu is 'n swakker reduseermiddel as H_2 (and OH^-) *en H_2O sal nie gereduseer word nie na H_2 (en OH^-).*

OR/*OF*

H_2 (and OH^-) are stronger reducing agent ✓ than Cu and H_2O ✓ will not be reduced✓ (to H_2 and OH^-).
H_2 (en OH^-) is 'n sterker reduseermiddel as Cu en H_2O sal nie gereduseer word (na H_2 en OH^-). (3)

10.2

10.2.1 Phase separator/boundary/difference ✓
Fase skeiding/grens/verskil (1)

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

10.2.3

OPTION/*OPSIE 1*	**Notes/*Aantekeninge***
$E^{\theta}_{cell} = E^{\theta}_{reduction} - E^{\theta}_{oxidation}$ ✓ = 0,77 ✓ - (-0,13) ✓ E^{θ}_{cell} = 0,90 V ✓	• Accept any other correct formula from the data sheet./*Aanvaar enige ander korrekte formule vanaf gegewensblad.* • Any other formula using unconventional abbreviations, e.g. $E^{\theta}_{cell} = E^{\theta}_{OA} - E^{\theta}_{RA}$ followed by correct substitutions:/*Enige ander formule wat onkonvensionele afkortings gebruik bv.* $E^{\theta}_{sel} = E^{\theta}_{OM} - E^{\theta}_{RM}$ *gevolg deur korrekte vervangings: Max/Maks:* $\frac{3}{4}$

OPTION/*OPSIE 2*

✓ $Pb(s) \rightarrow Pb^{2+}(aq) + 2e^-$ 0,13 (V) ✓
$2Fe^{3+}(aq) + 2e^- \rightarrow 2Fe^{2+}(aq)$ 0,77 (V) ✓
$Pb^{2+}(aq) + 2Fe^{3+}(aq) \rightarrow Pb(s) + 2Fe^{2+}(aq)$ 0,90 V ✓ (4)

[17]

ACTIVITY 11

11.1
- Pressure: <u>1 atmosphere</u> /101,3 kPa/1,01 x 10^5 Pa ✓
  Druk: <u>1 atmosfeer</u> /101,3 kPa/1,01 x 10^5 Pa
- Temperature/*Temperatuur*: <u>25 °C</u> /298 K ✓
- Concentration of electrolytes: <u>1 mol·dm^{-3}</u> ✓
  Konsentrasie van elektroliete: <u>*1 mol·dm^{-3}*</u>

(3)

11.2 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)

11.3

OPTION 1/*OPTION 1*	**Notes/*Aantekeninge***
$E^\theta_{cell} = E^\theta_{cathode} - E^\theta_{anode}$ ✓ $1{,}20^{\checkmark} = E^\theta_{cathode} - 0$ ✓ $E^\theta_{cathode} = 1{,}20$ (V) ✓ X is Pt/platinum ✓	• Accept any other correct formula from the data sheet./*Aanvaar enige ander korrekte formule vanaf gegewensblad.* • Any other formula using unconventional abbreviations, e.g. $E°_{cell} = E°_{OA} - E°_{RA}$ followed by correct substitutions:/*Enige ander formule wat onkonvensionele afkortings gebruik, bv. $E°_{sel} = E°_{OM} - E°_{RM}$ gevolg deur korrekte vervangings:* Max./*Maks.* $\frac{4}{5}$

OPTION 2/*OPSIE 2*

✓ $X^{2+} + 2e^- \rightarrow X$ $\quad E^\theta = 1{,}20$ V ✓
$H_2 \rightarrow 2H^+ + 2e^-$ $\quad E^\theta = 0{,}00$ V ✓
$H_2 + X^{2+} \rightarrow X + 2H^+$ $\quad E^\theta = 1{,}20$ V ✓

X is Pt/Platinum ✓

(5)

11.4. $H_2(g) \rightarrow 2H^+(aq) + 2e^-$ ✓✓

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

(2)

11.5 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]

ELECTROLYTIC CELLS

ACTIV ITY 1

1.1 D✓✓ (2)

1.2 B✓✓ (2)

1.3 A✓✓ (2)

1.4 B✓✓ (2)

1.5 D✓✓ (2)

1.6 A✓✓ (2)

[12]

ACTIVITY 2

2.1

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.*

ANY ONE/*ENIGE EEN:*

- The chemical process in which electrical energy is converted to chemical energy. ✓✓
- The use of electrical energy to produce a chemical change.
- Decomposition of an ionic compound by means of electrical energy.
- The process during which an electric current passes through a solution/ionic liquid/molten ionic compound.
- *Die chemiese proses waarin elektriese energie omgeskakel word na chemiese energie. ✓✓*
- *Die gebruik van elektriese energie om 'n chemiese verandering te weeg te bring.*
- *Ontbinding van 'n ioniese verbinding met behulp van elektriese energie.*
- *Die proses waardeur 'n elektriese stroom deur 'n oplossing/ioniese vloeistof/gesmelte ioniese verbinding beweeg.* (2)

2.2

2.2.1 X ✓ (1)

2.2.2 $2H_2O(\ell) + 2e^- \rightarrow H_2(g) + 2OH^-(aq)$ ✓✓

Ignore phases/*Ignoreer fases*

Marking criteria/*Nasienkriteria:*

- $H_2(g) + 2OH^-(aq) \leftarrow 2H_2O(\ell) + 2e^-$ ($^2/_2$) $2H_2O(\ell) + 2e^- \rightleftharpoons H_2(g) + 2OH^-(aq)$ ($^1/_2$)
  $H_2(g) + 2OH^-(aq) \rightleftharpoons 2H_2O(\ell) + 2e^-$ ($^0/_2$) $2H_2O(\ell) + 2e^- \leftarrow H_2(g) + 2OH^-(aq)$ ($^0/_2$)
- Ignore if charge omitted on electron./*Ignoreer indien lading weggelaat op elektron.*
- If charge (-) omitted on OH^- /*Indien lading (-) weggelaat op* OH^-:
  Example/*Voorbeeld:* $2H_2O(\ell) + 2e^- \rightarrow H_2(g) + 2OH(aq)$ ✓ Max./*Maks:* $^1/_2$

(2)

2.2.3 X to/*na* Y ✓ (1)

2.2.4 $2H_2O(\ell) + 2C\ell^-(aq)$ ✓ $\rightarrow C\ell_2(g) + H_2(g) + 2OH^-(aq)$ ✓ Bal ✓

OR/*OF*

$2H_2O(\ell) + 2NaC\ell(aq) \rightarrow C\ell_2(g) + H_2(g) + 2NaOH(aq)$

Ignore phases/*Ignoreer fases*

Marking criteria/*Nasienkriteria:*

- Reactants ✓ Products ✓ Balancing: ✓
  Reaktanse *Produkte* *Balansering*
- Ignore double arrows./*Ignoreer dubbelpyle.*
- Marking rule 6.3.10/*Nasienreël 6.3.10.*

(3)

2.3 Increases / *Toeneem* ✓ (1)

2.4 Solution becomes basic / alkaline **OR** NaOH / OH^- (ions) form ✓
Oplossing word basies / alkalies ***OF*** *NaOH / OH^-(-ione) vorm* (1)

[11]

ACTIVITY 4

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

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

ENIGE EEN**: **(2 of 0)

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

4.2 Anode ✓

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

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

4.3 $Cr^{3+}(aq) + 3e^- \rightarrow Cr(s)$ ✓✓

Ignore phases./*Ignoreer fases*.

Marking guidelines/*Nasienkriteria*

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

4.4

Marking criteria:

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

Nasienkriteria:

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

OPTION 1/*OPSIE 1*

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

$= \frac{2}{52}$✓

= 0,038 mol (0,04 mol)

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

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

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

OPTION 2/*OPSIE 2*

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

$= \frac{2}{52}$✓

= 0,038 mol (0,04 mol)

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

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

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

OPTION 3/*OPSIE 3*

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

$= \frac{2}{52}$✓

= 0,038 mol

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

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

(5)
[11]

ACTIVITY 5

5.1 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)

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

5.3
5.3.1 $Zn^{2+}(aq) + 2e^- \rightarrow Zn(s)$ ✓✓
Ignore phases/*Ignoreer fases*

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

(2)

5.3.2 Zinc/Zn/*Sink* ✓ (1)

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

ACTIVITY 6

6.1.1 A substance of which the aqueous solution contains ions. OR: a substance that dissolves in water to give a solution that conducts electricity. ✓✓ (2)

6.1.2 Cathode ✓ (1)

6.1.3 $Cu^{2+} + 2^{e-} \rightarrow Cu$✓✓ (2)

6.2 Positive✓ (1)

6.3.1 It will sink to the bottom of the cell. ✓ (1)

6.3.2 It will be oxidised/it will go into solution. ✓ (1)

6.4 Cu^{2+} Is a stronger oxidising agent than Zn^{2+} ✓and therefore the Zn^{2+} will not be reduced (will stay in solution). ✓ (2)

6.5

$m(Cu) = nM$

$= (3,75 \times 10^{-2})(63,5)$ ✓

$= 2,38$ g✓

$$\%Cu = \frac{m(Cu)_{pure}}{m(Cu)_{impure}} \times 100$$

$$= \frac{2,38}{4} \times 100$$✓

$= 59,53\%$✓ (4)

6.6 Gan bubbles✓ (1)

6.7 It will change from “bright blue” to pale blue/colourless. ✓✓ (2)

[17]

ACTIVITY 7

7.1

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.*

ANY ONE/*ENIGE EEN:*

- The chemical process in which electrical energy is converted to chemical energy. ✓✓
  Die chemiese proses waarin elektriese energie omgeskakel word na chemiese energie.
- The use of electrical energy to produce a chemical change.
  Die gebruik van elektriese energie om 'n chemiese verandering te weeg te bring.
- Decomposition of an ionic compound by means of electrical energy.
  Ontbinding van 'n ioniese verbinding met behulp van elektriese energie.
- The process during which an electric current passes through a solution/ ionic liquid/molten ionic compound.
  Die proses waardeur 'n elektriese stroom deur 'n oplossing/ioniese vloeistof/gesmelte ioniese verbinding beweeg. (2)

7.2 Copper(II) ions/Cu^{2+}/*koper(II)-ione* ✓
Zinc(II) ions/Zn^{2+}/*sink(II)-ione* ✓ (2)

7.3 Cu^{2+} (aq) + $2e^-$ → Cu (s) ✓✓

Notes/*Aantekeninge*

$Cu^{2+} + 2e^- \rightleftharpoons Cu$ $(\frac{1}{2})$ $\quad$ $Cu \leftarrow Cu^{2+} + 2e^-$ $(\frac{2}{2})$

$Cu \rightleftharpoons Cu^{2+} + 2e^-$ $(\frac{0}{2})$ $\quad$ $Cu^{2+} + 2e \leftarrow Cu$ $(\frac{0}{2})$

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

7.4 Zn^{2+} is a weaker oxidising agent ✓ than Cu^{2+} ✓ and will not be reduced to Zn. ✓
Zn^{2+} is 'n swakker oksideermiddel as Cu^{2+} en sal nie na Zn gereduseer word nie. (3)

7.5 n(Cu) = ½$n_{electrons/elektrone}$
= ½(0,6) ✓
= 0,3 mol
m = nM
= 0,3 x 63,5 ✓
= 19,05 g ✓

Marking criteria/*Nasienkriteria*
- Use mol ratio/*Gebruik molverhouding*: n(Cu) : n(electrons) = 1 : 2. ✓
- Substitute/*Vervang* 63,5 $g \cdot mol^{-1}$ in m = nM ✓
- Final answer/*Finale antwoord*: 19,05 g ✓

(3)
[12]

ACTIVITY 8

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

- Process in which electrical energy is converted to chemical energy✓✓
- Process in which electric current flows through an electrolyte✓✓

***ENIGE EEN*: (2 or 0)**

- *Proses waar elektriese stroom deur 'n elektroliet vloei*✓✓
- *Proses waar elektriese energie omgeskakel word in chemiese energie*✓✓ (2)

8.2 Copper Sulphate/$CuSO_4$✓ **Accept** : Copper ions/Cu^{2+}
Kopersulfaat/ $CuSO_4$✓***Aanvaar:*** *Koperione/Cu^{2+}* (1)

8.3 Cathode/*Katode*✓

$Cu^{2+} + 2e^- \rightarrow Cu$✓✓ (3)

8.4 Ag(s) is a weaker reducing agent ✓than Cu(s) ✓and will therefore not be able to reduce cu^{2+}(aq) to Cu(s) ✓/*Ag(s) is 'n swakker reduseermiddel*✓ *as Cu(s)* ✓ *en sal dus nie Cu^{2+} na Cu reduseer nie*.✓

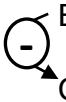
OR/*OF*

Cu(s) is a stronger reducing agent ✓than Ag(s) ✓and will therefore not be able to reduce cu^{2+}(aq) to Cu(s) ✓/ *Cu(s) is 'n sterker reduseermiddel* ✓ *as Ag(s)* ✓ *en sal dus nie Cu^{2+} na Cu reduseer nie*.✓ (3)

[9]

ACTIVITY 9

9.1 Electrolytic (cell)/*Elektrolitiese (sel)* ✓



Cells have a battery/DC power source/ /Electrical energy is converted to chemical energy. ✓
Selle het batterye/GS kragbron/ Elektriese energie is omgeskakel na chemiese energie. (2)

9.2

9.2.1 $2C\ell^- \rightarrow C\ell_2 + 2e^-$ ✓✓

Notes/*Aantekeninge*

$2C\ell^- \rightleftharpoons C\ell_2 + 2e^-$ ($^1/_2$) $C\ell_2 + 2e^- \leftarrow 2C\ell^-$ ($^2/_2$)

$C\ell_2 + 2e^- \rightleftharpoons 2C\ell^-$ ($^0/_2$) $2C\ell^- \leftarrow C\ell_2 + 2e^-$ ($^0/_2$)

- Ignore if charge omitted on electron./*Ignoreer indien lading weggelaat op elektron.*
- If charge (-) omitted on $C\ell^-$/*Indien lading (-) weggelaat op* $C\ell^-$:
  Example/*Voorbeeld:* $2C\ell(aq) \rightarrow C\ell_2(g) + 2e^-$ Max./*Maks:* $^1/_2$

(2)

9.2.2 $A\ell^{3+} + 3e^- \rightarrow A\ell$ ✓✓

Notes/*Aantekeninge*

$A\ell^{3+} + 3e^- \rightleftharpoons A\ell$ ($^1/_2$) $A\ell \leftarrow A\ell^{3+} + 3e^-$ ($^2/_2$)

$A\ell \rightleftharpoons A\ell^{3+} + 3e^-$ ($^0/_2$) $A\ell^{3+} + 3e \leftarrow A\ell$ ($^0/_2$)

- Ignore if charge omitted on electron./*Ignoreer indien lading weggelaat op elektron.*
- If charge (+) omitted on $A\ell^{3+}$ /*Indien lading (+) weggelaat op* $A\ell^{3+}$:
  Example/*Voorbeeld:* $A\ell^3(aq) + 3e^- \rightarrow A\ell(s)$ Max./*Maks:* $^1/_2$

(2)

9.2.3 Cu/copper/*koper* ✓ (1)

9.3 **ANY ONE/*ENIGE EEN***

- The electrode/carbon/C reacts with oxygen. ✓
  Die elektrode/koolstof/C reageer met suurstof.
- $C + O_2 \rightarrow CO_2$
- Oxidation takes place./Electrons are lost.
  Oksidasie vind plaas./Elektrone word verloor.
- Oxygen corrodes the carbon electrode.
  Suurstof roes die koolstof elektrode. (1)

[8]

ACTIVITY 10

10.1 **ANY ONE*:***

- The chemical process in which <u>electrical energy is converted to chemical energy</u>. ✓✓ **(2 or 0)**
- The use of <u>electrical energy to produce a chemical change</u>.
- The process during which an <u>electric current passes through a solution / molten ionic</u> compound.

***ENIGE EEN**:*

- *Die chemiese proses waarin <u>elektriese energie omgeskakel word na chemiese energie.</u>* ***(2 of 0)***
- *Die gebruik van <u>elektriese energie om 'n chemiese verandering te veroorsaak</u>.*
- *Die proses waar 'n <u>elektriese stroom deur 'n oplossing / gesmelte ioniese verbinding beweeg.</u>* (2)

10.2.1. $Cr^{3+}(aq) + 3e^- \rightarrow Cr$ ✓✓

<u>Marking criteria/*Nasienkriteria:*</u>

- $Cr \leftarrow Cr^{3+}(aq) + 3e^-$ $(2/2)$

  $Cr^{3+}(aq) + 3e^- \rightleftharpoons Cr$ $(1/2)$

  $Cr \rightleftharpoons Cr^{3+}(aq) + 3e^-$ $(0/2)$

  $Cr^{3+}(aq) + 3e^- \leftarrow Cr$ $(0/2)$
- Ignore if charge omitted on electron./*Ignoreer indien lading weggelaat op elektron.*
- If charge (+) omitted on Cr^{3+}/*Indien lading (+) weggelaat op* Cr^{3+}:

  Example/*Voorbeeld:* $Cr^3(aq) + 3e^- \rightarrow Cr$ Max./*Maks:* $1/2$ (2)

10.2.2 $q = I\Delta t$ ✓

$= \underline{(2,5)(10 \times 60 \times 60)}$ ✓

$= 9 \times 10^4$ C ✓ (90 000 C) (3)

10.2.3 **POSITIVE MARKING FROM QUESTION 10.2.2**
POSITIEWE NASIEN VANAF VRAAG 10.2.2.

Marking criteria:	***Nasienkriteria:***
a) Substitute 1,6 x 10^{-19} C in n = $\frac{Q}{e}$ ✓ b) N(Cr) = n(electrons) divide by 3 ✓ c) n(Cr) = N(Cr) divided by N_A ✓ d) Substitution of 52 into n = $\frac{m}{M}$ ✓ e) m(Cr) + 2,2 ✓ f) Final answer: 18,32 (g) ✓ Range: *18,32 to 18,40* (g)	a) *Vervang 1,6 x 10^{-19} C in n = $\frac{Q}{e}$* ✓ b) *N(Cr) = n(elektrone) gedeel deur 3* ✓ c) *n(Cr) = N(Cr) gedeel deur N_A* ✓ d) *Vervang 52 in n = $\frac{m}{M}$* ✓ e) *m(Cr) + 2,2* ✓ f) *Finale antwoord: 18,32 (g)* ✓ *Gebied: 18,32 tot 18,40 (g)*
OPTION 1/*OPSIE 1* n = $\frac{Q}{e}$ / $\frac{Q}{q_e}$ = $\frac{9 \times 10^4}{1,6 \times 10^{-19}}$ ✓**(a)** = 5,63 x 10^{23} electrons N(Cr atoms) = $\frac{5,63 \times 10^{23}}{3}$ ✓**(b)** = 1,88 x 10^{23} n(Cr) = $\frac{N}{N_A}$ = $\frac{1,88 \times 10^{23}}{6,02 \times 10^{23}}$ ✓**(c)** = 0,31 mol n(Cr) = $\frac{m}{M}$ m(Cr) = 0,31 x 52 ✓**(d)** = 16,12 g m(X) = 16,12 + 2,2 ✓**(e)** = 18,32 (g) ✓**(f)**	**OPTION 2/*OPSIE 2*** n(Cr) = $\frac{9 \times 10^4}{3 \times 96\,500}$ ✓✓**(a & c)** ✓**(b)** = 0,31 mol m(Cr) = 0,31 x 52 ✓**(d)** = 16,12 g m(X) = 16,12 + 2,2 ✓**(e)** = 18,32 (g) ✓**(f)**

(6)
[13]